UR1987_31

1987/31. Stability of land at Norwood.

W. L. Matthews

Abstract

Land comprising a proposed subdivision near the junction of Penquite and Quarantine Roads, Launceston is underlain by Tertiary sediments consisting of clay, silty clay, sandy clay and gravelly beds. The clay-rich beds usually have a high plasticity and a high linear shrinkage. Three residual strengths obtained from borehole samples resulted in low values. As the land has slope angles up to about 20°, there is risk of unstable conditions developing. Landslips occur at nearby locations. Taking the above into consideration and from stability analysis calculations, it is suggested that slopes above about 8° would be risky to develop. Development of land with this slope angle or lower should be undertaken with care.

INTRODUCTION

A request was made by Dale P. Luck and Associates to investigate the stability of about two hectares of land near the junction of Quarantine and Penquite Roads, Launceston. The property is owned by Mr B. L. Cordell, who is preparing to subdivide it into 13 lots. The land has been assigned mainly to classes 3 and 4 on the landslip zone map of the Tamar Valley. Much of the land in these classes, particularly the class 4 parts, is regarded as marginal for development, and detailed study is required to assess the likely future stability. Drilling has been undertaken to examine the nature of the material underlying the site. This has also allowed for the collection of samples for testing and for an examination of groundwater conditions.

RELIEF AND GEOLOGY

Much of the land is moderately steep, with slopes ranging up to about 20°. Flatter areas are present around the margins of the land near the two roads, and the land also flattens a little towards the top of the property. No definite features indicating landslips have been identified but there is a flattish area behind the existing house which may represent an old landslip. Landslips, both old and recent, are present on nearby slopes.

From an examination of surface exposures and nearby road cuttings it is apparent that the whole property is underlain by sediments of Tertiary age. This has been confirmed by the drilling. These sediments consist of clay, silty clay, sandy clay sand, and some gravel. Gravel occurs on the plateau to the west of the land.

DRILLING

Thirteen holes have been drilled on the land during two periods. Holes 1-6 were drilled on 12-13 November 1986, while Holes 7-13 were drilled on 3-4 February 1987. The holes were augered to depths of up to about eight metres. After examination of the disturbed samples from the auger drilling, a few sites were selected to drill a further hole nearby for the collection of undisturbed samples for strength testing over a few intervals of interest, and also to inspect the texture of the *in situ* material. Logs of the drill holes are appended.

