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1979/10. Site investigations for a proposed water main and reservoir at Rocherlea.

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Abstract

An engineering geology investigation indicates that a proposed water pipe-line at Rocherlea will be excavated in dolerite, dolerite talus and Tertiary clay. The clay, although the easiest to excavate, may have stability problems in one area where an old landslip exists. Deposits of coarse dolerite talus may be difficult to excavate and several trial pits are recommended in this material. These may also locate the Tertiary clay/dolerite boundary.

The proposed reservoir site is a flat topped hill capped by a restricted area of dolerite. A refraction seismic survey indicates that little or no dolerite is present at a shallow depth, whereas a magnetometer survey indicates that Tertiary sediments are restricted to the northern section of the hill while the dolerite is either *in situ* or large massive blocks.

Further investigations, including diamond drilling, are required to solve this problem.

INTRODUCTION

At the request of Gutteridge, Haskins and Davey, consulting engineers for the Lilydale Municipal Council, a preliminary reconnaissance visit was made to the site of the proposed water scheme. Two engineering problems were apparent from this visit;

(a) the stability of some of the ground in which the pipe-line was to be laid was suspect.

(b) was the area of bedrock dolerite on which the reservoirs were to be built sufficient?

An alternative pipe-line route and reservoir site on the ridge on which the existing reservoirs are sited was suggested after this visit. If this alternative scheme was rejected for reasons other than engineering geology, further investigation of the proposed route and site would be required. This would include geophysics, drilling and trenching.

GEOLOGY

The only rock that crops out along the pipe-line route and at the reservoir site is dolerite. This rock forms the northern ridge on which the existing reservoirs are situated. Dolerite also appears to crop out on top of the small flat topped hill to the south of the ridge, which is the proposed site of the new reservoirs. Outcrop on this hill is restricted; from the surface the rock appears to form two discontinuous zones of flat outcrop.

Dolerite boulders and talus deposits are present along the lower southern slopes of the northern dolerite ridge and appear to extend into the head of the valley area below the saddle that separates this ridge from the isolated dolerite hill to the south. Small, irregular areas of boulders and possible talus deposits are present on the western and southern slopes of this hill. There are few dolerite boulders on the north

