THE NEW PRIORITY CLASSIFICATION SYSTEMS FOR SLOPES AND RETAINING WALLS

GEO REPORT No. 68

C.K.L. Wong

GEOTECHNICAL ENGINEERING OFFICE
CIVIL ENGINEERING DEPARTMENT
THE GOVERNMENT OF THE HONG KONG
SPECIAL ADMINISTRATIVE REGION

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Prepared by:

Geotechnical Engineering Office,
Civil Engineering Department,
Civil Engineering Building,
101 Princess Margaret Road,
Homantin, Kowloon,
Hong Kong.

PREFACE

In keeping with our policy of releasing information, we make available some of our internal reports in a series of publications termed the GEO Report series. The reports in this series, of which this is one, are selected from a wide range of reports produced by the staff of the Office and our consultants. A charge is made to cover the cost of printing.

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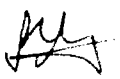
R.K.S. Chan
Principal Government Geotechnical Engineer
July 1998

FOREWORD

This report documents the New Priority Classification Systems (NPCSs) for slopes and retaining walls. The NPCSs for soil cut slopes, rock cut slopes and retaining walls were jointly developed by Messrs K.K.S. Ho and H.N. Wong of the Special Projects Division with contribution from Golder Associates on the NPCS for rock cut slopes. The NPCS for fill slopes was jointly developed by Mr H.N. Wong and Miss C.K.L. Wong. Other Divisions of the GEO provided valuable assistance and comments during the development of the NPCSs.

This report was compiled by Miss C.K.L. Wong under the supervision of Mr W.K. Pun. CGE/D, CGE/LI and CGE/SS reviewed a draft of this report and provided useful comments. All contributions are gratefully acknowledged.



P.L.R. Pang
Chief Geotechnical Engineer/Special Projects

ABSTRACT

This report documents the New Priority Classification Systems (NPCSs) for slopes and retaining walls developed as part of the GEO Slope Information System. Since different types of slope features are affected by different factors to different degrees, separate priority classification systems have been developed for soil cut slopes, rock cut slopes, fill slopes and retaining walls.

Under each system, a Total Score is calculated for each feature, reflecting the relative risk of landslide involving the feature. The Total Score is obtained from the multiplication of an Instability Score and a Consequence Score. The Instability Score is calculated based on an assessment of a number of key parameters that affect the likelihood of failure. The Consequence Score reflects the likely consequence of failure. The higher the Total Score, the higher is the priority for follow-up action on the feature generally.

Details of the scoring scheme and guidance notes for data collection and score calculation for the NPCSs, together with worked examples, are given in this report.

CONTENTS

1. INTRODUCTION

This report documents the new priority classification systems (NPCSs) primarily developed for pre-GCO man-made slopes and retaining walls (collectively referred to as "features" in this report).

The GEO uses the NPCSs for prioritizing follow-up Landslip Preventive Measures action on features in the New Slope Catalogue. The NPCSs may also be used by slope owners, including Government Departments, public organisations and private owners, to decide on actions (e.g. preventive maintenance or upgrading) required on their slopes to minimise risk to life and economic loss due to landslides.

This report presents and gives guidance on the use of each system. Worked examples are provided as part of the guidance notes.

2. GENERAL GUIDANCE

2.1 The New Priority Classification Systems

Since different types of feature are affected by different factors to differing degrees, separate priority classification systems have been developed for soil cut slopes, rock cut slopes, fill slopes and retaining walls.

Under each system, a Total Score is calculated for each feature, reflecting the relative risk of landslide involving the feature. The Total Score is obtained from the multiplication of an Instability Score and a Consequence Score. The Instability Score is calculated based on an assessment of a number of key parameters that affect the likelihood of failure. The Consequence Score reflects the likely consequence of failure. The higher the Total Score, the higher is the priority for follow-up action on the feature generally.

In putting together the factors for assessment of the Consequence Score of a feature, only the direct consequence-to-life in the event of failure was considered. Features which could pose an indirect consequence-to-life should failure occur, e.g. slopes affecting catchwaters or cul-de-sacs, may not have scores reflecting their actual consequence.

For combined features, the criteria for selection of the appropriate system for priority classification are as shown in Figures 1 and 2. Data collection and score calculation may have to be carried out based on more than one system for some features.

2.2 Grouping of Facilities for Consequence Assessment

In determining the Consequence Score for each feature, the facilities affected are classified in accordance with the guidelines given in Table 1 and Figure 3.

2.3 Selection of Cross Sections of Features for Priority Classification

The principles adopted for selection of cross sections of features for assessing scores are given in the following paragraphs.

The geometry at the *worst-consequence section* (as determined in accordance with the guidance below) is considered in assessing the IS, which is taken as the IS for the feature. If the feature height at the worst-consequence section is less than 75% of the maximum feature height, then the IS corresponding to the maximum-height section is also assessed and a warning message is flagged up.

A maximum of two sections is considered in assessing the CS of a feature. The principles below are followed in selecting the sections for consequence assessment :

(a) The group number of an affected facility above the crest of a feature is downgraded by one category when compared with affected facilities below the toe of the slope.

(b) If the affected facility groups at different sections differ by more than one category, only the section corresponding to the worst affected facility is considered in assessing the CS.

(c) If the affected facility groups at different sections do not differ by more than one category, the sections corresponding to the two worst affected facilities are considered in assessing the CS.

(d) If application of the above principles results in more than two sections to be considered, the two sections required for assessing the CS are selected based on the following criteria, according to the order as listed below :

  (i) The section with the worst combination (in terms of facility grouping) of crest and toe facilities (note that crest facility group number should be downgraded by one category) is selected. For fill slopes, the combination with the nearest two affected crest facilities and the nearest two affected toe facilities are considered (see Appendix C).

  (ii) The section with the greatest feature height is selected.

  (iii) The section with the smallest distance between the toe/crest of the feature and the toe/crest facility. (i.e. items F2 and G2 of the NPCS for cut slopes) is selected.

In the very rare circumstance where there are still more than two sections to be considered after applying the above guidelines, the two sections selected for consequence

assessment are based on professional judgement.

2.4 Features Requiring Immediate Action

Where there are significant signs of distress, or visual or documented evidence of continuing hazardous movement, of a slope or retaining wall feature, or a boulder or rock fragment, immediate action is recommended to be taken to remove or reduce the risk.

3. NPCS FOR SOIL CUT SLOPES

3.1 The System

The system is in the form of a scoring scheme. Details of the scoring scheme and guidance notes for data collection and score calculation are given in Appendix A. The rationale and background considerations in the development of the system have been reported by Wong & Ho (1995).

3.2 Instability Score

The Instability Score is calculated based on the subjective engineering judgement made in a preliminary study on the likelihood of preventive measures being necessary, combined with an objective assessment of a number of key parameters that affect the likelihood of failure. The factors considered and the range of individual scores that may be assigned are summarised below :

Factor	Range of Score
Slope Geometry	0 - 60
Signs of Distress	0 - 40
Evidence of Past Instability	0 - 40
Potential for Water Ingress	0 - 60
Nature of Slope-forming Material	0 - 40
Engineering Judgement	0 - 60

3.3 Consequence Score

The Consequence Score reflects the likely consequence of failure. The factors considered and the range of a combined score that may be assigned are summarised below :

Factor		Range of Score
Type and Proximity of Crest Facility	)	
Type and Proximity of Toe Facility	)	0 - 450
Upslope and Downslope Topography	)	
Likely Scale of Failure	)	
Consequence Factor	)	

4. NPCS FOR ROCK CUT SLOPES

4.1 The System

The system for rock cut slopes is similar, in terms of its rationale and structure, to the soil cut slope system. It is also in the form of a scoring scheme which reflects the risk to life posed by a rock slope based on consideration of the likelihood and consequence of failure. The system was developed by Golder Associates (1996). Details of the scoring scheme and guidance notes for data collection and score calculation are given in Appendix B.

4.2 Instability Score

The Instability Score reflects the likelihood of failure. The factors considered and the range of individual scores that may be assigned are summarised below :

Factor	Range of Score
Slope Geometry	10 - 80
Mode of Slope Failure	0.5 - 5
Rock Mass Condition	0 - 110
Potential for Water Ingress	0 - 30
Evidence of Distress or Past Instability	0 - 70
Engineering Judgement	0 - 30

4.3 Consequence Score

The Consequence Score reflects the likely consequence of failure. The factors considered and the range of a combined score that may be assigned are summarised below :

Factor		Range of Score
Type and Proximity of Crest Facility	)	
Type and Proximity of Toe Facility	)	
Upslope and Downslope Topography	)	0 - 450
Likely Scale of Failure	)	
Vulnerability (Consequence Factor)	)	

5. NPCS FOR FILL SLOPES

5.1 The System

The system for fill slopes is in the form of a scoring system which reflects the risk to life posed by a fill slope based on a consideration of the likelihood and consequence of failure.

Three possible mechanisms of fill slope failure are considered :

(a) sliding and minor wash-out : common slope failures which do not involve the build-up of excess pore water pressure and influence from a large amount of external water. The debris slides downslope and may involve disintegration of the soil mass, particle collision and minor erosion and wash-out action,

(b) liquefaction : mobile failure involving generation of high positive excess pore water pressures during shearing and hence a substantial reduction of the effective stress and the shearing resistance (e.g. the 1972 and 1976 Sau Mau Ping landslides), and

(c) major wash-out : mobile failure involving concentrated discharge of water (e.g. surface runoff from a road) resulting in scouring and erosion of the slope and the washing of debris downslope (e.g. the 1992 Baguio landslide).

Details of the scoring system and guidance notes for data collection and score calculation are given in Appendix C.

5.2 Instability Score

The Instability Score reflecting the likelihood of sliding and minor wash-out failure (i.e. IS_1) is based on the product of the scores of the following three groups of factors, each with equal weighting :

Factor	Range of Score
Geometry	1 - 32
Potential for Water Ingress	1 - 32
Past Instability and Signs of Distress	1 - 32

The Instability Score reflecting the likelihood of liquefaction failure (i.e. IS_2) is based on the Instability Score for sliding and minor wash-out adjusted by the following factors :

Adjustment Factor	Range of Adjustment Factor
Slope Height	0.5 - 4
Type of Surface Cover	0.25 - 1.1

The above adjustment factors have been chosen from a consideration of the factors affecting the likelihood of loose fill liquefaction and the scores have been determined from a global calibration based on the available landslide data.

The Instability Score reflecting the likelihood of major wash-out failure (i.e. IS_3) is based on the following factors :

Factor	Range of Score
Likelihood of Sliding and Minor Wash-out	1 - 32
Catchment Characteristics	0.5 - 32
Potential for the Development of Major Wash-out	0.00125 - 32

5.3 Consequence Score

The Consequence Score reflects the potential for loss of life in the event of failure. As the consequence of landslide depends on the failure mechanism, three Consequence Scores, viz. CS_1, CS_2 and CS_3 for the failure mechanisms corresponding to IS_1, IS_2 and IS_3 respectively, are calculated for each feature. A rational consequence model is adopted in the Consequence Score calculation, which involves consideration of the following factors :

(a) the potential for loss of life (L) in the case of direct impact by a 'standard' failure (i.e. a 10 m wide failure of 50 m^3 in volume),

(b) the likely scale of failure, which is related to the height (H) of the fill feature, and

(c) the degree of damage (V), which is based on the likely debris mobility for the corresponding landslide mechanism, the proximity of the facility to the fill feature, resistance of the facility to debris impact and ground deformation, and the likely volume of failure.

6. NPCS FOR RETAINING WALLS

6.1 The System

The system for retaining walls comprises a scoring scheme for the two key components, namely the Instability Score and the Consequence Score. Details of the scoring scheme and guidance notes for data collection and score calculation are given in Appendix D.

6.2 Instability Score

The Instability Score reflects the likelihood of wall failure. The factors considered and the range of individual scores that may be assigned are as follows :

Factor	Range of Score
Wall Slenderness Ratio and Nature of Retained Material	0 - 100
Wall Condition	0 - 100
Potential for Water Ingress	0 - 60
Type of Wall	0 - 30
Past Instability	0 - 30
Gradient of Natural Terrain below the Wall	0 - 60

6.3 Consequence Score

The Consequence Score reflects the likely consequence of failure. The relevant details are summarised below :

Factor	Range of Score
Type and Proximity of Crest Facility) Type and Proximity of Toe Facility) Upslope and Downslope Gradient)	0 - 600

7. SAMPLE FORMS

The following types of sample forms are given in Appendix E :

(a) SIFT (Systematic Inspection of Features in the Territory) Report - The SIFT Reports contain possible sources of data for the NPCS for fill slopes. Copies are available in the Civil Engineering Library.

(b) SIRST (Systematic Identification and Registration of Slopes in the Territory) Forms - These forms were developed by GEO's SIRST consultants for their use in the data collection for the NPCS. These may be taken as reference for the development of data collection forms by other users. Copies of the SIRST consultants' completed forms, which contain data valid as at the date of data collection, are held by the Slope Safety Division of the GEO.

8. REFERENCES

Golder Associates (1996). New Priority Classification System for Rock Cut Slopes. Report prepared by Golder Associates for the Hong Kong Government under Consultancy Agreement No. GEO 2/96, 15 p.

Wong, H.N. & Ho, K.K.S (1995). New priority classification system for soil cut slopes. Geotechnical Engineering Office Special Project Report No. SPR 6/95, 57 p.

LIST OF TABLES

Table 1 - Grouping of Facilities

	Facilities	Potential Loss of Life, L[1]
Group 1	(a) Buildings - any residential building, commercial office, store and shop, hotel, factory, school, power station, ambulance depot, market, hospital/polyclinic/clinic, welfare centre	3
	(b) Others - bus shelter, railway platform and other sheltered public waiting area - cottage, licensed and squatter area - dangerous goods storage site (e.g. petrol station) - road with very heavy vehicular or pedestrian traffic density	3
Group 2	(a) Buildings - built-up area (e.g. indoor car park, building within barracks, abattoir, incinerator, indoor games' sport hall, sewage treatment plant, refuse transfer station, church, temple, monastery, civic centre, manned substation)	2
	(b) Others - road with heavy vehicular or pedestrian traffic density - major infrastructure facility (e.g. railway, tramway, flyover, subway, tunnel portal, service reservoir) - construction sites (if future use not certain)[2]	1
Group 3	- densely-used open space and public waiting area (e.g. densely used playground, open car park, densely-used sitting out area, horticulture garden) - quarry - road with moderate vehicular or pedestrian traffic density	0.25
Group 4	- lightly-used open-aired recreation area (e.g. district open space, lightly-used playground, cemetery, columbarium) - non-dangerous goods storage site - road with low vehicular or pedestrian traffic density	0.03
Group 5	- remote area (e.g. country park, undeveloped green belt, abandoned quarry) - road with very low vehicular or pedestrian traffic density	0.001

Notes :

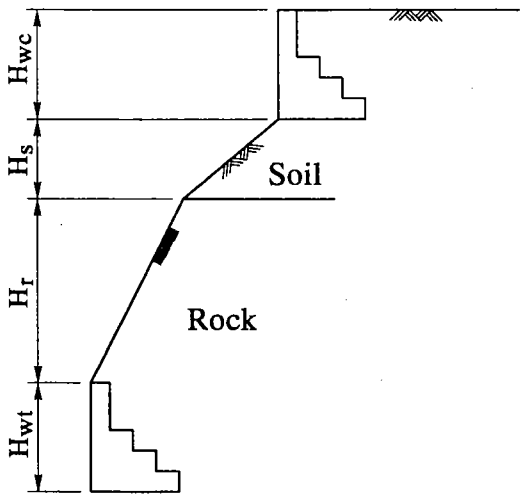
(1) L is the potential loss of life due to landslide. The values given in this Table should be used for the purpose of calculating scores in the NPCSs only.

(2) If the intended future use is known, the Facility Group should be based on the facility which corresponds to the intended future use of the site.

(3) For roads, the Facility Group should be based on Figure 3 taking into account the actual Annual Average Daily Traffic and the number of road lanes. For footpaths alongside roads, it may be assumed that footpaths are within the same group as the adjoining roads, except for Expressway (EX), Urban Trunk Roads (UT) and Rural Trunk Road (RT). Footpaths alongside EX, UT and RT roads may be taken, by default, as a Group 5 facility, unless dictated otherwise by site-specific conditions.

LIST OF FIGURES

(1) General



Get TS_{wall} if $H_{wc} \geqslant 3$ m

Get $TS_{soil\ cut}$ if $H_s \geqslant 3$ m

Get $TS_{rock\ cut}$ if $H_r \geqslant 3$ m

Get TS_{wall} if $H_{wt} \geqslant 3$ m

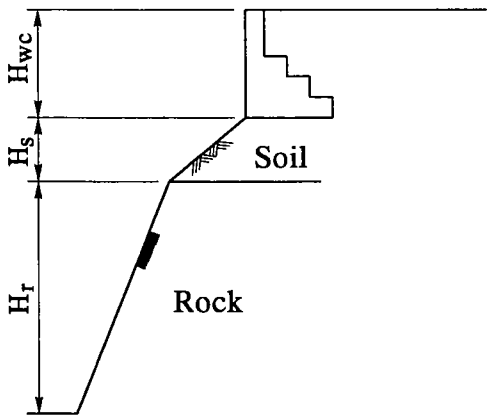
(2) Special Cases

(a) If H_{wc} & H_s & H_r & $H_{wt} < 3$ m, and if $H_{wc} + H_s \geqslant 3$ m,

then get $TS_{soil\ cut}$ if $H_s \geqslant H_{wc}$,

or get TS_{wall} if $H_{wc} > H_s$.

(b)



For $Hr \geqslant 3$ m :

If $H_{wc} < 3$ m and $H_s \geqslant 1.5$ m,
or $H_s \geqslant 1.0$ and $H_{wc} \geqslant 1.0$,

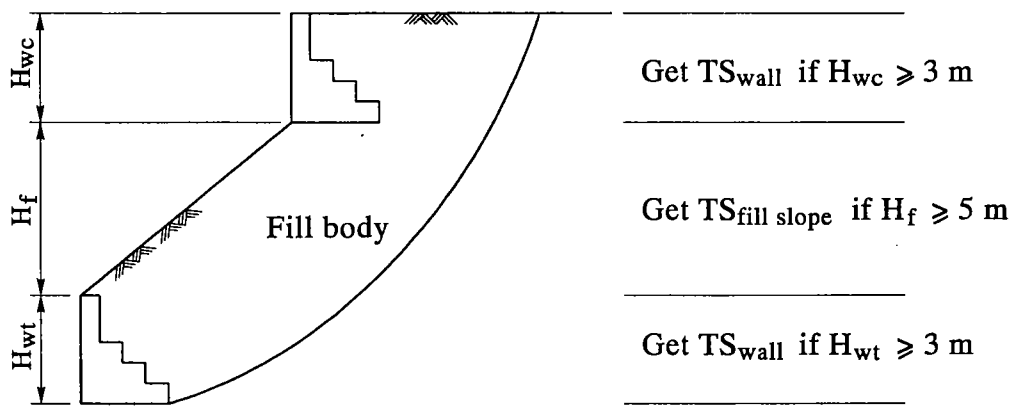
then get $TS_{soil\ cut}$ as well.

Legend :

$TS_{soil\ cut}$	Total Score calculated from NPCS for soil cut slopes
$TS_{rock\ cut}$	Total Score calculated from NPCS for rock cut slopes
TS_{wall}	Total Score calculated from NPCS for retaining walls

Figure 1 - Selection of Systems for Combined Soil Cut, Rock Cut and Retaining Wall Features

(1) General



(2) Special Cases

If H_{wc} & $H_{wt} < 3$ m and $H_f < 5$ m , and if $H_f + H_{wc} \geqslant 5$ m,

then get $TS_{fill\ slope}$ if $H_f \geqslant H_{wc}$,

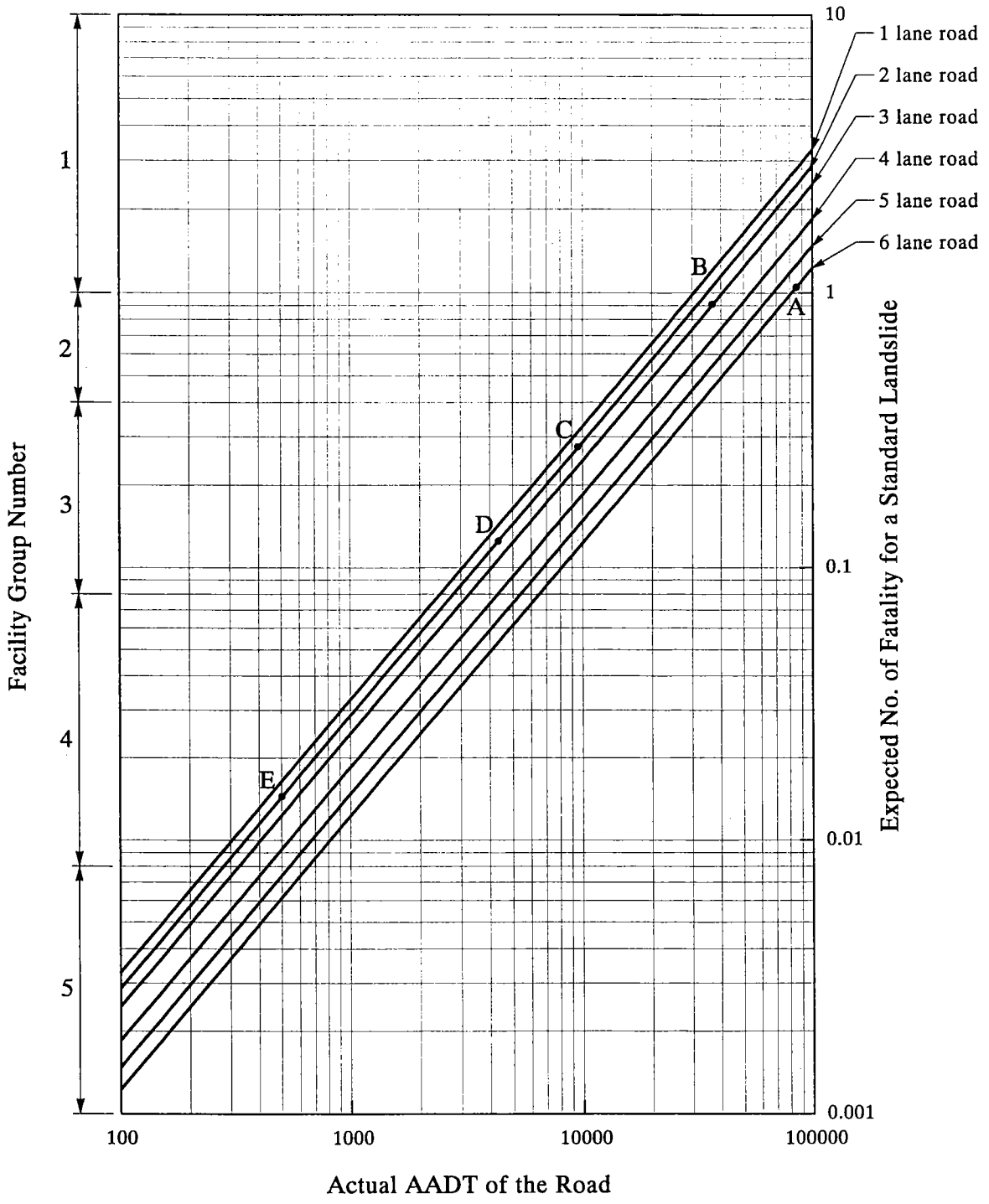
or get TS_{wall} if $H_{wc} > H_f$.

