

1980/24. Geological investigation of a proposed development at Rannoch Crescent, East Devonport

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Abstract

A development proposal at East Devonport involving the construction of a roadway along the base of a steep basalt slope, and subdivision of that slope, has been investigated by morphological mapping and trenching. The proposed alignment of the roadway passes through an area of known previous instability and construction will necessitate excavation and cutting into the base of the slope, which may induce further instability. Trenching has indicated the potential for shallow earth slides to develop on the steeper slope segments. A re-alignment of the road is recommended and guidelines set for the proposed subdivision of the basalt slope.

INTRODUCTION

The Devonport Municipal Council requested the Department of Mines to undertake a geological investigation of the proposed development of Rannoch Crescent at East Devonport [DQ485413; fig. 1]. The proposal involves the construction of a roadway, Rannoch Crescent, along the base of an old coastal escarpment between Caroline Street and Bovill Street to provide access for residential development (fig. 2).

The investigation involved geomorphological mapping and trenching by backhoe. This report describes the results of that investigation, and the prospect of future subdivision on the steep slope segment above Rannoch Crescent, and the proposed alignment of Rannoch Crescent itself, is discussed.

REGIONAL GEOLOGY

According to the published geological map of the area (Burns, 1964), Rannoch Crescent, which is to be constructed at the base of the old coastal escarpment, marks the approximate geological boundary between the Quaternary sand and clay marine deposits to the north, and the Tertiary basalt which underlies the escarpment and plateau region to the south. Reconnaissance geological mapping in conjunction with the trenching programme has confirmed this.

MORPHOLOGY

Two basic morphological units can be distinguished; a steep old coastal escarpment which rises abruptly from a gently sloping Pleistocene coastal marine platform (fig. 2).

The coastal plain segment between Rannoch Crescent and Brooke Street falls away gently to the north, with slopes decreasing from about 8° at the foot of the escarpment to 3° or less at Brooke Street. In contrast, the land between Upper Drew Street and Rannoch Crescent represents an old coastal escarpment. From Figures 2 and 3, it can be seen that the escarpment generally has a gentle upper segment and a steeper mid-lower segment where slope angles between 14°-23° occur.

The escarpment is mainly a simple convex slope segment with little pronounced micro-relief. However, an active, shallow, spring-induced earth slump has developed towards the base of the slope. There is reasonable surface evidence to suggest that this feature has formed parasitically

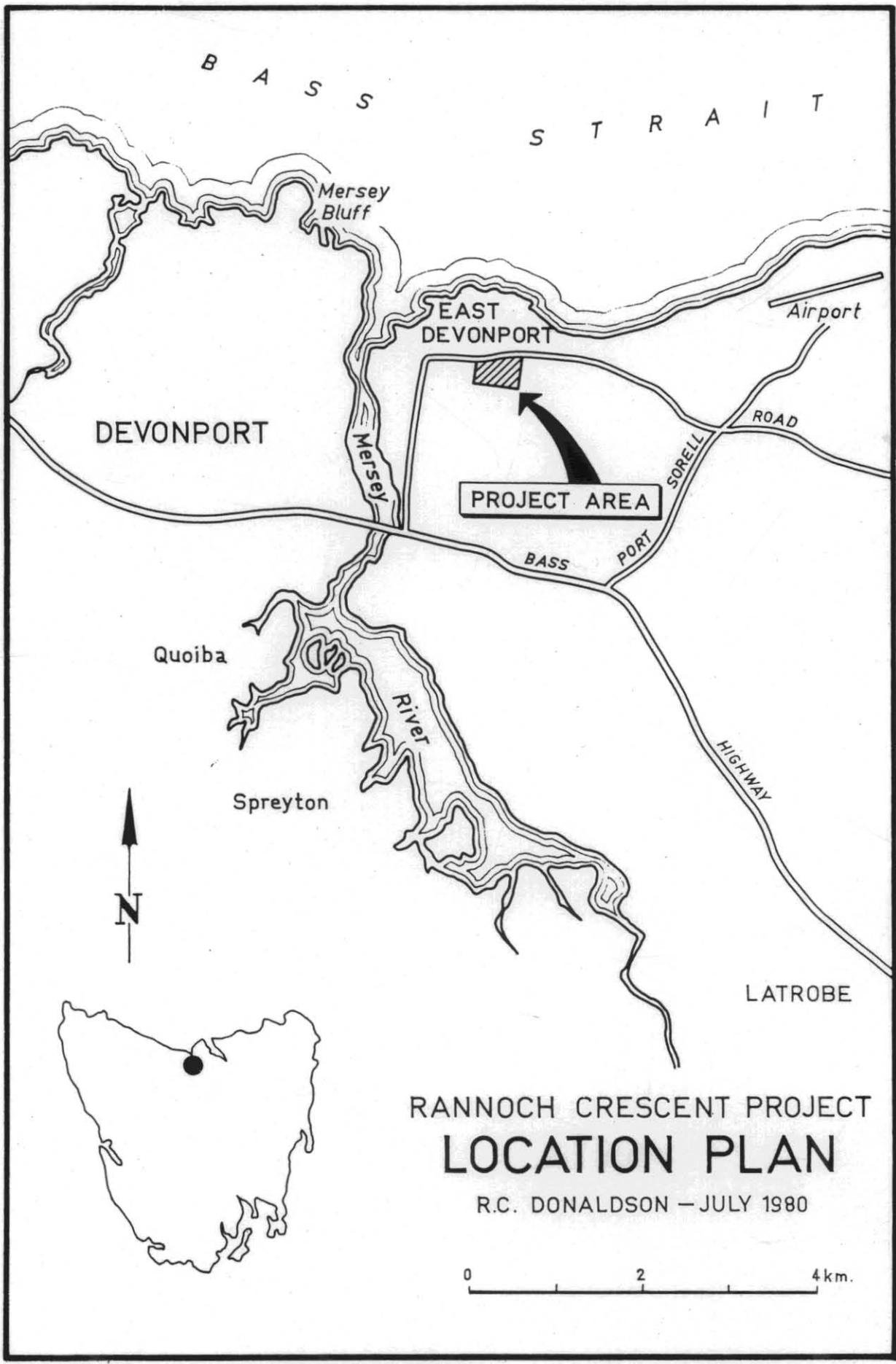
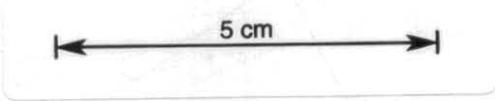


