UR1985_65

1985/65. House cracking at Sandown Road, Launceston

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Abstract

Three holes were drilled in an investigation of a cracked house at 41 Sandown Road, Launceston. Sandown Road is an area well known in Launceston for house cracking which, by reputation, is thought to be caused by landslides. Two holes were auger drilled to 7.9 m and the third hand augered to 1.0 m. The deep holes were at the north-east and north-west corners of the house where most cracking has occurred and where a high brick wall is tilted.

Clay was present in all three holes. In the two deeper holes, the clay was 2.0 m and 3.0 m thick and overlay sandy clay, with a cemented horizon at the interface. The moisture content, plasticity and linear shrinkage were all high in the upper clay and all declined with depth and increase in sand content. The sand content increased from approximately 15% to 50% below the cemented horizon in the sandy clay.

It is thought that seasonal movements in expansive clay, combined with poor foundations and the design of the house, caused the cracking. It is recommended that the foundation of the northern wall be strengthened with piers down to the sandy clay and that the driveway along the wall be concreted to keep water away from the foundations.

INTRODUCTION

Mr and Mrs S. Bristow requested on 28 June that an investigation be undertaken by the Department of Mines to ascertain the cause of cracking in their home at 41 Sandown Road (fig. 1). The house had recently become cracked, the cracking being particularly severe along the northern section of the house. The high, two-storied northern brick wall had also become slightly tilted downslope.

By chance the Department was also asked to structurally check the adjacent house upslope at 43 Sandown Road for a prospective buyer. The contrast between the two houses was remarkable. No. 43 Sandown Road, an older house, had some very old cracks that had been repaired many years ago. Since this initial cracking, the house has been stable with no recent cracking, despite the 1982-84 drought when widespread house cracking occurred in Launceston (Moore, 1983).

During this period houses in Sandown Road were badly affected and the accepted local explanation for this phenomena was that it was due to landslide movement. The reputation for house cracking at Sandown Road affected the sale not only of houses but also empty blocks. It was on behalf of an owner of Block 23 (fig. 1) that the Department of Mines was asked to investigate the slope stability (Moore, 1984). From this investigation it appeared that the explanation for the cracking was more likely to be the expansive nature of the clay subsoil rather than landslide movements. During the long drought, this clay subsoil dried and contracted more than usually occurs, causing the structurally weaker houses to crack.

Although house cracking is widespread in the Sandown Road area, only specific houses are affected, as seen by the two houses at 43 and 41 Sandown