(Same principle applies for H_{wt})

Legend :

$TS_{fill\ slope}$	Total Score calculated from NPCS for fill slopes
TS_{wall}	Total Score calculated from NPCS for retaining walls

Figure 2 - Selection of Systems for Combined Fill Slope and Retaining Wall Features



Legend :

AADT	Annual Average Daily Traffic
A	Princess Margaret Road (from Wylie Road to Pui Ching Road)
B	Pokfulam Road (from Pokfield Road to Mount Davies Road)
C	Castle Peak Road (from Sham Tseng to Siu Lam)
D	Borrett Road
E	Shouson Hill Road West

Figure 3 - Relationship between Facility Group Number, Actual AADT and Number of Lanes

APPENDIX A

SCORING SCHEME AND GUIDANCE NOTES ON NPCS FOR SOIL CUT SLOPES

CONTENTS

A.1 NEW PRIORITY CLASSIFICATION SYSTEM SCORING SCHEME FOR SOIL CUT SLOPES

Slope No. _____ **Section** : ○ 1-1 (Most Severe Consequence)
○ 2-2 (Maximum Feature Height)

(A) GEOMETRY (Figure A1)

		1-1	2-2
(i)	H_s	m	m
(ii)	H_r	m	m
(iii)	H_{cw}	m	m
(iv)	H_{tw}	m	m
(v)	β	°	°
(vi)	θ	°	°
(vii)	α	°	°
(viii)	Toe of realistic slip surface within Hs portion	Yes/ No*	Yes/ No*

· Feature Height, H
$= H_s + H_r + H_{cw} + H_{tw}$ m

· $H_w = H_{cw} + H_{tw}$ m

· $H_c = H_s + H_r$ m

· $H_o = H_s + H_{cw}$ m
(see Figure A2)

· $H_e = H_o (1 + 0.35 \tan \beta) + \frac{s}{\gamma_b}$
m

· Geometry Classification (Figure A2)
S1/S2/S3/S4*

Feature Type

For S1 A =60
S2 40
S3 20
S4 0

A

(B) EVIDENCE OF INSTABILITY

(B1) Signs of Distress

(i) Severe signs of distress, e.g. large tension cracks behind crest, distortion of channels and berms, severe cracking or bulging ○
(ii) Minor signs of distress, e.g. cracked chunam, damaged channels ○
(iii) Reasonable condition (including minor random cracks on surface cover) ○

For (i) B1 =40
(ii) 20
(iii) 0

B1

(B2) Past Instability

Confirmed Past Instability	B21	Inferred Past Instability	B22
○ Major	40	○ Major	30
○ Multiple Minor	20	○ Multiple Minor	15
○ Minor	10	○ Minor	5
○ None	0	○ None	0

B2 = B21 or B22, whichever is the greater

B2

(C) POTENTIAL FOR WATER INGRESS

(C1) Water Ingress through Surface

(i) Soil slope and crest area substantially unprotected ○
(ii) Either soil slope or crest area substantially unprotected ○
(iii) Either soil slope or crest area or both are partially protected but none of them substantially unprotected ○
(iv) Soil slope and crest area substantially protected ○

For (i) C1 =15
(ii) 10
(iii) 5
(iv) 0

C1

* delete where appropriate

(C2) Drainage Provisions for Surface Water		For (i) C2 = 15 (ii) 10 (iii) 5 (iv) 0
(i) Few or no channels + potential for convergent flow of surface water above crest	○	
(ii) Few or no channels	○	
(iii) Some channels but insufficient in size or number	○	
(iv) Adequate channels	○	C2 [ ]

(C3) Water-carrying Services		For (i) C3 = 15 (ii) 10 (iii) 0
(i) Presence of potentially leaky services and signs of leakage noted	○	
(ii) Presence of potentially leaky services but no signs of leakage noted	○	C3 [ ]
(iii) No potentially leaky services	○	

(C4) Seepage		For (i) C4 = 15 (ii) 10 (iii) 5 (iv) 0
(i) Heavy seepage at mid-height of H_o or above	○	
(ii) Slight to moderate seepage at mid-height of H_o or above, or heavy seepage below mid-height of H_o	○	
(iii) Slight to moderate seepage below mid-height of H_o, or signs of seepage at soil slope or crest wall	○	C4 [ ]
(iv) No signs of seepage	○	

(D) NATURE OF SLOPE-FORMING MATERIAL

Slope-forming Material (Soil Slope)		Weighting Factor, W_i	Material	Score, D_i
(i) Good	- saprolite derived from granitic and volcanic rocks, mainly composed of Grade IV material	[ ]	Good	0
(ii) Uncertain-A	- not certain but expected to be between Good and Moderate material	[ ]	Uncertain-A	10
			Moderate	20
(iii) Moderate	- saprolite derived from granitic and volcanic rocks, mainly composed of Grade V material; saprolite of any grade of decomposition derived from rocks other than granite and volcanics; Pleistocene colluvium (Qpd on geological map)	[ ]	Uncertain-B	30
			Poor	40
(iv) Uncertain-B	- not certain but expected to be between Moderate and Poor Material; not certain and can be any material.	[ ]	$D = \Sigma(D_i)(W_i) / \Sigma(W_i)$	
(v) Poor	- residual soil; all transported soils except Pleistocene colluvium	[ ]	D [ ]	
Lithology		Typical Granite or Volcanics / Atypical Granite or Volcanics / Other*		
Adverse Geological Features		Yes/No*		

(E) ENGINEERING JUDGEMENT

Engineering judgement on the likelihood of preventive measures being necessary :		For (i) E = 60 (ii) 30 (iii) 0
(i) Highly Probable (HP)	○	
(ii) Probable (P)	○	
(iii) Unlikely (U)	○	E [ ]

* delete where appropriate

(F) FACILITIES ABOVE CREST OF FEATURE

Type of crest facility (For roads and footpaths, give also the name)

Group No.

Distance from crest of feature to the facility, F2

m

Group		F1 =
	1	4
	2	2
	3	1
	4	0.5
	5	0.1

F1

F2

(G) FACILITY BELOW CREST OF FEATURE

Type of toe facility (for roads and footpaths, give also the name)

Group No.

Distance from the toe of the feature to the facility, G2 (for facility on the feature, G2 = 0)

m

Group		G1 =
	1	4
	2	2
	3	1
	4	0.5
	5	0.1

G1

G2

(J) UPSLOPE AND DOWNSLOPE TOPOGRAPHY

(i)	Upslope angle β above crest $< 35°$ & downslope angle α below toe $< 15°$	○
(ii)	Upslope angle β above crest $\geq 35°$	○
(iii)	Downslope angle α below toe : $15° \leq \alpha < 30°$	○
(iv)	Downslope angle α below toe $\geq 30°$	○
(v)	Conditions (ii) & (iii)	○
(vi)	Conditions (ii) & (iv)	○

For		J =
	(i)	0
	(ii)	0.3
	(iii)	0.6
	(iv)	1.2
	(v)	0.9
	(vi)	1.5

J

(K) CONSEQUENCE FACTOR

Priority Group No. from Stage 1 Study (if available)

Consequence-to-life category

(i)	"1"	○
(ii)	"2"	○
(iii)	"3"	○

Consequence factor is used if a large number of fatalities, say more than 10, will result from the landslip. The following conditions are typical for such situation :

(a)	the Consequence-to-life Category of the feature is "1" or "2",	○
(b)	large volume of failure is expected, and	○
(c)	occupied buildings may collapse or be covered in the event of landslip, or mass transportation is seriously affected.	○

If large number of casualty will result in the event of a failure (e.g. conditions (a), (b) & (c) apply), K = 1.25
Otherwise, K = 1.0

K

CALCULATED SCORES AND WARNING MESSAGES

REVISED INSTABILITY SCORE (I.S.)

I.S. = A + B1 + B2 + C1 + C2 + C3 + C4 + D + E

I.S.	

REVISED CONSEQUENCE SCORE (C.S.)

C.S. = K (F + GJ) V

C.S.	

where :

$$F = F_1 \left[\frac{H_o - F_2}{H_o} \right] \not< 0$$

$$GJ = 2G_1 \left[\frac{(1.5+J)H - G_2}{(1.5+J)H} \right] \not< 0$$

$$V = \gamma H_o$$

Notes: (1) γ = 1.0 for full-scale failure
= 0.7 for partial failure
= 0.4 for minor failure

(2) If $H_o > 30$ m, take $H_o = 30$ m in calculating V

REVISED TOTAL SCORE (T.S.)

T.S. = (I.S.) (C.S.) / 100

T.S.	

WARNING MESSAGES

W1 = Warning, if H of Section 1-1 < 75% of H of Section 2-2.

W1	

W2 = Warning, if Item (A)(viii) is "No".

W2	

W3 = Warning, if $H_{cw} > H_s/3$.

W3	

W4 = Warning, if E = 0 and (A + B1 + B2 + C1 + C2 + C3 + C4 + D) ≥ 90, or if E = 60 and (A + B1 + B2 + C1 + C2 + C3 + C4 + D) ≤ 60.

W4	

W5 = Warning, if C.S. ≤ 20 and Priority Group = 1 or 2, or if C.S. ≤ 20 and Consequence-to-life Category = "1".

W5	

W6 = Warning, if slope reinforcement is present.

W6	

W7 = Warning, if feature is "post-GCO".

W7	

W8 = Warning, if lithology is not "Typical Granite or Volcanics" or adverse geological features are observed

W8	

SECTION SKETCH	
COMMENTS	
Date of Inspection :	**By :**

A.2 GUIDANCE NOTES ON DATA COLLECTION AND SCORE CALCULATION

General

(1) If H of Section 1-1 $\geq$ 75% of H of Section 2-2, consider Section 1-1 (i.e. in terms of most severe consequence)in calculating the scores. Otherwise, both Sections 1-1 and 2-2 (in terms of maximum feature height, H) should be considered.

(2) ○ & □ for raw data to be collected. For ○, tick as appropriate. For □, fill in the appropriate data. For *, delete as appropriate. □ for parameters and scores processed from raw data.

(3) Geometric parameters of the feature (i.e. H_s, H_r, H_{cw}, H_{tw}, β, θ & α) may be obtained by technical staff based on survey plans and simple site measurements. Other parameters should be collected by experienced professional staff.

(4) Unless stated otherwise, "distance" refers to horizontal distance and "height" refers to vertical height.

ITEM A

(5) This involves the combined consideration of the effective height and average slope gradient, as defined in Figures A1 and A2. The definition of effective height takes into account the equivalent surcharging effect due to the uphill slope and applied vertical loading. The delineation of the various zones, namely S1 to S4, is largely based on the collective experience of the GEO and that of the practitioners in Hong Kong.

(6) Definitions of geometric parameters are given in Figure A1. H_o is the difference in elevation between the crest of the feature and the lowest daylighting point of realistic slip surfaces. In the case where the lowest daylighting point is at the toe of the soil portion of the slope, Item (viii) should be recorded as "Yes" and H_o calculated as $H_s + H_{cw}$. Where Item (viii) is judged to be "No", H_o should be taken to include the portion of the rock slope where a realistic failure surface can daylight.

(7) Geometry Classification is shown in Figure A2.

(8) Surcharge at slope crest may be converted to an equivalent thickness of soil.

ITEM B

(9) Signs of distress - This parameter is concerned with observed signs of distress. It should be noted that the rating does not cover cases with very significant signs of distress and continuous movement where it may be deemed to pose immediate and obvious danger. In such instances, appropriate prompt action, such as emergency repair works, should be taken.

ITEM B1

(10) Where there are significant signs of distress, or visual or documented evidence of continuing hazardous movement of a slope, excavation, retaining structure, boulder or rock fragment, immediate action should be taken.

(11) Judgement should be made in assessing whether cracked chunam, damaged channels, etc. are due to inadequate maintenance. If these are due to inadequate maintenance, they should not be regarded as signs of distress. In case of doubt, a conservative assessment should be made.

ITEM B2

(12) Evidence of past instability - A distinction is made between confirmed past instability with documented information relating to the failure (e.g. cause of failure, and scale and nature of remedial works, etc), and past instability inferred during field inspections or other available information. More credence is given to 'confirmed past instability', which is assigned a higher score than 'inferred past instability'. Also, the scale, mode (Figure A3) and recurrence of past instability is taken into consideration in the assessment. Assessment of evidence of past instability shall be based on :

(a) the available Incident Reports and Landslip Cards,
(b) B&P fieldsheets,
(c) 1:5000 GAS Reports, and
(d) site observations.

(13) "None" refers to no past instability. "Minor" and "Major" refer to minor and major past instability respectively. "Multiple minor" refers to more than one 'minor' past instabilities. Past instabilities at similar features in the immediate vicinity should be considered in the assessment.

(14) "Confirmed past instability" refers to past instability with confirmed documentary evidence of its occurrence.

(15) 'Inferred past instability' refers to past instability which is not confirmed but inferred from site observations or other available information.

(16) 'Major' past instability refers to past instability where :

(a) failure volume $\geq$ 50 m^3 (unbulked), or
(b) failure volume $\geq$ 25 m^3 (unbulked) and involving a major portion of the upslope area as indicated in Figure A3.

Otherwise, the past instability may be taken as 'minor'.

ITEM C

(17) Potential for water ingress - The assessment is intended to give attention to all the major flowpaths in respect of water ingress. Due consideration is given to infiltration through

the slope surface or the crest area, adequacy of the surface drainage provisions, effect of potentially leaky water-carrying services and evidence of seepage through the slope face. The possibility of ponding and convergent surface water flow are also considered in the assessment. Consideration should also be given to the overall setting of the slope features, e.g. whether the cut slope is at the head of a valley, along the side of a valley or across the nose of a spur, etc.

ITEM C1

(18) As a general guideline, 'substantially protected' refers to > 75% area covered, 'partially protected' refers to between 25% and 75% area protected and 'substantially unprotected' refers to < 25% area covered.

(19) Crest area refers to the area within a horizontal distance of $H_o/2$ beyond the crest of the feature.

(20) Where there is potential for ponding above the slope crest, the higher score for the next higher category should be adopted.

ITEM C2

(21) In assessing the adequacy of surface drainage provisions, the site topography, catchment area and environmental factors that are liable to give rise to convergent flow of surface water should be considered. In the case of vegetated surfaces, due regard should be given to the type of vegetation cover, e.g. grass, shrubs, trees, etc.

ITEM C3

(22) Assessment shall be based on site inspections.

(23) Any water-carrying services that could potentially affect the slope in the event of leakage, typically water-carrying services within H_o from the crest of the slope, should be considered. However, each case should be treated on its merits in determining the extent necessary for the assessment. If proper ducting provisions have been provided, the services may be taken as not "potentially leaky".

ITEM C4

(24) If the inspection is done in the dry season, a conservative assessment of the seepage condition should be made.

(25) Consideration should also be given to the overall setting of the slope features (e.g. whether the cut slope is at the head of a valley, along the side of a valley or across the nose of a spur), presence of hydrogeological features which might contribute water to the slope (e.g. streamcourse) or evidence of a high water table upslope (e.g. unusually rich vegetation covers).

ITEM D

(26) Nature of slope-forming material - This parameter accounts for the different types of geology based on field inspection and reference to geological maps. In the case of heterogeneous material, a weighted-average approach with respect to the thickness of the respective stratum is adopted. Consideration should also be given to presence of adversely-orientated relict joints.

(27) Assessment shall be based on 1:20 000 geological maps and site inspection of exposures.

(28) "Typical Granite" includes all granite except those occurring between Silvermine Bay and Tai Ho Wan, and between Penny's Bay and Yam O Wan on Lantau Island. "Typical Volcanics" refer to volcanics belonging to the following formations : Ap Lei Chau (JAC), Lai Chi Chong (JLC), High Island (JHI), Clear Water Bay (JCB), Silver Strand (JSS) and Lantau (JLT).

(29) For a slope that consists of different types of material, weighting factors shall be used to calculate Score D. The weighting factors should reflect the relative proportion of different types of slope-forming material, e.g. in terms of the height of the respective stratum at the cut face.

(30) Where adverse geological features, such as adversely-orientated relict joints, intensely weathered or altered seams, dykes etc., are noted, the highest score (i.e. D = 40) should be assigned for the entire soil slope. Where relict joints or weak seams that may result in a weakening of the mass strength are noted, the higher score for the next material group should be assigned. If adverse geological features are observed, the empirical approach to assessing the stability of the slope based on overall slope and material data may not be adequate and detailed investigation may be necessitated.

ITEM E

(31) Engineering judgement - Where available, this represents the engineering judgement made during the Stage 1 Study of the likelihood of preventive measures being necessary. It such information is not available, a geotechnical engineer should be engaged to inspect the slope to make the judgement. It is likely that there is a certain degree of overlapping in the consideration of some of the above key parameters in making the subjective engineering judgement. Nevertheless, such a judgemental assessment constitutes a readily available and invaluable piece of information which complements the objective assessment based on the other key parameters.

ITEMS F and G

(32) The crest and toe facilities shall be grouped as in Table 1.

ITEM K

(33) For consequence-to-life categories, refer to Table 5.2 of the Geotechnical Manual for Slopes and the latest relevant GEO Circulars.

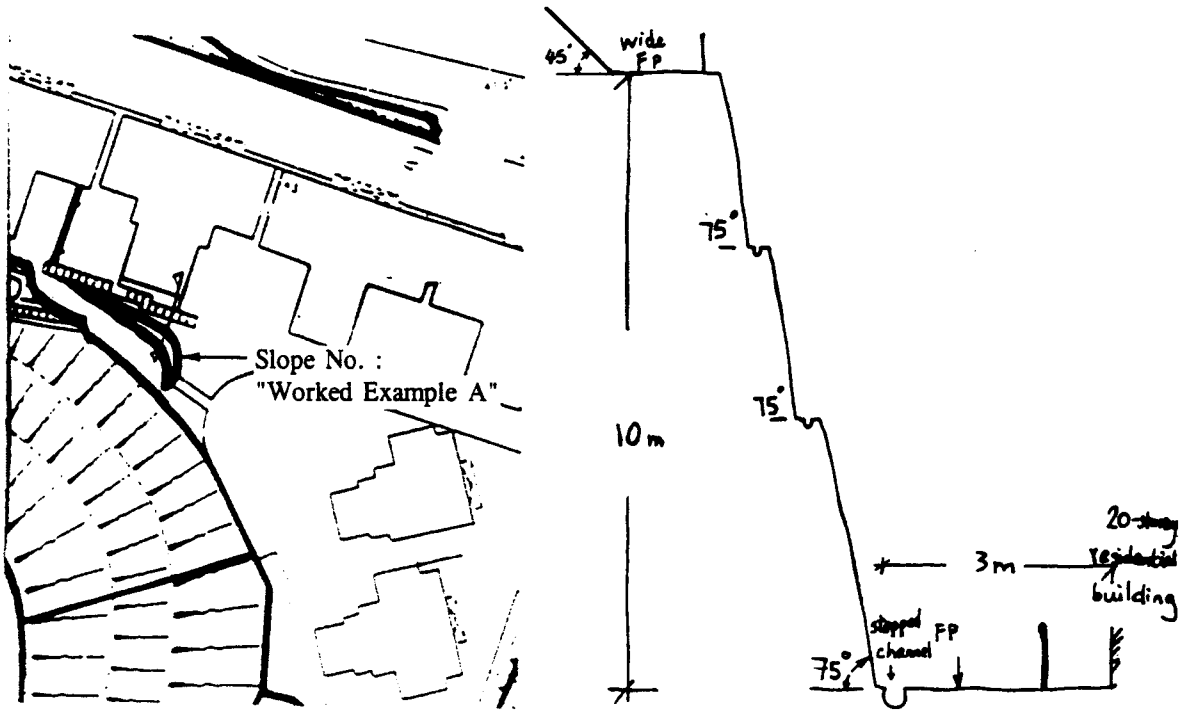
(34) As a general guide, debris volume in excess of 500 m^3 may be taken as a 'large volume of failure'. The Consequence Score will be increased by 25% if it is judged likely that a large number of fatalities will result from a landslide. This accounts for the public aversion to multiple fatalities arising from single event.

(35) γ may generally be taken as 1.0 for soil cut slopes, unless judged otherwise by the engineer.

(36) "Post-GCO" refers to features that were formed or upgraded to the current geotechnical standards after the establishment of GCO in 1977. It also refers to features that have been checked and found to meet current geotechnical standards.

A.3 WORKED EXAMPLE ON NEW PRIORITY CLASSIFICATION SYSTEM FOR SOIL CUT SLOPES

PLAN AND SECTION



NEW PRIORITY CLASSIFICATION SYSTEM SCORING SCHEME FOR SOIL CUT SLOPES

Slope No. "Worked Example A" **Section :** ☑ 1-1 (Most Severe Consequence) ○ 2-2 (Maximum Feature Height)

(A) GEOMETRY (Figure A1)

		1-1	2-2
(i)	H_s	10 m	— m
(ii)	H_r	0 m	— m
(iii)	H_{cw}	0 m	— m
(iv)	H_{tw}	0 m	— m
(v)	β	45°	— °
(vi)	θ	75°	— °
(vii)	α	0°	— °
(viii)	Toe of realistic slip surface within Hs portion	Yes/ ~~No*~~	~~Yes/~~ ~~No*~~

· Feature Height, H

$= H_s + H_r + H_{cw} + H_{tw}$ = 10 m

· $H_w = H_{cw} + H_{tw}$ = 0 m

· $H_c = H_s + H_r$ = 10 m

· $H_o = H_s + H_{cw}$ (see Figure A2) = 10 m

· $H_e = H_o (1 + 0.35 \tan \beta) + \frac{s}{\gamma_b}$ (s = 5 kPa, γ_b = 20 kN/m³) = 13.8 m

· Geometry Classification (Figure A2)

S1/~~S2/S3/S4*~~

Feature Type	Soil & Rock Slope

For S1 A = (60)
S2 40
S3 20
S4 0

A	60

(B) EVIDENCE OF INSTABILITY

(B1) Signs of Distress

(i)	Severe signs of distress, e.g. large tension cracks behind crest, distortion of channels and berms, severe cracking or bulging	○
(ii)	Minor signs of distress, e.g. cracked chunam, damaged channels	○
(iii)	Reasonable condition (including minor random cracks on surface cover)	☑

For (i) B1 = 40
(ii) 20
(iii) (0)

B1	0

(B2) Past Instability

Confirmed Past Instability		B21	Inferred Past Instability		B22
○	Major	40	○	Major	30
○	Multiple Minor	20	○	Multiple Minor	15
○	Minor	10	○	Minor	5
☑	None	0	☑	None	0

B2 = B21 or B22, whichever is the greater

B2	0

(C) POTENTIAL FOR WATER INGRESS

(C1) Water Ingress through Surface

(i)	Soil slope and crest area substantially unprotected	○
(ii)	Either soil slope or crest area substantially unprotected	○
(iii)	Either soil slope or crest area or both are partially protected but none of them substantially unprotected	○
(iv)	Soil slope and crest area substantially protected	☑

For (i) C1 = 15
(ii) 10
(iii) 5
(iv) (0)

C1	0

* delete where appropriate

(C2) Drainage Provisions for Surface Water

(i)	Few or no channels + potential for convergent flow of surface water above crest	○
(ii)	Few or no channels	○
(iii)	Some channels but insufficient in size or number	✓
(iv)	Adequate channels	○

For (i) C2 = 15
(ii) 10
(iii) (5)
(iv) 0

C2	5

(C3) Water-carrying Services

(i)	Presence of potentially leaky services and signs of leakage noted	○
(ii)	Presence of potentially leaky services but no signs of leakage noted	✓
(iii)	No potentially leaky services	○

For (i) C3 = 15
(ii) (10)
(iii) 0

C3	10

(C4) Seepage

(i)	Heavy seepage at mid-height of H_o or above	○
(ii)	Slight to moderate seepage at mid-height of H_o or above, or heavy seepage below mid-height of H_o	○
(iii)	Slight to moderate seepage below mid-height of H_o, or signs of seepage at soil slope or crest wall	○
(iv)	No signs of seepage	✓

For (i) C4 = 15
(ii) 10
(iii) 5
(iv) (0)

C4	0

(D) NATURE OF SLOPE-FORMING MATERIAL

Slope-forming Material (Soil Slope)		Weighting Factor, W_i
(i) Good	- saprolite derived from granitic and volcanic rocks, mainly composed of Grade IV material	0.5
(ii) Uncertain-A	- not certain but expected to be between Good and Moderate material	0.5
(iii) Moderate	- saprolite derived from granitic and volcanic rocks, mainly composed of Grade V material; saprolite of any grade of decomposition derived from rocks other than granite and volcanics; Pleistocene colluvium (Qpd on geological map)	—
(iv) Uncertain-B	- not certain but expected to be between Moderate and Poor Material; not certain and can be any material.	—
(v) Poor	- residual soil; all transported soils except Pleistocene colluvium	—
Lithology		Typical Granite or Volcanics / ~~Atypical Granite or Volcanics / Other~~*
Adverse Geological Features		~~Yes~~/No*

Material	Score, D_i
Good	0
Uncertain-A	10
Moderate	20
Uncertain-B	30
Poor	40

$D = \Sigma(D_i)(W_i) / \Sigma(W_i)$

$= \frac{0 \times 0.5 + 10 \times 0.5}{0.5 + 0.5}$

D	5

(E) ENGINEERING JUDGEMENT

Engineering judgement on the likelihood of preventive measures being necessary :

(i)	Highly Probable (HP)	○
(ii)	Probable (P)	✓
(iii)	Unlikely (U)	○

For (i) E = 60
(ii) (30)
(iii) 0

E	30

* delete where appropriate

(F) FACILITIES ABOVE CREST OF FEATURE

Type of crest facility (For roads and footpaths, give also the name): Footpath

Group No.: 3

Distance from crest of feature to the facility, F2: 0 m

Group 1 F1 = 4
2 2
3 (1)
4 0.5
5 0.1

F1 | 1

F2 | 0

(G) FACILITY BELOW CREST OF FEATURE

Type of toe facility (for roads and footpaths, give also the name): Residential Building

Group No.: 1

Distance from the toe of the feature to the facility, G2 (for facility on the feature, G2 = 0): 3 m

Group 1 G1 = (4)
2 2
3 1
4 0.5
5 0.1

G1 | 4

G2 | 3

(J) UPSLOPE AND DOWNSLOPE TOPOGRAPHY

(i)	Upslope angle β above crest $< 35°$ & downslope angle α below toe $< 15°$	○
(ii)	Upslope angle β above crest $\geq 35°$	⊘
(iii)	Downslope angle α below toe : $15° \leq \alpha < 30°$	○
(iv)	Downslope angle α below toe $\geq 30°$	○
(v)	Conditions (ii) & (iii)	○
(vi)	Conditions (ii) & (iv)	○

For (i) J = 0
(ii) (0.3)
(iii) 0.6
(iv) 1.2
(v) 0.9
(vi) 1.5

J | 0.3

(K) CONSEQUENCE FACTOR

Priority Group No. from Stage 1 Study (if available): N.A.

