1981/19. Proposed landslip zoning of Wulf's farm, Browns Hill, Underwood

W.R. Moore

Abstract

A proposal to subdivide Wulf's farm resulted in it being mapped and rezoned for landslip potential. The farm is located on the north-west flank of Browns Hill, an isolated fault-tilted block on which many steep slopes are present, with dormant landslips occurring on a variety of rock types.

The farm comprises two low sloping benches of 3 - 8° which are mapped as Zone I areas (not subject to landslip), and steep long slopes of 16 - 18° flattening to 11 - 13° which are mapped as Zone II areas (potential landslip area), except for a small area of Zone III of active landslip where a recent failure occurred in 1978. The upper bench is dolerite and dolerite talus and the slope and lower bench are in sandstone/mudstone sediments of Triassic age. A proposed house site was also investigated on one of the proposed blocks.

INTRODUCTION

K.H. Wulf's farm [EQ153309] is situated on Browns Hill Road three kilometres north of Underwood. Browns Hill Road connects Underwood on the Lilydale Road with Karoola on the North-eastern railway line. The farm which is situated on the north-west flank of Browns Hill and overlooks Karoola and Pipers River, comprises a series of paddocks that descend from the flank of Browns Hill at 390 m to 200 m level. The cultivated areas are situated on a series of flat benches which are connected by steeper slopes, some of which are grassed and open country, but others are covered in bush and scrub.

The subdivision, as proposed by Wulf, is to split the existing farm into three blocks with the boundaries as proposed by the Tamar Regional Master Planning Authority (fig. 1). It is planned that Block 1 be sold immediately and a house built on the proposed site (fig. 1) for M.G. Pinner of Karoola. Block 2 is to be sold as a rural block with access along the road reserve. Block 3, the homestead block, is to remain as a rural block with no further subdivision planned in the immediate future.

PREVIOUS LANDSLIP ZONING AND INVESTIGATION

On the provisional landslip zone map of the Lilydale area, all of Wulf's farm is shown as a potential landslip area (Zone II) except for a small area of Zone III in front of the homestead, where a landslip occurred in 1978. The Browns Hill area has some very localised steep slopes with old dormant landslips occurring on a variety of rock types. Until more detailed field work could be undertaken, with some supplementary subsurface investigation, all the Browns Hill area was provisionally classified either as Zone II or Zone III, even though it was known that many building sites were possible in the area. These sites had to be chosen selectively, with considerable attention being paid to possible slope failure and, associated with this problem, the disposal of sullage water, septic tank location, etc. Such investigations would often require trenching and, in some cases, drilling a proposed site. It was decided that until the regional zoning of the Lilydale area could be completed, individual subdivision applications would be dealt with as they arose.