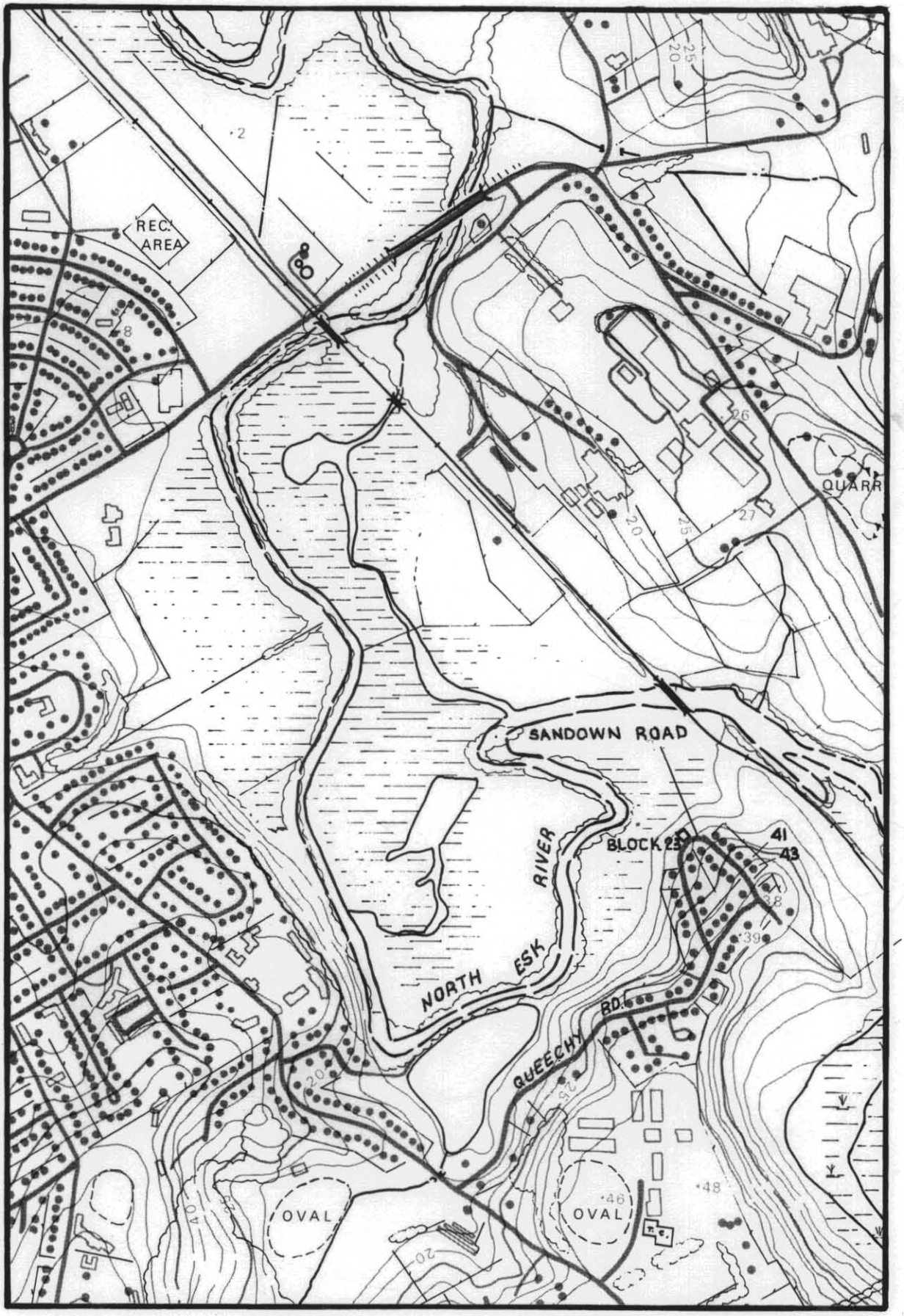

Figure 1. *Location map of Sandown Road area.*

5 cm

Road. No pattern could be seen in the distribution of this cracking and the explanation offered was as follows (Moore, 1984)....

"The lack of any obvious pattern to the house cracking in Sandown Road, as well as reflecting structural strength differences between houses, could be a reflection of the aereal distribution of the hard pan in the terrace sandy silt and the sandy clay lens in the clay of the Launceston Beds".

INVESTIGATION

Bristow's house was badly cracked along the north wall, and the wall was also slightly out of alignment. This two-story high, double brick wall is on the sunny and downslope side of the house. Cracking was only minor on the southern, shady side of the house. Cracking along sundecks and patios on the north-west and north-east corners gave an appearance that the high north wall was pulling away from the remainder of the house.

Two deep auger holes were drilled with the Triefus trailer-mounted drill to a depth of 7.9 metres. These holes were drilled on the north-west and north-east corners of the house on the grass driveway beside the northern wall. A hand auger hole was drilled on the built-up front lawn near the south-west corner to a depth of one metre. Another sample was collected from the rear of the house where the owner had dug a shallow trench exposing the clay. Samples were sieved for grain-size analysis, and tested for Atterberg limits, moisture content, and linear shrinkage.

TOPOGRAPHY

Because a considerable amount of cut and fill has occurred in the construction of the house and garden at Bristow's it is difficult to know precisely the natural slope of the land. On nearby blocks the slope appears to be 12°-13°. Bristow's house is situated on the steeper section of Sandown Road and is three blocks down from the crest of the slope, where a break in slope occurs to the flat terrace at the junction of Sandown and Queechy Roads. The natural slope falls away steeply at the rear of Bristow's block, with slopes of 17°-20° measured. These steep slopes form the head of a shallow gully that runs down to the flood plain of the North Esk River. By digging a sunken garden in the north-east corner of the block, and which is supported by a poor quality retaining wall, the natural slope has been over-steepened at this corner of the block, adding to instability.

GEOLOGY

The Launceston geological map sheet (Longman *et al.*, 1964) shows the area of Sandown and Queechy Roads to be underlain by the Launceston Beds of dominantly clay capped along the ridge by quartzite gravel. At the bottom of the slope at 23 Sandown Road river-deposited sand, silt and gravel overlying clay was exposed in a trench (Moore, 1984). These river deposited sediments are missing on the slope of the spur at 41 Sandown Road with only a surface, black, organic clay (OH) soil present. This soil layer is thin (0.2 m) in the shallow pit dug by the owner and is underlain by orange-brown clay (CH) subsoil with limonite nodules.