Consequence-to-life category

(i)	"1"	⊘
(ii)	"2"	○
(iii)	"3"	○

Consequence factor is used if a large number of fatalities, say more than 10, will result from the landslip. The following conditions are typical for such situation :

(a)	the Consequence-to-life Category of the feature is "1" or "2",	⊘
(b)	large volume of failure is expected, and	○
(c)	occupied buildings may collapse or be covered in the event of landslip, or mass transportation is seriously affected.	⊘

If large number of casualty will result in the event of a failure (e.g. conditions (a), (b) & (c) apply), K = 1.25
Otherwise, K = (1.0)

K | 1.0

CALCULATED SCORES AND WARNING MESSAGES

REVISED INSTABILITY SCORE (I.S.)

I.S. = A + B1 + B2 + C1 + C2 + C3 + C4 + D + E
= 60 + 0 + 0 + 0 + 5 + 10 + 0 + 5 + 30

I.S	110

REVISED CONSEQUENCE SCORE (C.S.)

C.S. = K (F + GJ) V
= 1 (1 + 6.67) 10

C.S	76.7

where :

$$F = F_1\left[\frac{H_o - F_2}{H_o}\right] \neq 0, \quad = 1\left[\frac{10-0}{10}\right] = 1$$

$$GJ = 2G_1\left[\frac{(1.5+J)H - G_2}{(1.5+J)H}\right] \neq 0, \quad = 2\,(4)\left[\frac{(1.5+0.3)(10)-3}{(1.5+0.3)(10)}\right] = 6.67$$

$$V = \gamma H_o = 1 \times 10 = 10$$

Notes: (1) γ = 1.0 for full-scale failure
= 0.7 for partial failure
= 0.4 for minor failure

(2) If $H_o > 30$ m, take $H_o = 30$ m in calculating V

REVISED TOTAL SCORE (T.S.)

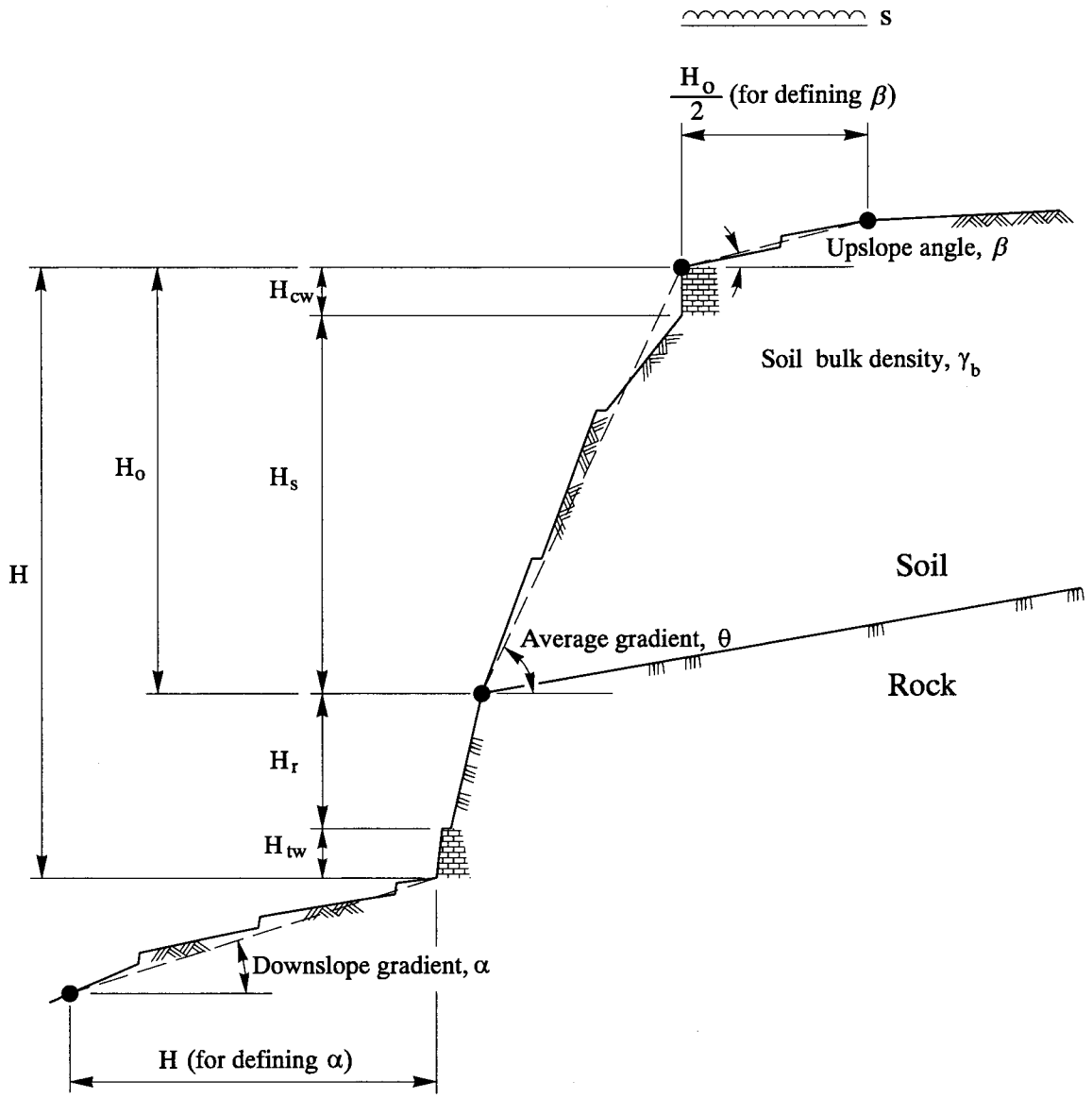
T.S. = (I.S.) (C.S.) / 100

T.S	84

WARNING MESSAGES

W1 = Warning, if H of Section 1-1 < 75% of H of Section 2-2.	W1	–
W2 = Warning, if Item (A)(viii) is "No".	W2	–
W3 = Warning, if $H_{cw} > H_s/3$.	W3	–
W4 = Warning, if E = 0 and (A + B1 + B2 + C1 + C2 + C3 + C4 + D) ≥ 90, or if E = 60 and (A + B1 + B2 + C1 + C2 + C3 + C4 + D) ≤ 60.	W4	–
W5 = Warning, if C.S. ≤ 20 and Priority Group = 1 or 2, or if C.S. ≤ 20 and Consequence-to-life Category = "1".	W5	–
W6 = Warning, if slope reinforcement is present.	W6	–
W7 = Warning, if feature is "post-GCO".	W7	–
W8 = Warning, if lithology is not "Typical Granite or Volcanics" or adverse geological features are observed	W8	–

LIST OF FIGURES



Note : See paragraph (6) of guidance notes on data collection and score calculation.

Figure A1 - Feature Geometry

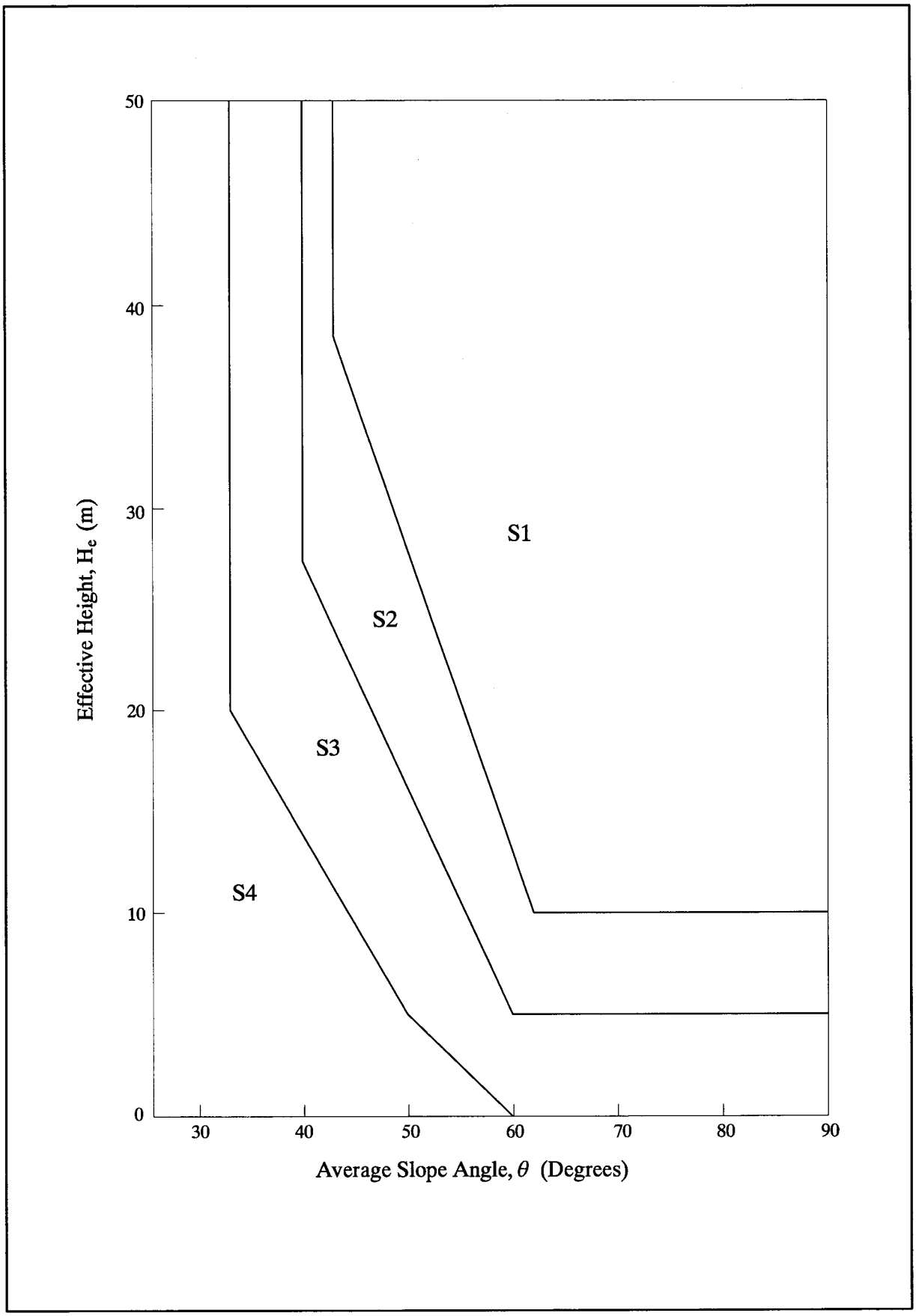
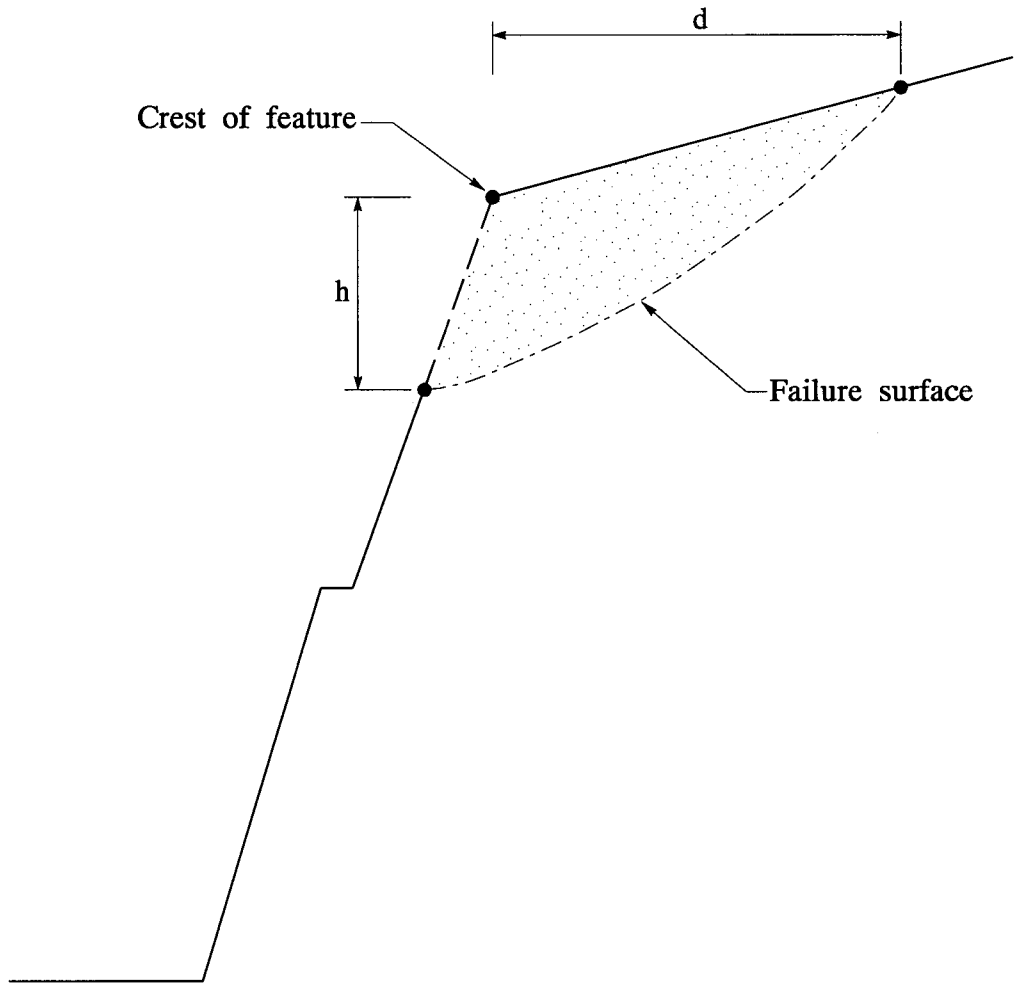


Figure A2 - Geometry Classification for Soil Cut Slopes



Note : A failure is deemed to be involving a major portion of the upslope area if $d \geq h$.

Figure A3 - Failure Involving a Major Portion of the Upslope Area

APPENDIX B

SCORING SCHEME AND GUIDANCE NOTES ON NPCS FOR ROCK CUT SLOPES

CONTENTS

B.1 NEW PRIORITY CLASSIFICATION SYSTEM SCORING SCHEME FOR ROCK CUT SLOPES

INSTABILITY FACTORS

Factor	Categories and Description	Score
SLOPE GEOMETRY		
(A1) Overall Height of Rock Cut (H)	1) $0 < H \leq 5$ m 2) $5 < H \leq 10$ m 3) $10 < H \leq 15$ m 4) $15 < H \leq 20$ m 5) $H > 20$	5 10 25 35 40
(A2) Overall Angle of Rock Cut (θ)	1) $\theta < 45°$ 2) $45° < \theta \leq 60°$ 3) $60° < \theta \leq 70°$ 4) $70° < \theta \leq 80°$ 5) $\theta > 80°$	5 10 25 35 40
(A3) Presence of concentrated Surcharge Load at Crest	Note the form of concentrated surcharge (i.e. building footing, caissons, etc.)	
MODE OF SLOPE FAILURE		
(B1) Ravelling	Discontinuities favourably oriented with respect to slope face. Slope failure limited to individual overhanging blocks or isolated loose blocks (< 5 m^3) falling off slope face.	3.0
(B2) Toppling	Dominant discontinuity set dips into the slope face. Orthogonal cross discontinuities in combination with the dominant set produce blocks which could topple from the slope.	3.0
(B3) Planar Failure	1) Dominant discontinuity set strikes sub-parallel to slope face and daylight into slope; shallow dipping discontinuities. 2) Dominant discontinuity set strikes sub-parallel to slope face and daylight into slope; moderately dipping discontinuities. 3) Dominant discontinuity set strikes sub-parallel to slope face and daylight into slope, steeply dipping discontinuities.	0.75 3.0 5.0
(B4) Wedge Failure	1) Two dominant discontinuity sets daylight and strike obliquely into slope face; shallow dipping discontinuity intersection. 2) Two dominant discontinuity sets daylight and strike obliquely into slope face; moderately dipping discontinuity intersection. 3) Two dominant discontinuity sets daylight and strike obliquely into slope face; steeply dipping discontinuity intersection.	0.5 2.0 4.0
ROCK MASS CONDITION		
(C1) Discontinuity Spacing of Rock Mass	1) Average Discontinuity Spacing ≥ 2 m 2) $1 \leq$ Average Discontinuity Spacing < 2 m 3) $0.5 \leq$ Average Discontinuity Spacing < 1 m 4) $0.2 \leq$ Average Discontinuity Spacing < 0.5 m 5) Average Discontinuity Spacing < 0.2 m	0 5 10 20 30

INSTABILITY FACTORS (Continued)

Factor	Categories and Description	Score	
(C2) Discontinuity Roughness and Infilling	1) Rough, tight, unweathered or slightly weathered. 2) Slightly rough, aperture < 1mm, open. 3) Slightly rough, aperture 1 to 5 mm, open. 4) Slightly rough, aperture < 1mm, weak, soft, infilling 5) Smooth, aperture 1 to 5mm, weak, soft, infilling. 6) Smooth, aperture > 5mm, weak, soft infilling. Note: **Ravelling Failure**, maximum value for C2 = 10 **Toppling Failure**, maximum value for C2 = 20	0 10 20 30 40 50	
		Toppling /Planar	Wedge
(C3) Persistence of Discontinuity	1) Persistent 2) Sub-Presistent 3) Non-Persistent	30 15 0	10 5 0
(C4) Rock Lithology + Nature of Discontinuity	Note the dominant lithology of the rock cut (Granite, Granodiorite, Volcanics etc.) Note the nature of dominant discontinuities (Fault Zone, Fault, Joint, Cleavage, Schistosity, Shear Plane, Fissure, Tension Crack, Foliation,Bedding)		
POTENTIAL FOR WATER INGRESS			
(D1) Drainage Provisions	1) Drainage measures adequately direct water away from the crest and face of the slope. 2) Drainage measures insufficient in size or extent to direct water away from crest and face of slope. 3) No drainage measures in place to direct water away from the crest and face of the slope. 4) Potential for convergence of runoff at crest and/or potential for water ingress into open discontinuities.	0 5 10 15	
(D2) Seepage Conditions	1) No sign of seepage from discontinuities. 2) Slight to moderate seepage from isolated rock discontinuities. 3) Slight to moderate seepage from several rock discontinuities or heavy seepage from isolated rock discontinuities. 4) Heavy seepage from several rock discontinuities.	0 5 10 15	
EVIDENCE OF DISTRESS/PAST FAILURE			
(E1) Signs of Distress	1) No evidence of surficial loosening. 2) Localised surficial loosening, or small overhanging blocks. 3) Surficial loosening and small overhanging blocks in several areas of slope. 4) Tension cracks exist along crest of slope. 5) Large overhanging blocks with potential release surfaces visible.	0 5 15 25 30	
(E2) Evidence of Past Instability	1) No recorded or observed evidence of past instability. 2) Observed evidence of past instability (rock blocks and fragments accumulated at toe of slope). 3) Documented evidence of past instability - minor rockfall (volume < 50 m^3). 4) Documented evidence of past instability - major rockfall (volume ≥ 50 m^3).	0 10 30 40	

CONSEQUENCE FACTORS

Factor	Categories and Description	Score
ENGINEERING JUDGEMENT		
(EJ) Potential for Failure to Occur	1) Low potential for failure 2) Moderate potential for failure 3) High potential for failure	0 10 30
FACILITY ABOVE CREST OF SLOPE		
(F1) Grouping of Facility Above Crest Type of Facility: (Road, Footpath, Building, give name)	1) Group 1 (Indicate Type of Facility) 2) Group 2 (Indicate Type of Facility) 3) Group 3 (Indicate Type of Facility) 4) Group 4 (Indicate Type of Facility) 5) Group 5 (Indicate Type of Facility)	4 2 1 0.5 0.1
(F2) Distance from slope crest to facility (m)		
FACILITY BELOW CREST OF SLOPE		
(G1) Grouping of Facility Below Toe Type of Facility: (Road, Footpath, Building, give name)	1) Group 1 (Indicate Type of Facility) 2) Group 2 (Indicate Type of Facility) 3) Group 3 (Indicate Type of Facility) 4) Group 4 (Indicate Type of Facility) 5) Group 5 (Indicate Type of Facility)	4 2 1 0.5 0.1
(G2) Distance from slope toe to facility (m) Note: For facility on the slope face, G2 = 0		
UPSLOPE AND DOWNSLOPE TOPOGRAPHY		
(J) Topography above and below rock slope.	1) Upslope angle < 35° Downslope angle < 15° 2) Upslope angle ≥ 35° Downslope angle < 15° 3) Upslope angle < 35° 15° ≤ Downslope angle < 30° 4) Upslope angle < 35° Downslope angle ≥ 30° 5) Upslope angle > 35° 15° ≤ Downslope angle < 30° 6) Upslope angle > 35° Downslope angle ≥ 30°	0 0.3 0.6 1.2 0.9 1.5
LIKELY SCALE OF FAILURE		
(K) Size of Failure	1) Individual Blocks (Volume < 5 m^3) 2) Minor (5 m^3 ≤ Volume < 50 m^3) 3) Moderate (50 m^3 ≤ Volume < 500 m^3) 4) Major (Volume ≥ 500 m^3)	0.1 0.3 0.7 1.0
VULNERABILITY (CONSEQUENCE FACTOR)		
(V) Consequence Factor	1) The Consequence-to-life Category of the feature is "1" or "2", large volume of failure is expected, and occupied building may collapse or be covered in the event of landslip, or mass transportation is seriously affected. 2) Other cases	1.25 1.0

NEW PRIORITY CLASSIFICATION SYSTEM FOR ROCK CUT SLOPES

CALCULATION OF SCORES

Instability Score for Failure Mode i ($I.S._i$)

$$I.S._i = (A\ 1 + A2)\ +\ B \times (C1 + C2 + C3 + D1 + D2)\ + (E1 + E2) + (EJ)$$

Notes: (1) For Ravelling Failure, maximum value of C2 = 10.
(2) For Toppling Failure, maximum value of C2 = 20.

Consequence Score for Failure Mode i ($C.S._i$)

$$C.S._i = K\,(F + G)\,H \times V$$

where: $$F = F1\left(\frac{\alpha H - F2}{\alpha H}\right);\quad G = 2\,G1\left(\frac{\beta H - G2}{\beta H}\right);$$

Notes: (1) If $H > 30$ m; $H = 30$ for all the consequence formulae.
(2) If F or G is negative it will be assigned zero value.

The parameters α and β can be determined from anticipated scale of failure (K) and upslope and downslope topography (J) using the table below:

		K = 0.1	K = 0.3	K = 0.7	K = 1.0
α		0.5	0.8	1.0	1.2
β	J = 0.0	0.5	1.0	1.3	1.5
	J = 0.3	0.6	1.2	1.5	1.8
	J = 0.6	0.7	1.4	1.7	2.1
	J = 1.2	0.9	1.8	2.3	2.7
	J = 0.9	0.8	1.6	2.0	2.4
	J = 1.5	1.0	2.0	2.6	3.0

Total Score for the Feature (T.S.)

$$T.S. = \sum_{i=1}^{N} \frac{I.S._i\ C.S._i}{100}$$

where N is the number of failure modes observed for the feature.