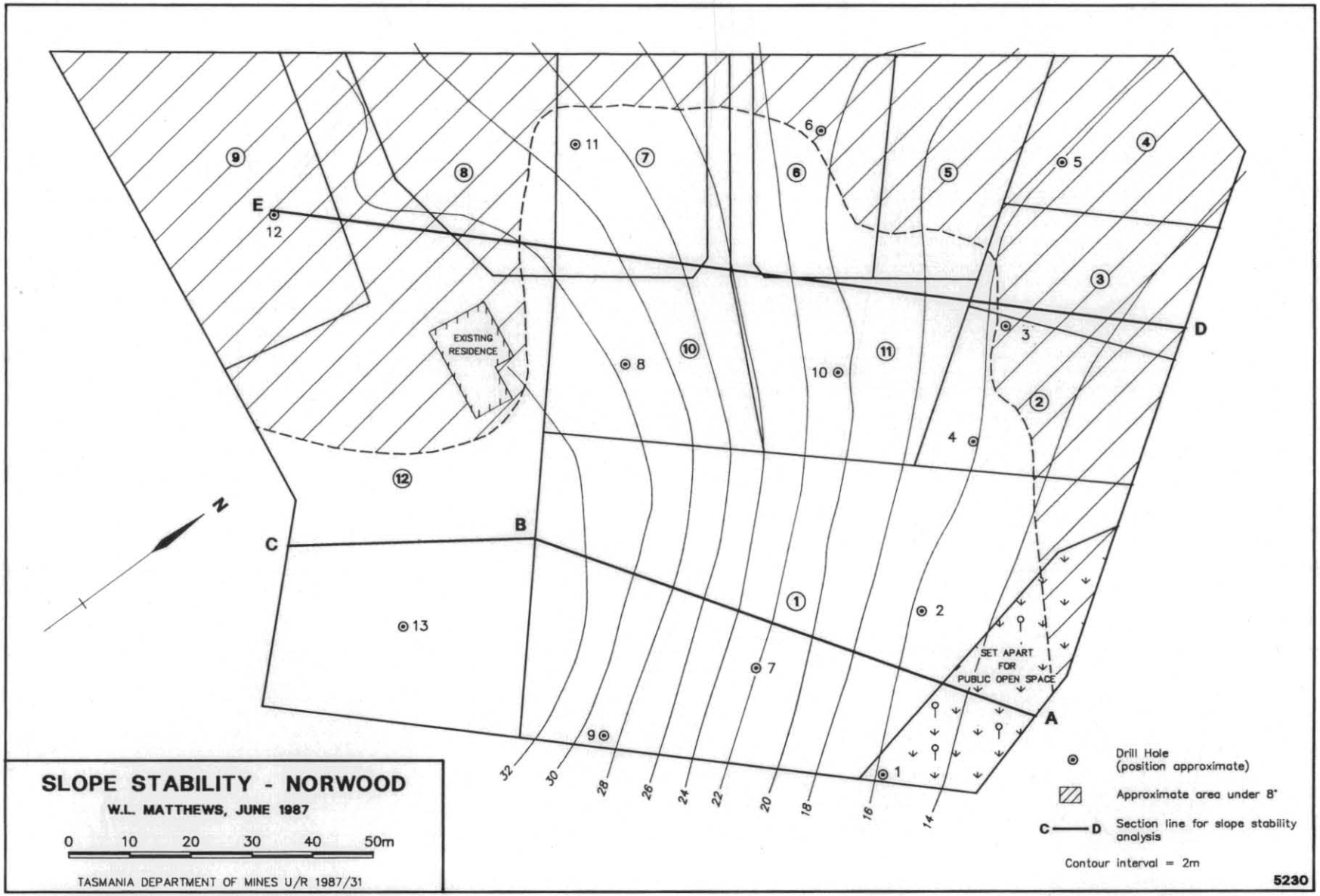

SLOPE STABILITY - NORWOOD
W.L. MATTHEWS, JUNE 1987
0 10 20 30 40 50m
TASMANIA DEPARTMENT OF MINES U/R 1987/31
EXISTING RESIDENCE
SET APART FOR PUBLIC OPEN SPACE
A
B
C
D
E
N
Drill Hole (position approximate)
Approximate area under 8°
C — D Section line for slope stability analysis
Contour interval = 2m
5230

Figure 1.

5 cm

The majority of sediments underlying the property are fine grained, i.e. clay and silty clay. Gravel beds prevented deep drilling in Holes 3 and 4 while Hole 12 consisted dominantly of sandy and gritty clay. Clay rich in carbonaceous matter was encountered in Holes 7 and 10.

SOIL TESTING

The properties of a range of materials are shown in Table 1. Plasticity is high for the majority of the samples and linear shrinkage is also high.

Three values of residual strength are shown in Table 1. These have been determined from shear box testing. The samples tested represent some of the softer materials encountered in the drilling. The sample from Hole 1 is a grey plastic clay; from Hole 7 it is a carbonaceous clay; while from Hole 13 the sample tested was a light grey to cream coloured plastic clay.

The strength factors determined indicate a low strength for these particular samples. Similar values could be expected for material in other holes at selected intervals.

Table 1. SOIL TESTING RESULTS

					Clay fraction XRD (%)				
Hole no.	Depth (m)	LL	PL	LS	K	M	G	ø'	c'(kPa)
1	2.4-4.9	76	21	17					
1	6.1-6.7	125	28	23	75	20	5	10°	4.1
2	0.6-1.4	118	25	22					
2	1.4-3.2	104	22	21					
2	3.2-4.0	87	23	19					
4	0.3-1.4	104	21	23					
5	3.5-4.7	85	19	20					
6	1.8-3.2	83	21	18					
6	3.2-3.7	67	18	16					
6	5.0-7.8	102	23	20					
7	6.4	100	28	19	75	15	10	9°	6.4
10	0.9-1.8	98	23	20					
10	1.8-4.3	107	24	21					
10	4.3-7.2	120	26	22					
11	1.8-2.1	92	26	19					
13	4.6-5.5	91	22	20				10°	1.5

Determinations by R.N. Woolley, Department of Mines, Rosny Park
K = kaolinite, M = montmorillonite, G = gibbsite

DISCUSSION OF STABILITY

To aid in the assessment of the future stability, the strength values determined above have been applied to various trial slips in sections drawn across the land. From examination of many recent slips in surrounding areas most slips extend only to relatively shallow depth (3-5 m) but deeper slips should not be discounted. Bishops method of slices has been used in the analyses.

Trial slips on the slope ABC result in a very low safety factor for a small segment of the slope as well as for the whole slope. It is obvious that the values used do not occur for the whole length of the theoretical slip surface, otherwise the slope would be unstable at present (see attached analyses). Similarly for a portion of a slope D-E using higher cohesion values, the factor of safety reaches satisfactory levels with very low pore pressure, but in the more dangerous periods, i.e. during extended wet periods, saturation may occur for at least half of the trial slip depth. Calculated factors of safety are too low to ensure stability with certainty when this is considered.