Figure 1



24-3

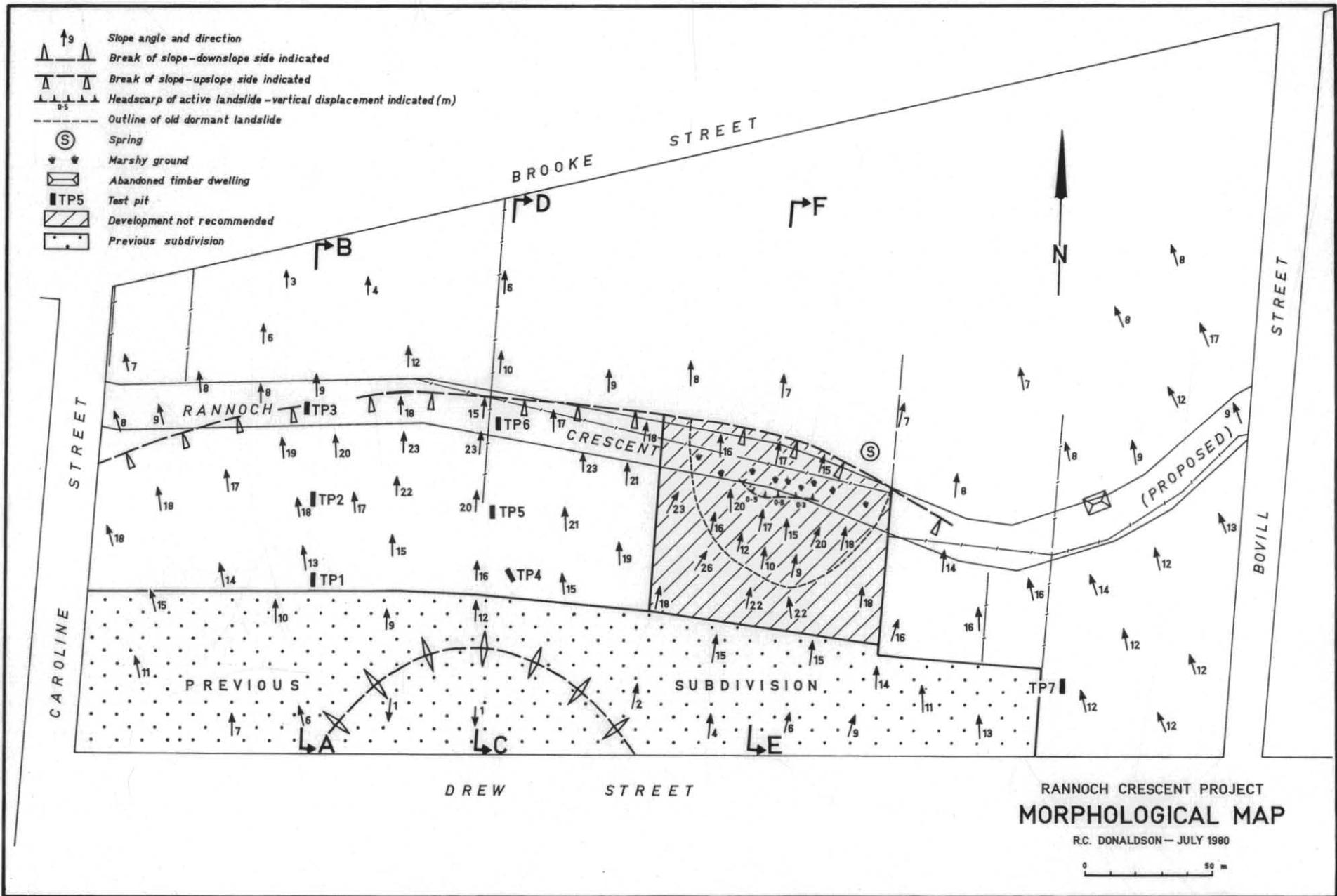
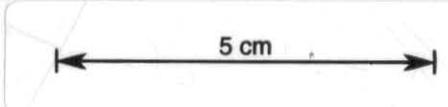


Figure 2.



upon the bulging toe region of an older, currently dormant landslide (figs. 2 and 3).

TRENCHING

The trenching programme has shown that the escarpment is underlain by basalt and its weathering products. The weathering is variable, both laterally and in depth, with a tendency for a more deeply weathered profile to exist higher up the slope.

A generalised weathering profile has been established; a clay top-soil overlies an iron enriched residual clay which grades downwards (transition zone) into an extremely weathered basalt.

With the exception of Test Pit 6, fresh basalt was not encountered within the limits of excavation (3.4 m). Test Pit 3, situated at the base of the slope, exposed a basalt talus deposit; the lateral or vertical limits of this material is not known. Extremely weathered basalt was exposed in Test Pits 1, 2, 5, 6 and 7 at depths varying between 0.85 m and 2.8 m below the surface. Test Pit 4 failed to encounter the extremely weathered basalt and was terminated in the overlying clay material (transition zone).

Detailed descriptions of materials encountered during excavation are appended.

SOIL PROPERTIES

The soil properties of the various materials are given in Table 1.

The results show that, in their remolded state, the range of materials encountered during trenching behave as high plasticity clay with corresponding medium to high linear shrinkage characteristics.

Table 1. GENERAL SOIL PROPERTIES

Trench	Depth (m)	Liquid Limit	Plastic Limit	Plasticity Index	Linear Shrinkage	Unified Soil Classification
1	0.5-0.95	149.3	36.4	112.9	25	CH
4	2.3-3.4	119.4	32.5	86.9	26	CH
5	1.3-3.1	72.6	26.9	45.7	13	CH
7	2.7-3.4	110.2	30.4	79.8	20	CH

DISCUSSION

There are two major aspects of this subdivision proposal which require discussion:-

- (a) the possible consequences of cutting into the base of the basalt slope in the course of construction of Rannoch Crescent.
- (b) the effect of development on the stability of the slope between Rannoch Crescent (proposed) and Upper Drew Street.