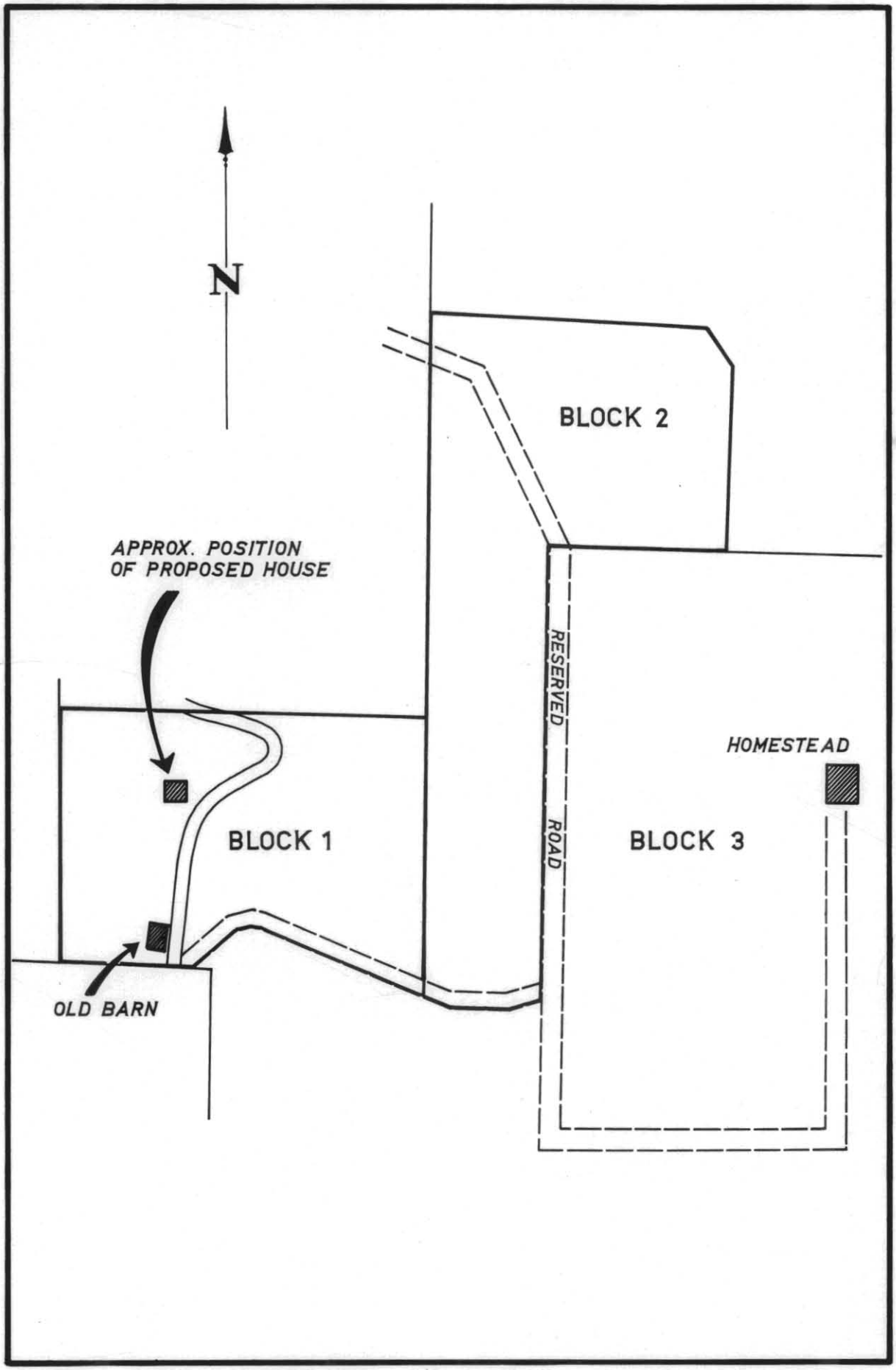


Figure 1. *Proposed subdivision of land, Wulf's farm, Browns Hill Road, Underwood*

The Department of Mines was first asked to investigate Wulf's farm in the winter of 1978, when the owner reported that a large slip had occurred in his front paddock and was worried that it may extend to his driveway and house. The slip was mapped by A.T. Moon (Appendix I) and it was hoped to monitor its movement, but staff shortages and a lack of drilling equipment stopped any further investigation of the slip. The movement appeared to have ceased during 1979 and the slip appears to have been confined by a thick sandstone bed that crops out along the road reserve. The slip occurs in Triassic sediments, with the slip crown exposing as a main scarp a 1.5 - 2 m thick bed of bedded sandstone. Above the crown of the slip is a very moist seepage area (fig. 2). It is possible that a localised perched water table may be present in this sandstone, as water was seen to seep from the main scarp of the slip. A permanent spring is present in the paddock above the slip and this paddock was often exceptionally wet when the failure was first visited. In an attempt to establish if a perched water table existed in the sandstone, and what material was above this sandstone, a bore was sited on the homestead driveway This bore passed through 3.5 m of clay and dolerite boulders before hitting the sandstone. The sandstone was dry and the hole was continued to a depth of 32.5 metres. A sequence of thick sandstone dominated, with minor mudstone and silty soft sandstone. This sequence could not be correlated with the rocks thought to form the benches at the southern end of Browns Hill.

It is thought that the slip is anasymmetrical slip circle confined between two thicker sandstone bands. Even though some of the upper sandstone has failed its retreat is likely to be slow. The main movement appears to have been in softer sediments on the steeper slope of 13 - 14° between the two benches that form the flatter bench areas. There is considerable bulging at the top and side fissures. This slip needs further investigation, particularly drilling and monitoring of water levels etc., but with present financial limitations this appears unlikely.

GEOLOGY

Browns Hill is a fault-tilted block capped by dolerite, with the tilting dipping towards south-east (fig. 3). The north-east uplift is highest at where Wulf's farm is situated. Here the lower bench of dolerite crops out on the higher flat section of the homestead block. A low sloping area of red and brown clay soil with very large dolerite boulders overlies the uppermost Triassic sandstone bench. These dolerite boulders, with their red and brown soils, cover the western half of Block 3. No slope stability problems are likely to be encountered on the dolerite and dolerite talus areas.

Below the flat talus bench are long steep slopes to the west and north-west. The soils are sandy and rock outcrops are few, and these are all sandstone concentrated in the banks of the road reserve. Here the sandstone bench has a low dip to the south-east against the slope. Only on the road reserve is any bench developed; elsewhere the slopes are long, with slope angles of 16 - 19° flattening to 11 - 12° on the lower levels.

Because of the steepness and the length of slope without any benches north of the stream that parallels Browns Hill Road, all of this area is mapped as Zone II potential landslip, and the risk must be considered high, especially where mudstones are present in this sequence, as occurred in water bores near this area. The critical angle for such a slope, if the water content of sediments is increased, appears to be 11 - 12°. Wulf's homestead dam is on the edge of this slope and no failure has occurred