The strength values have been applied to constant slopes of 10° and 8°. Low values for factors of safety are again calculated for 10° slopes under most of the values used. Only when the pore pressure is very low are safety factor values at reasonable levels (above 1.3) but these may be unrealistic situations for very wet periods. Reasonable values for safety factors are calculated for the 8° slope over the range of values that are most likely to prevail.

The values calculated are likely to apply over short parts of these slopes at least (not the whole slope, otherwise it would be in continuous failure). Development which includes excavation, loading and alteration of drainage will alter the present situation. Because of the presence of unstable conditions on some surrounding land which appears to have similar material, it is suggested that development only take place on areas where slopes are no greater than 8°. This excludes large portions of the steeper land. Even on slopes of 8° or less particular attention will have to be given to ensuring excellent drainage and to the limiting or the strong support of excavations. Disturbance of the nearby steep slopes should be avoided as much as possible, and tree planting should be encouraged.

CONCLUSIONS

Drilling and strength testing has shown that the proposed subdivision is underlain by materials with low strength. This confirms that the situation is similar to that of nearby areas where testing has been undertaken and where signs of landslips have been noted.

Taking the surrounding signs of past instability into consideration and the stability analyses for this area, it is apparent that the steeper land has a risk of becoming unstable if developed. For this reason it is recommended that areas with slopes of greater than 8° remain undeveloped.

On developing the flatter land extreme care will need to be taken to ensure excellent drainage. Excavations, unless retained by strengthened drained structures, shold be kept to a minimum. Excavations on nearby steep slopes should be avoided as far as possible. Tree planting would aid in maintaining the stability of the steeper land.

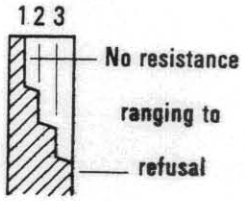
[23 June 1987]

5/22

EXPLANATION SHEET FOR ENGINEERING LOGS

Borehole and excavation log

Penetration



Water

22 Jan, 80 Water level on date shown.

Water inflow.

Water outflow.

Notes - samples and tests

U50	Undisturbed sample 50mm diameter.
D	Disturbed sample.
N	Standard penetrometer blow count for 300mm.
N*	SPT + sample.

Material classification

Based on Unified Soil Classification System.

In Graphic Log materials are represented by clear contrasting symbols consistent for each project.

Moisture content

D	Dry, looks and feel dry.
M	Moist, no free water on hand when remoulding.
W	Wet, free water on hand when remoulding.
LL	Liquid limit.
PL	Plastic limit.
PI	Plasticity Index.

eg. M > PL – Moist, moisture content greater than the plastic limit.

Consistency

		hand penetrometer (kPa)
VS	Very soft.	< 25
S	Soft.	25 - 50
F	Firm.	50 - 100
St	Stiff.	100 - 200
VSt	Very stiff.	200 - 400
H	Hard.	> 400
Fb	Friable.	

Notes: X on log is test result

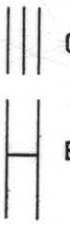
— is range of results.

Density index

		%
VL	Very loose.	0 - 15
L	Loose.	15 - 35
MD	Medium dense.	35 - 65
D	Dense.	65 - 85
VD	Very Dense	85 - 100

Cored borehole log

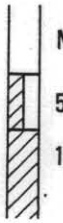
Case - lift



Casing used.

Barrel withdrawn.

Fluid loss



No loss

50% loss

100% loss.

Lugeons

Lugeon units (μL) are a measure of rock mass permeability. For a 46 to 74mm diameter borehole 1 Lugeon is defined as a rate of loss of 1 litre per metre per minute. 1 Lugeon is roughly equivalent to a permeability of 1×10^{-4} mm/sec.

Graphic log

No core.

Rock substances represented by clear, contrasting symbols consistent for each project.

Weathering

Fr	Fresh.
SW	Slightly weathered.
HW	Highly weathered.
EW	Extremely weathered.

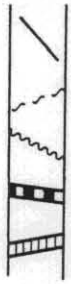
Strength

		point load strength index $I_{s(50)}$ (MPa)
EL	Extremely low.	< 0·03
VL	Very low.	0·03 - 0·1
L	Low.	0·1 - 0·3
M	Medium.	0·3 - 1
H	High	1 - 3
VH	Very high.	3 - 10
EH	Extremely high.	> 10

Note: X on log is test result.

Significant defects

Significant defects shown graphically.



Joint.

Sheared zone.

Crushed seam.

Infill seam.

Extremely weathered seam.