DRILLING

The logs for the holes drilled are given in Appendix 1. In Hole 1, located at the north-west corner of the house, below the soil layer of black clay (OH) was a sequence of orange and then grey clay (CH) which was

drilled to a depth of 3.0 m. The clay was highly plastic, moist and soft. Similar clay sequences are common in Launceston.

A noticeable change was present below 3.0 m, where a cemented limonite layer occurred. The material below this cemented layer was drier and drilling became harder as the material was more compact. There was also a change in composition, with the clay having a higher percentage of fine sand. It is possible that what was logged as a dominantly sandy clay sequence was lithic sandstone with minor clay bands. Lithic sandstone, when deeply weathered, is difficult to recognise in auger samples.

A similar sequence was drilled in Hole 2 at the north-east corner of the house, except that the surface clay sequence was 2.0 m thick compared with 3.0 m in Hole 1.

Because of the gardens and trees the trailer auger drill was not used in Hole 3 near the south-west corner of the house. A hand auger hole was dug to a depth of one metre. This was an adequate depth to obtain samples from the orange and grey clay. The cemented hard sandy-clay layer was not reached. Hole 4 was dug by the owner to expose the clay, from which a sample was collected using the hand auger. The hole was on the eastern side of the house.

LABORATORY RESULTS

The soil laboratory results are given in Table 1 and the grain size analyses in Appendix 2 and diagrammatically in Figure 2. The grain size analyses show that in the top three metres of Hole 1 and two metres in Hole 2 the sand percentage was less than 20%. Below this depth, the sand percentage increases to 50%. This increase in sand content occurs at the cemented horizon in both holes and remains at approximately 50% below 4.0 m in Hole 1 and 2.5 m in Hole 2, throughout the sandy clay section of the holes (fig. 2). This sand content increase was noted when drilling and logging the hole, but on analysis the sand percentage was far higher than anticipated. This is probably because the sand is fine and well graded, giving the appearance that the clay material is dominant, with the fine sand being masked by the mixing of the auger drilling.

The moisture content is highest in the clay section of all the holes: 22-25% in Hole 1, 17-22% in Hole 2, and 23-25% in Hole 3. The moisture content declines with depth in the sandy clay section of the holes and remains constant at 13-14% below 4.0 m depth in Hole 1 and at 14-15% below 2.5 m in Hole 2 (fig. 2). These moisture contents are low compared with the 32% at 1.4 m and 28% at 1.8 m in similar clay in an investigation trench at 23 Sandown Road (Moore, 1984).

The plasticity of the clay in the upper sections of Holes 1 and 2 is high, with liquid limits ranging from 72-82 and plastic indices of 44-52. This plasticity declines sharply with the increase in the sand content below the cemented sandy clay layer. The liquid limits in the sandy clay section of the holes range from 42-55, with plastic indices of 22-34 (fig. 2).

A general decline in the plasticity of clay occurs with increase in depth in Holes 1 and 2 as shown on the soil classification graph (fig. 3). In Hole 1 there is a uniform decline from very high plasticity down to low to high (medium) plasticity. In Hole 2 this decline is irregular but still persists (fig. 3).

The linear shrinkage is highest in the upper clay section of both Holes 1 and 2. In Hole 1 it is 14-17% which declines to 8-11% in the sandy clay. In Hole 2 it is 16-18% in the clay and 9-13% in the sandy clay. In Hole 3 it is 14-16% and 16% in Hole 4.

All of the linear shrinkage values in the clay at 41 Sandown Road are lower than 23 Sandown Road, where the clay at 1.8 m depth had a 24% linear shrinkage. The clay at 41 Sandown Road is classified as high plasticity clay with liquid limits of 72-82 and plastic indices of 44-52 but these are low compared with the liquid limits of 118 and plastic index of 91 at 23 Sandown Road (Moore, 1984). Both the linear shrinkage and plasticity at 41 Sandown Road are low compared with other areas in the Tamar Valley where expansive soil and house cracking problems occur (Moore, 1983; 1985).

CONCLUSIONS

1. No surface evidence was found for landslide movement from the examination of the blocks at 41 and 43 Sandown Road. The cracking of Bristow's house does not appear to be caused by incipient movements of a landslide.

2. It is significant that the area of severest cracking, the north-west corner of the house, is where the clay was thickest in the two holes drilled along the northern wall.

3. The tilted and cracked northern wall is on the sunny side of the house. The clay in this area could be expected to dry out more and experience greater seasonal moisture content fluctuations than on the southern, shady side of the house.

