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1982/16. Reconnaissance seismic survey at a proposed reservoir site, Lanena Street, Warrane

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Abstract

The Clarence Municipal Council proposes to construct two 39 m diameter concrete reservoirs near Lanena St, Warrane. A reconnaissance seismic refraction survey showed that the site is probably underlain by a surface layer of soil and dolerite boulders about 1.2 m thick, then weathered dolerite grading into fresh dolerite between 2.5 - 3.8 metres. The rock above this level should be capable of excavation by ripping, but below this depth blasting will be required.

INTRODUCTION

At the request of the Clarence Municipal Council (Engineering Department) a reconnaissance seismic refraction survey was undertaken at the proposed site for two concrete reservoirs above Lanena Street, Warrane. These reservoirs are to be sited on the lower slope of a dolerite ridge, west of Mornington Hill [EN307538]. The ground surface at the site slopes down at approximately 10° to the west. The excavation will require to be eight metres deep on the uphill side of the reservoir, but with a planned diameter of 39 m, the outer edge of the reservoirs on the downhill side will be close to the existing ground surface. The total area to be excavated for both tanks will be approximately 100 m by 50 m (fig. 1).

The Council's intention is to only excavate the western tank site if the seismic survey shows both sites to be rippable to the proposed depth. Both tank sites will be excavated together if blasting is required. The seismic survey was undertaken to answer this question, as well as to give a general guide to the rippability depth of the area. This guide is based on the seismic velocities for various rock types, which are rippable up to a given velocity by a D9 tractor as shown on Figure 2.

SEISMIC SURVEY DETAILS

A twelve-channel Nimbus Model ES1210F seismograph was used in the survey. A preliminary hammer survey was undertaken on the N-S centre line of the two tanks to establish the velocities present. The N-S centre line of the reservoirs and the outline of the southern reservoir had been surveyed and pegged by the Clarence Council surveyors.

The preliminary hammer survey was followed by four seismic spreads with variable geophone spacing. These spreads were fired from both ends and the middle, using gelignite and seismic boosters with electric detonators. A crew of three was used and the field survey was completed in one day. The location of these spreads is shown on Figure 1 and the results are given in Table 1.

LIMITATIONS OF THE SEISMIC SURVEY

It should be stressed that the survey, because of its limited coverage, is only reconnaissance in nature and aims only to provide rock seismic velocities and a general guide as to the rippable depth at the site for the Clarence Council engineering staff. It should not be used