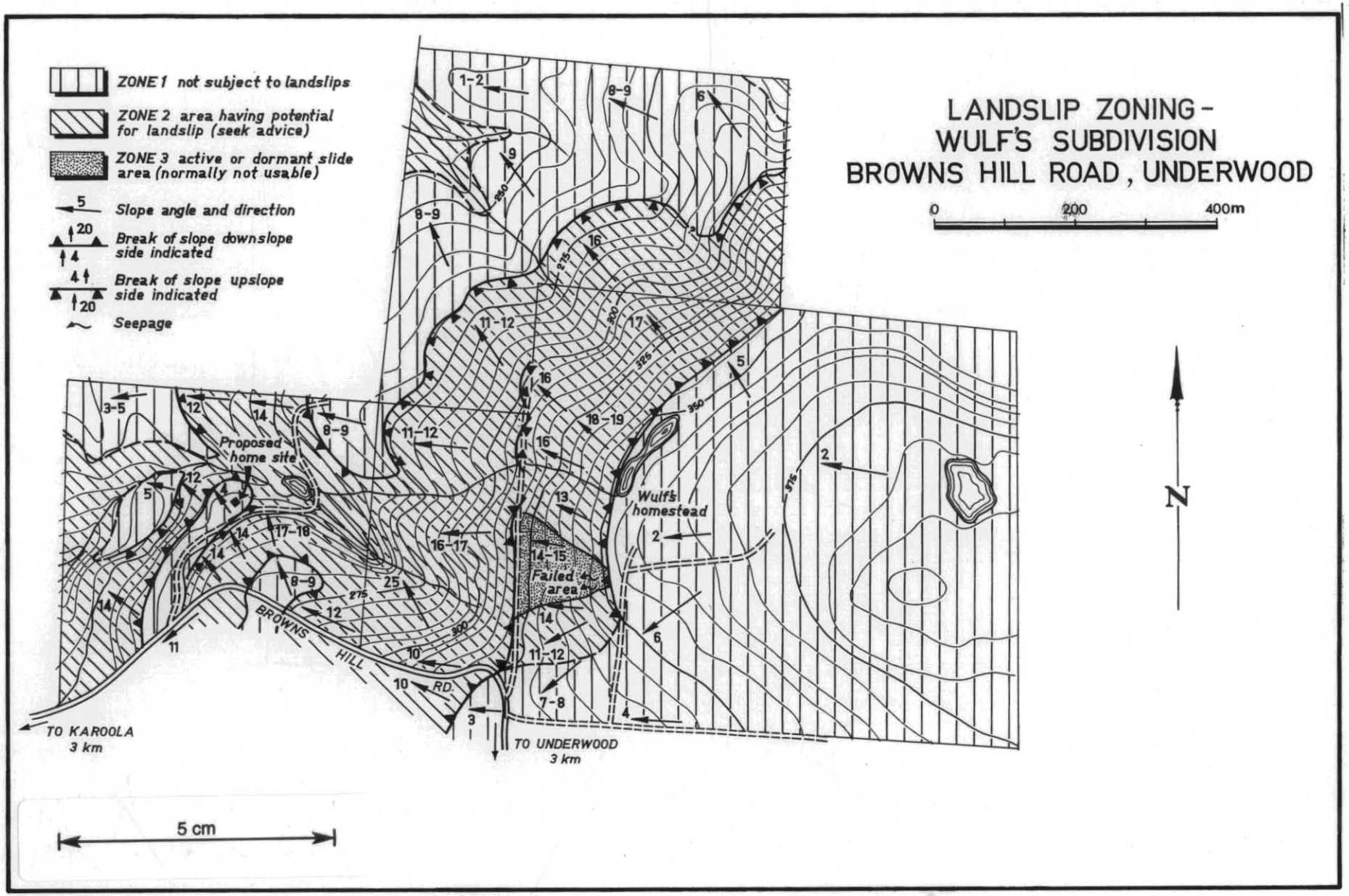

LANDSLIP ZONING -
WULF'S SUBDIVISION
BROWNS HILL ROAD, UNDERWOOD
0
200
400m
ZONE 1 not subject to landslips
ZONE 2 area having potential for landslip (seek advice)
ZONE 3 active or dormant slide area (normally not usable)
5 Slope angle and direction
20 / 4 Break of slope downslope side indicated
4 / 20 Break of slope upslope side indicated
Seepage
Proposed home site
Wulf's homestead
Failed area
BROWNS HILL RD.
TO KAROOLA 3 km
TO UNDERWOOD 3 km
N
5 cm

Figure 2.