The present alignment of Rannoch Crescent will necessitate excavation and cuts of about one to two metres into the base of the steep basalt slope along almost the entire length of the proposed road (fig. 2). Although cuttings of this depth are generally considered to be relatively shallow, there is a possibility that serious ground movements could result. Test Pit 3 showed the presence of a talus deposit at the base of the slope. In general, talus slopes often have marginal stability and it is therefore preferable that they be avoided during construction, unless other alternatives are not available. The Brooke Street landslide (Bovills property), approximately one kilometre to the west, is an example of the consequences of cutting into a talus slope. It is not unreasonable to consider that a similar situation could eventuate at Rannoch Crescent.

The proposed road alignment also cuts directly across the toe region of the dormant old landslide and the smaller active parasitic slump (figs. 2 and 3). Removal of material from the toe of this old landslide will only further increase the potential for a renewal of activity. The groundwater issuing from the active slump may also pose problems with respect to the stability of the cut.

The subdivision of the moderate to steeply sloping ground above Rannoch Crescent into residential lots is not without problems. There is a distinct possibility that, at some time in the future, shallow seated soil movements may develop. Evidence supporting this can be borne out by observing the shallow earth slide which developed several years ago on the slope above Warkworth Court, only some 70 m to the west of Caroline Street.

Shallow earth slides of this nature (about one metre in depth) are fairly common along the north-west coastal region where moderate to steep slopes are underlain by basalt derived soils. Experience has indicated that those slopes which are steeper than about 14° are most prone to instability. The factors most commonly attributed to inducing failure in these situations include periods of intense or prolonged rainfall; groundwater seepages; and saturation of soil brought about by the concentrated disposal of sullage and septic effluents and by stormwater dispersal in the area of discharge.

From the results of the trenching programme, it is considered that the materials encountered overlying the extremely weathered basalt are those most likely to be associated with the problem of shallow earth movements. To minimise the potential risk attached to building in these areas, it would be prudent for all dwellings sited on a slope of 14° or greater to have their foundations keyed into a more stable material - the underlying extremely weathered basalt.

The depth to this extremely weathered rock was found to vary considerably over the site (fig. 3 and Appendix I). It appears from the information available that house foundations will have to be between about one metre (minimum) and three metres (plus) deep. Pier and beam foundations may be a more practical alternative to the conventional strip footing.

CONCLUSIONS

The site of the proposed subdivision comprises two basic slope segments, each related to the geology. Quaternary clay, sand and gravel deposits underly the flat segment between Rannoch Crescent and Brooke Street. The steep slope segment to the south of Rannoch Crescent is underlain by Tertiary basalt and its weathering products.

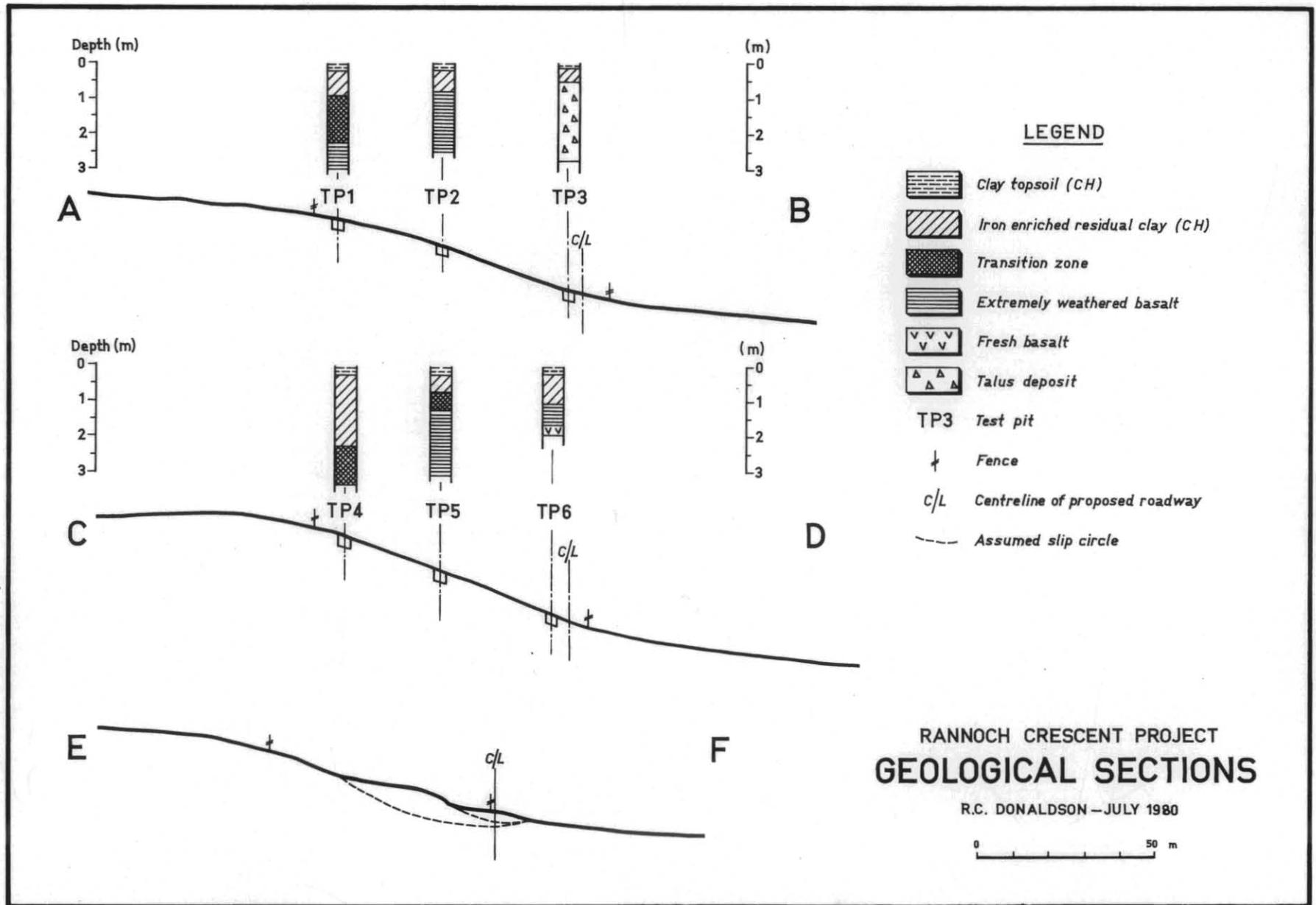


Figure 3.