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – BOREHOLE

6/22

borehole no. 1

sheet 1 of 1

project CORDELLS SUBDIVISION location NORWOOD

co-ordinates 5133(5)4092 drill type TRIEFUS

R.L.

inclination vertical drill method Auger

bearing drill fluid

hole commenced 12/11/86

hole completed 12/11/86

drilled by B Cox

logged by L Matthews

checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
							MH	SOIL - silty brown, friable				Soil
							CH	CLAY - plastic, light brown	M			Tertiary sediments
					1		CH	SILTY CLAY - light brown, a few small quartz fragments	M			Tertiary sediments
					2		CH	SILTY CLAY - darker brown grey, friable occasional quartz fragments	M			"
			ATT. LS		3		CH	SILTY CLAY - light brown / plastic, medium stiffness	M			"
					4							
					5		CH	SILTY CLAY - lighter brown, a little softer	M-W			"
			ATT. LS XRD ϕ', c'		6		OH	CLAY - dark grey plastic, organic rich	M-W			"
					7							
							CL	SANDY CLAY - brown, harder, some small quartz fragments (up to 1.5 cm)	M			"
					8							

5 cm

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – BOREHOLE

7/22

borehole no. 2

sheet 1 of 1

project CORDELLS SUBDIVISION location NORWOOD

co-ordinates 5153(5)4092 drill type Trilfos

drill method Auger

R.L.

inclination vertical drill fluid

bearing

hole commenced 12/11/86

hole completed 12/11/86

drilled by B Cox

logged by L. Matthews

checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa (25 50 100 200 400)	structure, geology
						MH	SOIL - silty, brown, friable				Soil
	NONE		ATT LS	1		CH	CLAY - mid grey, plastic, fairly soft fissured	M			Tertiary sediments
			ATT LS	2		CH	CLAY - light brown and grey mottled, plastic, fairly soft.	M-W			"
				3		CH	CLAY - grey and brown mottled, plastic moderately soft	M-W			"
			ATT LS	4		CH	CLAY - grey, plastic, fairly soft, becoming silty	M			"
				5		CL	CLAY-SILTY to SANDY - grey brown	M-W			"
				6 7		SC	NO return on drilling but on withdrawal of augers - SANDY MATERIAL, CLAYEY SAND - grey brown wet.	W			"
				8 9							

5 cm

TASMANIA DEPARTMENT OF MINES

8/22

borehole no. 3

sheet 1 of 1

ENGINEERING LOG – BOREHOLE

project CORDELLS SUBDIVISION location NORWOOD

co-ordinates 5153(5) 4092 drill type Triefus
drill method Auger
R.L.
inclination vertical drill fluid
bearing

hole commenced 12/11/84
hole completed 12/11/84
drilled by B. Cox
logged by L. Matthews
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
							SM	SAND - brown friable				Soil
					1		CH	CLAY - brown, plastic, hard	M			Tertiary sediments
					2		GC	CLAYEY GRAVEL - light brown, quartz fragments	M			"
					3							
					4							

5 cm

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – BOREHOLE

9/22

borehole no. 4

sheet 1 of 1

project CORDELLS SUBDIVISION location

co-ordinates 5153 (5) 4092

R.L.

inclination vertical

bearing

drill type Triefus

drill method Auger

drill fluid

hole commenced 13/11/86

hole completed 13/11/86

drilled by B. Cox

logged by L. Matthews

checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa (25 50 100 200 400)	structure, geology
							SM	SOIL - dark brown silty				Soil
			ATT.		1		CH	CLAY - light brown, plastic, fairly soft.	M-W			Tertiary sediments
					2		CH	CLAY - darker brown, plastic, becoming fragmental, a little silty	M			"
					3		GC	GRAVELLY CLAY - fragments up to 5cm across	M			"
					4			Further drilling prevented by hardness				
					5							
					6							

5 cm

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – BOREHOLE

10/22

borehole no. 5

sheet 1 of 1

project CORDELLS SUBDIVISION location

co-ordinates 5153(5)4092

R.L.

inclination vertical

bearing

drill type Triefus

drill method Auger

drill fluid

hole commenced 13/11/86

hole completed 13/11/82

drilled by B. Cox

logged by L. Matthews

checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa (25 50 100 200 400)	structure, geology
						OH	SOIL - black, clayey	M			Soil and Tertiary sediments
				1		CL	CLAY, SILTY, AND SANDY - brown, some quartz pebbles up to 5cm across	M			Tertiary sediments
						GC	GRAVEL				"
				2		CH	CLAY, SILTY - brown, fairly soft and plastic to fragmental	M			"
				3							
			ATT.	4		CH	CLAY, SILTY - lighter brown, becoming less silty and more plastic	M			"
				5		CH	CLAY, SILTY - brown (as in 1.5-3.5m)	M			"
				6							
				7			SAND, SANDY CLAY - hard band at 7.3m, then soft.	M			"
				8							