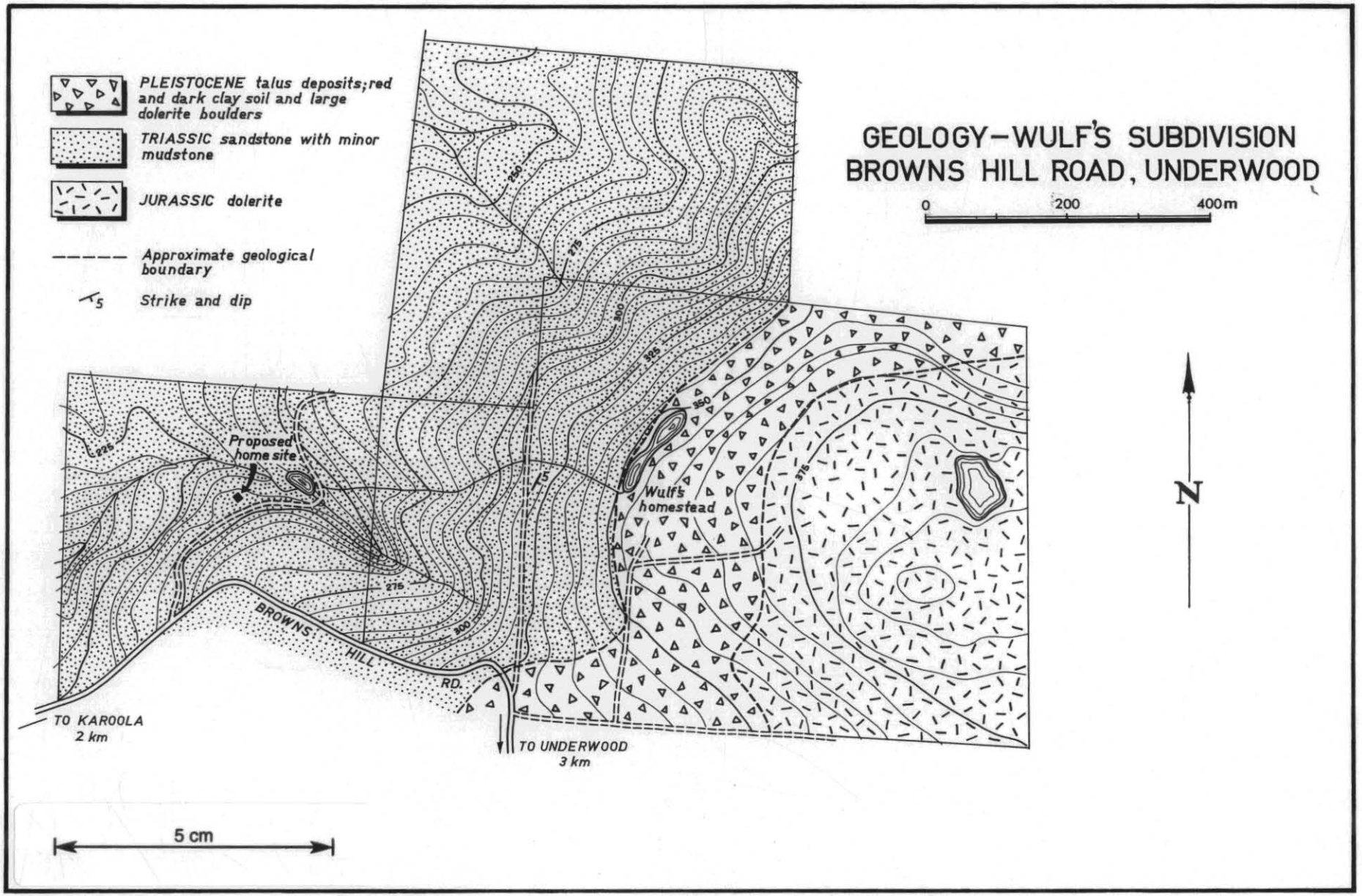

PLEISTOCENE talus deposits; red and dark clay soil and large dolerite boulders
TRIASSIC sandstone with minor mudstone
JURASSIC dolerite
Approximate geological boundary
Strike and dip
GEOLOGY—WULF'S SUBDIVISION
BROWNS HILL ROAD, UNDERWOOD
0
200
400m
Proposed home site
Wulf's homestead
BROWNS HILL RD.
TO KAROOLA
2 km
TO UNDERWOOD
3 km
N
5 cm

Figure 3.

below it, despite the steep 16° slope. This small dam appears to be very well constructed, with no leaks visible, or moist area below its wall. The dam is also very shallow.

At the base of this steep slope is an area of wide flat benches with low slopes at 8 - 9° and even as flat as 1 - 2° on one spur in Block 2. On Block 1, south of the stream, the wider bench area is more dissected, with three narrow benches occurring on the south side of the stream. As slopes are low and the rock underlying these benches is thought to be of competent rock no landslips are likely to occur on these benches and the only potentially unstable areas are the steep narrow valley sides, which are likely to develop shallow planar slides as the stream erodes downwards. Therefore the benches are zoned as Zone I areas and narrow streams and gully heads are Zone II areas.

INVESTIGATION OF PINNER'S HOME SITE, BLOCK 1

Because the benches are less well developed south of the stream to the Browns Hill Road, the geology and the alternation of slope and bench is obviously more complex. There is a possibility that these small benches were produced in this area by an old landslip. It is on the middle of one of these benches, the site of an old homestead and barn, that Mr Pinner wishes to build his home. The site is shown on Figures 1 and 2.

To try and prove that this bench was structural a hole was augered to 7.3 m depth. Because little to no core was recovered when the hard rock was encountered, the drilling results were inconclusive. In the top three metres sandy clay soil and clay subsoil were present. This was overlain by a weathered layer of clayey sand. At 6.8 m the rock became harder and the drill could not penetrate beyond 7.3 m depth. From the few rock fragments recovered, the bottom rock layer between 7.0 - 7.3 m is thought to be a hard grey sandstone interbedded with grey mudstone, which is probably the top of the bench rock surface. No water was present in the hole and top layers were only slightly moist.

From this subsurface evidence it appears that no stability problem is likely on the bench as the result of building a house. A more likely problem is that failure may occur on the slope behind the house. This steep slope has a slope angle of 14°, which increases to 17 - 18° towards the stream; the slope is short with another bench above it. To reduce the risk to the house if a failure should occur on this slope, the house should be located on the north side of the track away from the bank. No excavation of the toe of this slope is proposed now or in the future for any future building etc. No further subdivision should be permitted on the other two benches, particularly the small one above the proposed house site. Any extra water from this higher bench would seep down the slope, and as the slope is within the critical range for landslips to occur, this can be avoided by allowing no further subdivision of Block 1 between the road and the stream. Any future subdivision of this block should be confined to the more extensive terrace on the north side of the stream.