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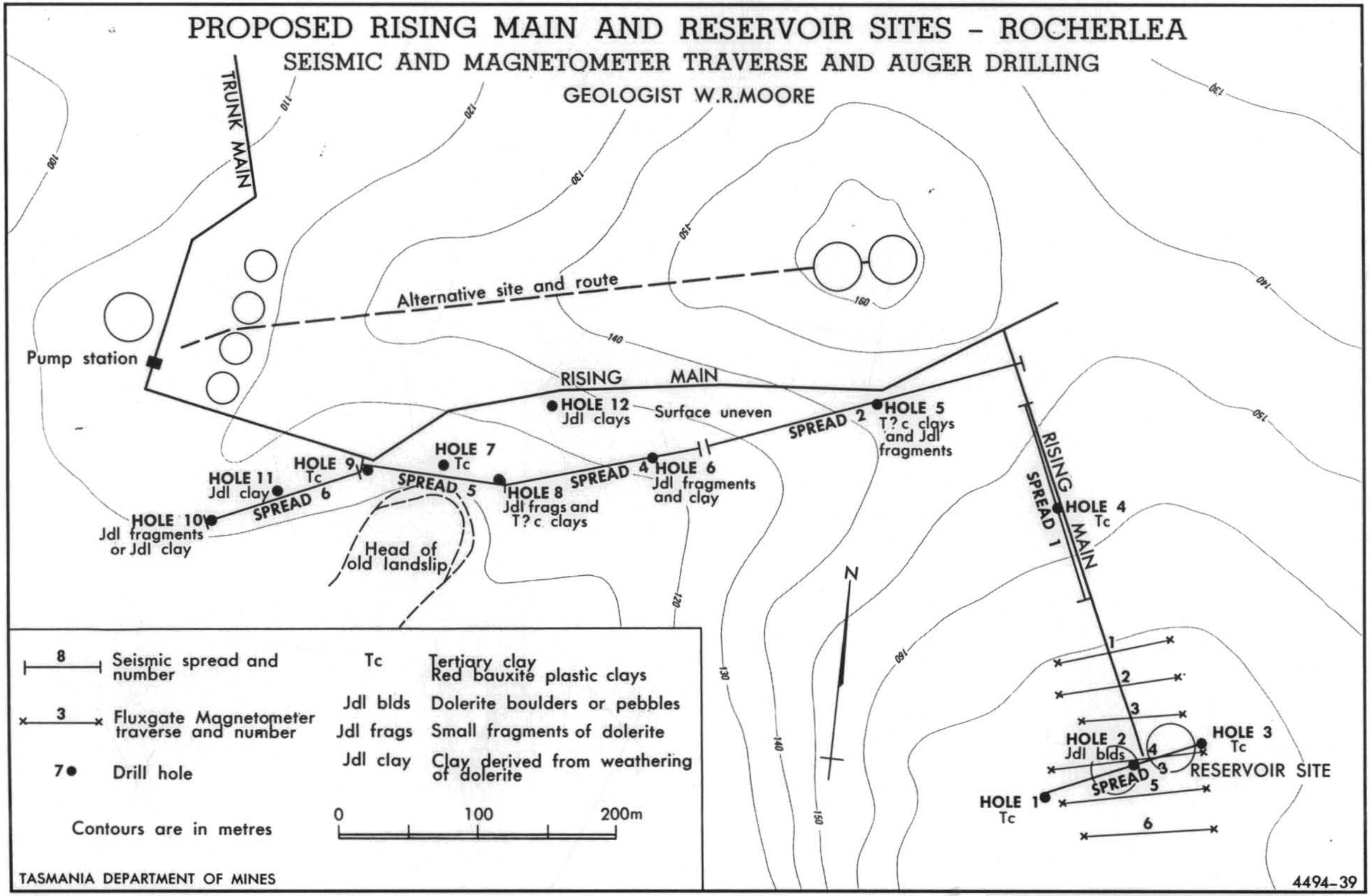

Figure 1

5 cm

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side, in the saddle, and on the eastern slopes down to Russells Plains. The soil is clayey with abundant ironstone pebbles and boulders and is thought to be underlain by Tertiary sediments of the Launceston Group (Longman *et al.*, 1964; Longman, 1966). These sediments extend westward into the head of the valley area below the northern dolerite ridge. The only outcrop of these Tertiary sediments occurs at a small farm dam approximately 200 m south-east of the proposed reservoir site. Here, light-grey and white clay and mottled bauxitic stained clay with ironstone boulders and nodules form the wall and side of the dam. Red and grey clay of the Tertiary Launceston Group have been found in many of the holes drilled in conjunction with the seismic investigation. These sediments are overlain by talus deposits along the pipe-line route and abut closely against and possibly overlie the dolerite at the reservoir site (fig. 1).

SLOPE STABILITY

The Tertiary sediments of the Launceston Group have a long history of slope failure in the Tamar Valley and it is of interest to note that at this locality, the dolerite and Tertiary sediment boundary on the regional geological map (Longman *et al.*, 1964) coincides with the stable ground and potential landslip zones on the Department of Mines Tamar Valley landslip zone map.

Gully headward erosion has been recently active as indicated by the old landslip, the heel of which is close to the proposed pipe-line route (fig. 1). Auger hole 7 drilled near this landslip penetrated 8.2 m of red plastic clay indicating that Tertiary sediments underlie the unstable area.

GEOPHYSICS

Five seismic spreads were fired near the proposed pipe-line route (fig. 1). A mechanical defect on the tractor mounted drill prevented the firing of spreads on the actual route. The spreads extend from the foot of the east-west dolerite ridge to the saddle and cover an area with no outcrop.

A fluxgate magnetometer traverse was undertaken along the pipe-line route across the saddle, to the proposed reservoir site. This was followed by an east-west seismic spread (spread 3, fig. 1) where the dolerite/Tertiary contact was thought to be located. Six closely spaced east-west magnetometer traverses were undertaken across this hill. The geophysical investigation was followed by shallow auger drilling using a tractor mounted 'Proline' drill.