4. Although the plasticity and linear shrinkage of the clay at Bristow's are not as high as in other areas where cracked houses occur in the Tamar Valley, they are considered to be high enough to cause the damage, particularly if the house foundations are shallow, entirely in clay, and the design of the house is not built to withstand the seasonal vertical movements. These seasonal movements in the clay have resulted in a downslope soil creep translational component, which is considered to be causing the problem of tilting of the northern wall and most of the associated cracking of the house.

The design and structure of the Bristow's house appears to the writer to accentuate the problem. It is a long, split level structure, with a large double garage and workshop area which has been dug out into the bank. Only the southern section is founded on the original bank surface. The large upstairs section over the garage and workshop is poorly supported and tied to the high north wall by long steel beams with few supporting columns. If the northern wall moves more than the southern part of the house and with suspected shallow foundations under this northern wall, cracking and tilting of the wall appears a most likely result. Added to this are light concrete sundecks and walkways which will also move differentially to the main house structure along the northern half of the house. These probably cause additional strain on the main structure which is released by further cracking.

RECOMMENDATIONS

1. The foundations along the northern wall be strengthened by underpinning the existing foundation with supporting piers dug through the clay into the underlying dry sandy clay.

2. To keep the water away from the clay near these foundations, it would be desirable to seal the driveway, for example by concrete with Forticon underlay.

3. It appears to the author that the underneath section of the house appears to require strengthening and be tied to the northern wall by extra beams and columns.

4. The monitoring of any cracks should be maintained on the house.

REFERENCES

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MOORE, W.R. 1983. Subsurface geological investigation of cracked houses in the Mowbray area, Launceston. *Unpubl.Rep.Dep.Mines Tasm.* 1983/24.

MOORE, W.R. 1984. Subsurface movement in expansive clay : An alternative explanation for house cracking at Sandown Road, Launceston. *Unpubl. Rep.Dep.Mines Tasm.* 1984/59.

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[17 December 1985]

Table 1. RESULTS OF SOIL TESTING, 41 SANDOWN ROAD

Hole No. & Location	Sample No.	Depth (m)	Moisture content (%)	Plastic limit	Liquid limit	Plastic index	Linear shrinkage (%)	Lab. classification
1	1	0.9	26	30	82	52	17	CH
Front of	2	1.6	24	29	78	49	16	CH
driveway	3	2.5	22	28	72	44	17	CH
at side	4	3.4	19	26	55	29	14	CH
of house	5	4.3	13	20	42	21	8	CL-CH
[NW corner]	6	5.2	14	19	53	34	11	CH
	7	6.1	13	21	42	21	9	CL-CH
	8	7.9	14	21	43	22	10	CL-CH
2	1	0.9	22	33	82	49	16	CH
Rear of	2	1.6	17	29	81	52	18	CH
driveway at	3	2.5	16	27	55	28	12	Mh
side of	4	3.4	16	22	55	33	13	CH-Mh
house	5	4.3	14	20	53	33	12	CH
[SE corner]	6	5.2	15	24	46	22	9	CL-CH
	7	6.1	15	21	56	35	13	CH
	8	7.0	15	19	48	29	12	CL-CH
	9	7.9	14	21	52	31	10	CH
3	1	0.5	25	31	67	36	14	CH
Small lawn	2	1.0	23	35	85	50	16	CH
[SW corner]								
4	1		Not	31	74	43	16	CH
Rear of house east side			Determined					