5 cm

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – BOREHOLE

11/22

borehole no. 6

sheet 1 of 1

project CORDELLS SUBDIVISION location

co-ordinates 5153(5)4092 drill type Failfurs

drill method Auger

R.L.

inclination vertical

bearing

drill fluid

hole commenced 13/11/86

hole completed 13/11/86

drilled by B. Cox

logged by L. Matthews

checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
							ML	SOIL - grey brown, silty loose				Soil
					1		CH	CLAY - light brown, plastic, occasional quartz fragments, fairly soft	M-W			Tertiary sediments
					2		CH	CLAY - a little silt, light brown plastic, occasional quartz pebbles up to 5 mm across	M			"
					3		CL	CLAY - SILTY AND SANDY - dark grey brown	M			"
					4		CH	CLAY - silty, light brown, plastic occasional rounded quartz pebbles up to 4 cm across.	M			"
					5							
			ATT		6		CH	CLAY - brown, plastic, silty fairly soft.	M-W			"
					7							
					8							

5 cm

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – BOREHOLE

12/22

borehole no. 7

sheet 1 of 1

project CORDELLS SUBDIVISION location

co-ordinates 5153(5)4092

R.L.

inclination vertical

bearing

drill type Tractor

drill method Auger

drill fluid

hole commenced 3/2/87

hole completed 3/2/87

drilled by B Cox

logged by L Mattheus

checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
							CH to CL	SOIL AND CLAY - brown silty, occasional pebbles	D-M			Soil and Tertiary sediments
					1		CH	CLAY - Brown, plastic to fragmental	M			Tertiary sediments
					2		CL	CLAY - SILTY AND SANDY - fragmental occasional iron oxide fragments	M			"
					3							
							CH	CLAY - brown, silty, plastic to fragmental	M			"
					4		CH to OH	CLAY - grey, some carbonaceous material, soft	M			"
					5		CH	CLAY - lighter grey plastic	M			"
			ATT LS XRD ϕ' c'		6		OH	CLAY - dark grey to black plastic and carbonaceous	M			"
					7							
					8							

5 cm

TASMANIA DEPARTMENT OF MINES

13/22

borehole no. 8

sheet 1 of 1

ENGINEERING LOG – BOREHOLE

project CORDELLS SUBDIVISION location

co-ordinates 5153 (5) 4092 drill type Triefus drill method Auger

R.L.

inclination vertical bearing

drill fluid

hole commenced 3/2/87
hole completed 3/2/87
drilled by B. Cox
logged by L. Matthews
checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa (25 50 100 200 400)	structure, geology
	NONE	NONE		1		CH	CLAY – brown, plastic to fragmental occasional pebbles	M			Soil and Tertiary Sediments
				2							
				3		CH	CLAY – red brown and grey mottled, plastic	M			Tertiary Sediments
				4		CH	CLAY – grey brown and reddish plastic	M			"
				5		CH to CL	SILTY CLAY – brown, some fine sand, fragmental	M			"
				6							
				7							
				0.9		SC,CL	SANDY SILTY CLAY – fragmental				"
				8			Further drilling prevented owing to hardness				

5 cm

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – BOREHOLE

14/22

borehole no. 9

sheet 1 of 1

project CORDELLS SUBDIVISION location

co-ordinates 5153(5) 4092

R.L.

inclination vertical

bearing

drill type Trieflus

drill method Auger

drill fluid

hole commenced 3/2/87

hole completed 3/2/87

drilled by B. Cosc

logged by L. Matthews

checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa (25 50 100 200 400)	structure, geology
	NONE	NONE		1		CH	CLAY – brown, hard plastic slightly moist.	D to M			Tertiary sediments
				2							
				3		SC to CL	SANDY SILTY CLAY – brownish grey, fragmental	D to M			"
				4		SC to CL	SANDY SILTY CLAY – mid brown, some partly consolidated fragments, fragmental	D to M			"
				5							
				6		SC CL	SANDY SILTY CLAY – darker brown	D to M			"
				7							
				8							

5 cm

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – BOREHOLE

15/22

borehole no. 10

sheet 1 of 1

project CORDELLS SUBDIVISION location

co-ordinates 5153(5)4092 drill type Triefus

drill method Auger

R.L.