Geophysics and auger drilling results

The detailed seismic results are summarised in Table I and the lithological logs of the drilling are given in Appendix 1.

The five seismic spreads along the pipe-line route showed a wide range of velocities. Three velocity layers could be recognised; a surface layer with velocities of 600-900 m/s, an intermediate layer covering a wide velocity range from 1 200-2 000 m/s and a third layer with velocities above 2 500 m/s.

The surface layer is interpreted geologically as Tertiary clay, dolerite talus, or weathered dolerite which has formed a yellow flecked clay subsoil with dolerite boulders. A variety of geological conditions were encountered, as indicated by the assymetrical nature of many of the velocity plots and the varying thicknesses of the surface and intermediate seismic layers.

Table 1. *SEISMIC RESULTS, ROCHERLEA.*

Spread	Geophone interval (m)	Shot point distances (m)	Velocity layers (m/s)	Shape of time velocity plot	Calculated depth* to interface (m)	Geological interpretation
1	7.5	40N 25N 30S	V_0 = 700-900 V_1 = 1200-1500 V_2 = 2500-3500	Assymetrical with slope down to north. V_0 layer thicker at north end.	*North end* V_0/V_1 = 12-13 V_1/V_2 = 19 *South end* V_0/V_1 = 9 V_1/V_2 = 11-15	V_0 - Tertiary clay V_1 - compact clay probably grading down to clay with boulders and weathered dolerite. V_2 - bedrock, presumed to be dolerite.
2	15	35W Mid point 30E	V_0 = 700-800 V_1 = 1500-1800 V_2 = 3000-5000	Symmetrical. No slope.	V_0/V_1 = 4-5 V_1/V_2 = 10-11	V_0 - clay (Tertiary and Talus) V_1 - compacted clay with boulders grading to weathered dolerite. V_2 - Dolerite
3	7.5	15W 22.5E 30E	*West end* V_0 = 600 V_1 = 3200 *East end* V_0 = 800 V_1 = 1500 V_2 = 3200	Highly assymetrical. No evidence of V_1 velocity layer of 1500 m/s present at the east end.	*West end* V_0/V_1 = 6-8 *East end* V_0/V_1 = 8-10 V_1/V_2 = 17	*West end* V_0 - Tertiary clay V_1 - Dolerite *East end* V_0 - Tertiary clay V_1 - compacted clay and sand possibly grading to dolerite boulders and weathered dolerite. V_2 - Dolerite
4	7.5	30W Mid point 30E	V_0 = 700-800 V_1 = 1800-2200 V_2 = 4300-5000	Symmetrical.	V_0/V_1 = 2 V_1/V_2 = 9	V_0 - clay? and boulders (Talus) clay derived from weathering of dolerite. V_1 - weathered dolerite V_2 - Dolerite

* Depth calculations only approximate as critical distance formula used.

Spread	Geophone interval (m)	Shot point distances (m)	Velocity layers (m/s)	Shape of time velocity plot	Calculated depth* to interface (m)	Geological interpretation
5	7.5	15W Mid point 7.5E	*West end* V_0 = 500-800 V_1 = 1500-1700 V_2 = 3500 *East end* V_0 = 500-800 V_1 = 1500-2200 V_2 = 3500	Very assymetrical. Thicker surface layer at west end.	*West end* V_0/V_1 = 5-6 V_1/V_2 = 15-16 *East end* V_0/V_1 = 2-2.5 V_1/V_2 = 12	*West end* V_0 - Tertiary clay V_1 - Compacted clay with dolerite boulders and weathered dolerite. V_2 - Dolerite *East end* V_0 - Clay and dolerite boulders (Talus) V_1 - Dolerite boulders and clay and weathered dolerite. V_2 - Dolerite
6	7.5	15W Mid point 15E	*West end* V_0 = 600-900 V_1 = 1500 V_2 = 3200 *East end* V_0 = 600 V_1 = 3000	Assymetrical no V_1 layer of 1500 seen at East end.	*West end* V_0/V_1 = 2-3 V_1/V_2 = 5-6 *East end* V_0/V_1 = 6	*West end* V_0 - Clay and dolerite boulders (Talus) V_1 - Weathered dolerite and clay. V_2 - Dolerite *East end* V_0 - Tertiary clay V_1 - Dolerite

* Depth calculations only approximate as critical distance formula used.