Determination by Department of Mines Laboratory, Launceston

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91/2

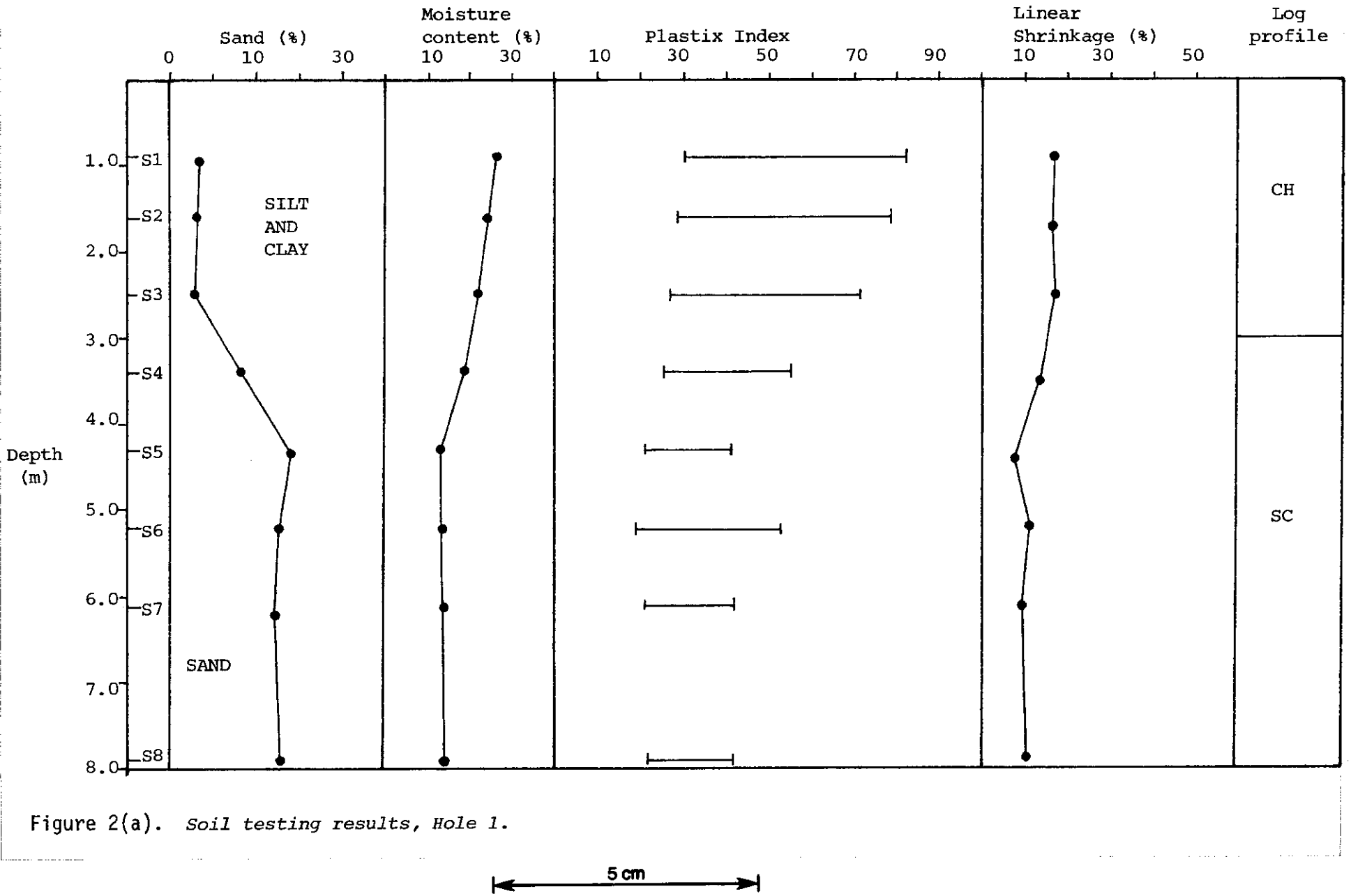


Figure 2(a). *Soil testing results, Hole 1.*