inclination vertical drill fluid

bearing

hole commenced 4/2/87

hole completed 4/2/87

drilled by B. Cox

logged by L. Matthews

checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
								SANDY SILTY CLAY – brown, slightly moist				Tertiary Sediments
			ATT.		1			CLAY – light grey, plastic, moist	M			"
					2			CLAY – darker grey, plastic, moist	M			"
								CLAY – dark grey, plastic, organic rich	M			"
			ATT		3			CLAY – lighter grey plastic	M			"
					4			CLAY – grey brown, plastic to slightly fragmental	M			"
					5			CLAY – grey and black, plastic, moist, organic rich	M			"
			ATT		6			CLAY – dark grey to black plastic	M			"
					7							
					8							

5 cm

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – BOREHOLE

16/22

borehole no. 11

sheet 1 of 1

project CORDELLS SUBDIVISION location

co-ordinates 5153(5)4092

R.L.

inclination vertical

bearing

drill type Triefus

drill method Auger

drill fluid

hole commenced 4/2/87

hole completed 4/2/87

drilled by B. Cox

logged by L. Matthews

checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
							GM	GRAVELLY SANDY SILT - dry	D			Tertiary Sediments
					1		CH	CLAY - light brown, plastic, moist	M			"
			ATT.		2		CH	CLAY - light grey brown, plastic, moist	M			"
					3		CH	CLAY - light brown, plastic				"
					4		CH	CLAY - light brown plastic becoming more silty with depth.	M			"
					5							
					6		CH to CL	CLAY - silty brown, a little fragmentary.	M			"
					7		SC to CL	CLAY - SANDY SILTY, dark grey fragmentary	M			"
					8		SC	CLAYEY SAND, some SILT, brown	M			"

5 cm

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – BOREHOLE

17/22

borehole no. 12

sheet 1 of 1

project CORDELLS SUBDIVISION location

co-ordinates 5153(5)4092

R.L.

inclination vertical

bearing

drill type Triefus

drill method Auger

drill fluid

hole commenced 4/2/87

hole completed 4/2/87

drilled by B. Cook

logged by L. Matthews

checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
						SM	SOIL and CLAYEY SAND – light grey brown.				Tertiary sediments
				1		ML	SANDY SILTY CLAY – brown, pebbles upto 3cm across (quartz)				"
				2		GC & CL	GRITTY SANDY SILTY CLAY – wet and fragmental	W			"
				3							
				4		GC	CLAYEY GRIT – brown, wet	W			"
				5							
				6		SM GSC	CLAYEY SAND (brown) passing into SILTY CLAY and CLAY (blue) at base	W			"
				7							
				8		CH					

5 cm

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – BOREHOLE

18/22

borehole no. 13

sheet 1 of 1

project CORDELLS SUBDIVISION location

co-ordinates 5153(5) 4092 drill type Triefus

drill method Auger

R.L.

inclination vertical drill fluid

bearing

hole commenced 4/2/87

hole completed 4/2/87

drilled by B. Cox

logged by L. Matthews

checked by

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa (25 50 100 200 400)	structure, geology
				1			CLAYEY SAND – moist	M			Tertiary sediments
				2			CLAY – sandy silty, brown, becoming finer with depth, slightly fragmentary	M			"
				3			CLAY – silty, light brown, a little fragmentary				"
				4			CLAY – silty, reddish brown, fragmentary	M			"
			ATT	5			CLAY – silty, brown plastic, becoming finer grained (less silt) towards base	M			"
			ϕ' c'	6			CLAY – light grey brown to yellow, plastic, some zones with a little silt	M			"
				7							
				8			CLAY – reddish and brownish mottled, plastic.	M			"

5 cm

SLOPE STABILITY ANALYSIS - COMPUTATIONS SHEET 1 OF.....

NAME OF SLIP CORDELLS LAND SECTION ABC MAP REF.....

ANALYSIS BY.....
DATE.....
CHECKED BY.....