The septic tank of the proposed house should be located on the same bench as the house and towards the road entrance, but the overflow should be piped down the slope in front of the house to the lower bench. The stormwater should be kept from draining on to this slope and should enter the stream at the lower bench level. Any swimming pool should not be located in front of the house because any leakage from it would flow on

to the slope. The removal of trees on the slope behind the house should be kept to the minimum. With these precautions, the risk of failure on the slope behind and in front of the house can be reduced to an acceptable level.

CONCLUSIONS AND RECOMMENDATIONS

Block 1

(a) One house site should be permitted on the most extensive flat area of the largest middle bench on the south side of the stream, on the site proposed by Mr Pinner.

(b) Any further future subdivision of Block 1 should be confined to the northern area of the block on the north side of the stream. Neither the existing owner Mr Wulf, nor the future owner Mr Pinner envisage any further subdivision of the block.

(c) Access is likely to be a problem to the north side of the stream.

(d) Reasonable precautions, as outlined previously in this report, should be undertaken to reduce the risk of small landslips occurring on the slopes in front of and to the rear of the proposed house site.

Block 2

(a) Close subdivision of this block is unlikely to occur in the immediate future as it is proposed to sell it as a rural block.

(b) If subdivision is proposed in the future, there are large areas of low sloping stable ground with excellent views that could be used (Zone I areas).

(c) Any future building in the Zone II areas would require detailed sub-surface investigation. Even though the slopes are low (11 - 12°), they are considered within the range, given the correct conditions, that land-slips can occur in these sediments.

(d) Any widening and upgrading of the access track along the road reserve should be undertaken without cutting too much into the sandstone bank that this track follows. The removal of this bank would remove the toe of the existing active failure and the track itself could slip. This sandstone bank is confining the existing slip and its removal is not recommended.

Block 3

(a) No close subdivision is planned on this block by Mr Wulf. There are large areas suitable for future subdivision on the talus and dolerite flats. If subdivision should occur, care should be taken that water from the septic tanks, sullage, and stormwater is so planned that it is kept from seeping on to the active Zone III and potentially active Zone II areas. Unfortunately the natural drainage is in this direction, and there is no doubt that drainage of rain and irrigation water from these cultivated and heavily stocked pastures has caused the landslip.

(b) The steep slope area is zoned as a potential landslip area, but all of this slope is so sensitive and steep, with slopes of 16 - 19°, that it is doubtful if any future subdivision or even a single house site could be justified on it. For any building on this slope to be permitted, it would require the most detailed subsurface investigation as well as soil analysis and slope stability studies in order to prove that the existing active slip is a geological accident and not, as is thought, the normal geological erosional process on slopes above 10° in Triassic sediments in the Lilydale-Karoola area.

[16 April 1981]

APPENDIX 1

Survey of Wulf's slip, Underwood

A.T. Moon

NOTES

(1) The survey was carried out by tape, compass, and abney level on 20 November 1979. The survey was carried out quickly (in about two hours) and the writer has not visited the site since the survey.

(2) Some, or all, of the pegs on Section DD′ were mislabelled as 'C' pegs (*i.e.* C6, C7 etc.)

(3) Markings on pegs may have faded, some may be missing, but the plan should enable pegs to be identified.

(4) The two pegs aligned with A1 may be used to sight the original position of A1 which has probably been covered by the toe of the landslip.

(5) The outline of the landslip is approximate only; where it crosses the survey lines it is accurate to ± 1.0 m. Peg A10 was 0.3 m from the headscarp at the time of survey.

(6) The reduced levels (RLs) on Figures 4 and 5 are based on an arbitrary site datum. The base of fence post F1 has been given the value of RL 100.0.

(7) Error checks have been made (Table 2); Section AA′ is drawn as accurately as possible and known errors are accommodated along the fenceline F0 to F7.

(8) The approximate maximum error in the survey within the shaded area on Figure 4 is RL ± 0.1 m
position ± 0.5 m

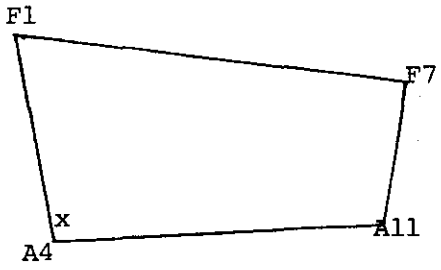
Outside the shaded area the approximate maximum error is
RL ± 0.6 m
position ± 3.0 m