NEW PRIORITY CLASSIFICATION SYSTEM
FOR ROCK CUT SLOPES
DATA COLLECTION SHEET

FEATURE NUMBER	
LOCATION:	
DISTRICT:	
EASTING:	
NORTHING:	

PLAN AND CROSS-SECTION:

SECTION REFERS TO: ☐MOST SEVERE CONSEQUENCE. ☐ MAXIMUM FEATURE HEIGHT

INSTABILITY FACTORS

FACTOR	FAILURE MECHANISM / REMARKS				
(A1) SLOPE HEIGHT					
(A2) AVERAGE SLOPE ANGLE					
(A3) SURCHARGE LOADING					
(B) MODE OF FAILURE					
(C1) DISCONTINUITY SPACING					
(C2) DISCONTINUITY ROUGHNESS AND INFILLING					
(C3) PERSISTENCE OF DISCONTINUITY					
(C4) ROCK LITHOLOGY + NATURE OF DISCONTINUITY					
(D1) DRAINAGE PROVISIONS					
(D2) SEEPAGE CONDITIONS					
(E1) SIGNS OF DISTRESS					
(E2) EVIDENCE OF PAST INSTABILITY					
(EJ) ENGINEERING JUDGEMENT					

CONSEQUENCE FACTORS

FACTOR	FAILURE MECHANISM / REMARKS			
(F1) FACILITY ABOVE CREST OF SLOPE				
(F2) DISTANCE FROM CREST				
(G1) FACILITY BELOW CREST OF SLOPE				
(G2) DISTANCE FROM TOE				
(J) UP AND DOWN SLOPE TOPOGRAPHY				
(K) LIKELY SCALE OF FAILURE				
(V) VULNERABILITY (CONSEQUENCE FACTOR)				

NEW PRIORITY CLASSIFICATION SYSTEM
FOR ROCK CUT SLOPES
DATA COLLECTION SHEET

PHOTOGRAPHIC OVERVIEW OF SLOPE	FEATURE #:
COMMENTS:	
WARNING MESSAGES:	
STABILISATION/PROTECTION MEASURES (such as rock bolts, dowels, anchors, ditches, catch fences, etc.)	☐
ROCK CUT CONCEALED BY SHOTCRETE OR CHUNAM.	☐
ROCK CUT CONCEALED BY VEGETATIVE COVER.	☐
NO SAFE ACCESS TO CREST.	
PRESENCE OF PRESISTENT DICONTINUITY WITH INFILL OF CLAYEY MATERIAL OR WEATHERED CLAY SEAM	☐
PRESENCE OF FAULT ZONE, FAULT, SCHISTOCITY, CLEAVAGE, FOLIATION, BEDDING OR SHEAR PLANE.	☐
PRESENCE OF BENCHES	☐
INSPECTION DATE:	BY:

NEW PRIORITY CLASSIFICATION SYSTEM
FOR ROCK CUT SLOPES
PHOTOGRAPHIC RECORD SHEET

Feature Number: Description:	Date Taken:
Feature Number: Description:	Date Taken:

NEW PRIORITY CLASSIFICATION SYSTEM
FOR ROCK CUT SLOPES
PHOTOGRAPHIC RECORD SHEET

Feature Number:	Date Taken:
Description:	
Note : Sketches may be prepared where considered appropriate.	

B.2 GUIDANCE NOTES ON DATA COLLECTION AND SCORE CALCULATION

The following notes accompany the field score sheet and are intended to briefly explain the application of the scheme when assessing a slope in the field.

A1 OVERALL SLOPE HEIGHT

Slope height refers to the height of the rock cut and does not include the height of features including soil slopes above the crest of the cut. For the small vertical cuts the height can be measured using a cloth tape. For larger slopes, a clinometer can be used to measure the slope height as shown in Figure B1.

If the height of the feature varies over its length, the height used in score calculation should be the height of the slope in the vicinity of area identified as having the potential for a particular mode of failure. This is defined as the "critical section" and it does not necessarily correspond to the maximum slope height. It should be noted on the data collection sheet which section was used for score calculation.

Care should be taken to provide a reasonably accurate value of slope height as it is used in the calculation of both the instability and consequence factors. If it is not feasible to make direct or indirect measurement, the height should be estimated with reference to other features such as buildings, lamp posts, etc.

A2 OVERALL SLOPE ANGLE

The overall angle of the slope refers to the mean angle of the slope face and is measured from the toe to the crest of the slope. Note if the slope is benched, the overall slope angle will be less than the angle of the individual bench faces.

A3 PRESENCE OF CONCENTRATED SURCHARGE LOAD AT CREST

If concentrated surcharge load on the crest of the slope could potentially influence the slope's stability its presence should be noted. Examples of typical surcharge loads include building footings and caissons. This category does not receive a rating and is not part of the instability score.

B MODE OF SLOPE FAILURE

The following modes of slope failure are considered:

1. Ravelling
2. Toppling
3. Wedge Failure; and

4. Planar Failure.

'Dominant discontinuity set' refers to discontinuities that are of such persistence and orcentation as to render particular mode of slope failure kinematically possible.
Defining conditions for each case are given on the score sheet. **In the case where more than one failure mode is kinematically possible in the same slope, a separate, complete ranking should be given for each mode of failure** as variables such as engineering judgement and volume of failure will differ for each failure mode. For example, the same slope may have the potential for small scale ravelling of surficial blocks with relatively minor consequences in one location and large scale planar failure with corresponding large slide volumes and more serious consequences in another location. Each should be assessed accordingly to give separate scores for the same slope.

For the purpose of this system, the following guidelines are need for describing the dips of the discontinuities or line of intersection of discontinuities for B3 and B4:

shallow dipping :	between 5 and 20°.
moderately dipping :	between 21 to 45°.
steeply dipping :	greater than 45°

Photographs of obviously unstable loose blocks should be taken and attached to the photographic record sheets to assist in future analyses or for comparative purposes during subsequent inspections.

C1 DISCONTINUITY SPACING

The average spacing of the discontinuity set(s) controlling the failure mode in question is measured or estimated. This refers to that for the particular mode of failure under consideration. The scheme assumes that closely spaced discontinuities are least favorable in terms of overall slope stability and thus receive a higher score than joint sets with large spacings. In case of wedge failure, the average spacing of each controlling discontinuity set should be recorded and the smaller one used to determine the score.

C2 DISCONTINUITY ROUGHNESS / INFILLING

It should be noted that primary weathering products within a discontinuity could be mistaken for secondary infill such as sandy, silty or clayey soils washed into the joint by surface runoff. Discontinuities with foreign material washed in is still considered as an open discontinuity. This is an important distinction - tight unweathered discontinuities may be recorded as highly weathered if covered in secondary material. In either case discontinuities must be examined carefully to identify their true condition.

C3 DISCONTINUITY PERSISTENCE

The degree of persistence of discontinuities is to be assessed by reference to the discontinuity trace length on the surface of rock exposures. For the description of individual discontinuities, the maximum persistence dimension should be used where possible. For practical purposes, 'persistent' refers to a trace length of > 5 m, 'sub-persistent' refers to a trace length of between 1 m and 5 m, and 'non-persistent' refers to a trace length of < 1 m.

C4 ROCK LITHOLOGY + NATURE OF DISCONTINUITY

Note the dominant lithology of the rock cut (i.e. Granite, Selected Formations of Volcanics, Granodiorite, etc.) by reference to GEO's 1:20 000 geological maps. This category does not receive a rating and is not part of the instability score.

"Granite" refers to areas that comprise a solid geology of granite. "Selected Formations of Volcanics" refer to volcanics belonging to the following formations : Ap Lei Chau (JAC), High Island (JHI), Clear Water Bay (JCB), Silver Strand (JSS) and Lantau (JLT).

GLOSSARY OF TERMS ON TYPES OF DISCONTINUITY

Fault zone - A fault that is expressed as a zone of numerous small fractures or of breccia or fault gouge.

Fault - A fracture or a zone of fractures along which there has been displacement of the sides relative to one another parallel to the fracture.

Joint - A surface of fracture or parting in a rock, without displacement; the surface is usually plane and often occurs with parallel joints to form part of a joint set.

Cleavage - The property or tendency of a rock to split along secondary, aligned fractures or other closely spaced, planar structures or textures, produced by deformation or metamorphism.

Schistosity - The foliation in schist or other coarse-grained, crystalline rock due to the parallel, planar arrangement of mineral grains of the platy, prismatic, or ellipsoidal types, usually mica.

Shear plane - A surface along which differential movement has taken place parallel to the surface.

Fissure - A surface of fracture or a crack in rock along which there is a distinct separation. It is often filled with mineral-bearing material.

Tension Crack - A fracture caused by tensile stress.

Foliation - A planar arrangement of textual or structural features in any types of rock; esp. the planar structure that results from flattening of the constituent grains of a metamorphic rock.

Bedding - The general physical and structural character or pattern of the beds or layers of varying thickness and their contacts within a rock mass or sediment.

D1 DRAINAGE PROVISIONS

In assessing the adequacy of surface drainage provisions, the site topography, catchment area and hydrogeological features (i.e. a nearby stream course or lake) should be considered which could give rise to convergence of surface water towards the slope or might contribute water to the slope. This requires an examination of the crest of the slope as well as the slope's face to make a proper assessment.
When assessing the adequacy of channels, consideration should be given to whether they prevent water from reaching the slope face. If despite the channels, surface water can still reach the face, then the channels should be considered inadequate. If the channels are blocked they should still be considered adequate provided they are of sufficient extent. However, a note should be made that states the nature and extent of the blockage in the comments section.

If drain holes have been installed in the face they should be considered inadequate if they are blocked and/or have no connectivity with joints.

If it is not possible to assess the drainage provisions due to difficulties in gaining access, use a default value of D1=10.

D2 SEEPAGE CONDITIONS

Staining on or below joints often indicates seepage, as do erosion features at the toe of the slope. When seepage is noted from joints on the slope, the location of the seepage should be marked on the feature plan. "Seepage from several joints" in the category descriptions refers to seepage from more than one joint at a given location on the slope.

If the inspection is being done in the dry season, seepage conditions could be assessed based on water staining on the slope surface.

E EVIDENCE OF DISTRESS / PAST FAILURE

As noted in Engineering Judgement, anecdotal evidence of slope instability is considered important. The presence of talus or loose blocks at the toe of the slope should be considered as evidence of distress. Under item E1, small overhanging blocks refer to those with a volume of $0.01\ m^3 < V < 1\ m^3$, and large overhanging blocks as those with $V \geq 1.0\ m^3$.

Judgement should be made in assessing whether cracked chunam, damaged channels, etc. are due to inadequate maintenance. If these are due to inadequate maintenance, they should not be regarded as signs of distress.

If access to the crest is not practicable, the assessment of signs of distress shall be made in relation to any loosening or overhanging blocks at the slope face.

Where there are significant signs of distress, or visual or documented evidence of continuing hazardous movement of a slope, excavation, retaining structure, boulder or rock fragment, immediate action should be taken.

In addition to "inferred evidence", GEO. landslide records need to be checked for "confirmed evidence" of previous instability. "Confirmed" refers to documented evidence of past instability. Records which should be reviewed include :

a) the available Incident Reports and Landslip Cards;
b) B & P fieldsheets; and
c) 1:2500 G.A.S. Reports.

EJ ENGINEERING JUDGEMENT

This reflects the general 'feel' the geotechnical engineer has for the slope and acts as an overall assessment of the potential for failure. This judgement does not affect the consequence scores.

F,G FACILITIES ABOVE AND BELOW SLOPE

The actual facility group used in the ranking system depends on the mode of failure under consideration. For example, consider the case of a slope with a road directly below the toe and a hospital on the opposite side of the road 10 m away from the toe. If minor ravelling failure is under consideration, the scale of the potential failure is likely to be small and the facility affected would only be the road. However, if a large scale block failure along a steep slide plane is envisaged, the hospital could be affected. It is important to note which facility is envisaged to be effected by each of the failure modes on the score sheets, to facilitate subsequent interpretation of the scores during the ranking process.
It is important not to confuse the difference between the group number and group score. For instance, a group 1 facility scores 4 points. Incorrect assignment of this score leads to serious errors in final ranking.

A summary of the facility description is given in Table 1.

J UPSLOPE / DOWNSLOPE TOPOGRAPHY

Representative sections should be measured with a clinometer or estimated if direct measurement is not possible, and indicated on field sketches as necessary.

K LIKELY SCALE OF FAILURE

This category should be ranked by considering the persistence of the joint sets bounding the potentially unstable block(s). As only a two dimensional view of the bounding discontinuities is normally present on the slope's face, the volume of failure has to be estimated by extrapolating the daylighting discontinuities back into the slope to the most likely release surface(s). If more than one possible block or wedge size could form, choose the largest for determining the value of K. Individual blocks (volume < 5 cu. m.) also applies to multiple individual blocks of similar volume.

In estimating the likely scale of failure, reference should be made to the degree of persistence of the discontinuities.

V VULNERABILITY

The degree of vulnerability is equivalent to the "Consequence Factor" in the Soil Cut Slope Priority Classification System. For Consequence-to-life categories refer to Table 5.2 of the Geotechnical Manual for Slope and the latest relevant GEO Circular. As a general guide, debris volume in excess of 500 m^3 may be taken as a "large volume of failure".

GENERAL NOTES

(1) This ranking sheet is to be completed for all rock cut features which are "pre-GCO" or where the status (i.e. "pre-GCO" or "post-GCO") is uncertain.

(2) Geometric parameters of the feature such as slope height and angle may be obtained by technical staff based on survey plans and simple site measurements. Other parameters should be collected by professional staff with background in engineering geology. Inspection of features on the slopes that are above eye level should be made with the aid of a pair of binoculars and/or from nearby buildings.

(3) Where access is only limited to the lower part of the slope, the joint spacing and joint conditions (roughness and infilling) may be inferred from inspection of the accessible joints.

(4) Unless otherwise stated, "distance" refers to horizontal distance and "height" refers to vertical height.

(5) If necessary, a feature can be zoned and each zone ranked independently in terms of stability, failure mode, consequence etc. This is normally required when assessing larger features which contain a variety of geological conditions.

(6) If access is available, the slope crest should be examined carefully, especially with regard to the existence of tension cracks, open joints and for the provision of drainage. However, it is recognised that this is not always possible due to safety considerations or access difficulties. Under such conditions, default values as suggested in these guide notes shall be used.

(7) Anecdotal evidence from local residents is considered useful information - any such details should be noted in the comments section, along with names and addresses if possible. If relevant, anecdotal evidence should be used in the allocation of scores to each category and clearly recorded, i.e. *"No obvious signs of seepage but local residents report major seepage during heavy rainfall"*.

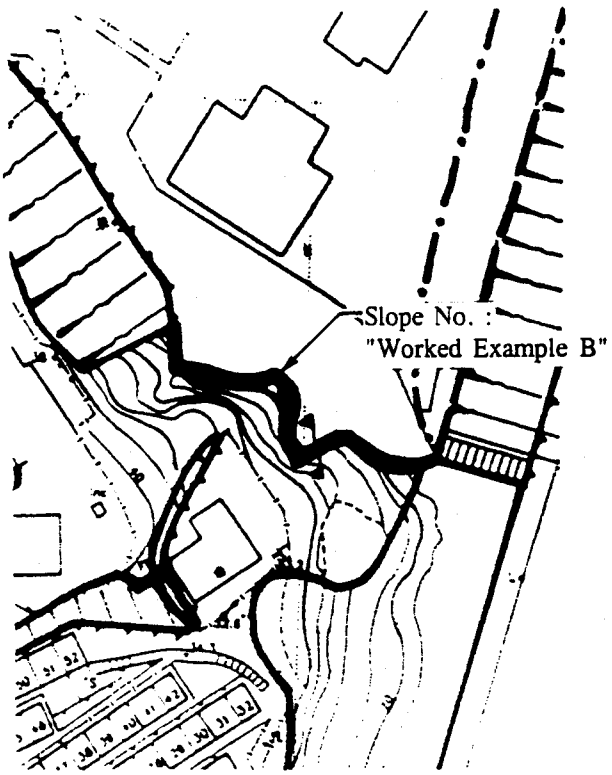
(8) Scaled photographs should be prepared as a supplement to the ranking scheme. Not only do they allow for the recording of any information not directly included in the ranking scheme, they also ensure that the final score can be considered and used in context, without the need to revisit the slope. Additional field sketches may be prepared only where considered useful by the inspecting engineer.

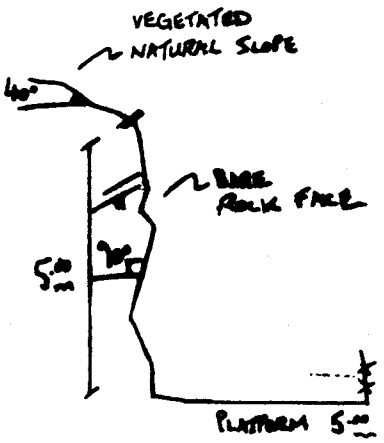
(9) It is important when applying this scheme to recognise the scale of any potential failure. Slopes should not only be examined on a small scale to identify unstable wedges and blocks, but also on a larger scale to identify possible failure of large portions of the slope. These observations are recorded in categories F, G, J, K and V.

(10) Every effort should be made, as far as practicable, to gain access for the inspection and collection of the necessary data. If site constraints are such that a meaningful assessment of a number of items cannot be made, this should be noted accordingly in the "Comments" column.

B.3 WORKED EXAMPLE ON NEW PRIORITY CLASSIFICATION SYSTEM FOR ROCK CUT SLOPES

PLAN AND SECTION





NEW PRIORITY CLASSIFICATION SYSTEM SCORING SCHEME FOR ROCK CUT SLOPES

Slope No "Worked Example B." **INSTABILITY FACTORS**

Factor	Categories and Description	Score
SLOPE GEOMETRY		
(A1) Overall Height of Rock Cut (H)	(1) $0 < H \leq 5$ m 2) $5 < H \leq 10$ m 3) $10 < H \leq 15$ m 4) $15 < H \leq 20$ m 5) $H > 20$	(5) 10 25 35 40
(A2) Overall Angle of Rock Cut (θ)	1) $\theta < 45°$ 2) $45° < \theta \leq 60°$ 3) $60° < \theta \leq 70°$ 4) $70° < \theta \leq 80°$ (5) $\theta > 80°$	5 10 25 35 (40)
(A3) Presence of concentrated Surcharge Load at Crest	Note the form of concentrated surcharge (i.e. building footing, caissons, etc.)	Yes 2 Storey Residential
MODE OF SLOPE FAILURE		
(B1) Ravelling	Discontinuities favourably oriented with respect to slope face. Slope failure limited to individual overhanging blocks or isolated loose blocks (< 5 m^3) falling off slope face.	(3.0)
(B2) Toppling	Dominant discontinuity set dips into the slope face. Orthogonal cross discontinuities in combination with the dominant set produce blocks which could topple from the slope.	3.0
(B3) Planar Failure	1) Dominant discontinuity set strikes sub-parallel to slope face and daylight into slope; shallow dipping discontinuities. 2) Dominant discontinuity set strikes sub-parallel to slope face and daylight into slope; moderately dipping discontinuities. 3) Dominant discontinuity set strikes sub-parallel to slope face and daylight into slope, steeply dipping discontinuities.	0.75 3.0 5.0
(B4) Wedge Failure	1) Two dominant discontinuity sets daylight and strike obliquely into slope face; shallow dipping discontinuity intersection. 2) Two dominant discontinuity sets daylight and strike obliquely into slope face; moderately dipping discontinuity intersection. 3) Two dominant discontinuity sets daylight and strike obliquely into slope face; steeply dipping discontinuity intersection.	0.5 2.0 4.0
ROCK MASS CONDITION		
(C1) Discontinuity Spacing of Rock Mass	1) Average Discontinuity Spacing ≥ 2 m (2) 1 ≤ Average Discontinuity Spacing < 2 m 3) 0.5 ≤ Average Discontinuity Spacing < 1 m 4) 0.2 ≤ Average Discontinuity Spacing < 0.5 m 5) Average Discontinuity Spacing < 0.2 m	0 (5) 10 20 30

INSTABILITY FACTORS (Continued)

Factor	Categories and Description	Score
(C2) Discontinuity Roughness and Infilling	(1) Rough, tight, unweathered or slightly weathered. 2) Slightly rough, aperture < 1mm, open. 3) Slightly rough, aperture 1 to 5 mm, open. 4) Slightly rough, aperture < 1mm, weak, soft, infilling 5) Smooth, aperture 1 to 5mm, weak, soft, infilling. 6) Smooth, aperture > 5mm, weak, soft infilling. Note: **Ravelling Failure**, maximum value for C2 = 10 **Toppling Failure**, maximum value for C2 = 20	(0) 10 20 30 40 50
(C3) Persistence of Discontinuity	Not applicable for Ravelling 1) Persistent 2) Sub-Presistent 3) Non-Persistent	Toppling /Planar | Wedge 30 | 10 15 | 5 0 | 0
(C4) Rock Lithology + Nature of Discontinuity	Note the dominant lithology of the rock cut (Granite, Granodiorite, Volcanics etc.) Note the nature of dominant discontinuities (Fault Zone, Fault, Joint, Cleavage, Schistosity, Shear Plane, Fissure, Tension Crack, Foliation,Bedding)	Typical Granite Volcanics / Joint
POTENTIAL FOR WATER INGRESS		
(D1) Drainage Provisions	1) Drainage measures adequately direct water away from the crest and face of the slope. 2) Drainage measures insufficient in size or extent to direct water away from crest and face of slope. (3) No drainage measures in place to direct water away from the crest and face of the slope. 4) Potential for convergence of runoff at crest and/or potential for water ingress into open discontinuities.	0 5 (10) 15
(D2) Seepage Conditions	1) No sign of seepage from discontinuities. 2) Slight to moderate seepage from isolated rock discontinuities. (3) Slight to moderate seepage from several rock discontinuities or heavy seepage from isolated rock discontinuities. 4) Heavy seepage from several rock discontinuities.	0 5 (10) 15
EVIDENCE OF DISTRESS/PAST FAILURE		
(E1) Signs of Distress	1) No evidence of surficial loosening. (2) Localised surficial loosening, or small overhanging blocks. 3) Surficial loosening and small overhanging blocks in several areas of slope. 4) Tension cracks exist along crest of slope. 5) Large overhanging blocks with potential release surfaces visible.	0 (5) 15 25 30
(E2) Evidence of Past Instability	(1) No recorded or observed evidence of past instability. 2) Observed evidence of past instability (rock blocks and fragments accumulated at toe of slope). 3) Documented evidence of past instability - minor rockfall (volume < 50 m^3). 4) Documented evidence of past instability - major rockfall (volume ≥ 50 m^3).	(0) 10 30 40

CONSEQUENCE FACTORS

Factor	Categories and Description	Score
ENGINEERING JUDGEMENT		
(EJ) Potential for Failure to Occur	(1) Low potential for failure 2) Moderate potential for failure 3) High potential for failure	(0) 10 30
FACILITY ABOVE CREST OF SLOPE		
(F1) Grouping of Facility Above Crest Type of Facility: (Road, Footpath, Building, give name)	1) Group 1 (Indicate Type of Facility) 2) Group 2 (Indicate Type of Facility) 3) Group 3 (Indicate Type of Facility) 4) Group 4 (Indicate Type of Facility) (5) Group 5 (Indicate Type of Facility)	4 2 1 0.5 (0.1)
(F2) Distance from slope crest to facility (m)		0
FACILITY BELOW CREST OF SLOPE		
(G1) Grouping of Facility Below Toe Type of Facility: (Road, Footpath, Building, give name)	1) Group 1 (Indicate Type of Facility) 2) Group 2 (Indicate Type of Facility) 3) Group 3 (Indicate Type of Facility) 4) Group 4 (Indicate Type of Facility) 5) Group 5 (Indicate Type of Facility)	4 2 1 (0.5) 0.1
(G2) Distance from slope toe to facility (m) Note: For facility on the slope face, G2 = 0		0
UPSLOPE AND DOWNSLOPE TOPOGRAPHY		
(J) Topography above and below rock slope.	1) Upslope angle < 35° Downslope angle < 15° (2) Upslope angle ≥ 35° Downslope angle < 15° 3) Upslope angle < 35° 15° ≤ Downslope angle < 30° 4) Upslope angle < 35° Downslope angle ≥ 30° 5) Upslope angle > 35° 15° ≤ Downslope angle < 30° 6) Upslope angle > 35° Downslope angle ≥ 30°	0 (0.3) 0.6 1.2 0.9 1.5
LIKELY SCALE OF FAILURE		
(K) Size of Failure	(1) Individual Blocks (Volume < 5 m^3) 2) Minor (5 m^3 ≤ Volume < 50 m^3) 3) Moderate (50 m^3 ≤ Volume < 500 m^3) 4) Major (Volume ≥ 500 m^3)	(0.1) 0.3 0.7 1.0
VULNERABILITY (CONSEQUENCE FACTOR)		
(V) Consequence Factor	1) The Consequence-to-life Category of the feature is "1" or "2", large volume of failure is expected, and occupied building may collapse or be covered in the event of landslip, or mass transportation is seriously affected. (2) Other cases	1.25 (1.0)

NEW PRIORITY CLASSIFICATION SYSTEM FOR ROCK CUT SLOPES

CALCULATION OF SCORES

Instability Score for Failure Mode i (I.S.$_i$)

$$\mathbf{I.S._i = (A\,1 + A2) + B \times (C1 + C2 + C3 + D1 + D2) + (E1 + E2) + (EJ)}$$

$IS_1 = (5 + 40) + 3 \times (5 + 0 + 0 + 10 + 10) + (5 + 0) + 0 = 125$

Notes:

(1) For Ravelling Failure, maximum value of C2 = 10.
(2) For Toppling Failure, maximum value of C2 = 20.

Consequence Score for Failure Mode i (C.S.$_i$)

$$\mathbf{C.S._i = K\,(F + G)\,H \times V} \qquad CS_1 = 0.1\,(0.1 + 1)(5)(1) = 0.55$$

where: $\mathbf{F = F1\left(\frac{\alpha H - F2}{\alpha H}\right)}$; $\mathbf{G = 2\,G1\left(\frac{\beta H - G2}{\beta H}\right)}$; $G = 2(0.5)\left[\frac{0.6(5) - 0}{0.6(5)}\right]$

$F = 0.1\left[\frac{0.5(5) - 0}{0.5(5)}\right]$

Notes:

(1) If **H** > 30 m; **H** = 30 for all the consequence formulae.
(2) If **F** or **G** is negative it will be assigned zero value.