The present proposed alignment of Rannoch Crescent will necessitate excavation and cuts into the base of a steep slope, which may induce instability. This proposed road will also pass through an area known to be previously unstable; construction of Rannoch Crescent through this area may reactivate the old landslide.

There is a potential for shallow earth slides to develop on the steeper slope segments ($>14^\circ$) in the clay materials overlying the extremely weathered basalt. The extremely weathered rock (basalt) exposed in the majority of the trenches is regarded as a competent foundation material for proposed residential housing requirements.

RECOMMENDATIONS

The current alignment of Rannoch Crescent should be modified, with the re-alignment skirting around the base of the steep slope. The most critical section is obviously the central portion of the road. From Figure 2 it can be seen that the proposed road need be displaced only a maximum of its own width (approximately 18 m) to the north.

Housing development should not be allowed within the area of landslide activity (shaded area, Figure 2). Instead the planting of shrubs and trees should be encouraged as an aid to stabilising the soil.

Development of land for subdivision on slopes less than 14° should be in strict accordance with existing building codes. However, development on slopes greater than 14° will require foundations to be keyed into bedrock (extremely weathered basalt) and not the overlying materials.

To reduce the potential for instability to develop in the materials overlying bedrock, all sullage, septic and stormwater outlets should be connected to the Devonport town system. Septic tank installations must be discouraged.

The density of the proposed subdivision and the siting of houses on the steeper slope segments above Rannoch Crescent should be planned on the premise that dwellings must be founded on bedrock.

REFERENCE

BURNS, K.L. 1964. One mile geological map series. K/55-6-29. Devonport. *Department of Mines, Tasmania.*

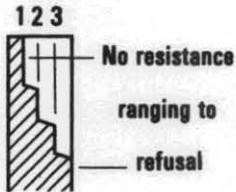
[23 July 1980]

TASMANIA DEPARTMENT OF MINES

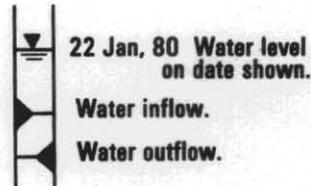
EXPLANATION SHEET FOR ENGINEERING LOGS

Borehole and excavation log

Penetration



Water



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. | |

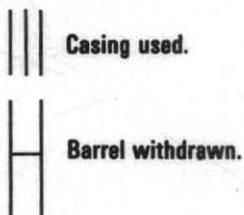
Notes: X on log is test result
— is range of results.

Density index

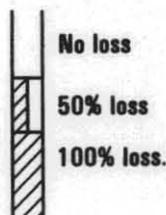
- | | | % |
|----|---------------|----------|
| VL | Very loose. | 0 - 15 |
| L | Loose. | 15 - 35 |
| MD | Medium dense. | 35 - 65 |
| D | Dense. | 65 - 85 |
| VD | Very Dense | 85 - 100 |

Cored borehole log

Case - lift



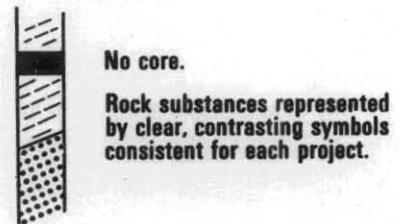
Fluid loss



Lugeons

Lugeon units (μ L) 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



Weathering

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

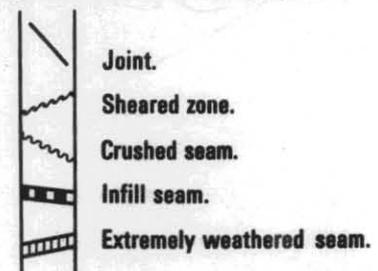
Strength

- | | | 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.