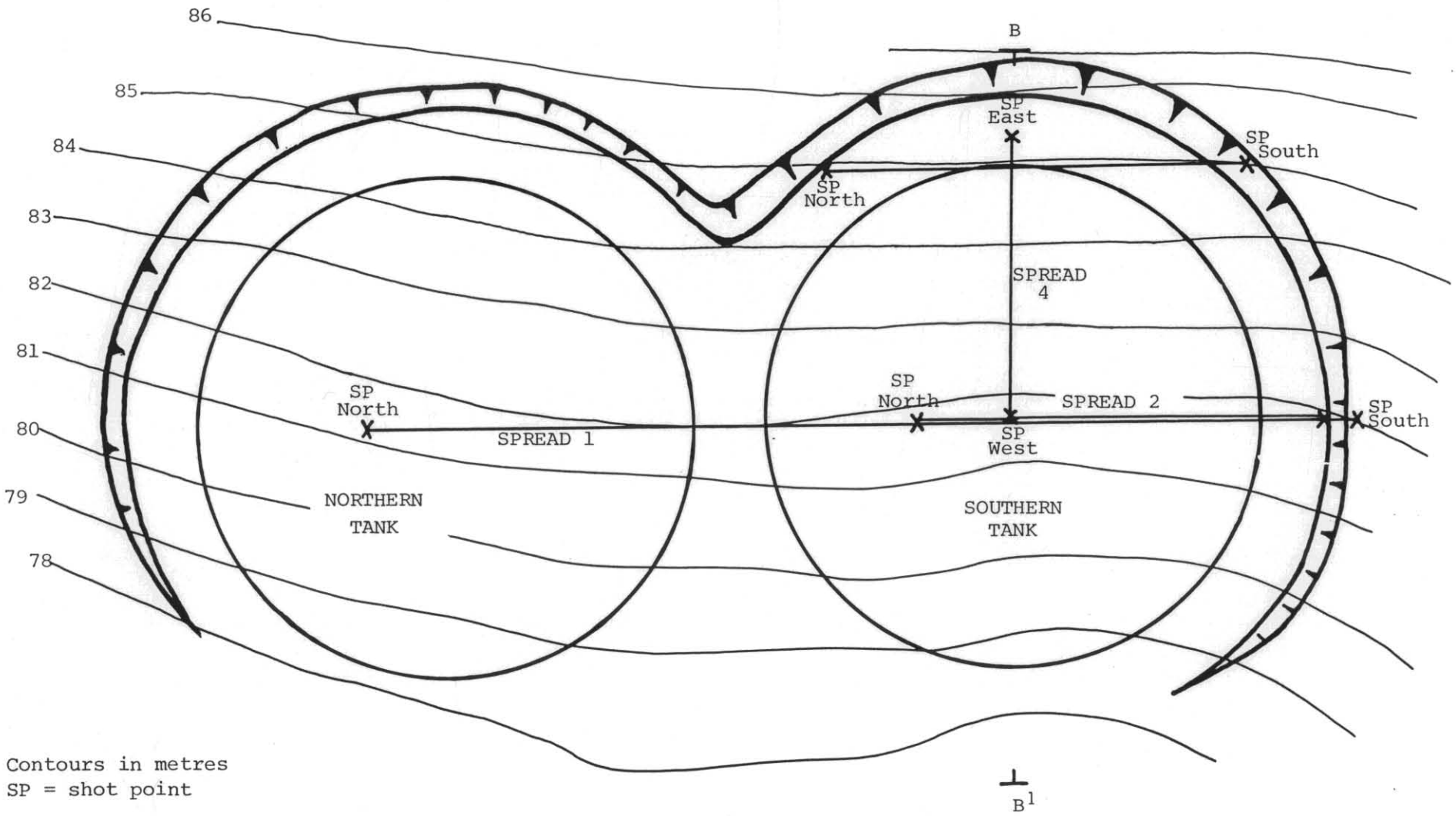

Figure 1. *Location of seismic spreads, proposed reservoir site, Lanena Street.*

5 cm

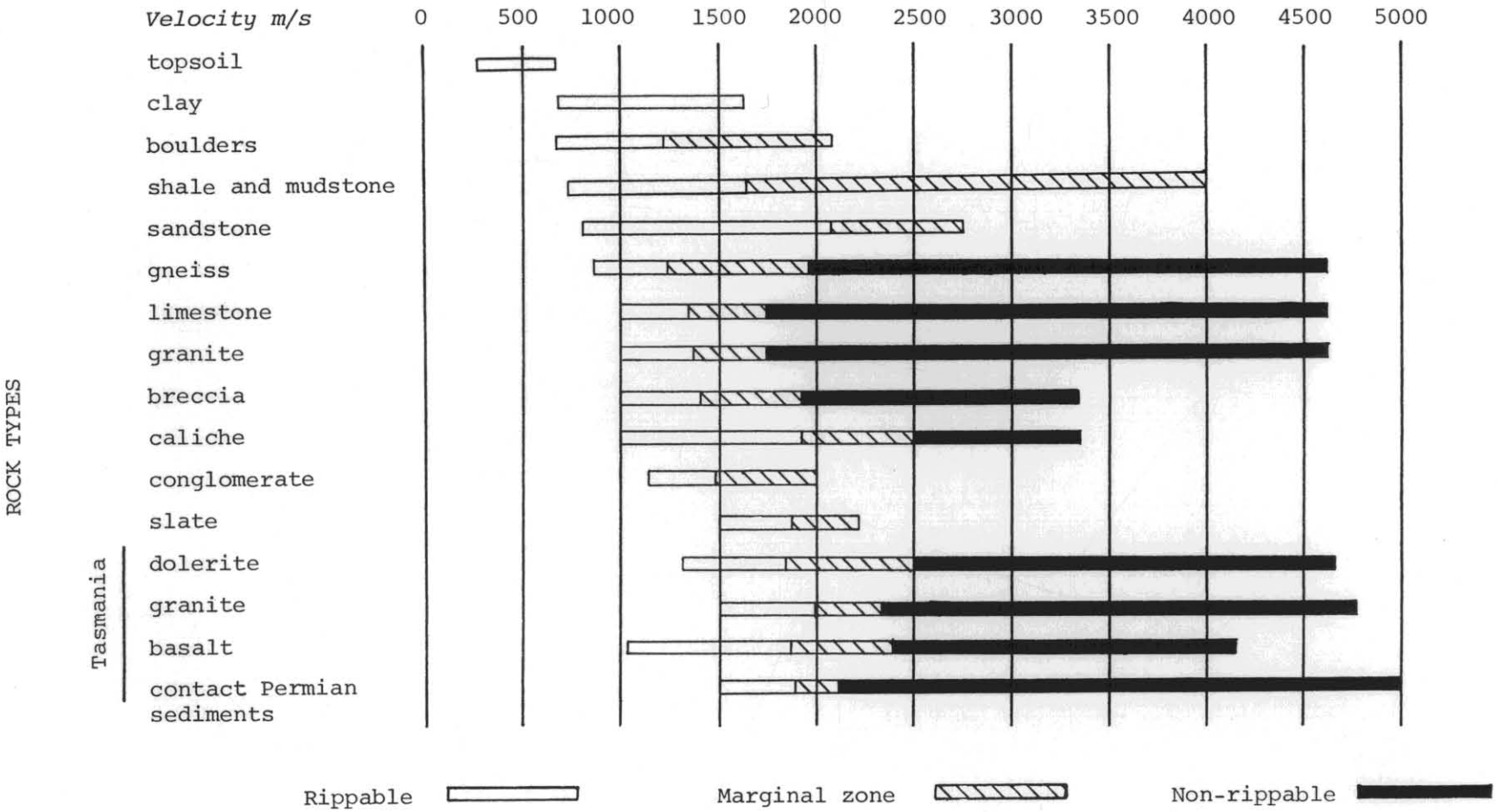

Figure 2. *Guide to rippability (adapted from Soil Test Inc.)*

5 cm

for detail contracts dealing with estimated costs for the amount of material to be removed from the proposed excavation by scraping, ripping, or blasting; the survey's coverage is too limited for this type of detail. Because of the shortage of time allocated by the Council for the results, only the simplest method, that of critical distances, was used to calculate the depth to the various velocity layers.

If the contractors require more detailed information, a more intensive seismic survey would be required, probably with some drill control. The time to complete such a survey would be far too great for the Department of Mines staff and a consultant geophysicist should be used.

GEOLOGY

Weathered dolerite boulders and some outcrops of dolerite occur around the site, and dolerite is exposed in nearby road banks. Clarence Council staff had excavated five to six shallow trenches on the site with a light backhoe. These were reported to have exposed a shallow soil horizon underlain by dolerite boulders with the average depth of refusal for this machine being 1.2 metres. Since the seismic survey was conducted, a heavier machine has been used by a contractor, reaching 3.0 m before refusal.

The Hobart sheet of the 1:50 000 Geological Atlas series (Leaman, 1973) shows the entire ridge west of Mornington Hill, on which the reservoirs are to be sited, as being composed of dolerite.