10/15

Table 1. SURVEY DATA, WULF'S SLIP, UNDERWOOD

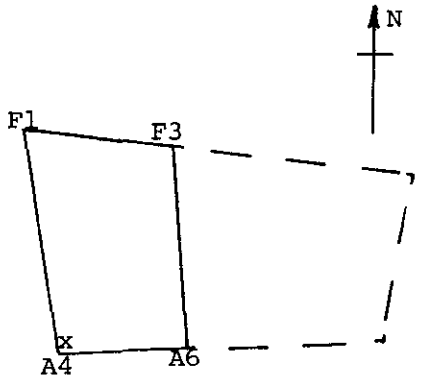
From	To	Slope distance (m)	Slope angle	Bearing	Horizontal distance (m)	Vertical distance (m)
A1	A2	4.00	+28°15'	092°	3.52	+1.89
A2	A3	11.03	+9°30'	092°	10.88	+1.82
A3	A4	15.00	+8°30'	092°	14.84	+2.17
A4	B3	7.00	+3°30'	176°	6.99	+0.43
B3	B2	7.00	0°00'	176°	7.00	0.00
B2	B1	8.00	-2°30'	176°	7.99	-0.35
B1	B0	8.00	0°00'	176°	8.00	0.00
B0	F1	7.17	-2°15'	176°	7.16	-0.28
A4	B5	7.00	+1°00'	176°	7.00	+0.12
B5	B6	7.00	+6°00'	176°	6.96	+0.73
B6	B7	7.00	+6°10'	176°	6.96	+0.75
B7	B8	7.00	+5°30'	176°	6.97	+0.67
C7	C8	7.00	+8°00'	178°	6.93	+0.97
C6	C7	7.00	+1°00'	178°	7.00	+0.12
C5	C6	7.00	+3°15'	178°	6.99	+0.40
A6	C5	7.00	+3°00'	178°	6.99	+0.37
C4	A6	7.00	-6°45'	178°	6.95	-0.82
C3	C4	7.00	+4°45'	178°	6.98	+0.60
C2	C3	7.00	-2°50'	178°	6.99	-0.35
C1	C2	7.00	-1°00'	178°	7.00	-0.12
C1	F3	2.54	+0°20'	178°	2.54	+0.01
A5	A4	15.00	-16°00'	092°	14.42	-4.13
A6	A5	14.91	-10°45'	092°	14.65	-2.78
A7	A6	14.95	-12°45'	092°	14.58	-3.30
A8	A7	15.08	-8°15'	092°	14.92	-2.16
D8	D7	7.00	-25°30'	000°	6.32	3.01
D7	D6	7.00	0°00'	000°	7.00	0.00
D6	A8	7.00	+5°10'	000°	6.97	0.63
A8	D5	7.00	+5°20'	000°	6.97	0.65
D5	D4	9.00	+4°20'	000°	8.97	0.68
D4	D3	8.00	+0°45'	000°	8.00	0.10
D4	F5	9.18	+0°40'	000°	9.18	0.11
A9	A8	14.59	-12°40'	092°	14.23	3.20
A10	A9	7.39	-32°15'	092°	6.25	3.94
A11	A10	5.81	-9°00'	092°	5.74	0.91
A11	F7	19.58	+2°15'	007°	19.56	0.77
F7	F6	14.28	-19°10'	102°	13.49	4.69
F6	F5	16.75	-12°50'	104°	16.33	3.72
F5	F4	16.33	-12°35'	101°	15.94	3.56
F4	F3	15.50	-10°00'	102°	15.26	2.69
F3	F2	15.28	-13°10'	101°	14.88	3.48
F2	F1	16.39	-15°20'	101°	15.80	4.33
F1	F0	17.52	-13°15'	097°	17.05	4.02

Table 2. SURVEY ERROR CHECKS, WULF'S SLIP



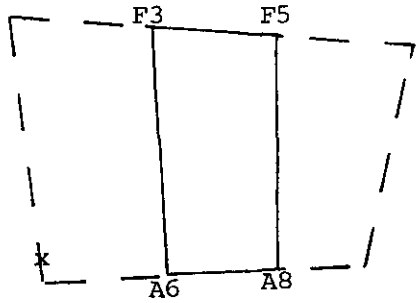
A4-A11-F7-F1

From	To	Bearing	ΔHoriz.	ΔVert.	South	East
A4	A11	092°	84.79	+20.42	-2.96	+84.74
A11	F7	007°	19.56	+0.77	-19.41	+2.38
F7	F1	102°	91.69	-22.47	-19.06	-89.69
F1	A4	176°	37.14	+0.20	+37.05	+2.59
				-1.08	-4.38	+0.02



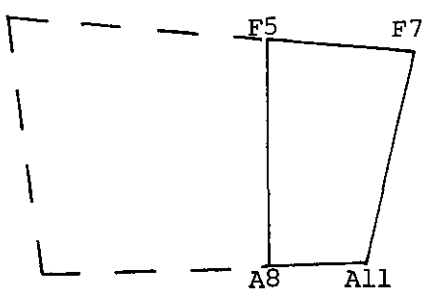
A4-A6-F3-F1

From	To	Bearing	ΔHoriz.	ΔVert.	South	East
A4	A6	092°	29.07	+6.91	-1.01	+29.05
A6	F3	178°	30.46	+0.70	-30.44	-1.06
F3	F1	101°	30.68	-7.81	-5.85	-30.12
F1	A4	176°	37.14	+0.20	+37.05	+2.59
				0.00	-0.25	+0.46



A6-A8-F5-F3

From	To	Bearing	ΔHoriz.	ΔVert.	South	East
A6	A8	092°	29.50	+5.46	-1.03	+29.48
A8	F5	000°	25.12	+1.44	-25.12	0.00
F5	F3	101.5°	31.20	-6.25	-6.22	-30.57
F3	A6	178°	30.46	-0.70	+30.44	+1.06
				-0.05	-1.93	-0.03