The geological conditions vary from a shallow, three-layered dolerite weathering profile as seen in Spread 4 to a thick sequence of Tertiary clay with probable dolerite talus as a surface layer, to a compacted thicker intermediate layer of sediments, presumably Tertiary, overlying a third high velocity "bedrock" layer, which on little evidence is presumed to be dolerite. Both of these geological conditions appear to exist at either end of a single spread, as seen in Spreads 5 and 6.

Though difficult to interpret, the seismic survey did define the areas of Tertiary clay which were confirmed by later auger drilling. It also indicated that most of the trench for the pipe-line, if excavated no deeper than 2.5 m, should be capable of being dug by a back-hoe. This can only be accepted as an indicator because neither in the seismic nor the auger drilling was it possible to distinguish the talus deposits of dolerite from the weathered dolerite derived clay with dolerite boulders. The ability of a back-hoe to remove the dolerite talus at this locality is unknown; this will depend on the number and the size of boulders and the matrix of the talus deposits. Such properties as these are not predictable and will not be known without some trial pits.

RESERVOIR SITE

The final positioning of the reservoirs is dependant on the underlying rock type. They should be sited completely on dolerite in preference to Tertiary sediments and not across the boundary of these two rock types. The preliminary fluxgate magnetometer traverse across the saddle to the reservoir site indicated that the boundary between the dolerite and Tertiary sediments was sharp and situated close to if not at the actual exposures of what were thought to be dolerite outcrops.

An east-west seismic spread (spread 3, fig. 1) in the vicinity of this boundary ignored these dolerite outcrops even though the shots were located as close as it was feasible to drill a shot hole. Both ends of the Spread 3 indicated the presence of a thick slow surface layer with depths to dolerite or unknown bedrock at the west end of 6 - 8 m and 17 m at the east end (table 1). Unfortunately all attempts to fire a suitable mid-shot on this spread had to be abandoned because of the danger of flyrock.

The auger drilling at the east and west end of the spread confirmed the presence of Tertiary clay to 8.2 and 2.7 m (Appendix 1). Drilling in the middle of the spread showed a weathering dolerite profile before being stopped by an outcrop or a large boulder at 2 m depth.

In order to see if the dolerite was *in situ* six east-west fluxgate magnetometer traverses were undertaken to cover the whole area of the flat topped hill in which dolerite appears to be exposed. In these magnetometer traverse profiles a small area of Tertiary sediments is indicated in the southern three traverses but for most of the traverses it would appear that the bedrock is dolerite *in situ* or exceptionally large blocks overlying Tertiary clay. Clearly this problem must be solved before the reservoirs can be sited.

CONCLUSIONS AND RECOMMENDATIONS

Pipe-line

The potential unstable section along the proposed pipe-line is between auger holes 7, 9 and 12. In this section, it is not known how far the Tertiary sediments extend up the slope from auger holes 7 and 9 toward auger hole 12. The most stable position in the Tertiary sediments is generally close to the dolerite contact, but here the contact is frequently obscured by dolerite talus.

There appears to be a considerable cost saving if the amount of dolerite the trench has to pass through is kept to a minimum. The seismic traverses indicate that there is an adequate depth (2 m) of soft material even above the dolerite in Spread 4 along the pipe-line route. Seismic velocities are a good indicator of rippability and need for explosives, but are not reliable for indicating excavation of some materials by a back-hoe. This is particularly true in boulder deposits where the size of boulders, the number of boulders and their packing etc., is of more importance than the overall hardness of the sediment as indicated by the seismic velocity.

It is recommended that;

(a) Two or three back-hoe pits be dug between auger holes 7, 9 and 12 in an attempt to establish the Tertiary/dolerite boundary.

(b) That the pipe-line route be resurveyed and pegged closely so that the pegs cannot be confused with the other sub-division pegs. This appears to have caused a discrepancy between the map supplied by the engineer and a preliminary survey of the seismic lines by this Department.