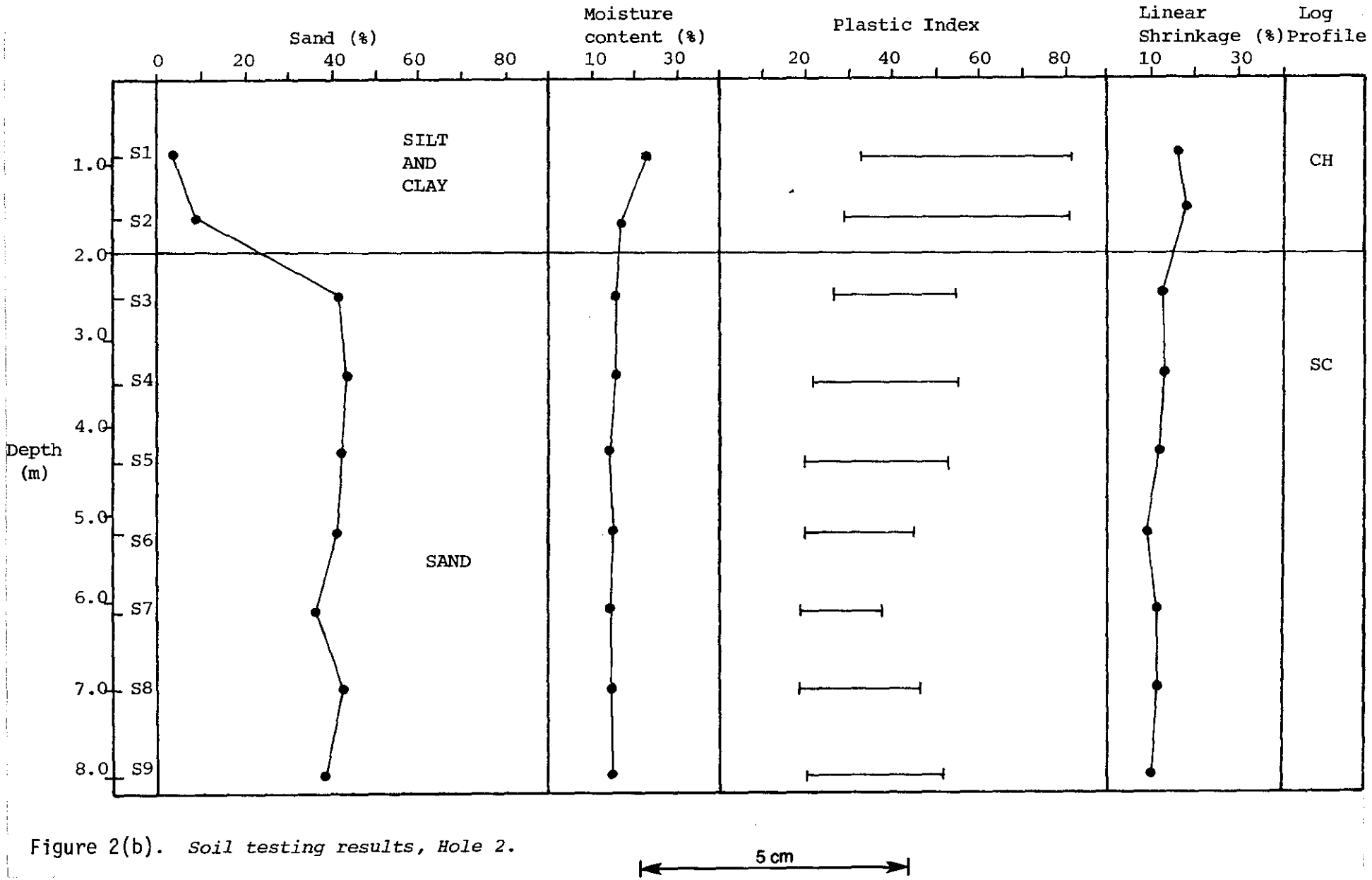


Figure 2(b). *Soil testing results, Hole 2.*

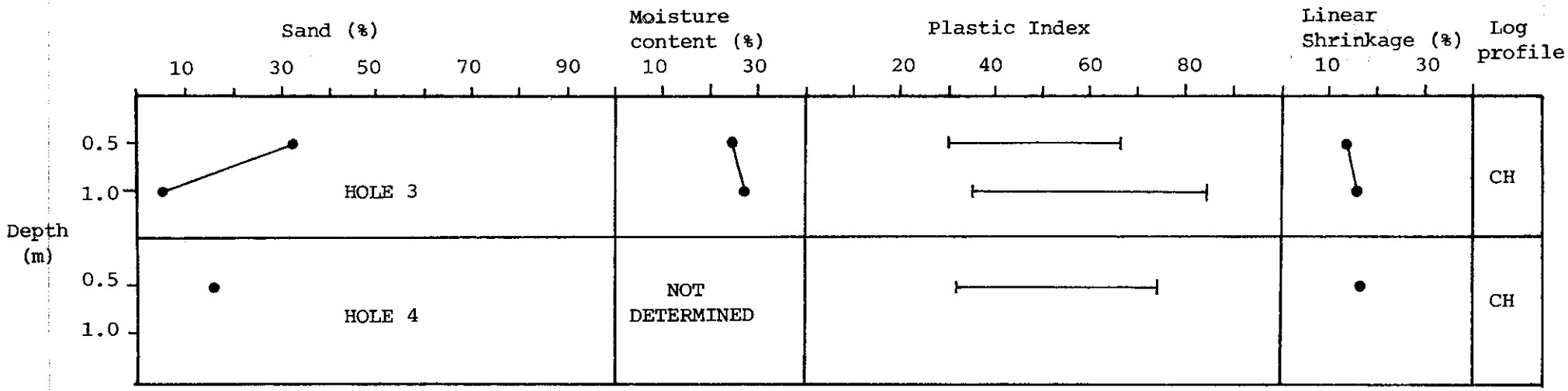
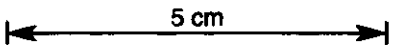