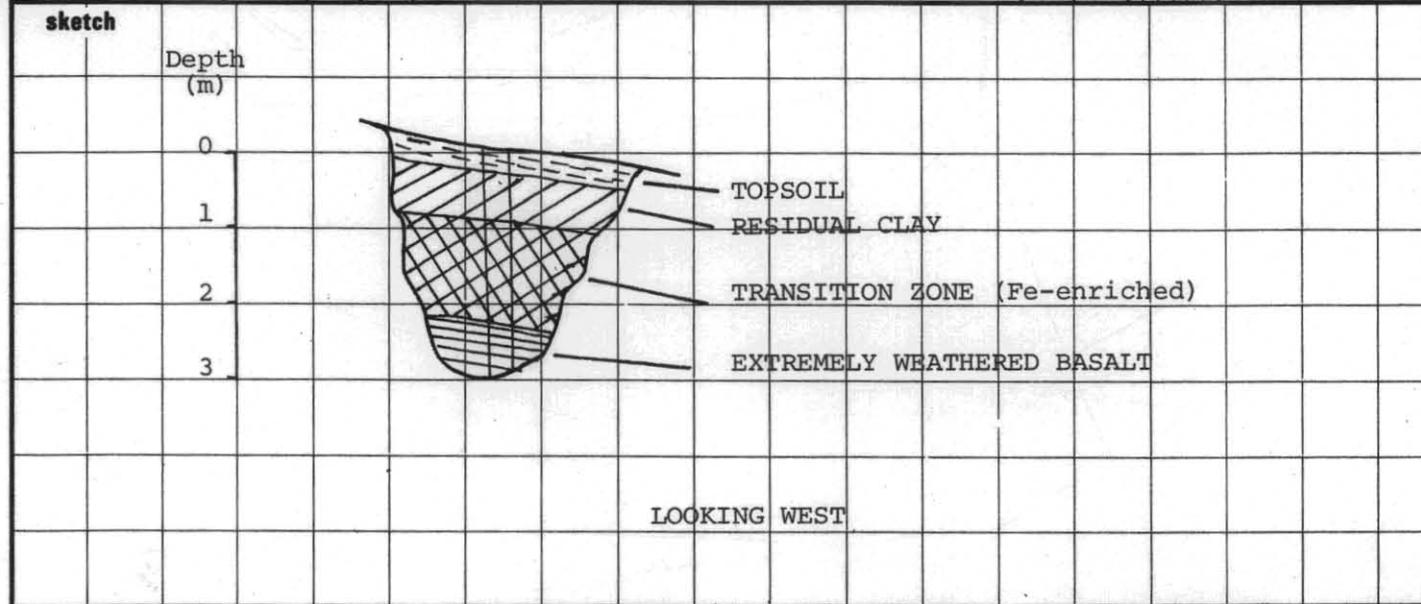
ENGINEERING LOG - EXCAVATION

5 cm

9/15
excavation no. 1
sheet 1 of 1

project RANNOCH CRESCENT SUBDIVISION	location EAST DEVONPORT	
co-ordinates DQ485413	exposure type Backhoe Pit	pit commenced 18 March 1980
R.L.	equipment Massey Ferguson 400 mm bucket	pit completed 18 March 1980
excavation dimensions 3m x 0.6m x 3.0m deep	operator H.F. Storay	logged by R.C. Donaldson checked by A.T. Moon

penetration	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	structure, geology
1 2 3											25 50 100 200 400	
					D	CH	CLAY: high plasticity, red-brown, some sand, fine to coarse (quartz and iron stone) many fine root fibres.	D				* >450 TOPSOIL
						CH	CLAY: high plasticity, red, trace fine sand.	M < PL	H			* >450 Iron-enriched RESIDUAL CLAY
				1		CH	CLAY: high plasticity, mottled red, yellow-brown and grey, trace fine sand together with pockets of extremely weathered basalt (see description below)	M < PL	H			* >450 TRANSITION * >450 ZONE
				2			BASALT: blue-grey, vesicular, cavities filled with carbonates, very low strength. Remoulds with water to clay (CH) - high plasticity, grey, some fine sand.					EXTREMELY WEATHERED BASALT
				3			HOLE TERMINATED AT REQUIRED DEPTH 3.00m.					

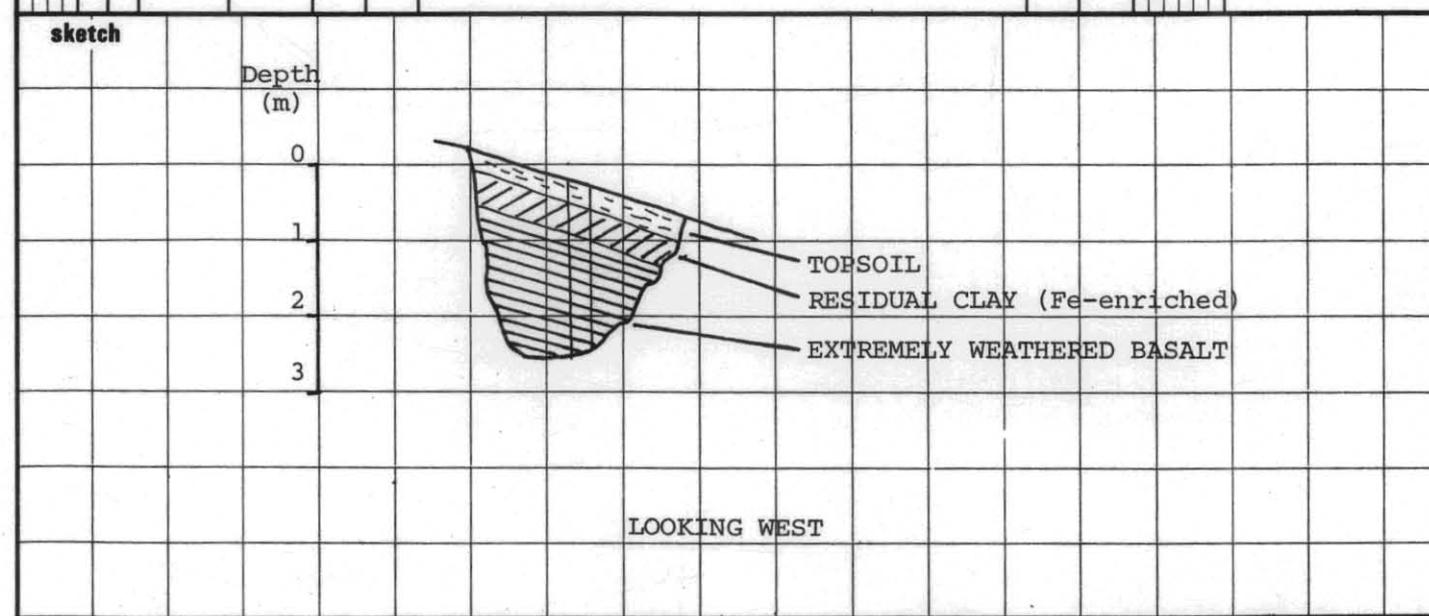


ENGINEERING LOG - EXCAVATION

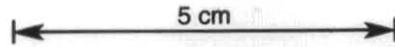
excavation no. 2
sheet 1 of 1

project	RANNOCH CRESCENT SUBDIVISION	location	EAST DEVONPORT
co-ordinates		exposure type	pit commenced 18 March 1980
R.L.		equipment	pit completed 18 March 1980
excavation dimensions	2.7m x 0.6m x 2.5m deep	operator	logged by R.C. Donaldson checked by A.T. Moon

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 penetr- ometer kPa	structure, geology
					CH	CLAY: high plasticity, red-brown, some sand fine to medium, trace coarse sand and charcoal, many root fibres.	V.St.			TOPSOIL
					CH	CLAY: high plasticity, red-brown, trace sand, fine to medium, trace charcoal, fine roots and root fibres.	D	H		* Fe-enriched * RESIDUAL CLAY * Vertically fissured 200 mm spacings, up to 20 mm open
	NONE NOT ENCOUNTERED		1			BASALT: mottled yellow-brown, red and blue-grey, vesicular, very low strength. Remoulds with water to sandy clay [CL] - low-medium plasticity, yellow-brown, sand fine.	M	PL		EXTREMELY WEATHERED BASALT
			3			HOLE TERMINATED AT REQUIRED DEPTH 2.5 m				