A8-A11-F7-F5

From	To	Bearing	ΔHoriz.	ΔVert.	South	East
A8	A11	092°	26.22	+8.05	-0.92	+26.20
A11	F7	007°	19.56	+0.77	-19.41	+2.38
F7	F5	103°	29.81	-8.41	-6.71	-29.05
F5	A8	000°	25.12	-1.44	+25.12	0.00
				-1.03	-1.92	-0.47

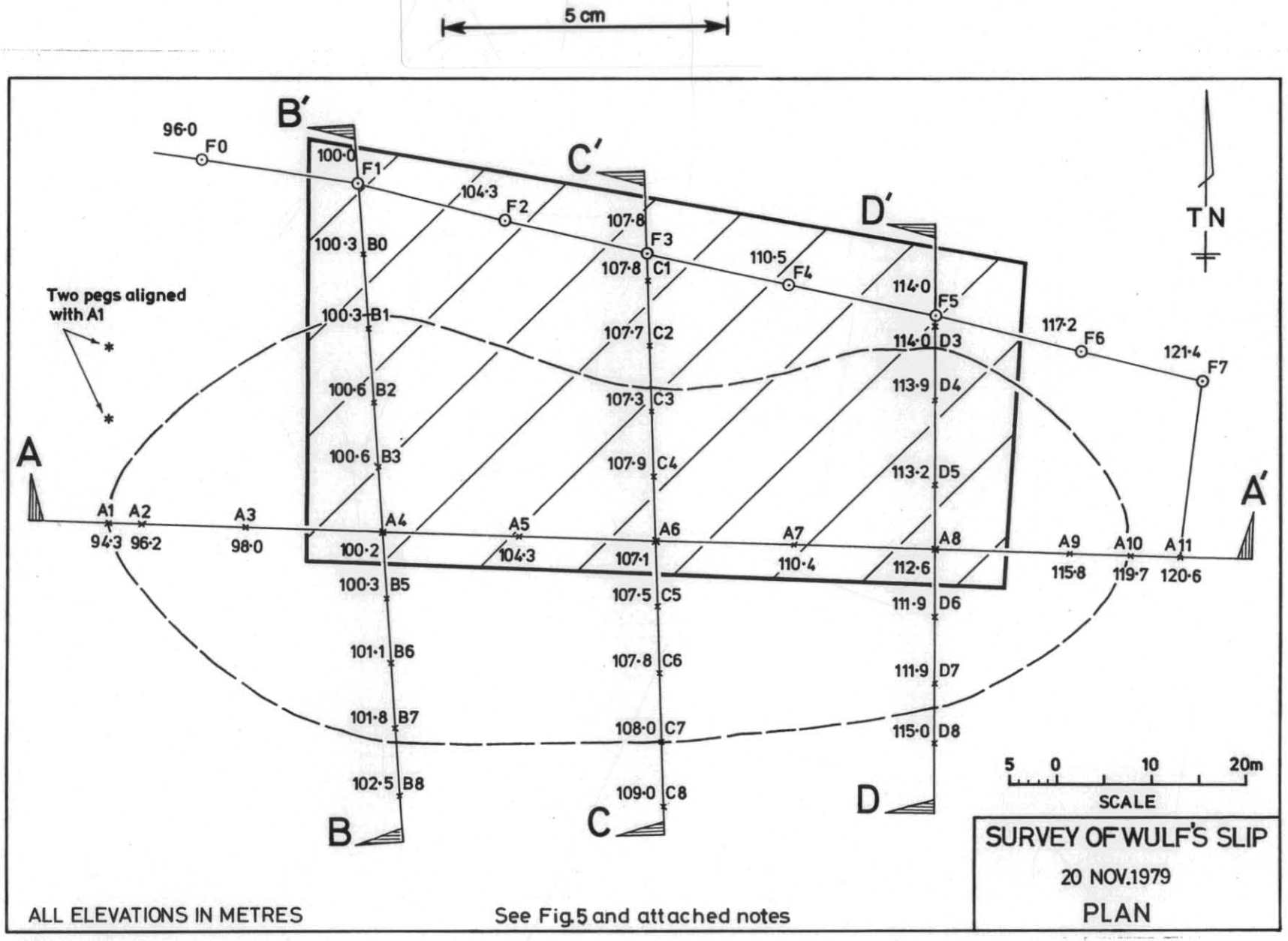


Figure 4.