GEOPHYSICS

Regional

In his Gravity Survey of the Hobart District, Leaman (1972) indicated that dolerite forms the entire ridge west of Mornington Hill. The ridge is the top of a dolerite sheet which Leaman estimates to be 500 m thick, with a dip towards Rosny Hill to the west. The sheet feeder or centre is thought to be located beneath Rosny Hill. In the Hobart Engineering Geology Map Series, Leaman (1971) showed the ridge as being composed of a Class I hard rock dolerite, which when unweathered can only be excavated by hammer or explosives. Anticipated seismic velocities for the area are also given, with three layers likely to be present: a V_0 surface soil layer of 300 m/sec; a V_1 intermediate layer of 2000 - 2800 m/sec of weathered dolerite; and a third layer (V_2) of unweathered dolerite with velocities of 4500 m/sec.

Seismic survey site

Three velocity layers were present in all four spreads. In three of these spreads, the layer velocities are consistent, with a V_0 surface layer of 350 - 600 m/sec, an intermediate V_1 layer of 1000 - 1800 m/sec, and a third V_2 layer of 3000 - 4500+ m/sec. The anomalous higher layer velocities found in Spread 1, with a V_0 velocity of 800 - 1000 m/sec, intermediate V_1 of 2800 - 3350 m/sec, and V_2 of 4500 m/sec is the result of having the shot point and geophone spacing at too great a distance compared with the other three spreads. This resulted in the slow surface layer of 350 - 600 m/sec, found in the other spreads, being missed. In Spread 1 the V_0/V_1 interface is in reality the bedrock layer interface V_1/V_2 of the other three spreads.