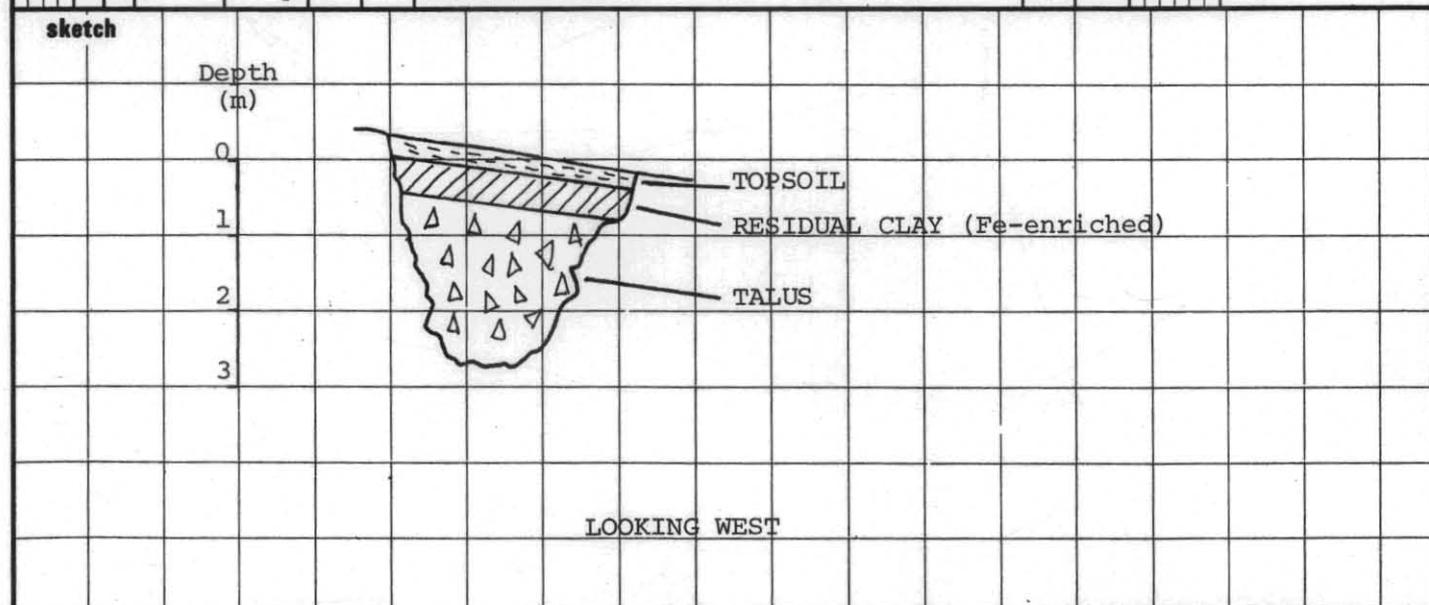
ENGINEERING LOG - EXCAVATION

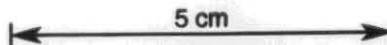


excavation no. 3
sheet 1 of 1

project	RANNOCH CRESCENT SUBDIVISION	location	EAST DEVONPORT
co-ordinates		exposure type	Backhoe pit
R.L.		equipment	
excavation dimensions	3.1 m x 0.6m x 2.8m deep	operator	
		pit commenced	18 March 1980
		pit completed	18 March 1980
		logged by	R.C. Donaldson
		checked by	A.T. Moon

penetration	support	water	notes	metres	graphic log	classification	material	moisture	consistency	hand	structure, geology
1 2 3			samples, tests	R.L. depth		symbol	soil type: plasticity or particle characteristics, colour secondary and minor components	condition	index	penetr-ometer kPa	
						CH	CLAY: high plasticity, brown, some sand fine to coarse (ironstone and rock fragments), trace charcoal, many root fibres.	D to H	V. St.		TOPSOIL
						CH	CLAY: high plasticity, brown, some fine to coarse sand, some gravel (angular fragments of slightly weathered basalt), some fine roots.	M < H	P.L.		Fe-enriched RESIDUAL CLAY near-vertical fissures
						CH	BOULDER CLAY: high plasticity, yellow brown, some sand, fine to medium, trace coarse sand (basalt fragments). Between 30-40% basalt boulders to 300 mm, fine grained, blue-grey, fresh, extremely high strength				TALUS
							HOLE TERMINATED AT REQUIRED DEPTH 2.8 m.				