Figure 2(c). *Soil testing results, Holes 3 and 4.*



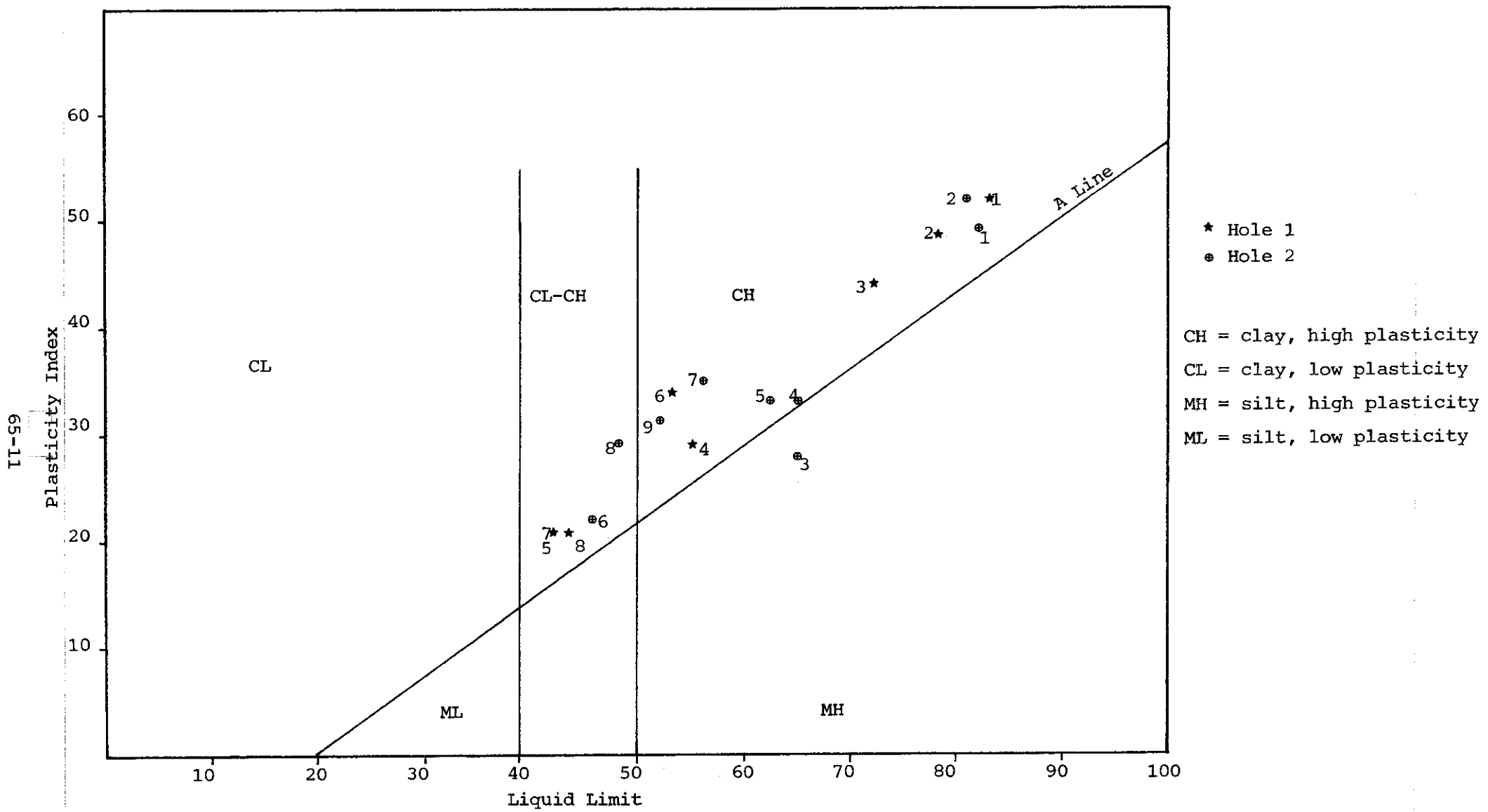


Figure 3. *Laboratory classification of soil samples.*

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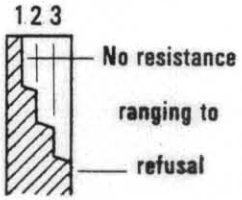
EXPLANATION SHEET FOR ENGINEERING LOGS

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

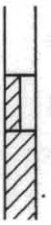
Cored borehole log

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

5 cm

ENGINEERING LOG – BOREHOLE

borehole no. 1 13/16

sheet 1 of 1

project House cracking, S. Bristow, Norwood location 41 Sandown Road, NW corner of house

co-ordinates EQ148114
R.L. 30 m (approx.)
inclination Vertical
bearing --

drill type Triefus
drill method Auger
drill fluid None

hole commenced 13.8.85
hole completed 13.8.85
drilled by B.E. Cox
logged by W.R.M.
checked by R.C.D.