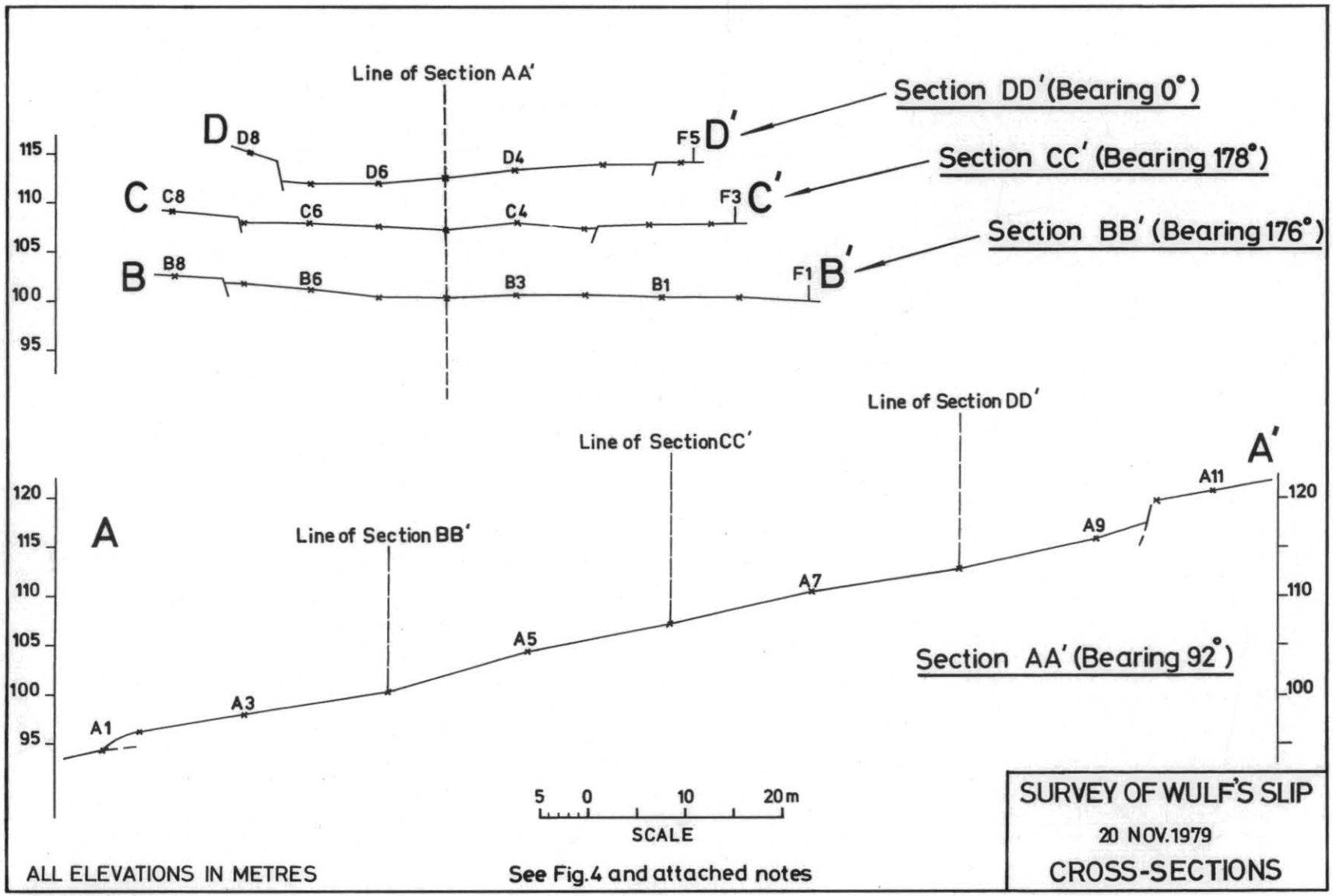

5 cm
Line of Section AA'
Section DD'(Bearing 0°)
Section CC' (Bearing 178°)
Section BB' (Bearing 176°)
D
D8
D6
D4
F5
D'
C
C8
C6
C4
F3
C'
B
B8
B6
B3
B1
F1
B'
115
110
105
100
95
Line of Section DD'
Line of SectionCC'
A'
A11
A9
A7
A5
A3
A1
A
Line of Section BB'
120
115
110
105
100
95
Section AA' (Bearing 92°)
5 0 10 20m
SCALE
SURVEY OF WULF'S SLIP
20 NOV.1979
CROSS-SECTIONS
ALL ELEVATIONS IN METRES
See Fig.4 and attached notes

Figure 5.

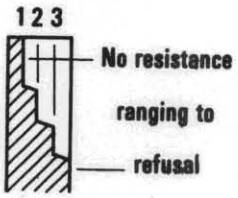
14/15

TASMANIA DEPARTMENT OF MINES

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	Undistributed 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

5 cm

borehole no. 1

sheet 1 of 1

15/15

ENGINEERING LOG – BOREHOLE

project Wulf's Subdivision

location Browns Hill Road, Underwood

co-ordinates EQ152310

R.L. 247 m

inclination vertical

bearing --

drill type Triefus

drill method auger

drill fluid nil

hole commenced 6.4.81

hole completed 6.4.81

drilled by B.E. Cox

logged by W.R. Moore

checked by R.C. Donaldson

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
				246	1		CH	SANDY CLAY: High plasticity, dark grey sand (20%), fine. some organic material	M < PL	S	x	Topsoil
			D		1.5					VSt	x	
				245	2		CH	CLAY: High plasticity brown, some fine sand.	M > PL			Subsoil
			D	244	3						x	
	None	None			3.3			CLAYEY SAND: Fine, yellow, well sorted clay (30-40%) high plasticity (CH)				Deeply weathered Transitional zone between sand and sandstone
				243	4		SC					
			D	242	5							
				241	6							
			D	240	7			Hard rock				
			D		7.3			Sandstone, dark grey, hard. Some dark grey mudstone.				Bedrock
								Hole terminated at 7.3 m on hardrock. Drill refused at this depth.				