* values for whole slope

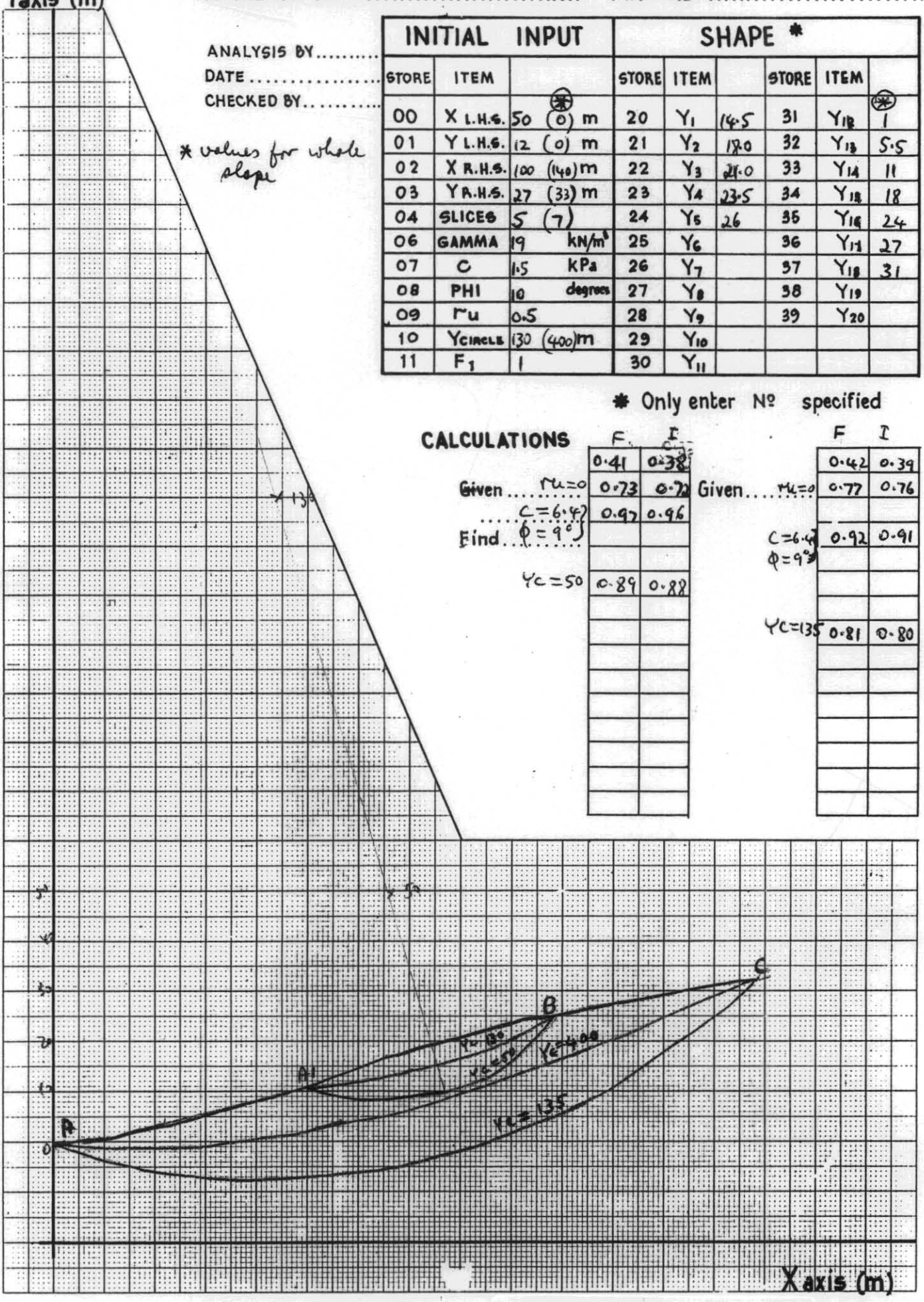
INITIAL INPUT				SHAPE *					
STORE	ITEM			STORE	ITEM		STORE	ITEM	*
00	X L.H.S.	50 (0)	m	20	Y_1	14.5	31	Y_{12}	1
01	Y L.H.S.	12 (0)	m	21	Y_2	17.0	32	Y_{13}	5.5
02	X R.H.S.	100 (140)	m	22	Y_3	21.0	33	Y_{14}	11
03	Y R.H.S.	27 (33)	m	23	Y_4	23.5	34	Y_{15}	18
04	SLICES	5 (7)		24	Y_5	26	35	Y_{16}	24
06	GAMMA	19	kN/m³	25	Y_6		36	Y_{17}	27
07	C	1.5	kPa	26	Y_7		37	Y_{18}	31
08	PHI	10	degrees	27	Y_8		38	Y_{19}	
09	ru	0.5		28	Y_9		39	Y_{20}	
10	YCIRCLE	130 (400)	m	29	Y_{10}				
11	F_1	1		30	Y_{11}				

* Only enter Nº specified

CALCULATIONS

	F	I
	0.41	0.38
Given ru=0	0.73	0.72
C=6.4	0.97	0.96
Find Φ=9°		
Yc=50	0.89	0.88

	F	I
	0.42	0.39
Given ru=0	0.77	0.76
C=6.4 Φ=9°	0.92	0.91
Yc=135	0.81	0.80



5 cm

SLOPE STABILITY ANALYSIS - COMPUTATIONS SHEET 1 OF.....

NAME OF SLIP CORBELS LAND SECTION DE MAP REF.....

ANALYSIS BY.....
DATE.....
CHECKED BY.....