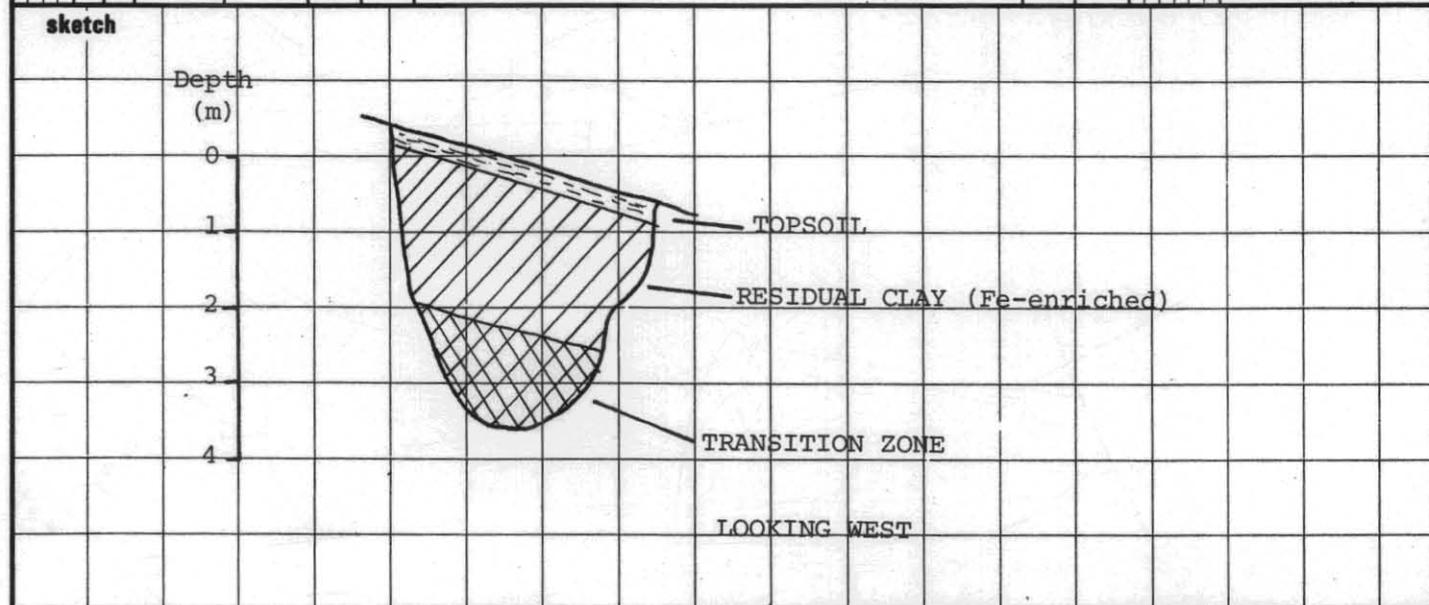


excavation no. 4
sheet 1 of 1

ENGINEERING LOG - EXCAVATION

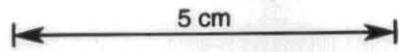
project	RANNOCH CRESCENT SUBDIVISION	location	EAST DEVONPORT
co-ordinates		exposure type	pit commenced 19 March 1980
R.L.		equipment	pit completed 19 March 1980
excavation dimensions	3.6m x 0.6m x 3.4m deep	operator	logged by R.C. Donaldson
			checked by A.T. Moon

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 penetr- ometer kPa 25 50 100 200 400	structure, geology
				CH	CH	CLAY: high plasticity, red-brown, some sand, fine to medium, trace charcoal, many root fibres.	DV.St. H			TOPSOIL
			1	CH	CH	CLAY: high plasticity, red, trace fine sand.	M < PL	H		Fe-enriched RESIDUAL CLAY
			2							X >450
		D	3		CH	CLAY: high plasticity, mottled green and yellow-brown, some sand, fine to medium (weathered mineral grains)	M = PL	St to V.St.		TRANSITION ZONE
	NONE NOT ENCOUNTERED		4			HOLE TERMINATED AT MAXIMUM BACKHOE DEPTH - 3.4 m.				



ENGINEERING LOG - EXCAVATION

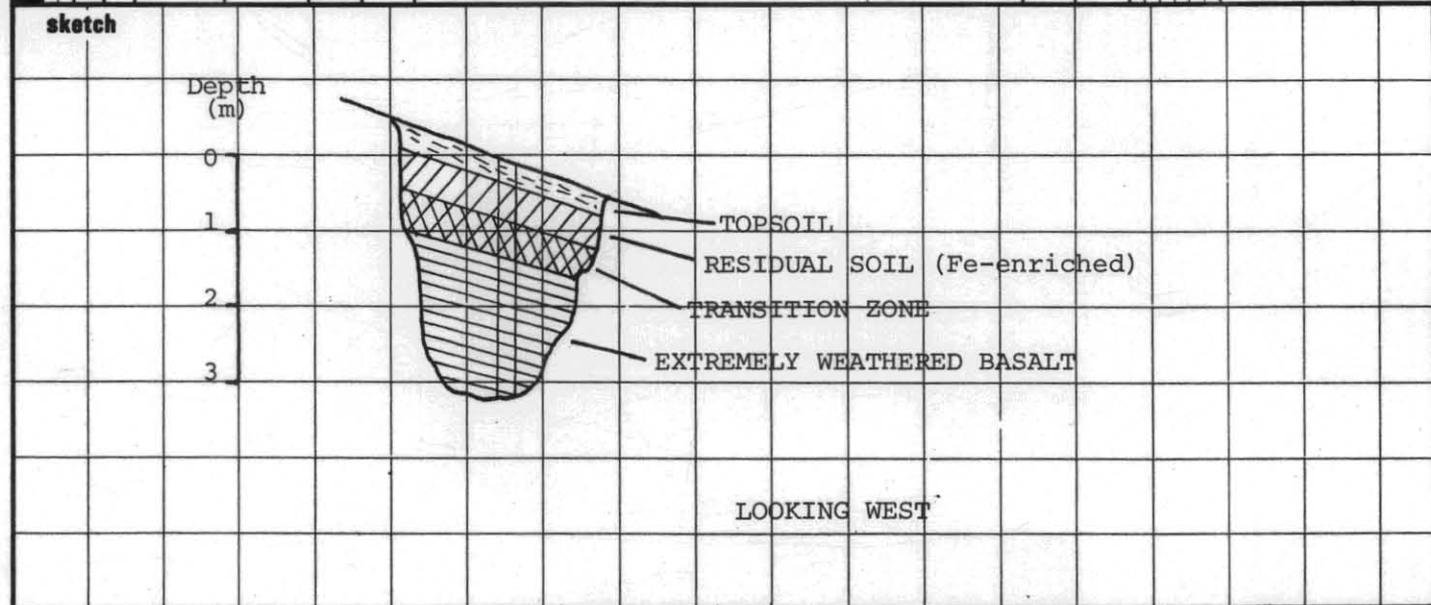
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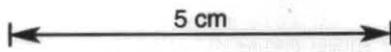
excavation no. 5
sheet 1 of 1

project	RANNOCH CRESCENT SUBDIVISION	location	EAST DEVONPORT
co-ordinates		exposure type	
R.L.		equipment	
excavation dimensions	2.8m x 0.6m x 3.1m deep	operator	
		pit commenced	19 March 1980
		pit completed	19 March 1980
		logged by	R.C. Donaldson
		checked by	A.T. Moon

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 penetr- ometer kPa				structure, geology
									25	50	100	200	
					CH	CLAY: high plasticity, red-brown, some sand, fine to coarse, trace charcoal, many root fibres	D	H					X TOPSOIL
					CH	CLAY: high plasticity, red-brown, some fine to medium sand, trace charcoal, root fibres.	M < PL	H					X Fe-enriched RESIDUAL CLAY near vertical fissures 100- 300 mm.
			1		CH	CLAY: high plasticity, mottled green-brown, trace sand, fine to medium							X TRANSITION ZONE
	NONE NOT ENCOUNTERED		2			BASALT: mottled grey green-yellow brown, vesicular, very low strength. Remoulds with water to sandy clay (CL-CH) - medium-high plasticity, green-grey, sand fine to medium (mineral grains).							X EXTREMELY WEATHERED BASALT
		D	3			HOLE TERMINATED AT REQUIRED DEPTH OF 3.1m.							