(c) A series of trial pits be dug with a back-hoe close to this pegged route to site the line into the Tertiary sediments as much as possible within design and stablility limitations.

Reservoir site

The existing drilling and geophysics has yet to prove without doubt that any of the dolerite is *in situ*. The magnetometer traverses indicate that south of the seismic line near the highest section of this flat topped hill is the most likely area for solid rock. A heavier drilling rig is required and a seismograph not requiring explosives.

It is recommended that;

(a) On the higher section of this hill a grid of an adequate size for the reservoirs be pegged and then checked with a hammer seismograph.

(b) This grid then be drilled using a combined auger and diamond drill. Some of these combined auger and diamond holes will be required to go to the bedrock seismic refractors.

REFERENCES

LONGMAN, M.J.; MATTHEWS, W.L.; ROWE, S.M. 1964. One mile geological map series. K/55-7-39. Launceston. *Department of Mines, Tasmania*.

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[20 March 1979]

APPENDIX I

Logs of auger holes.

Hole No.	*Depth (m)*	*Description*
1	0 - 0.9	Soil and sub-soil and iron stained clay and limonite nodules.
	0.9 - 1.8	Dark brown white-flecked clay.
	1.8 - 5.5	Orange white flecked clay with red bauxitic staining.
	5.5 - 8.2	Orange and red plastic clay.
2	0 - 0.9	Thin soil cover and dark brown iron stained clay derived from the weathering of dolerite.
	0.9 - 1.8	Brown clay with dolerite fragments, cobbles and pebbles.
	1.8 - 2.0	Dolerite boulder or *in situ* dolerite.
3	0 - 0.9	Soil and yellow clay sub-soil.
	0.9 - 1.8	Grey and light brown clay.
	1.8 - 2.7	Fine yellow clay with grey clay nodules or pellets.
4	0 - 0.9	Soil and dark brown clay and grey clay with some organic material and bauxitic staining.
	0.9 - 2.7	Dark red bauxitic stained clay with white flecks.
	2.7 - 3.6	Dark yellow-white flecked clay.
	3.6 - 4.6	Dark brown and red bauxitic clay.
5	0 - 0.9	Soil and dark brown clay sub-soil
	0.9 - 1.8	Fine yellow clay.
	1.8 - 4.6	Fine yellow clay with some completely weathered fragments of dolerite.
		Mixture of Tertiary clay and dolerite derived clay.
6	0 - 0.9	Soil and dark brown clay sub-soil with ironstone pellets.
	0.9 - 2.1	Brown rubbly clay with dolerite pebbles and fragments.
	2.1 +	Dolerite boulder or bedrock.
7	0 - 0.9	Soil and dark brown clay sub-soil.
	0.9 - 1.8	Yellow brown clay.
	1.8 - 4.6	Red brown clay with white flecks.
	4.6 - 8.2	Dark red brown, bauxitic plastic clay.
	Hole located 3 m from landslip, seismic spread 5.	
8	0 - 0.9	Soil and brown clay sub-soil
	0.9 - 2.7	Yellow-white flecked clay with dolerite fragments.
	2.7 - 4.6	Rubbly brown clay. Clay not plastic and no dolerite fragments. Clay appears to be more a dolerite derived clay than a Tertiary clay.
9	0 - 0.9	Soil and dark brown clay with small ironstone

Hole No.	Depth (m)	Description
		pellets.
	0.9 - 4.6	Bauxitic red plastic clay becoming moist at 3.7 m.
10	0 - 0.9	Light brown clay.
	0.9 - 2.7	Fine yellow compact and hard silty clay with white flecks.
	2.7 - 4.6	Light brown, compact hard, silty clay with white nodules. Very hard drilling. Clay on auger bits appear to have been derived from the weathering of dolerite.
11	0 - 1.8	Dark brown soil and sub-soil and yellow silty clay - as above.
	1.8 +	Jurassic dolerite boulder or *in situ*.
12	0 - 0.9	Soil and grey brown clay with ironstone pellets.
	0.9 - 1.8	Yellow silty clay with ironstone pellets. Sediments as seen in Holes 10 and 11. Clay too hard to penetrate.