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	S1	1.0		CH	*Clay:* Orange-brown, highly plastic	M	F		Clay - Launceston Beds
			S2				*Clay:* Grey-brown, highly plastic	≅ PL			
			S3	2.0				M < PL			
				3.0		SC	*Sandy clay:* Red-brown, limonite layer and cementing	D	H		Iron-pan
			S4				*Clay and sand:* Yellow-brown, clay highly plastic	M < PL	St		Clay with sand ↓ Sand increases ↓ Sandy clay
			S5	4.0							
			S6	5.0		SC	*Sand:* Fine, poorly graded, clay % reduces with depth.				Lithic Sandstone?
				6.0							
			S7	7.0			Harder layer				
			S8			SC	*Clay and sand:* Clay yellow, highly plastic. Sand fine, yellow, poorly-graded.	M ≅ PL	St		Sandy clay
							Drill stopped - required depth reached.				

65-73

TASMANIA DEPARTMENT OF MINES

5 cm

ENGINEERING LOG – BOREHOLE

borehole no. 2

sheet 1 of 1

14/16

project House cracking, S. Bristow, Norwood location 41 Sandown Road, NE corner of house

co-ordinates EQ148114
R.L. 30 m (approx.)
inclination Vertical
bearing --

drill type Triefus
drill method Auger
drill fluid None

hole commenced 13.8.85
hole completed 13.8.85
drilled by B.E. Cox
logged by W.R.M.
checked by R.C.D.

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	S1	1.0		CH	*Clay:* Orange-brown, highly plastic	M ≈ PL	F		Surface moist clay layer
			S2			CH	*Clay:* Grey-brown, highly plastic	M < PL			
				2.0		CH	*Clay:* red-brown, limonite cementing	M	F		Hard pan
			S3			SC	*Sandy clay:* Yellow-brown. Clay - low-medium plasticity. Sand - fine-grained, poorly graded.	D	St		Sandy clay
			S4	3.0							
			S5	4.0		SC	*Sandy clay:* Yellow-brown. Clay - high plasticity. Sand - fine, poorly graded. Sand % reduces with depth.	M < PL			↓ Sand becomes less
			S6	5.0							
			S7	6.0		SC	*Clay with sand:* Light brown. Clay highly plastic. Sand fine, appears less than clay in auger samples.	M ≅ PL	F		Clay
			S8	7.0							
			S9				Hole stopped - required depth reached.				

TASMANIA DEPARTMENT OF MINES

5 cm

ENGINEERING LOG – BOREHOLE

borehole no. 3

sheet 1 of 1

15/16

project House cracking, S. Bristow, Norwood location 41 Sandown Road, SW corner of house

co-ordinates EQ 148114
R.L. 30 m (approx.)
inclination Vertical
bearing --

drill type Hand auger
drill method Auger
drill fluid None

hole commenced 14.8.85
hole completed 14.8.85
drilled by B.E. Cox
logged by W.R.M.
checked by R.C.D.

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
						≈≈	OH	*Clay:* Black, organic.	M	VS		Soil
							CH	*Clay:* Brown. Highly plastic. Roots and limonite nodules present.	M ≅ PL	S		Clay
			S1		0.5			*Clay:* Grey, highly plastic. Limonite fragments present.				
	None	None	S2		1.0			Hole stopped. Auger difficult to pull out.				

TASMANIA DEPARTMENT OF MINES

5 cm

ENGINEERING LOG – BOREHOLE

borehole no. 4 16/16

sheet 1 of 1

project: House cracking, S. Bristow, Norwood

location: 41 Sandown Road, east side of house

co-ordinates: EQ148114

R.L.: 30 m (approx.)

inclination: Vertical

bearing: --

drill type: Hand auger and spade

drill method: Auger

drill fluid: None

hole commenced: 14.8.85

hole completed: 14.8.85

drilled by: Owner

logged by: W.R.M.

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
						~ ~ ~		*Clay:* Black, organic	M	VS		Soil
			S1					*Clay:* Brown, highly plastic, limonite nodules.	M ≡ PL	S		Subsoil

65-16