14/15

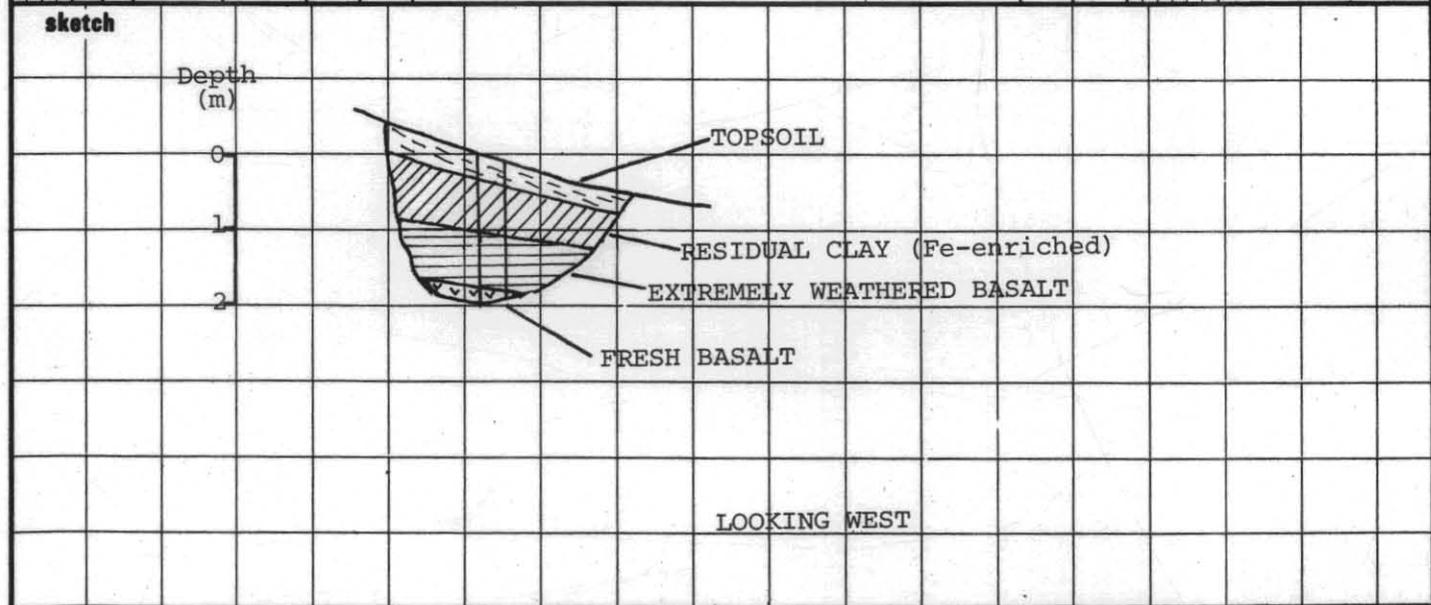


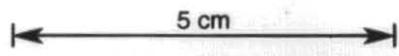
excavation no. 6
sheet 1 of 1

ENGINEERING LOG - EXCAVATION

project	RANNOCH CRESCENT SUBDIVISION	location	EAST DEVONPORT
co-ordinates		exposure type	
R.L.		equipment	
excavation dimensions	3.3m x 0.6m x 1.8m deep	operator	
		pit commenced	19 March 1980
		pit completed	19 March 1980
		logged by	R.C. Donaldson
		checked by	A.T. Moon

penetration	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 2 3						CH	CLAY: high plasticity brown-red, some sand, fine to medium, some charcoal, root fibres.	D	V. St. to H		TOPSOIL
				1		CH	CLAY: high plasticity, brown, some sand, fine to coarse, (basalt fragments and mineral grains) some charcoal	M < PL	H		Fe-enriched RESIDUAL CLAY
							BASALT: mottled yellow-brown and green, very low strength. Remoulds to clayey gravel (CG) - fine to medium gravel, some coarse (weathered rock fragments), clay of high plasticity. Up to 30% boulders to 250mm, fresh to slightly weathered grey basalt of extremely high strength, Dry.	MD to D			EXTREMELY WEATHERED BASALT
				2							FRESH BASALT
							Backhoe refused at 1.8 m on basalt - fine grained, blue-grey, fresh, extremely high strength. Dry.				





excavation no. 7
sheet 1 of 1

ENGINEERING LOG - EXCAVATION

project	RANNOCH CRESCENT SUBDIVISION	location	EAST DEVONPORT
co-ordinates		exposure type	
R.L.		equipment	
excavation dimensions	3.5m x 0.6m x 3.4m deep	operator	
		pit commenced	19 March 1980
		pit completed	19 March 1980
		logged by	R.C. Donaldson
		checked by	A.T. Moon

penetration	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	structure, geology
1 2 3						CH	CLAY: high plasticity, red-brown, some sand, fine to coarse, trace gravel, trace charcoal, root fibres.	D	H		TOPSOIL
				1		CH	CLAY: high plasticity, red, some sand, fine to medium (quartz and ironstone), trace charcoal.	M < PL	H		Fe-enriched RESIDUAL CLAY
				2		CH	CLAY: Similar to above with the addition of irregular pockets of extremely weathered basalt.	M < PL	St. to V.St.		TRANSITION ZONE -fissured, slickenside surfaces.
				3			BASALT: mottled yellow, white and brown, extremely low strength, remoulds to clay (CH) - high plasticity, trace fine sand.				EXTREMELY WEATHERED BASALT Fe-stained joint planes
				4			HOLE TERMINATED AT MAXIMUM BACKHOE DEPTH - 3.4 m.				