The parameters α and β can be determined from anticipated scale of failure (K) and upslope and downslope topography (J) using the table below:

		K = (0.1)	K = 0.3	K = 0.7	K = 1.0
α		(0.5)	0.8	1.0	1.2
β	J = 0.0	0.5	1.0	1.3	1.5
	J = (0.3)	(0.6)	1.2	1.5	1.8
	J = 0.6	0.7	1.4	1.7	2.1
	J = 1.2	0.9	1.8	2.3	2.7
	J = 0.9	0.8	1.6	2.0	2.4
	J = 1.5	1.0	2.0	2.6	3.0

Total Score for the Feature (T.S.)

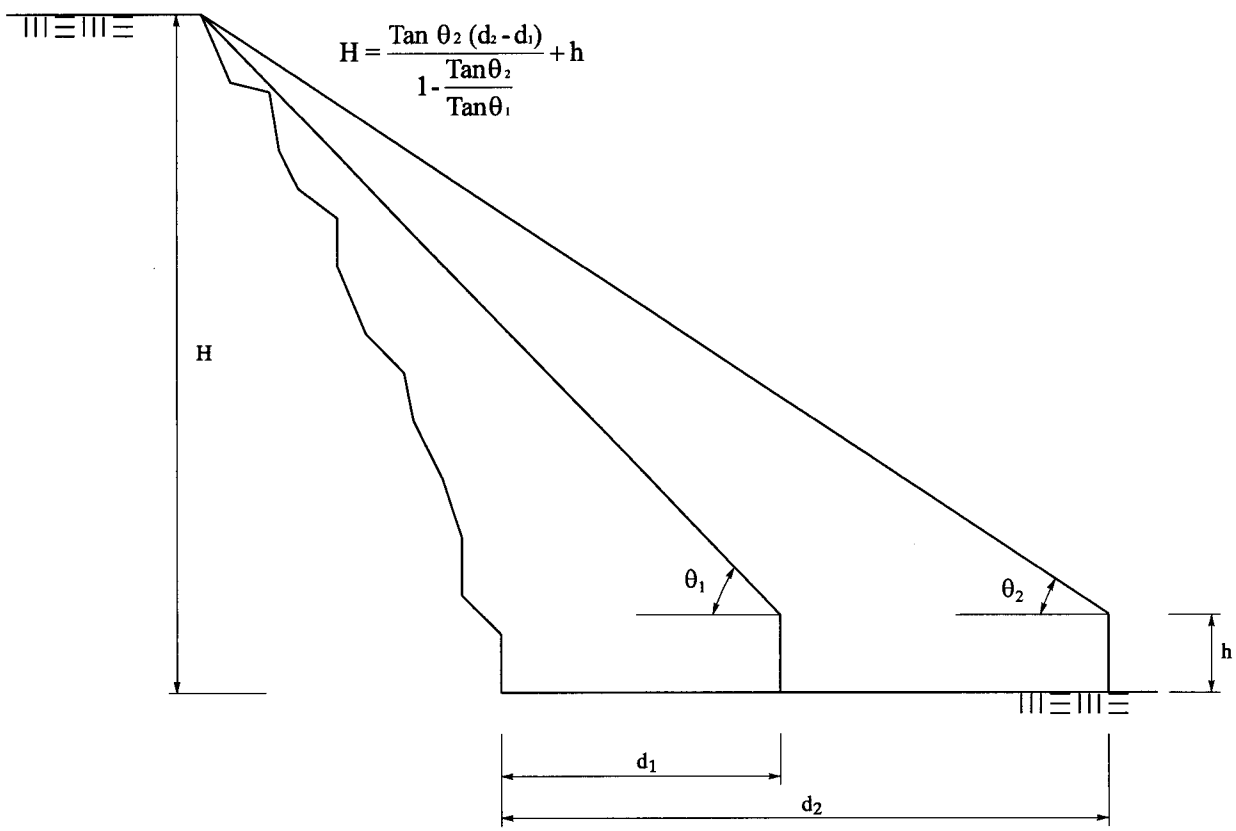
$$\mathbf{T.S. = \sum_{i=1}^{N} \frac{I.S._i\ C.S._i}{100}} = \frac{IS_i * CS_i}{100}$$ (since only 1 mode of failure observed)

where N is the number of failure modes observed for the feature.

$$= \frac{(125)(0.55)}{100}$$

$$= 0.69$$

LIST OF FIGURES



Legend :

H	Height of rock cut	θ_1	Angle to crest at distance d_1 from from toe
h	Height of Clinometer while taking readings	θ_2	Angle to crest at distance d_2 from from toe

Figure B1 - Overall Slope Height

APPENDIX C

SCORING SCHEME AND GUIDANCE NOTES ON NPCS FOR FILL SLOPES

CONTENTS

C.1 NEW PRIORITY CLASSIFICATION SYSTEM SCORING SCHEME FOR FILL SLOPES

Slope Data

Slope No. :	SIFT No. :	SIFT Class :
Slope Height, H = _____ m Slope Angle, θ = _____ °	Crest Wall Height, H_{wc} = _____ m Toe Wall Height, H_{wt} = _____ m	
SIFT Section Profile No.	Part of Larger Fill Body : Yes / No	

Instability Score (IS)

Sliding (IS_1 = a.b.c.d.e.f.g =)

(a) Geometry (From Figure C1)
S1 = 32
S2 = 16
S3 = 8
S4 = 4
S5 = 2
S6 = 1

(b) Type of Surface Cover
Bare = 4
Vegetated = 3
Chunam = 1.5
Shotcrete = 1

(c) Surface Drainage Provision
No = 2
Yes = 1

(d) Signs of Seepage
Yes = 2
No = 1

(e) Potential Leaking Services
Leaking = 2
Presence = 1.5
None = 1

(f) Past Instability
Major = 8
Minor = 2
No = 1

(g) Signs of Distress
Yes = 4
No = 1

Liquefaction (IS_2 = ¼.IS_1.h.i =)

(h) Slope Height
≥30 m = 4
≥20 - <30 = 3
≥10 - <20 = 1
<10 m = 0.5

(i) Type of Surface Cover
Bare = 1.1
Vegetated = 1.1
Chunam = 0.5
Shotcrete = 0.25

Major Washout (IS_3 = $(IS_1)^{1/3}$ .j.k.l.m.n.o.p.q =)

(j) Catchment Characteristics : Topographic Setting and Size of Catchment

Topographic Setting	Size of Catchment (m^2)				
	≤100	100 - 500	500 - 1000	1000 - 10000	>10000
Traverse Drainage Line	2	4	8	16	32
Adjacent Drainage Line	2	3	6	12	24
Traverse Topographic Depression	1	2	4	8	16
Adjacent Topographic Depression	1	2	3	6	12
Planar Slope	0.5	1	3	5	10
Spur	0.5	1	2	4	8

(k) Type of Crest Facility

Road	Platform & Urban development	Catch-water	Minor Development eg. Rural Footpath	Natural
1.0	0.5	0.25	0.10	0.05

(l) Volume of Fill Body (m^3)

≤100	100 - 500	500 - 1000	1000 - 10000	>10000
0.10	0.25	0.5	1	2

(m) Channelisation of Debris — Yes = 2.0, No = 0.5

(n) Erosion and Entrainment along Debris Trail — Yes = 2.0, No = 1.0

(o) Spread of Debris — Yes = 0.5, No = 1.0

(p) Unstable Terrain — Yes = 2.0, No = 1.0

(q) Masonry Wall at Crest

Wall Height ≥ 3 m	2.0
Wall Height < 3 m	1.5
No Masonry Wall	1.0

Consequence Score (CS)

Facility	Type	Group No.	Proximity			K	L	V			C = H * K * L * V / 10		
								V_1	V_2	V_3	C_1	C_2	C_3
Toe (1)			α =										
Toe (2)			α =										
Crest (1)			<3 m	3 - 6 m	6 - 10 m								
Crest (2)			<3 m	3 - 6 m	6 - 10 m								
										CS = ΣC			

Total Score (TS)

$S = \sum_{1}^{3} [IS_i CS_i]$	$TS = \log_{10}(S)$ =

Warning Messages : W1, W2, W3, W4 & W5

C.2 GUIDANCE NOTES ON DATA COLLECTION AND SCORE CALCULATION

Data/Input parameters required	Source of Data/ Input parameters required	Remarks
Slope No.	--	--
SIFT No.	SIFT Report	(1) SIFT Reports were prepared by the GEO under the project "Systematic Inspection of Features in the Territory". Copies of SIFT Reports are kept in the Civil Engineering Library of the Civil Engineering Department. Further details about the SIFT Reports may be obtained from CGE/P, GEO. (2) Sample forms of SIFT Report are attached in Appendix E.
SIFT Class	SIFT Report Section 2	(1) W1 = warning, if SIFT class = A
Slope Height, H	--	(1) Slope height refers to the height of a fill feature including the height of the crest wall and half of the height of the toe wall. Maximum height should be used (Figure C1(a)). Information from survey plans may be used.
Slope Angle, θ	--	(1) Refers to average slope angle, as shown in Figure C1(a). Information from survey plan may be used.
Crest Wall Height, H_{wc}	--	(1) Refers to dimensions as shown in Figure C1(a). (2) The NPCS for fill slopes shall be used in the following circumstances : (a) $H_f \geq 5$ m. (b) $H_f < 5$ m, H_{wc} & $H_{wt} < 3$ m, $H_f + H_{wc} \geq 5$ m and $H_f \geq H_{wc}$. (c) $H_f < 5$ m, H_{wc} & $H_{wt} < 3$ m, $H_f + H_{wt} \geq 5$ m and $H_f \geq H_{wt}$. (3) W2 = warning, if none of the cases, listed in (2) above is applicable.
Toe Wall Height, H_{wt}	--	
SIFT Section Profile No.	SIFT Report Section 6.2	(1) W3 = warning, if profile no. : B, D, K or L.
Part of Larger Fill Body	SIFT Report Section 6.1	(1) W4 = warning, if the fill feature is part of a larger fill body.
Item (a) Geometry	Slope Height, H_F Slope Angle, θ	(1) Geometry Cateogy S1 to S6 should be determined from Figure C1(b)

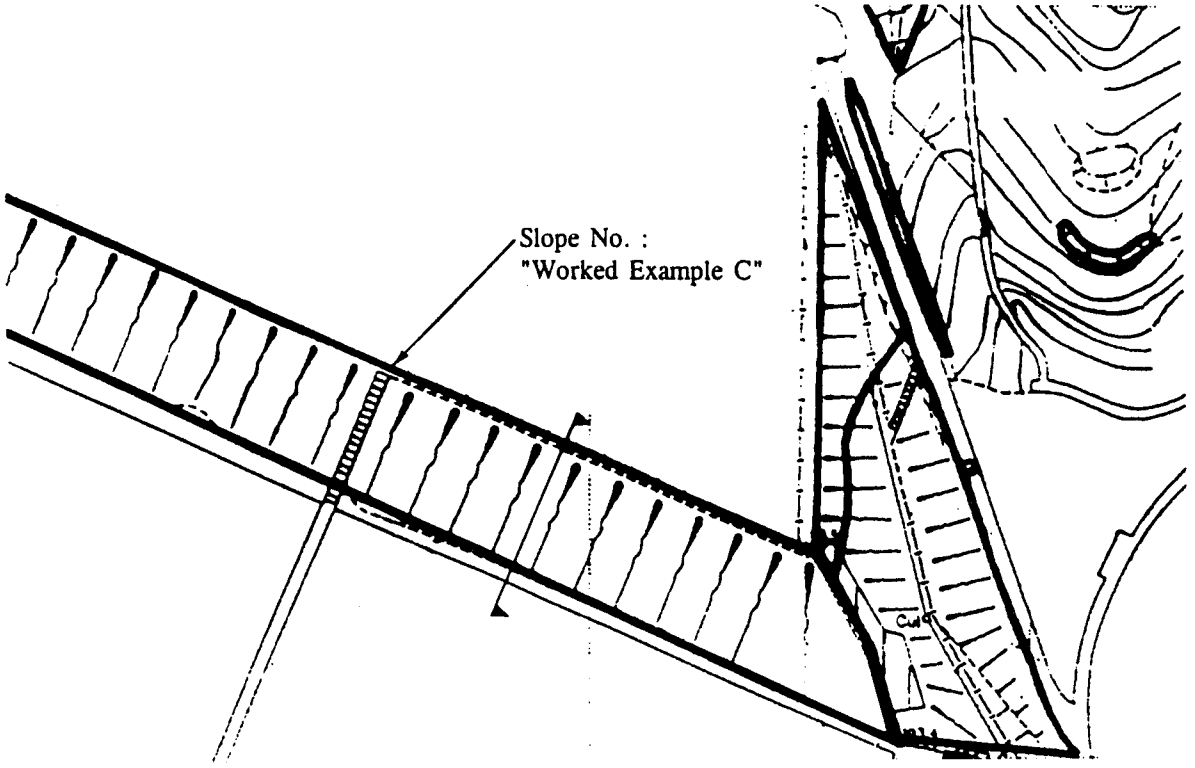
Data/Input parameters required	Source of Data/ Input parameters required	Remarks
Item (b) Type of Surface Cover	--	--
Item (c) Surface Drainage Provision	--	--
Item (d) Signs of Seepage	--	--
Item (e) Leaking Services	--	--
Item (f) Past Instability	--	(1) Past instability include observed or recorded past instability. (2) Observed past instability can be taken as 'minor' by default unless noted otherwise.
Item (g) Signs of Distress	--	--
Item (h) Slope Height	--	(1) Same as 'Slope Height, H'.
Item (i) Type of Surface Cover	--	(1) Same as Item (b).
Item (j) Catchment Characteristics : Topographic Setting and Size of Catchment	SIFT Report Section 6.3	(1) If data are not available, default values are suggested as follows : Parameter (j) = 32 for type of crest facility (i.e. Parameter (k)) being a road or a catchwater, Parameter (j) = 12 for other types of crest facility.
Item (k) Type of Crest Facility	--	--
Item (l) Volume of Fill Body	--	(1) Estimated from survey map, field measurement, or aerial photos. Information from SIFT Report Section 6.1 may be used, if available.

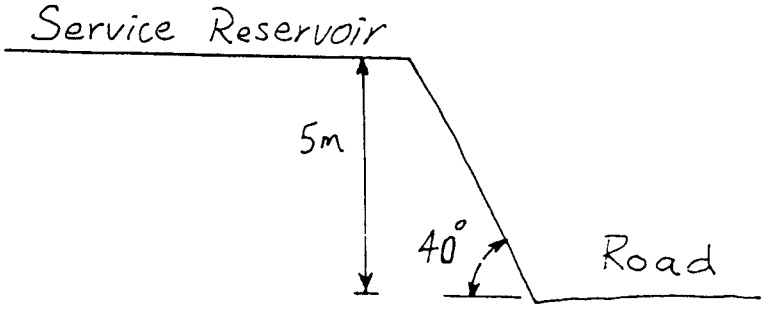
Data/Input parameters required	Source of Data/ Input parameters required	Remarks
Item (m) Channelisation of Debris Item (n) Erosion and Entrainment along Debris Trail Item (o) Spread of Debris	SIFT Report Section 6.3	(1) If data are not available default values are suggested as follows : Parameter (m) = 0.5, Parameter (n) = 1.0, Parameter (o) = 1.0.
Item (p) Unstable Terrain	GASP Report	(1) The Geotechnical Area Studies Programme (GASP) Reports are available from the Government Publication Sales Centre. (2) Unstable terrain refers to the presence of the following between the fill feature and the toe facilities : (i) zones of general instability associated with predominantly colluvial terrain or insitu terrain, and (ii) instability on disturbed terrain. (3) W5 = warning, if unstable terrain is present.
Facility Toe (1) Toe (2) Crest (1) Crest (2)	--	(1) Toe (1), Toe (2), Crest (1) and Crest (2) are the nearest two affected crest and two affected toe facilities at the critical section.
Facility Type	--	--
Facility Group No.	Facility Type	(1) Grouping of facilities is shown in Table 1. (2) Relationship between facility group number and road traffic is shown in Figure 3.
Proximity	--	(1) See Figure C1(a) for definition of α. Information from survey plan or site measurement may be used.

Data/Input parameters required	Source of Data/ Input parameters required	Remarks
Multiple Fatality Factor, K	Facility Group No. and judgement	(1) The Multiple Fatality Factor, K, is used if the potential loss of life is expected to be much higher than the typical value for the relevant facility group given in Table 1. As a default value, K = 3 for the following situations (otherwise K = 1) : (i) failure affecting facility Group 1a facilities (ii) failure affecting mass transport facilities (e.g. railway platform in Group 1(b), railway, tramway & light rails in facility Group 2b).
Potential Loss of life, L	Facility Group No.	(1) Potential loss of life, L, for different facility groups is shown in Table 1.
Vulnerability, V	Toe Facilities : (a) Slope Height, H (b) Proximity Crest Facilities: (a) Slope Height, H (b) Distance from Crest, D, from survey plan or site measurement	(1) V is determined from Tables C1 & C2.
Consequence Score for Sliding Failure, CS_1	$C_1 = H*K*L*V_1/10$	(1) CS_1 = C_1 for Toe (1) facility + C_1 for Toe (2) facility + C_1 for Crest (1) facility + C_1 for Crest (2) facility
Consequence Score for Liquefaction Failure, CS_2	$C_2 = H*K*L*V_2/10$	(1) CS_2 = C_2 for Toe (1) facility + C_2 for Toe (2) facility + C_2 for Crest (1) facility + C_2 for Crest (2) facility
Consequence Score for Washout Failure, CS_3	$C_3 = H*K*L*V_3/10$	(1) CS_3 = C_3 for Toe (1) facility + C_3 for Toe (2) facility + C_3 for Crest (1) facility + C_3 for Crest (2) facility
Total Score (TS)	$IS_1 = a*b*c*d*e*f*g$, $IS_2 = ¼\ IS_1*h*i$, $IS_3=(IS_1)^{1/3}*j*k*l*m*n*o*p*q$, CS_1, CS_2, CS_3	(1) TS = Log_{10} $(IS_1 * CS_1 + IS_2 * CS_2 + IS_3 * CS_3)$

C.3 WORKED EXAMPLE ON NEW PRIORITY CLASSIFICATION SYSTEM FOR FILL SLOPES

PLAN AND SECTION





NEW PRIORITY CLASSIFICATION SYSTEM FOR FILL SLOPES

Slope Data

Slope No. : "Worked Example"	"SIFT No. : Worked Example	SIFT Class : B 1
Slope Height, H = 5 m Slope Angle, θ = 40 °	Crest Wall Height, H_{wc} = 0 m Toe Wall Height, H_{wt} = 0 m	
SIFT Section Profile No. A	Part of Larger Fill Body : Yes / ~~No~~	

Instability Score (IS)

Sliding (IS_1 = a.b.c.d.e.f.g = 27.6)

(a) Geometry (From Figure C1)
S1 = 32
S2 = 16
(S3) = (8)
S4 = 4
S5 = 2
S6 = 1

(b) Type of Surface Cover
(Bare) = 4 × 0.1
(Vegetated) = 3 × 0.15
Chunam = 1.5 × 0
(Shotcrete) = 1 × 0.4
} (2.3)

(c) Surface Drainage Provision
No = 2
(Yes) = (1)

(d) Signs of Seepage
Yes = 2
(No) = (1)

(e) Potential Leaking Services
Leaking = 2
(Presence) = (1.5)
None = 1

(f) Past Instability
Major = 8
Minor = 2
(No) = (1)

(g) Signs of Distress
Yes = 4
(No) = (1)

Liquefaction (IS_2 = ¼.IS_1.h.i = 2.6)

(h) Slope Height
≥30 m = 4
≥20 - <30 = 3
≥10 - <20 = 1
(<10 m) = (0.5)

(i) Type of Surface Cover
Bare = 1.1
Vegetated = 1.1
Chunam = 0.5
Shotcrete = 0.25
} (0.76) (as in item b)

Major Washout (IS_3 = $(IS_1)^{1/3}$ .j.k.l.m.n.o.p.q =) 0.15

(j) Catchment Characteristics : Topographic Setting and Size of Catchment

Topographic Setting	Size of Catchment (m²)				
	(≤100)	100 - 500	500 - 1000	1000 - 10000	>10000
Traverse Drainage Line	2	4	8	16	32
(Adjacent Drainage Line)	(2)	3	6	12	24
Traverse Topographic Depression	1	2	4	8	16
Adjacent Topographic Depression	1	2	3	6	12
Planar Slope	0.5	1	3	5	10
Spur	0.5	1	2	4	8

(k) Type of Crest Facility

Road	(Platform & Urban development)	Catch-water	Minor Development eg. Rural Footpath	Natural
1.0	(0.5)	0.25	0.10	0.05

(l) Volume of Fill Body (m³)

(≤100)	100 - 500	500 - 1000	1000 - 10000	>10000
(0.10)	0.25	0.5	1	2

(m) Channelisation of Debris — Yes = 2.0 (No) = (0.5)

(n) Erosion and Entrainment along Debris Trail — Yes = 2.0 (No) = (1.0)

(o) Spread of Debris — Yes = 0.5 (No) = (1.0)

(p) Unstable Terrain — Yes = 2.0 (No) = (1.0)

} default values used in absence of further information

(q) Masonry Wall at Crest

Wall Height ≥ 3 m	2.0
Wall Height < 3 m	1.5
(No Masonry Wall)	(1.0)

Consequence Score (CS)

Facility	Type	Group No.	Proximity			K	L	V			C = H * K * L * V / 10		
								V_1	V_2	V_3	C_1	C_2	C_3
Toe (1)	Road	5	α = 40			1	0.001	0.08	0.13	0.0625	0.000004	0.000065	0.0000312
Toe (2)	—	—	α = —			—	—	—	—	—	—	—	—
Crest (1)	Service Reservoir	2(b)	(≤3 m)	3 - 6 m	6 - 10 m	1	1	0.0375	0.0315	0.055	0.01875	0.01875	0.0275
Crest (2)	—	—	<3 m	3 - 6 m	6 - 10 m	—	—	—	—	—	—	—	—
										CS = ΣC	0.01879	0.018815	0.0275312

Total Score (TS)

$S = \sum_{1}^{3} [IS_i CS_i]$ = (27.6)(0.01879) + (2.6)(0.018815) + (0.15)(0.0275312) = 0.57

TS = $\log_{10}(S)$ = −0.24

Warning Messages : W1, W2, W3, W4 & W5

LIST OF TABLES

Table C1 - Vulnerability of Toe Facilities

(a) Buildings

Slope Height, H (m)		Angle, α (degree)								
		$\alpha > 50$	$50 \geq \alpha > 45$	$45 \geq \alpha > 40$	$40 \geq \alpha > 35$	$35 \geq \alpha > 30$	$30 \geq \alpha > 25$	$25 \geq \alpha > 20$	$20 \geq \alpha > 15$	$15 \geq \alpha > 10$
H < 5	V_1	0.0225	0.0225	0.0155	0.005	0.001	0.0001	0	0	0
	V_2	0.0225	0.0225	0.0225	0.0155	0.005	0.001	0.0001	0	0
	V_3	0.010	0.008	0.004	0.002	0.0005	0.00008	0.000005	0	0
$5 \leq H < 10$	V_1	0.1125	0.1125	0.0775	0.025	0.005	0.0005	0	0	0
	V_2	0.1125	0.1125	0.1125	0.0775	0.025	0.005	0.0005	0	0
	V_3	0.05	0.04	0.02	0.01	0.0025	0.0004	0.000025	0	0
$10 \leq H < 15$	V_1	0.45	0.45	0.31	0.10	0.02	0.002	0	0	0
	V_2	0.45	0.45	0.45	0.31	0.10	0.02	0.002	0	0
	V_3	0.25	0.24	0.18	0.10	0.0425	0.0104	0.001525	0	0
$15 \leq H < 20$	V_1	0.95	0.92	0.70	0.35	0.11	0.02	0	0	0
	V_2	0.95	0.95	0.95	0.8	0.48	0.18	0.045	0.005	0
	V_3	0.60	0.60	0.56	0.45	0.29	0.135	0.0435	0.0076	0
$20 \geq H$	V_1	0.95	0.95	0.86	0.59	0.26	0.075	0.013	0	0
	V_2	0.95	0.95	0.95	0.95	0.87	0.63	0.34	0.12	0.015
	V_3	0.80	0.80	0.80	0.72	0.50	0.25	0.084	0.015	0.001

(b) Others

Slope Height, H (m)		Angle, α (degree)								
		$\alpha > 50$	$50 \geq \alpha > 45$	$45 \geq \alpha > 40$	$40 \geq \alpha > 35$	$35 \geq \alpha > 30$	$30 \geq \alpha > 25$	$25 \geq \alpha > 20$	$20 \geq \alpha > 15$	$15 \geq \alpha > 10$
H < 5	V_1	0.03	0.03	0.026	0.016	0.006	0.00075	0	0	0
	V_2	0.03	0.03	0.03	0.026	0.016	0.006	0.00075	0	0
	V_3	0.040	0.036	0.025	0.013	0.004	0.001	0.0001	0	0
$5 \leq H < 10$	V_1	0.150	0.150	0.130	0.08	0.030	0.00375	0	0	0
	V_2	0.15	0.15	0.15	0.13	0.08	0.03	0.00375	0	0
	V_3	0.20	0.18	0.125	0.0625	0.02	0.005	0.0005	0	0
$10 \leq H < 15$	V_1	0.60	0.60	0.52	0.32	0.12	0.015	0	0	0
	V_2	0.6	0.60	0.6	0.52	0.32	0.12	0.015	0	0
	V_3	0.60	0.58	0.435	0.315	0.145	0.05	0.0105	0	0
$15 \leq H < 20$	V_1	0.95	0.92	0.92	0.70	0.49	0.08	0	0	0
	V_2	0.95	0.95	0.95	0.95	0.80	0.50	0.20	0.02	0
	V_3	0.875	0.875	0.835	0.725	0.530	0.285	0.1	0.0235	0
$20 \geq H$	V_1	0.95	0.95	0.95	0.86	0.59	0.25	0.03	0	0
	V_2	0.95	0.95	0.95	0.95	0.95	0.8	0.50	0.20	0.02
	V_3	0.95	0.95	0.95	0.95	0.81	0.48	0.18	0.045	0.005

Note : Refer to Figure C1 (a) for definition of slope geometry H, α.