INITIAL INPUT				SHAPE *					
STORE	ITEM			STORE	ITEM		STORE	ITEM	
00	X L.H.S.	50	m	20	Y_1	8	31	Y_{12}	
01	Y L.H.S.	7	m	21	Y_2	10	32	Y_{13}	
02	X R.H.S.	120	m	22	Y_3	12·5	33	Y_{14}	
03	Y R.H.S.	18·5	m	23	Y_4	14·5	34	Y_{15}	
04	SLICES	7		24	Y_5	16·5	35	Y_{16}	
06	GAMMA	19	kN/m³	25	Y_6	17·5	36	Y_{17}	
07	C	1·5	kPa	26	Y_7	18·0	37	Y_{18}	
08	PHI	10	degrees	27	Y_8		38	Y_{19}	
09	ru	0·5		28	Y_9		39	Y_{20}	
10	YCIRCLE	170	m	29	Y_{10}				
11	F_1	1		30	Y_{11}				

* Only enter Nº specified

CALCULATIONS

	F	I
	0·65	0·64
Given ..... $r_u=0$	1·17	1·18
Find ..... $C=6.4$	1·48	1·49
$\phi=9$		
$r_u=0.1$	1·38	1·39
$r_u=0.25$	1·24	1·25

Given.....

Yaxis (m)

Xaxis (m)

5 cm

SLOPE STABILITY ANALYSIS - COMPUTATIONS SHEET 1 OF.....

NAME OF SLIP CORDELLS LAND 10° Slope MAP REF.....

ANALYSIS BY.....
DATE.....
CHECKED BY.....

INITIAL INPUT				SHAPE *					
STORE	ITEM			STORE	ITEM		STORE	ITEM	
00	X L.H.S.	30	m	20	Y_1	7	31	Y_{12}	
01	Y L.H.S.	6	m	21	Y_2	9	32	Y_{13}	
02	X R.H.S.	80	m	22	Y_3	11	33	Y_{14}	
03	Y R.H.S.	15.5	m	23	Y_4	13	34	Y_{15}	
04	SLICES	5		24	Y_5	15	35	Y_{16}	
06	GAMMA	19	kN/m³	25	Y_6		36	Y_{17}	
07	C	1.5	kPa	26	Y_7		37	Y_{18}	
08	PHI	10	degrees	27	Y_8		38	Y_{19}	
09	ru	0.25		28	Y_9		39	Y_{20}	
10	YCIRCLE	97	m	29	Y_{10}				
11	F_1	1		30	Y_{11}				

* Only enter Nº specified

CALCULATIONS

	F	I
	1	0.84
Given ..ru=0.1	0.98	0.98
....ru=0	1.07	1.07
Find.....		
ϕ = 9°)	1.47	
C = 6.4)		
ru = 0.1	1.39	1.40
ru = 0.25	1.27	1.27
ru = 0.5	1.06	1.06

Given.....

Yaxis (m)

X 97

Y 25

Xaxis (m)

5 cm

SLOPE STABILITY ANALYSIS - COMPUTATIONS SHEET 1 OF.....

NAME OF SLIP CORBELLS LAND 8°SLOPE MAP REF.....

ANALYSIS BY.....
DATE .....
CHECKED BY.....

INITIAL INPUT				SHAPE *					
STORE	ITEM			STORE	ITEM		STORE	ITEM	
00	X L.H.S.	0	m	20	Y_1	1	31	Y_{12}	
01	Y L.H.S.	0	m	21	Y_2	2.25	32	Y_{13}	
02	X R.H.S.	60	m	22	Y_3	3.5	33	Y_{14}	
03	Y R.H.S.	80	m	23	Y_4	5.0	34	Y_{15}	
04	SLICES	6		24	Y_5	6.25	35	Y_{16}	
06	GAMMA	19	kN/m³	25	Y_6	7.75	36	Y_{17}	
07	C	1.5	kPa	26	Y_7		37	Y_{18}	
08	PHI	10	degrees	27	Y_8		38	Y_{19}	
09	ru	0.25		28	Y_9		39	Y_{20}	
10	YCIRCLE	148	m	29	Y_{10}				
11	F_1	1		30	Y_{11}				

* Only enter Nº specified

CALCULATIONS

	F	C
	1	1.24
Given ru=0.1	1.44	1.45
ru=0	1.57	1.58
Find ru=0.1	1.32	1.33
Φ=9		
C=4.1	1.75	
ru=0.25	1.66	1.68
Φ=10		
C=6.4	1.94	1.96
Φ=9		
	1.65	1.66
ru=0.5		

Given.....

Yaxis (m)

Xaxis (m)

5 cm