Table C2 - Vulnerability of Crest Facilities

(a) Buildings				
Slope Height, H (m)		Distance from Crest, D (m)		
		$10 > D \geq 6$	$6 > D \geq 3$	$D < 3$
$H < 5$	$V_1 = V_2$	0	0.0000125	0.0003
	V_3	0	0.00023	0.0023
$5 \leq H < 10$	$V_1 = V_2$	0	0.0000625	0.0015
	V_3	0	0.00115	0.0115
$10 \leq H < 15$	$V_1 = V_2$	0	0.00025	0.006
	V_3	0	0.00715	0.0375
$15 \leq H < 20$	$V_1 = V_2$	0.0002	0.003	0.02
	V_3	0.008	0.0285	0.101
$H \geq 20$	$V_1 = V_2$	0.0005	0.01	0.05
	V_3	0.015	0.045	0.15
(b) Others				
Slope Height, H (m)		Distance from Crest, D (m)		
		$10 > D \geq 6$	$6 > D \geq 3$	$D < 3$
$H < 5$	$V_1 = V_2$	0	0.00025	0.0075
	V_3	0	0.0022	0.011
$5 \leq H < 10$	$V_1 = V_2$	0	0.00125	0.0375
	V_3	0	0.011	0.055
$10 \leq H < 15$	$V_1 = V_2$	0	0.005	0.15
	V_3	0	0.043	0.18
$15 \leq H < 20$	$V_1 = V_2$	0.002	0.04	0.4
	V_3	0.004	0.092	0.2825
$H \geq 20$	$V_1 = V_2$	0.002	0.074	0.54
	V_3	0.006	0.12	0.315
Note : Refer to Figure C1(a) for definition of slope geometry H, D.				

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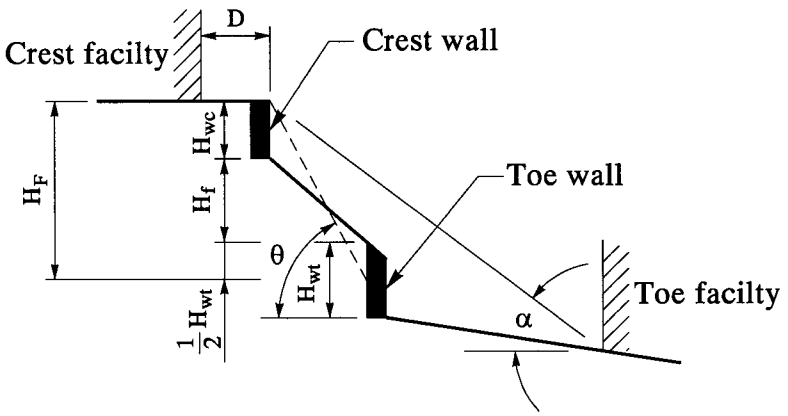
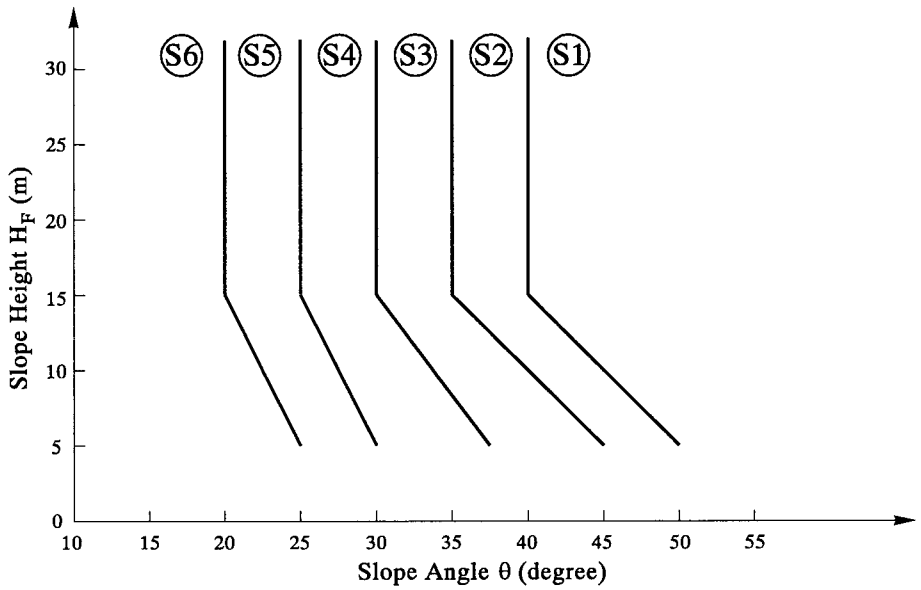


(a) Slope Geometry



(b) Geometry Grouping

Notes : (1) For a slope with geometry at the dividing line between two categories, the slope is taken to be within the less severe cateogory.

(2) If the toe wall is not retaining the fill body, use $H_F = H_{wc} + H_f$.

Figure C1 - Slope Geometry and Grouping

APPENDIX D

SCORING SCHEME AND GUIDANCE NOTES ON NPCS FOR RETAINING WALLS

CONTENTS

D.1 NEW PRIORITY CLASSIFICATION SYSTEM SCORING SCHEME FOR RETAINING WALLS

Wall No. _____ **Section :** ○ 1-1 (Most Severe Consequence)
○ 2-2 (Maximum Feature Height)

(A) GEOMETRY (Figure D1)

		1-1	2-2
(i)	H_w	m	m
(ii)	H_r	m	m
(iii)	H_s	m	m
(iv)	β	°	°
(v)	θ_f	°	°
(vi)	α	°	°
(vii)	Surcharge at crest of wall, s	kPa	kPa
(viii)	$\frac{H_e}{B_w}$ =		
(ix)	In the case of multiple walls, θ =	°	°

· Feature Height, H

$= H_s + H_r + H_w$ m

· Effective Height

$H_e = H_w (1 + 0.35 \tan \beta) + \frac{s}{20}$

m

(B) WALL SLENDERNESS RATIO ($\frac{H_e}{B_w}$)

(i)	$4.2 < \frac{H_e}{B_w} \leq 5$	○
(ii)	$3.5 < \frac{H_e}{B_w} \leq 4.2$	○
(iii)	$2.8 < \frac{H_e}{B_w} \leq 3.5$	○
(iv)	$2.0 < \frac{H_e}{B_w} \leq 2.8$	○
(v)	$\frac{H_e}{B_w} < 2.0$	○
(vi)	Is $\frac{H_e}{B_w} > 5$	○

For (i) B = 100
(ii) 75
(iii) 50
(iv) 25
(v) 0

B | |

Yes/No*

(C) WALL CONDITION

(i)	Advanced stage of severe deformation and/or distress	○
(ii)	Onset of severe deformation and/or distress	○
(iii)	Moderate deformation and/or distress	○
(iv)	Minimal deformation and distress	○

For (i) C= 100
(ii) 70
(iii) 30
(iv) 0

C | |

(D) NATURE OF RETAINED MATERIAL

(i)	Fill or unknown	○
(ii)	Colluvium, residual soil, PW 0/30 or PW 30/50 rock mass	○

For (i) D = 1.0
(ii) 0.7

D | |

* Delete where appropriate

(E) POTENTIAL FOR WATER INGRESS

(E1) Water Ingress through Surface

For (i) E1 = 15
(ii) 10
(iii) 0

(i) Crest area substantially unprotected ○
(ii) Crest area partially protected ○
(iii) Crest area substantially protected ○

E1 [ ]

(E2) Drainage Provisions for Surface Water

For (i) E2 = 15
(ii) 10
(iii) 5
(iv) 0

(i) Few or no channels above wall crest plus potential for convergent flow of surface water towards the wall ○
(ii) Few or no channels above wall crest ○
(iii) Some channels above wall crest but insufficient in size and/or number ○
(iv) Adequate channels above wall crest ○

E2 [ ]

(E3) Water-carrying Services

For (i) E3 = 15
(ii) 10
(iii) 0

(i) Presence of potentially leaky services and signs of leakage noted ○
(ii) Presence of potentially leaky services but no signs of leakage noted ○
(iii) No potentially leaky services ○

E3 [ ]

(E4) Seepage

For (i) E4 = 15
(ii) 10
(iii) 5
(iv) 0

(i) Heavy seepage at mid-height or above ○
(ii) Slight to moderate seepage at mid-height or above, or heavy seepage below mid-height ○
(iii) Slight to moderate seepage below mid-height, or signs of seepage on wall face ○
(iv) No signs of seepage ○

Form of wall drainage: Weepholes/Horizontal drains/Nil*

E4 [ ]

(F) TYPE OF WALL

For (i) or (ii) F = 30
(iii) or (iv) or (v) or (vi) F = 20
(vii) or (viii) F = 10
(ix) or (x) F = 0

(i) Random rubble masonry wall (with or without pointing) with no ties or horizontal beams ○
(ii) Random rubble masonry wall (with or without pointing) with ties or horizontal beams ○
(iii) Wall composed of lime-stabilised soil ○
(iv) Brick wall ○
(v) Dry packed dressed block/squared rubble wall without ties ○
(vi) Any type of masonry wall (except for random rubble walls) with horizontal beams made of lime-stabilised soil or brick ○
(vii) Dry packed dressed block/squared rubble wall with ties ○
(viii) Any type of masonry wall (except for random rubble walls) with concrete horizontal beams ○
(ix) Masonry facing to concrete wall ○
(x) Concrete wall ○
(xi) Others (Please specify : _____) ○

F [ ]

Evidence of the wall having been extended upwards in the past? Yes/No*

Is wall of dry packed random rubble > 5 m Yes/No*

* Delete where appropriate

(G) PAST INSTABILITY

Confirmed Past Instability	G1	Confirmed Past Instability	G2
○ Full-height failure	30	○ Full-height failure	20
○ Multiple part-height or structural failures	25	○ Multiple part-height or structural failures	15
○ Part-height failure	20	○ Part-height failure	10
○ Structural failure only	20	○ Structural failure only	10
○ None	0	○ None	0

G = G1 or G2, whichever is the greater

G

(J) AVERAGE GRADIENT OF NATURAL SLOPE BELOW WALL

(i) $\alpha > 35°$
(ii) $25° < \alpha \leq 35°$
(iii) $15° < \alpha \leq 25°$
(iv) $\alpha \leq 15°$

If there is no natural slope below wall, take J = 0

For (i) J = 60
(ii) 30
(iii) 15
(iv) 0

J

(K) FACILITY BELOW CREST OF FEATURE

Type of crest facility (for roads and footpaths, give also the name)

Group No.

Distance of facility from crest of feature, K_2 m

Group 1 K_1 = 4
2 2
3 1
4 0.5
5 0.1

K_1

K_2

(L) FACILITY BELOW TOE OF FEATURE

Type of toe facility (for roads and footpaths, give also the name

Group No.

Distance of facility from toe of feature, L_2 m

Group 1 L_1 = 4
2 2
3 1
4 0.5
5 0.1

L_1

L_2

(M) UPSLOPE AND DOWNSLOPE TOPOGRAPHY

(i) Upslope angle β above crest $< 35°$ & downslope angle α below toe $< 15°$ ○

(ii) Upslope angle β above crest $\geq 35°$ ○

(iii) Downslope angle α below toe : $15° \leq \alpha < 30°$ ○

(iv) Downslope angle α below toe $\geq 30°$ ○

(v) Conditions (ii) & (iii) ○

(vi) Conditions (ii) & (iv) ○

For (i) M = 0
(ii) 0.3
(iii) 0.6
(iv) 1.2
(v) 0.9
(vi) 1.5

M

(N) CONSEQUENCE FACTOR

Consequence-to-life category

(i) '1' ○
(ii) '2' ○
(iii) '3' ○

Consequence factor is used if a large number of fatalities, say more than 10, will result from the landslip. The following conditions are typical for such situation :

(a) the Consequence-to-life Category of the feature is '1' or '2', ○
(b) large volume of failure is expected, and ○
(c) occupied buildings may collapse or be covered in the event of failure, or mass transportation is seriously affected. ○

If large number of casualty will result in the event of a failure (e.g. conditions (a), (b) & (c) apply), N = 1.25
Otherwise, N = 1.0

N	

CALCULATED SCORES AND WARNING MESSAGES

INSTABILITY SCORE (I.S.)

I.S. = (B X D) + C + E1 + E2 + E3 + E4 + F + G + J

I.S.	

Notes: (a) If $\frac{H_e}{B_w} > 5$, take [(B x D) + C] to be 200 for all wall types

(b) If wall is of dry-packed random rubble of > 5 m, take C = 100

CONSEQUENCE SCORE (C.S.)

C.S. = $2N\,(K + L^*)V$

C.S.	

where :

$$K = K_1 \left[\frac{1.2H_w - K_2}{1.2H_w}\right] \geq 0$$

$$L^* = 2L_1 \left[\frac{(2+M)H - L_2}{(2+M)H}\right] \geq 0$$

$$V = \gamma H_w$$

Notes : (1) γ = 1.0 for full-scale failure
= 0.7 for partial failure
= 0.4 for minor failure

(2) If H_w > 20 m, take H_w = 20 m in calculating V.

TOTAL SCORE (T.S.)

T.S. = (I.S.) (C.S.) / 100

T.S.	

WARNING MESSAGES

W1 = Warning, if the nature of retained material is PW 50/90 or better rock mass. | W1 | |

W2 = Warning, if θ_f is < 75° | W2 | |

W3 = Warning, if there is evidence of the wall having been extended upwards in the past. | W3 | |

W4 = Warning, if muddy water indicating internal erosion is observed to be flowing out of the wall face. | W4 | |

W5 =	Warning, if H of Section 1-1 < 75% of H of Section 2-2.	W5
W6 =	Warning, if reinforcement (e.g. soil nails) or other forms of support to the wall (e.g. buttresses, propping by buildings etc.) is present.	W6
W7 =	Warning, if wall is "post-GCO".	W7
W8 =	Warning, if wall belongs to "other" type that is not included in Item F.	W8
W9 =	Warning, if there is a natural slope below the wall.	W9
W10 =	Warning, if the feature is a SIFT Class A feature.	W10
W11 =	Warning, if θ < 60° and individual walls are < 3 m in the case of a series of walls retaining a number of platforms	W11
W12 =	Warning if wall slenderness ratio is greater than 5	W12

* Delete where appropriate

D.2 GUIDANCE NOTES ON DATA COLLECTION AND SCORE CALCULATION

General

(1) If H of Section 1-1 ≥ 75% of H of Section 2-2, consider Section 1-1 (i.e. in terms of most severe consequence) in calculating the scores. Otherwise, both Sections 1-1 & 2-2 (in terms of maximum feature height, H) should be considered. In the latter case, a full assessment should be carried out for Section 1-1 to determine the scores but for Section 2-2, only the geometrical details need to be recorded.

(2) ○ & □ for raw data to be collected. For ○, tick as appropriate. For □, fill in the appropriate data.

(3) All parameters may be obtained by experienced technical staff based on simple site measurements and inspections, and literature search.

(4) Unless stated otherwise, "distance" refers to horizontal distance and "height" refers to vertical height.

Items A and B

(5) Definitions of the geometric parameters are given in Figure D1.

(6) A retaining wall is defined as one with an average face angle (θ_f) of 75° or more. Where θ_f is less than 75°, it would be considered as a facing to a slope.

(7) An assessment of the building surcharge at slope crest may be made by reference to Table 16 in the second edition of Geoguide 1 (GEO 1993).

(8) In the case of a series of walls retaining a number of platforms, the walls should be considered as a single feature if the average gradient (θ) of the line joining the toe of the lowermost wall and the top of the uppermost wall is ≥ 60° (Figure 1). if $\theta < 60°$, the walls should be considered as separate walls for data collection purposes if each wall is "registrable" based on the SIRST criteria.

The criteria for features requiring registration are as follows :

(a) Cut slopes, including any associated retaining walls, and retaining walls greater than 3 m high,

(b) Fill slopes, including any associated retaining walls, greater than 5 m high,

(c) Fill slopes, including any associated retaining walls, less than 5 m high, in consequence Categories 1, 2 & 3 are equivalent to the High, Low and Negligible Risk Categories respectively in Table 5.2 of the Geotechnical Manual for Slopes (GCO, 1984). It should be noted that the Consequence Category for slopes affecting bus shelters is 1.

References

GCO (1984). Geotechnical Manual for Slopes. (Second edition). Geotechnical Control Office, 306 p.

GEO (1993). Guide to Retaining Wall Design. (Second edition). Geotechnical Engineering Office, 268 p.

ITEM C

(9) See Table D1 for guidance on the assessment of the state of wall deformation.

(10) Minimal distress refers to wall fabric in good condition; moderate distress refers to the situation where much mortar is missing, or where there is minor dislocation of isolated wall blocks; onset of severe distress refers to the situation where some of the wall blocks are missing or dislocated; advanced stage of severe distress refers to the condition where many of the wall blocks are missing or subject to major dislocation.

(11) Where there are significant signs of distress, or visual or documented evidence of continuing hazardous movement, of a slope, excavation, retaining structure, boulder or rock fragment, immediate action should be taken.

(12) Care should be taken in assessing whether apparent signs of distress (such as cracking) are induced during wall construction or due to inadequate maintenance. In the latter circumstances, although maintenance work may be required, they should not be regarded as signs of distress. In case of doubt, a conservative assessment should be made.

ITEM D

(13) Reference may be made to the findings from the SIFT study available from CGE/Planning concerning the nature of the retained material.

ITEM E1

(14) As a general guideline, 'substantially protected' refers to $>75\%$ area covered, 'partially protected' refers to between 25% and 75% area protected and 'substantially unprotected' refers to $<25\%$ area covered.

(15) Crest area refers to the area within a horizontal distance of $H_0/2$ beyond the crest of the wall.

(16) Where there is potential for ponding above the wall crest, the higher score for the next higher category should be adopted.

ITEM E2

(17) In assessing the potential for convergent flow of surface water, consideration should be given to site topography, catchment area and environmental factors.

ITEM E3

(18) Assessment shall be based on site inspections.

(19) Any water-carrying services that could potentially affect the slope in the event of leakage, typically water-carrying services within H_0 from the crest of the slope, should be considered. However, each case should be treated on its merits in determining the

extent necessary for the assessment. If proper ducting provisions have been provided, the services may be taken as not "potentially leaky".

ITEM E4

(20) If the inspection is carried out during the dry season, a conservative assessment of the seepage condition should be made.

(21) Consideration should also be given to the overall setting of the slope features, e.g. whether the retaining wall is at the head of a valley, along the side of a valley or across the nose of a spur, presence of hydrogeological features (e.g. streamcourse) which might contribute water to the retained material, or evidence of a high water table upslope (e.g. an unusually rich vegetation cover).

ITEM F

(22) For typical photographs of common types of masonry walls, reference may be made to Figure D2 and attached plates.

(23) In general, most of the walls constructed after the War were of concrete construction. However, some masonry walls may be built after the War. Such walls are normally found in cottage and squatter areas as well as in less developed areas, such as the New Territories and outlying islands, where cheap unskilled labour was readily available. Post-war masonry walls can sometimes be recognised by their generally poor workmanship, such as small and poorly squared blocks, and presence of thick mortar between blocks.

(24) Concrete walls sometimes have a decorative masonry facing which can give the impression of being a masonry wall. This type of wall can often be distinguished by the presence of vertical movement joints at a regular spacing, uniformity of the pointing and regular squared-shaped, well dressed blocks. Smaller squared blocks, not necessarily laid in horizontal courses, but arranged to create a regular pattern on the wall face, and often without pointing, have also been used as a decorative facing to concrete walls.

(25) In assessing whether the wall has been extended upwards in the past, attention should be given to possible different style, workmanship and material nature of the upper and lower parts of the wall.

ITEM G

(26) The assessment of evidence of past instability shall be based on :

(a) the available Incident Reports and Landslip Cards,
(b) B&P fieldsheets,
(c) 1:5 000 GASP Reports, and
(d) site observations.

(27) Full-height failure refers to wall failure involving failure of the overall height of the

wall and the retained material. Part-height failure refers to incidents not involving full-height failure of the wall. Structural failure refers to failure of the wall fabric only without movement of the retained material.

(28) "Confirmed past instability" refers to past instability with confirmed documentary evidence of its occurrence.

(29) 'Inferred past instability' refers to past instability which is not confirmed but inferred from site observations or other available information.

ITEM J

(30) The assessment of whether the downslope comprises a natural slope should be made during site inspection. Reference may also be made to the SIFT report . For definition of the average downslope angle, see Figure D1.

ITEMS K and L

(31) The crest and toe facilities shall be grouped as given in Table 1.

ITEM N

(32) For consequence-to-life categories, refer to Table 5.2 of the Geotechnical Manual for Slopes and the latest relevant GEO Circulars.

(33) As a general guide, debris volume in excess of 500 m^3 may be taken as a 'large volume of failure'.

(34) In addition, the Consequence Score will be increased by 25% if a large number of casualties may be caused by a failure. This factor accounts for public aversion to multiple fatalities arising from a single event.

CALCULATED SCORES

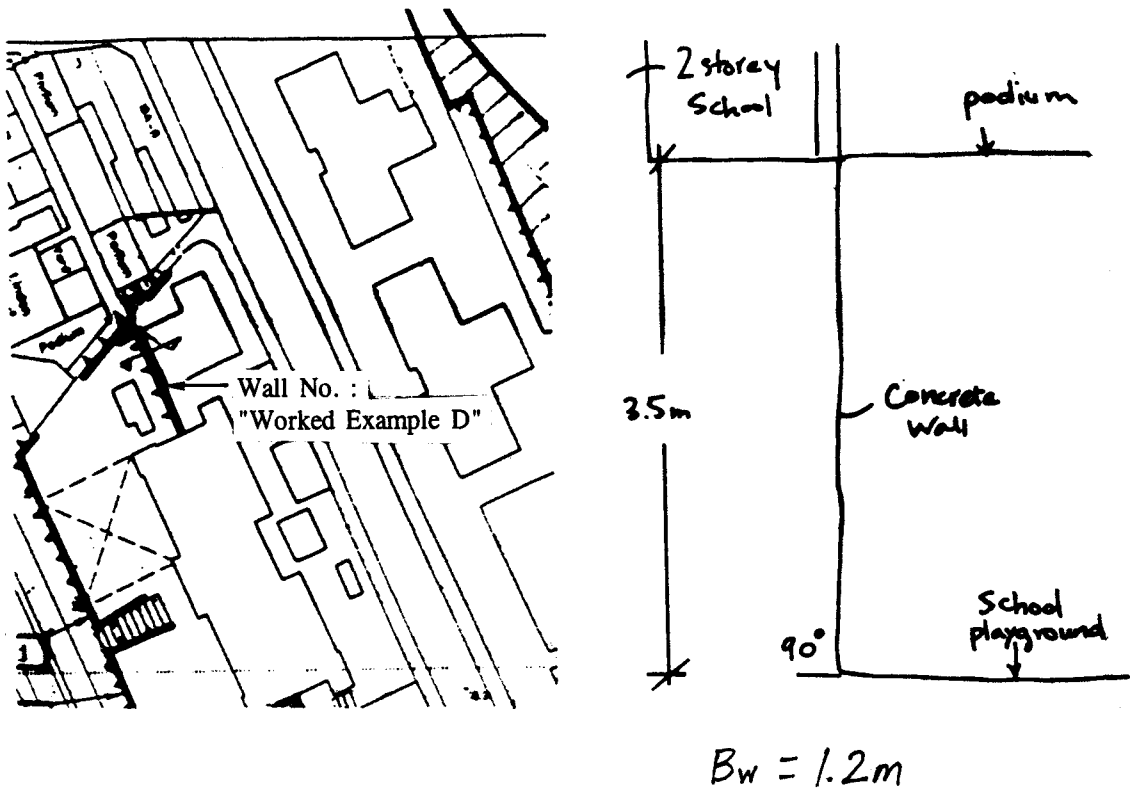
(35) γ may generally be taken as 1.0 for retaining walls, unless judged otherwise by the engineer. It should be noted that the maximum Consequence Score is only attainable for retaining walls in excess of 20 m in height. It is very rare that walls will be of this range of height, and hence most walls will have much lower Consequence Scores in practice.

WARNING MESSAGES

(36) "POST-GCO" refers to features that were formed or upgraded to the current geotechnical standards after the establishment of GCO in 1977. It also refers to features that have been checked and found to meet current geotechnical standards.

D.3 WORKED EXAMPLE ON NEW PRIORITY CLASSIFICATION SYSTEM FOR RETAINING WALLS

PLAN AND SECTION



NEW PRIORITY CLASSIFICATION SYSTEM FOR RETAINING WALLS

Wall No. "Worked Example D" **Section :** ☑ 1-1 (Most Severe Consequence) ○ 2-2 (Maximum Feature Height)

(A) GEOMETRY (Figure D1)

		1-1	2-2
(i)	H_w	3.5 m	— m
(ii)	H_r	0 m	— m
(iii)	H_s	0 m	— m
(iv)	β	0 °	— °
(v)	θ_t	90 °	— °
(vi)	α	0 °	— °
(vii)	Surcharge at crest of wall, s	20 kPa	— kPa
(viii)	$\frac{H_e}{B_w}$ =	3.75	—
(ix)	In the case of multiple walls, θ =	— °	— °

· Feature Height, H

$= H_s + H_r + H_w$

3.5 m

· Effective Height (s = 20)

$H_e = H_w (1 + 0.35 \tan \beta) + \frac{s}{20}$

4.5 m

(B) WALL SLENDERNESS RATIO ($\frac{H_e}{B_w}$)

(i)	$4.2 < \frac{H_e}{B_w} \leq 5$	○
(ii)	$3.5 < \frac{H_e}{B_w} \leq 4.2$	☑
(iii)	$2.8 < \frac{H_e}{B_w} \leq 3.5$	○
(iv)	$2.0 \leq \frac{H_e}{B_w} \leq 2.8$	○
(v)	$\frac{H_e}{B_w} < 2.0$	○
(vi)	Is $\frac{H_e}{B_w} > 5$	○

For (i) B = 100, (ii) 75, (iii) 50, (iv) 25, (v) 0

B	75

~~Yes~~/No*

(C) WALL CONDITION

(i)	Advanced stage of severe deformation and/or distress	○
(ii)	Onset of severe deformation and/or distress	○
(iii)	Moderate deformation and/or distress	○
(iv)	Minimal deformation and distress	☑

For (i) C = 100, (ii) 70, (iii) 30, (iv) 0

C	0

(D) NATURE OF RETAINED MATERIAL

(i)	Fill or unknown	☑
(ii)	Colluvium, residual soil, PW 0/30 or PW 30/50 rock mass	○

For (i) D = 1.0, (ii) 0.7

D	1.0

*Delete where appropriate

(E) POTENTIAL FOR WATER INGRESS

(E1) Water Ingress through Surface

For (i) E1 = 15, (ii) 10, (iii) 0

(i) Crest area substantially unprotected ○
(ii) Crest area partially protected ○
(iii) Crest area substantially protected ✓

E1: 0

(E2) Drainage Provisions for Surface Water

For (i) E2 = 15, (ii) 10, (iii) 5, (iv) 0

(i) Few or no channels above wall crest plus potential for convergent flow of surface water towards the wall ○
(ii) Few or no channels above wall crest ✓
(iii) Some channels above wall crest but insufficient in size and/or number ○
(iv) Adequate channels above wall crest ○

E2: 10

(E3) Water-carrying Services

For (i) E3 = 15, (ii) 10, (iii) 0

(i) Presence of potentially leaky services and signs of leakage noted ○
(ii) Presence of potentially leaky services but no signs of leakage noted ○
(iii) No potentially leaky services ✓

E3: 0

(E4) Seepage

For (i) E4 = 15, (ii) 10, (iii) 5, (iv) 0

(i) Heavy seepage at mid-height or above ○
(ii) Slight to moderate seepage at mid-height or above, or heavy seepage below mid-height ○
(iii) Slight to moderate seepage below mid-height, or signs of seepage on wall face ○
(iv) No signs of seepage ✓

Form of wall drainage: ~~Weepholes/Horizontal drains~~/Nil*

E4: 0

(F) TYPE OF WALL

For (i) or (ii) F = 30
(iii) or (iv) or (v) or (vi) F = 20
(vii) or (viii) F = 10
(ix) or (x) F = 0

(i) Random rubble masonry wall (with or without pointing) with no ties or horizontal beams ○
(ii) Random rubble masonry wall (with or without pointing) with ties or horizontal beams ○
(iii) Wall composed of lime-stabilised soil ○
(iv) Brick wall ○
(v) Dry packed dressed block/squared rubble wall without ties ○
(vi) Any type of masonry wall (except for random rubble walls) with horizontal beams made of lime-stabilised soil or brick ○
(vii) Dry packed dressed block/squared rubble wall with ties ○
(viii) Any type of masonry wall (except for random rubble walls) with concrete horizontal beams ○
(ix) Masonry facing to concrete wall ○
(x) Concrete wall ✓
(xi) Others (Please specify: _____) ○

F: 0

Evidence of the wall having been extended upwards in the past? ~~Yes~~/No*

Is wall of dry packed random rubble >5 m ~~Yes~~/No*

*Delete where appropriate

(G) PAST INSTABILITY

Confirmed Past Instability	G1	Confirmed Past Instability	G2
○ Full-height failure	30	○ Full-height failure	20
○ Multiple part-height or structural failures	25	○ Multiple part-height or structural failures	15
○ Part-height failure	20	○ Part-height failure	10
○ Structural failure only	20	○ Structural failure only	10
✓ None	(0)	✓ None	(0)

G = G1 or G2, whichever is the greater

G: 0

(J) AVERAGE GRADIENT OF NATURAL SLOPE BELOW WALL

(i) $\alpha > 35°$
(ii) $25° < \alpha \leq 35°$
(iii) $15° < \alpha \leq 25°$
(iv) $\alpha \leq 15°$

If there is no natural slope below wall, take J=0

For (i) J = 60
(ii) 30
(iii) 15
(iv) (0)

J: 0

(K) FACILITY BELOW CREST OF FEATURE

Type of crest facility (for roads and footpaths, give also the name): School

Group No.: 1

Distance of facility from crest of feature, K_2: 0 m

Group (1) K_1 = (4)
2 2
3 1
4 0.5
5 0.1

K_1: 4

K_2: 0

(L) FACILITY BELOW TOE OF FEATURE

Type of toe facility (for roads and footpaths, give also the name): Heavily-used Playground

Group No.: 3

Distance of facility from toe of feature, L_2: 0 m

Group 1 L_1 = 4
2 2
(3) (1)
4 0.5
5 0.1

L_1: 1

L_2: 0

(M) UPSLOPE AND DOWNSLOPE TOPOGRAPHY

(i)	Upslope angle β above crest < 35° & downslope angle α below toe < 15°	✓
(ii)	Upslope angle β above crest ≥ 35°	○
(iii)	Downslope angle α below toe : 15° ≤ α < 30°	○
(iv)	Downslope angle α below toe ≥ 30°	○
(v)	Conditions (ii) & (iii)	○
(vi)	Conditions (ii) & (iv)	○

For (i) M = (0)
(ii) 0.3
(iii) 0.6
(iv) 1.2
(v) 0.9
(vi) 1.5

M: 0

(N) CONSEQUENCE FACTOR

Consequence-to-life category
(i) '1' ✓
(ii) '2' ○
(iii) '3' ○

Consequence factor is used if a large number of fatalities, say more than 10, will result from the landslip. The following conditions are typical for such situation :

(a) the Consequence-to-life Category of the feature is '1' or '2', ✓
(b) large volume of failure is expected, and ○
(c) occupied buildings may collapse or be covered in the event of failure, or mass transportation is seriously affected. ✓

If large number of casualty will result in the event of a failure (e.g. conditions (a), (b) & (c) apply),
N = 1.25
Otherwise, N = 1.0

N	1.0

CALCULATED SCORES AND WARNING MESSAGES

INSTABILITY SCORE (I.S.)

I.S. = $(B \times D) + C + E1 + E2 + E3 + E4 + F + G + J$ = $(15\times1) + 0 + 0 + 10 + 0 + 0 + 0 + 0 + 0$

Notes: (a) If $\frac{H_t}{B_w} > 5$, take [(B × D) + C] to be 200 for all wall types
(b) If wall is of dry-packed random rubble of >5 m, take C = 100

I.S	85

CONSEQUENCE SCORE (C.S.)

C.S. = $2N(K + L^*)V$ = $2(1)(4+2)(3.5)$

C.S	42

where :

$$K = K_1\left[\frac{1.2H_w - K_2}{1.2H_w}\right] \neq 0, \quad K = 4\left[\frac{1.2(3.5) - 0}{1.2(3.5)}\right]$$

$$L^* = 2L_1\left[\frac{(2+M)H - L_2}{(2+M)H}\right] \neq 0 \quad L^* = 2(1)\left[\frac{(2+0)3.5 - 0}{(2+0)3.5}\right] = 2$$

$V = \gamma H_w$ = $1.0(3.5)$

Notes: (1) γ = 1.0 for full-scale failure
= 0.7 for partial failure
= 0.4 for minor failure

(2) If H_w >20 m, take H_w = 20 m in calculating V.

TOTAL SCORE (T.S.)

T.S. = (I.S.) (C.S.) / 100

T.S	35.7

WARNING MESSAGES

W1 =	Warning, if the nature of retained material is PW 50/90 or better rock mass	W1 —
W2 =	Warning, if θ_f is < 75°.	W2 —
W3 =	Warning, if there is evidence of the wall having been extended upwards in the past.	W3 —
W4 =	Warning, if muddy water indicating internal erosion is observed to be flowing out of the wall face.	W4 —

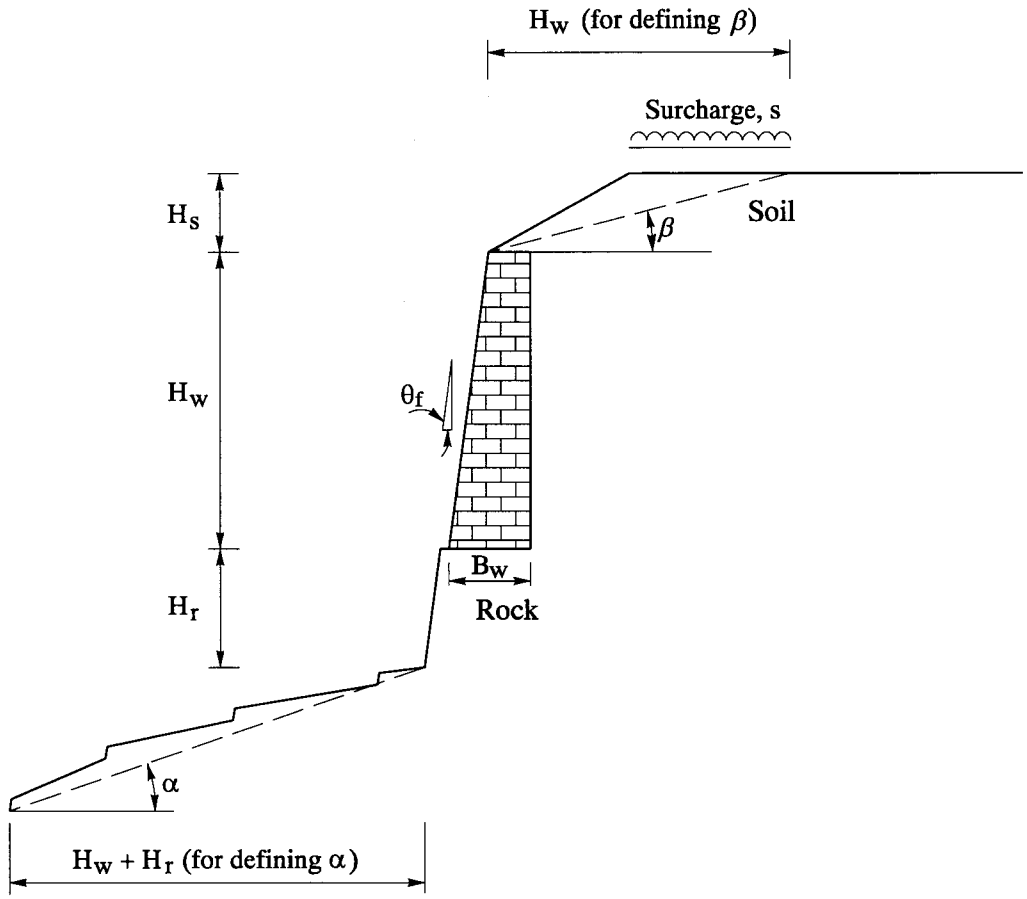
W5 = Warning, if H of Section 1-1 < 75% of H of Section 2-2.	W5 —
W6 = Warning, if reinforcement (e.g. soil nails) or other forms of support to the wall (e.g. buttresses, propping by buildings etc.) is present.	W6 —
W7 = Warning, if wall is "post-GCO".	W7 —
W8 = Warning, if wall belongs to "other" type that is not included in Item F.	W8 —
W9 = Warning, if there is a natural slope below the wall.	W9 —
W10 = Warning, if the feature is a SIFT Class A feature.	W10 —
W11 = Warning, if θ < 60° and individual walls are < 3 m in the case of a series of walls retaining a number of platforms	W11 —
W12 = Warning if wall slenderdness ratio is greater than 5	W12 —

LIST OF TABLES

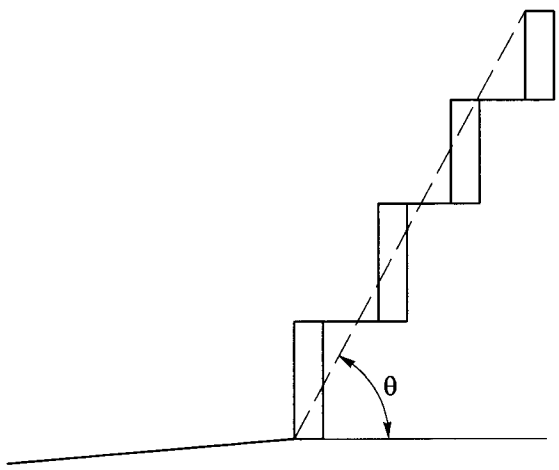
Table D1 - Guidelines for Evaluation of the State of Wall Deformation

Observed State of Wall Deformation	Forward Movement	Bulging
Minimal Deformation	Forward movement of wall as indicated by: (a) long continuous movement cracks at wall crest sub-parallel to wall, total width at any section $<0.1\%$ of wall height or (b) sub-vertical through cracks in return wall of total width at each level $<0.1\%h$ where h is height of measurement point from ground surface level in front of toe	Negligible bulging of wall
Moderate Deformation	Forward movements as (1) except crack width totalling between 0.1% and 0.2%h	Minor bulging of wall face noticeable to naked eye
Onset of Severe Deformation	Forward movements as (1) except crack width totalling between 0.2% and 0.6%h	Bulged profile of wall face sufficient to touch a vertical line drawn through wall toe, or maximum bulging of wall approaching or equal to 75 mm
Advanced Stage of Sever Deformation	Forward movements as (1) except crack width totalling to a value $>0.6\%h$	Bulging as (3) but protruding beyond a vertical line drawn through toe, or maximum bulging of wall $>$ 75 mm
Note : In using this Table, engineering judgement is crucial since different walls are likely to present different degrees of difficulty in deformation determination. The proposed deformation limits shown in this Table should not be regarded as absolute.		

LIST OF FIGURES

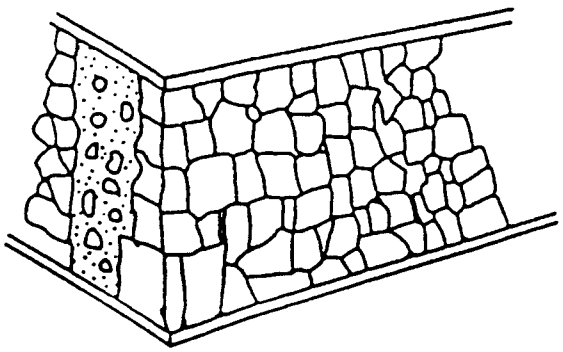


(a) Feature Geometry

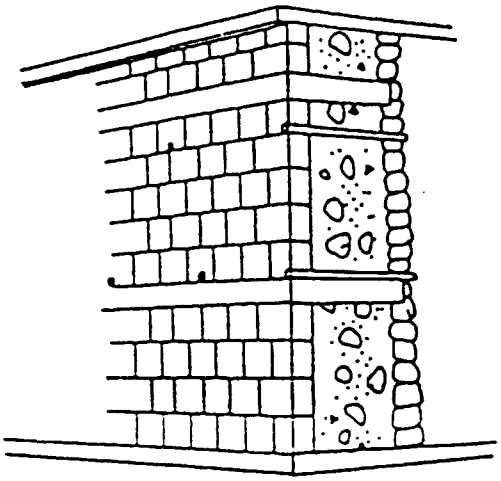


(b) Multiple Walls

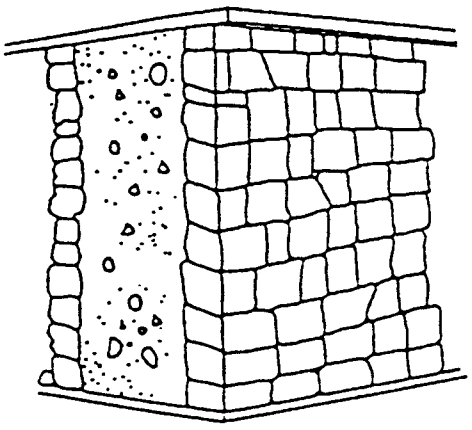
Figure D1 - Feature Geometry



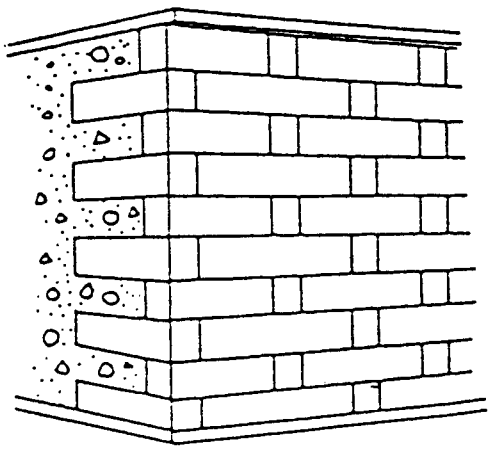
(a) Dry Packed Random Rubble Wall



(b) Dressed Block Wall with Horizontal Beams



(c) Dry Packed Squared Rubble Wall



(d) Tied Face Wall

Figure D2 - Typical Forms of Construction of Masonry Walls

LIST OF PLATES

Plate D1 - Dry Packed Random Rubble Wall (11SW-A/R389)

Plate D2 - Pointed Random Rubble Wall (11SW-A/R116)

Plate D3 - Dry Packed Squared Rubble Wall (11SW-A/R109)

Plate D4 - Dry Packed Squared Rubble Wall with Horizontal Beams (11SW-A/R163)

Plate D5 - Pointed Squared Rubble Wall (11SW-A/R295)

Plate D6 - Pointed Squared Rubble Wall with Horizontal Beams (11SW-A/R194)

Plate D7 - Dressed Block Wall (11SW-A/R46)

Plate D8 - Dressed Block Wall with Horizontal Beams (11SW-A/R423)

Plate D9 - Tied Face Wall (11SW-A/R74)

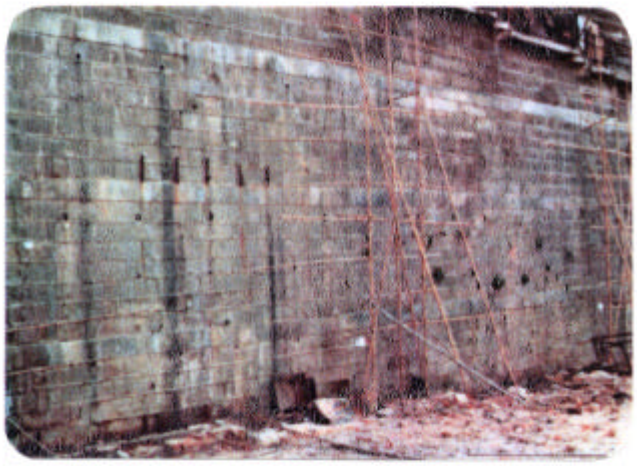


Plate D10 - Tied Face Wall with Horizontal Beams (11SW-A/R45)

Plate D11 - Random Rubble Wall with Stone Ties

Plate D12 - Recent Masonry Walls

(a) presence of expansion joints or similar construction joints,

(b) special architectural features, such as masonry blocks with irregular pattern.

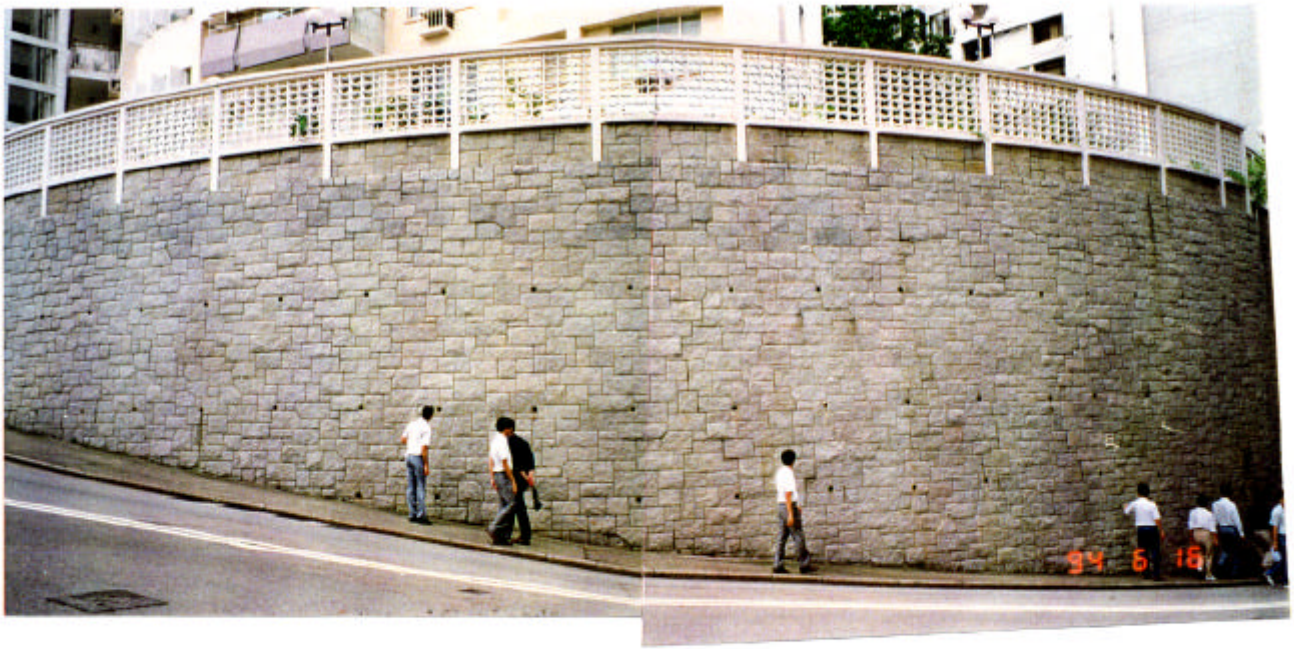


Plate D13 - Masonry Facing to a Wall

APPENDIX E

SAMPLE FORMS

CONTENTS

E.1 SAMPLE FORMS FOR SIFT

Version 4.4 (1.7 V5)

PHASE 2 SYSTEMATIC INSPECTION OF FEATURES IN THE TERRITORY (SIFT 2 Version 4.4)

SIFT No: _____ GEO Reg. No: _____ Grid Ref. : _____N_____E
Location: _____

1. Registration Criteria from GEO Circular 7/93:

R greater than 3m high. F or FR greater than 5m high. } Part of Larger
F or FR less than 5m high which pose a direct risk to life in the event of failure. } Fill Body (Y / N)

C or CR greater than 3m high.

WC (work complete)
WIP (work in progress) } Date:_____, registerable features may be present.

NR does not meet GEO slope registration criteria _____ NE no longer exists _____

OTHER _____

2. SIFT Classification: from Guidelines for Phase 2 SIFT Version 3.1 and Addendum 5

Aerial Photograph Year and Number _____

☐ Class A Fill feature considered to have similar circumstances to the Baguio landslide site.

Class B Fill feature considered to meet GEO criteria for slope registration but does not meet criteria A.

☐ B1 Have been formed or substantially modified before 30.6.78 or to have been illegally formed after 30.6.78.

☐ B2 Have been formed or substantially modified after 30.6.78, studied to GEO Stage 2, or equivalent or to be Housing Dept. Feature.

Class C Cut feature considered to meet GEO criteria for slope registration.

☐ C1 Have been formed or substantially modified before 30.6.78 or to have been illegally formed after 30.6.78.

☐ C2 Have been formed or substantially modified after 30.6.78

Formation/Modification before or after 30.6.78 determined by :- } ☐ Confirmed by API ☐ Assumed (Reason:_____)

3. Consequence: *(Modified B&P Assessment of Risk for A, B1 only. See Section 6 on page 2 for details.)*

☐ Low ☐ Low to moderate ☐ Moderate ☐ Moderate to High ☐ High ☐ Very High

4. Remarks : _____

_____

5. Photograph :
Mandatory for A, B1 only

Negative Number

_____

Compiled by _____ **API CONSULTANT/**_____ **dated** _____ **1996**

Version 4.4 (1.7.95)

6. Modified B&P Assessment of Risk : (For Class A, B1 only) SIFT No._____

6.1 Feature Dimensions

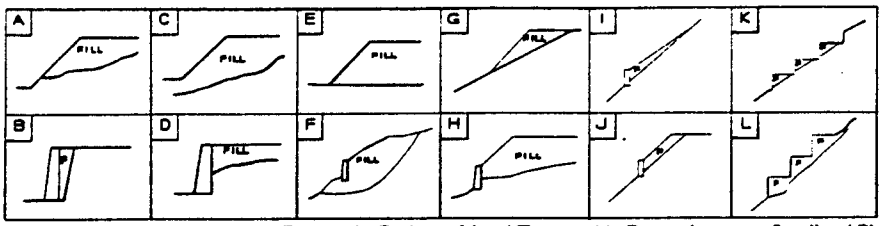
Estimated Slope Height _____m. Estimated Slope Length _____m. Estimated Slope Gradient _____°.

Estimated Retaining Wall Height _____m. Estimated Max. Fill Width _____m. Estimated Fill Thickness _____m.

Total Height of Feature _____m. Part of Larger Fill Body ? (Y / N)

Volume Calculation _____ Estimated Fill Volume _____m^3.

6.2 Estimated critical section profile: circle the appropriate model below or draw others as appropriate.



6.3 Topographic Situation Adjacent / Traversed : Drainage Line / Topographic Depression or Spurline / Planar Slope

Catchment area : (1=<100m^2, 2=100-500m^2, 3=500-1000m^2, 4=1000-10000m^2, 5= >10000m^2)

To Fill Body _____ To Drainage Line (if Affected Structure located downstream) _____

Intervening Ground, feature to facility: Platform / Slope / Drainage Line . Natural / Cut / Fill . Vegetation (Y / N)

Debris Trail : Channelisation ; Spread ; Erosion and Entrainment ; Assumed to occur along debris trail

6.4 Facilities

Facility(ies) below feature. Bus Shelter (Y / N)

Facility _____; Distance, Plan _____m, Vertical _____m, Angle _____°

Facility _____; Distance, Plan _____m, Vertical _____m, Angle _____°

Facility(ies) on slope/platform of feature: road / building / other _____

6.5 Consequences of Slope Failure :_____

_____

_____

7. Aerial Photograph Interpretation / Site Observations : (For Class A and Class B1 with VH, H, and MH risk classes only)

7.1 Site History

Year of initial fill placement: _____ Years of subsequent major filling: _____

Modification / history: _____

_____

_____

Years and numbers of significant aerial photos used: _____

7.2 Instability

Past landslips: (Y / N) details: _____

_____

Signs of distress: (Y / N) details: _____

_____

7.3 Hydrology

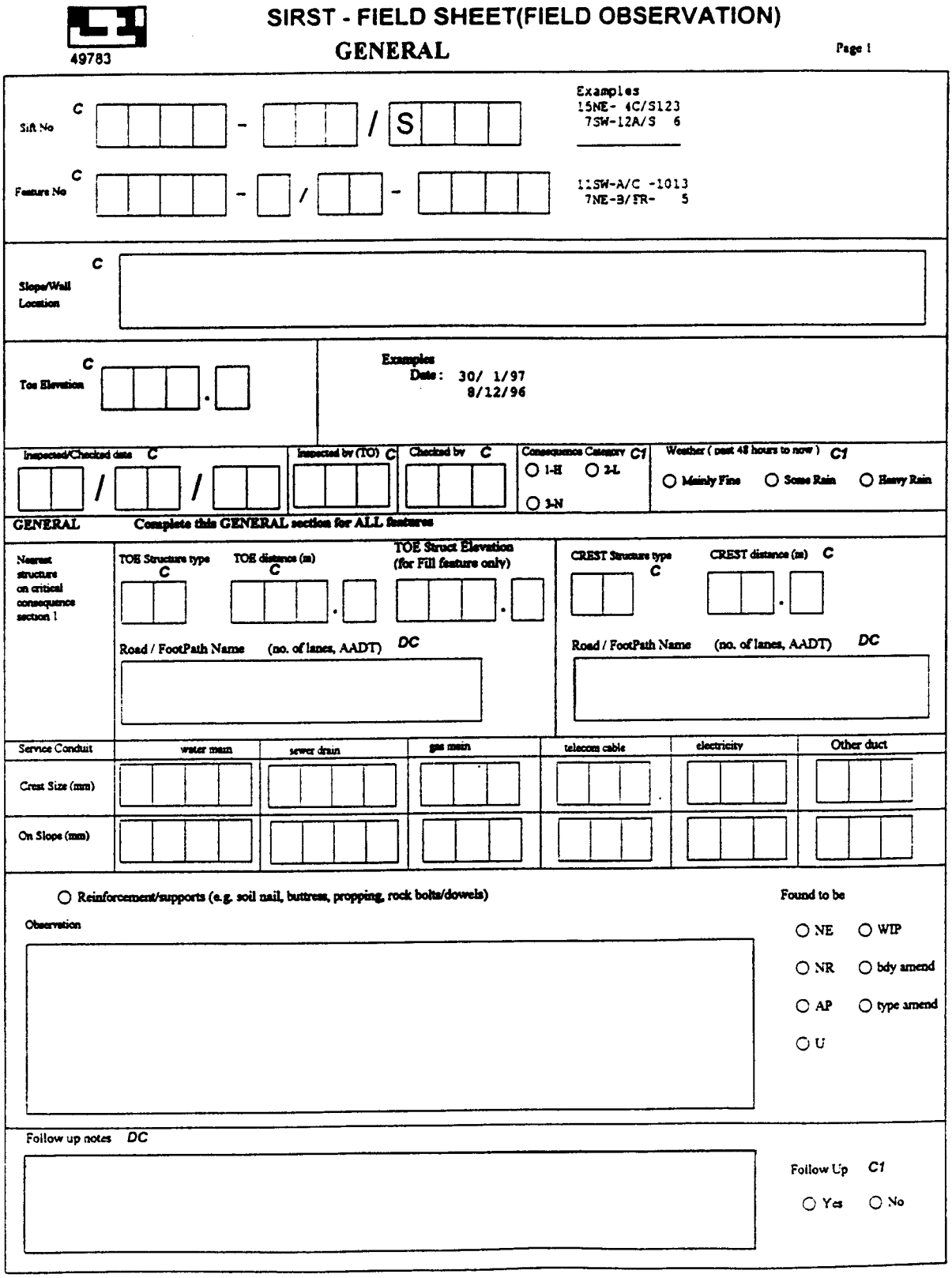
Surface cover: Slope _____ Platform _____

Estimated area of fill body: _____m^2 Estimate permeable infiltration area : _____m^2 Cover _____

Surface drainage channels observed: (Y / N) Potential for toe erosion loose material / undercutting

Evidence for groundwater seepage : _____

E.2 SAMPLE FORMS (TELEFORMS) FOR SIRST



49783

SIRST - FIELD SHEET(FIELD OBSERVATION)

GENERAL

Page 1

Sift No C [ ][ ][ ][ ] - [ ][ ][ ] / S[ ][ ][ ]

Examples
15NE- 4C/S123
7SW-12A/S 6

Feature No C [ ][ ][ ][ ] - [ ] / [ ][ ] - [ ][ ][ ][ ]

11SW-A/C -1013
7NE-B/FR- 5

Slope/Wall Location C

Toe Elevation C [ ][ ][ ][ ].[ ]

Examples
Date: 30/ 1/97
8/12/96

Inspected/Checked date C [ ][ ] / [ ][ ] / [ ][ ]

Inspected by (TO) C

Checked by C

Consequence Category C1
○ 1-H ○ 2-L ○ 3-N

Weather (past 48 hours to now) C1
○ Mainly Fine ○ Some Rain ○ Heavy Rain

GENERAL Complete this GENERAL section for ALL features

Nearest structure on critical consequence section 1

TOE Structure type C

TOE distance (m) C

TOE Struct Elevation (for Fill feature only)

CREST Structure type C

CREST distance (m) C

Road / FootPath Name (no. of lanes, AADT) DC

Road / FootPath Name (no. of lanes, AADT) DC

Service Conduit	water main	sewer drain	gas main	telecom cable	electricity	Other duct
Crest Size (mm)						
On Slope (mm)						

○ Reinforcement/supports (e.g. soil nail, buttress, propping, rock bolts/dowels)

Observation

Found to be
○ NE ○ WIP
○ NR ○ bdy amend
○ AP ○ type amend
○ U

Follow up notes DC

Follow Up C1
○ Yes ○ No

41370

SIRST - FIELD SHEET(FIELD OBSERVATION)
SLOPE

Page 2

Feature No C [ ][ ][ ][ ] - [ ] / [ ][ ] - [ ][ ][ ][ ]

SLOPE **This SLOPE section should be completed if the feature has a significant slope portion**

C1 ○ soil ○ rock ○ soil & rock

Cut Slope Soil Type DC1 ○ colluvium ○ d.volcanic ○ d.granite ○ other geology

Covering type and extent (% age)	Sealed C	Vegetated C	Bare soil/rock C	Seal Type DC2	Condition
Slope Face	[ ][ ][ ]	[ ][ ][ ]	[ ][ ][ ]	○ chunam ○ shotcrete	C1 ○ poor ○ fair ○ good
Beyond Crest	C [ ][ ][ ]				C1 ○ poor ○ fair ○ good

Maximum Height(m) C [ ][ ].[ ] Length(m) C [ ][ ][ ].[ ] Angle(deg) C [ ][ ] Berm No. [ ][ ] Min width (m) [ ].[ ]

C1	Spacing(m)		Size(mm)		Condition	Flow	
○ WeepHole	○ Occasional	○ 1.4-1.8	○ <30	○ 51-80	○ Blocked	○ None	○ Major
○ Horiz. Drains	○ Random	○ <1.4	○ 31-50	○ > 80	○ Partially Blocked	○ Minor	○ With soil/muddy
○ None	○ 1.9-2.5				○ Clear		

Urbanmal Type	Size (mm) C1 for each group								condition					flow			
	<100	101-150	151-200	201-250	251-300	>300	None	CND	severe cracks	crack	blocked	partially blocked	clear	dry	small	high	ponding
stepped	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
crest	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
berm	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
slope	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
toe	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

Seepage

C1
- ○ Heavy seepage at or above mid-ht or from several rock jt at one location
- ○ slight/mod. seepage at or above mid-height or from several rock jt at one location
- ○ heavy below mid-height or from isolated rock joints
- ○ slight/mod. below mid-height or from isolated rock joints
- ○ signs at slope or crest wall
- ○ no sign

Water-carrying Services

C1
- ○ potential leaky services and leakage signs
- ○ potential leaky services but no leakage sign
- ○ no potential leaky service

Leakage Notes DC

Inferred Past Instability

C1 ○ Major ○ Minor ○ Multiple minor ○ None

Sign of Distress

C1 ○ Severe ○ Minor ○ Reasonable ○ None

Distress Location DCM

○ near crest ○ midportion ○ toe

Distress Notes DC

27680

STAGE1 CUT, and RETAINING WALL

Feature No C ____ - ____ / ____ - ____ | Date Inspected C ____ / ____ / ____ | Inspected by (GE) C ____

Sketch Plan | Section: Critical consequence 1 (2)

Critical Consequence Section	Consequence Category C1	Engineering Judgement C1	Overall Fail Possible (for Toe Wall only)	Weather (past 48 hours to now) C1
	○ 1-H ○ 2-L ○ 3-N	○ HP ○ P ○ U	○ Y ○ N	○ Mainly Fine ○ Some Rain ○ Heavy Rain

Masonry Wall/ Masonry Facing C1	Masonry Notes	Non routine Maintenance Required C1	NRM Notes DC
○ Y ○ N		○ Y ○ N	

Emergency action Required C1 ○ Y ○ N

Action agency (NRM or Emergency) DCM ○ Private(BD) ○ HyD ○ ASD ○ DLO ○ WSD ○ HD ○ Other

Action to initiate preventive works/study	Criterion A C1	Criterion D C1	Further Study	Other External Action	Check / Repair Service	Action By	Inspection Agency
	○ Y ○ N	○ Y ○ N	○		○	Repair Services Agency DC1 ○ BD ○ WSD ○ DSD	C
	Action By DC1 ○ BD(private) ○ Govt						

37479

CUT SLOPE (NPCS)

Page 4

Feature No C ____ - ____ / ____ - ____ | Date Inspected C ____ / ____ / ____ | Inspected by (GE) C ____

NEW PRIORITY CLASSIFICATION SYSTEM FOR SOIL AND ROCK CUT SLOPES (Note : For ROCK NPCS, complete P.7 also)

GEOMETRY

	Critical 1 all C	Critical 2	Max. Ht. (if ΔH > 25%)
H_s (Soil part)	____ m	____ m	____ m
H_r (Rock part)	____ m	____ m	____ m
H_{cw} (Crest wall)	____ m	____ m	____ m
H_r (Toe wall)	____ m	____ m	____ m
β (Upslope)	____ °	____ °	____ °
θ (Slope part)	____ °	____ °	
α (Downslope)	____ °	____ °	____ °
Toe of realistic slip surface within Hs	○ YES ○ NO	○ YES ○ NO	
Surcharge	____ kPa	____ kPa	

Weather (past 48 hours to now)
C1 ○ Mainly Fine
○ Some Rain
○ Heavy Rain

POTENTIAL FOR WATER INGRESS

Drainage Provisions C1
○ Few / no channel + potential for convergent surface water flow above crest
○ Few / no channels
○ Some channels but insufficient size or number
○ Adequate channels

Lithology C1
○ Typical Granite or Volcanics
○ Atypical Granite or Volcanics
○ Others

This box is for Soil Cut only

NATURE OF SLOPE-FORMING MATERIAL

Adverse Geological Features DC1
○ AO relict jt., intensely weather/alter seams, dykes
○ Present which may weaken mass strength
○ None

Weighting Factor, W all C

Good	Uncertain A
Moderate	Uncertain B
Poor	

CONSEQUENCE FACTOR CM

○ Large failure Volume (> 500 cubic metre) expected
○ buildings may collapse / covered in landslip, or mass transportation seriously affected
○ None of the above or Conseq. Cat. 3

Soil Slope Failure Mode
C1 ○ Full-scale
○ Partial
○ Minor

Nearest structure on critical consequence section 2	TOE Structure type	TOE distance (m)	TOE Struct Elevation (for Fill feature only)	CREST Structure type	CREST distance (m)
	____	____ . ____	____ . ____	____	____ . ____

42674

WALL (FIELD OBSERVATION & NPCS)

Page 5

Feature No C | NPCS Date Inspected DC | NPCS Inspected by (GE) DC

WALL — The WALL section should be completed if the feature has a significant wall portion

Wall ID C

Type
- ○ Retaining wall with level platform
- ○ Assoc. wall at crest C1
- ○ Assoc. wall toe
- ○ Assoc. wall mid-slope

Height(m) C | Wall face Angle C | Length(m) C

Wall Material
- ○ Random Rubble
- ○ Square Rubble
- ○ Dressed Block
- ○ Brick C1
- ○ Lime Soil
- ○ Concrete
- ○ masonry facing
- ○ Other (specify in observ.)

⇒ With (Multiple select OK)
- ○ pointing
- ○ ties
- ○ conc. beam
- ○ lime/brick beam

Berms No.

Min width (m)

C1
- ○ WeepHole
- ○ Horiz. Drains
- ○ None

Spacing(m)
- ○ Occasional
- ○ Random
- ○ 1.9-2.5
- ○ 1.4-1.8
- ○ <1.4

Size(mm)
- ○ <30
- ○ 31-50
- ○ 51-80
- ○ > 80

Condition
- ○ Blocked
- ○ Partially Blocked
- ○ Clear

Flow
- ○ None
- ○ Minor
- ○ Major
- ○ With soil/muddy

Unusual Type	all C1 Size (mm) <100	101-150	151-200	201-250	251-300	>300	None	CND	condition severe cracks	cracks	blocked	partially blocked	clear	flow dry	small	high	ponding
downpipe/ Stepped crest	○	○	○	○	○	○	○	○	○	○ C1 ○	○	○	○ C1 ○	○	○	○ C1	○ ○
toe	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

Seepage C1
- ○ Heavy seepage at mid-ht. on above
- ○ slight/mod. seepage at mid-height
- ○ heavy below mid-height
- ○ slight/mod. seepage below mid-height
- ○ sign on wall face ○ no sign

Water-carrying services C1
- ○ Potential leaky service and leaking sign
- ○ Potential leaky service but no leaking sign
- ○ No potential leaky service

Leakage Notes DCC

Inferred Past Instability
- ○ Full-ht.
- ○ Multi. part-ht. or struct fail
- ○ Part-ht. fail
- ○ Struct fail only ○ None

Distress Location DCM
- ○ near crest ○ midportion ○ toe

Distress Notes

Sign of Distress C1
- ○ Advanced stage of severe distress
- ○ Onset of severe distress
- ○ Moderate distress
- ○ Minimal distress
- ○ None

NEW PRIORITY CLASSIFICATION SYSTEM FOR RETAINING WALLS

Beyond Wall Crest: Sealed % age C

Potential for Ponding C1 ○ Yes ○ No

GEOMETRY

	Critical Consequence 1 all C	Critical Consequence 2	Max. Ht. (if ΔH > 25%)
$H_{...}$ (Wall)	m	m	
H_r (Rock part)	m	m	m
H_s (Crest slope)	m	m	m
β (Upslope)	°	°	°
β_f (Wall face)	°	°	
α (Downslope)	°	°	°
Surcharge at crest of wall-s	kPa	kPa	

Others

Drainage Provisions for Surface Water C1
- ○ Few / no channel above+ potential flow to wall
- ○ Few / no channel above wall crest
- ○ Some channel above wall but insufficient
- ○ Adequate channel above wall crest

Wall extended upwards in the past C1 ○ Yes ○ No

Natural slope below wall C1 ○ Yes ○ No

Wall failure mode C1
- ○ Full scale
- ○ Partial
- ○ Minor

NATURE OF RETAINED MATERIAL
- ○ Fill/unknown C1
- ○ Colluvium, residual soil, PW0/30 or PW30/50 rock mass
- ○ PW50/90 or better rock mass

Weather (past 48 hours to now) C1
- ○ Mainly Fine
- ○ Some Rain
- ○ Heavy Rain

CONSEQUENCE FACTOR CM
- ○ large failure Vol. (>500 cu m) expected
- ○ occupied buildings may collapse / covered in landslip, or mass transportation seriously affected
- ○ None of the above or Conseq. Cat. 3

Nearest structure on critical consequence section 2	TOE Structure type	TOE distance (m)	TOE Struct Elevation (for Fill feature only)	CREST Structure type	CREST distance (m)

28398

FILL SLOPE (NPCS)

Page 6

Feature No C1 ☐☐☐☐ - ☐ / ☐☐ - ☐☐☐☐ | Date C1 ☐☐ / ☐☐ / ☐☐ by C1 ☐☐☐

NEW PRIORITY CLASSIFICATION SYSTEM FOR FILL SLOPES

SIFT Data (from SIFT Report)

6.1 Part of Large Fill Body C1
○ Yes ○ No ○ Unknown

6.1 Volume of Fill Body (cu m) C1
○ <=100 ○ 100-500 ○ 500-1000 ○ 1000-10000 ○ >10000

6.2 Critical Section Profile Type C1 ○ A ○ C ○ E ○ F ○ G ○ H ○ I ○ J Others : DO WALL (NPCS)

6.3 Topographic Situation

Catchment Size (sq m) C1 ○ <=100 ○ 100-500 ○ 500-1000 ○ 1000-10000 ○ >10000 ○ Unknown

Topographic Setting C1
○ Adjacent Drainage Line ○ Traverse Drainage Line ○ Unknown
○ Adjacent Topographic Depression ○ Traverse Topographic Depression
○ Spurline ○ Planar Slope

Debris Trail C2 ○ Channelisation ○ Spread ○ Erosion & Entrainment along Debris Trail ○ Unknown

Unstable Terrain (from GASP Report) C1 ○ Yes ○ No

Between fill feature & toe facilities, any of the following 3 present ?
- Zones of general instability ..... colluvial or in-situ terrain, or
Instability on disturbed terrain

Type of Crest Facility C1
○ Road ○ Minor Development e.g. Rural foot path ○ Platform & Urban Development ○ Catchwater ○ Natural

Further Second Structure along Critical Section 1

TOE (2) struct type ☐☐ | TOE (2) dist. (m) ☐☐☐.☐ | Crest (2) struct type ☐☐ | CREST (2) dist. ☐☐.☐

Struct Elevation ☐☐☐.☐ | Toe Wall Height (m) ☐☐.☐ | Crest Wall Height (m) ☐☐.☐ | Masonry ○ Yes ○ No

Critical Section 2

TOE (1) struct type ☐☐ | TOE (1) dist. (m) ☐☐☐.☐ | Crest (1) struct type ☐☐ | CREST (1) dist. ☐☐.☐

Struct Elevation ☐☐☐.☐ | Toe Wall Height (m) ☐☐.☐ | Crest Wall Height (m) ☐☐.☐ | Masonry ○ Yes ○ No

Further Second Structure along Critical Section 2

TOE (2) struct type ☐☐ | TOE (2) dist. (m) ☐☐☐.☐ | Crest (2) struct type ☐☐ | CREST (2) dist. ☐☐.☐

Struct Elevation ☐☐☐.☐

23329

ROCK SLOPE (NPCS)

(Note: Complete P.4 also)

Page 7

Feature No CC - / - | Date Inspected C / / | Inspected by (GE) C

Benches present C1 ○ Y ○ N | Concentrated Surcharge at Crest C1 ○ Yes ○ No | Surcharge Type | ○ Surface Sealed from detailed assessment | ○ No safe access to crest

Nature of dominant discont'y ○ Fault Zone ○ Fault ○ Joint ○ Cleavage ○ Schistosity ○ Shear Plane ○ Fissure ○ Tension Crack ○ Foliation ○ Bedding

Mode of Failure C1 ○ Y ○ N

Dominant Discont'y dip ang ψ, dip dir'n α

	1	2	3	4	5	Pass
ψ						
α						

		○ Ravelling Discont'y favour orient fail bd to indivd OH blk or isolate loose blk (<5 cu m) off face	○ Toppling dom discont'y dips into face + orthog cross discont'y → blk which could topple from slope	○ Planar dom discont'y set strike // face, daylight and ○ ψ > 45° ○ ψ = 21–45° ○ ψ = 5–20°	○ Wedge 2 dom discont'y sets → wedge and line of intersection ○ ψ > 45° ○ ψ > 21–45° ○ ψ = 5–20°
Discont'y Spacing (S m)	S < 0.2	○	○	○	○
	0.2 <= S < 0.5	○	○	○	○
	0.5 <= S < 1	○ DC1	○ DC1	○ DC1	○ DC1
	1 <= S < 2	○	○	○	○
Discont'y Roughness & Infilling	Smooth, apert >5 mm, weak, soft IF	○	○	○	○
	Smooth, apert 1-5 mm, weak, soft, IF	○	○	○	○
	Sig rough, apert < 1 mm, weak soft IF	○	○	○	○
	Sig rough, apert 1-5 mm open	○ DC1	○ DC1	○ DC1	○ DC1
	Sig rough, apert < 1 mm open	○	○	○	○
	Rough tight, unw or sw	○	○	○	○
Persistence of Discont'y	max trace length > 5 m	○	○	○	○
	max trace length 1-5 m	○ DC1	○ DC1	○ DC1	○ DC1
	max trace length < 1 m	○	○	○	○
Sign of Distress lge >= 1 cu m sm 0.01–1 cu m (215mm²=0.01m²)	Lge OH blk pot. release surfaces visible	○	○	○	○
	tension crack along crest	○	○	○	○
	Surf. loosening + sm. OH blk several areas	○ DC1	○ DC1	○ DC1	○ DC1
	Localised surf. loosening or small OH blk	○	○	○	○
	No evidence of surf. loosening	○	○	○	○
Eng. Judgement	High potential for failure	○	○	○	○
	Moderate potential for failure	○ DC1	○ DC1	○ DC1	○ DC1
	Low potential for failure	○	○	○	○
Size of Failure	major (vol. >= 500 cu m)	○	○	○	○
	moderate (50 - 500 cu m)	○ DC1	○ DC1	○ DC1	○ DC1
	minor (5 - 50 cu m)	○	○	○	○
	individual blocks (< 5 cu m)	○	○	○	○