Table 1. RESULTS OF SEISMIC REFRACTION SURVEY

Spread No.	*Velocity (m/sec)*	*Calc. Thickness (m)*	*Total Depth (m)*	*Velocity Plots*	*Geological Interpretation*	*Excavation Conditions*
1	800 - 1000	2.8 - 3.5	2.8 - 3.5	Symmetrical	Top soil/weak rock	Rippable
(7.5 m geophone spacings)	2800 - 3350	8.0 -13.5	10.8 - 17.0		SW-FR high strength rock	Blasting required
	4500+	-	-			
2	350 - 600	0.8 - 1.1	0.8 - 1.1	Symmetrical and stepped	Top soil/boulders	Scrapers
(3.0 m geophone spacings)	1100 - 1500	1.7 - 2.7	2.5 - 3.8		HW-SW closely jointed rock	Rippable
	4000+				FR high strength rock	Blasting required
3	450 - 600	0.8 - 1.1	0.8 - 1.1	Symmetrical and stepped	Top soil/boulders	Scrapers
(3.0 m geophone spacings)	1100 - 1550	1.7 - 2.6	2.5 - 3.7			Rippable
	3000 - 4500	-				Blasting required
4	350 - 500	0.7 - 0.8	0.7 - 0.8	Symmetrical and stepped	Top soil/boulders	Scrapers
(2.0 m geophone spacings)	1350 - 1800	2.5 - 3.0	3.2 - 3.8		HW-SW jointed rock	Rippable
	4000+	-			FR high strength rock	Blasting required

HW Highly weathered

SW Slightly weathered

FR Fresh unweathered

All the velocity plots of the four spreads are symmetrical and there is no evidence of any great slopes on the interfaces or lensing out of any of the seismic layers. There is a considerable amount of stepping in the plots of the intermediate layer and third layer velocities. This is due to the irregular weathering profile of the dolerite, particularly between the weathered dolerite with open joints and unweathered dolerite with closed joints. There will be a variable topography between the V_1/V_2 interface.

GEOLOGICAL INTERPRETATION OF THE SEISMIC LAYERS

V_0 surface layer (350 - 600 m/sec)

The V_0 surface layer is a thin soil and boulder layer which extends to a calculated depth of 0.7 - 1.1 metres. It was this layer that was excavated by the Clarence Council backhoe. This layer can be removed by light machinery, such as scrapers or tractor-mounted backhoes, with little difficulty.

V_1 intermediate layer (1000 - 1800 m/sec)

The intermediate layer is weathered dolerite which covers a wide range of velocities. It varies from a friable rock which is highly weathered, but still retains its original dolerite texture and some of its strength, through to a competent rock with open joints which are completely weathered and coloured brown. The dolerite generally has strong vertical joints and weathers concentrically, giving large kernels or cores of slightly weathered to even, fresh dolerite. These make for an irregular surface between the weathered and unweathered dolerite and give a stepped velocity profile between the V_1/V_2 seismic interfaces. This seismic interface is an averaging of the velocities which often does not coincide exactly with any visible physical boundary when excavated. All of this middle seismic layer should be rippable using a heavy machine such as a D9, but jack hammers and some pop blasting would be required to obtain a flat surface.

V_2 layer (3000 - 4500+ m/sec)

In the third velocity layer the dolerite will be unweathered and is likely to have tight but stained joints. The mass of the rock is likely to be fresh but stained grey-brown or even unstained grey-blue in colour. This rock will require heavy blasting, especially in the higher velocity range of 4000 - 4500+ m/sec. Any jointing is not likely to be of any great assistance to ripping without having been pre-blasted.

CONCLUSIONS

(1) The site of both proposed tanks is underlain by a hard competent rock which from the geological and geophysical evidence appears to be dolerite. This rock is likely to be encountered over all of the site and for the entire depth of the excavation. No foundation problems are likely on this site.

(2) The underlying rock has very high seismic velocities at a shallow depth and the only rocks that produce such velocities in this area are hard unweathered dolerite and the thermally metamorphosed mudstone and siltstone sedimentary contact rocks of Permian age. Both the unweathered dolerite and the flinty siltstone and mudstone have proved difficult to excavate on the nearby Eastern Outlet Road. From the geology, it appears

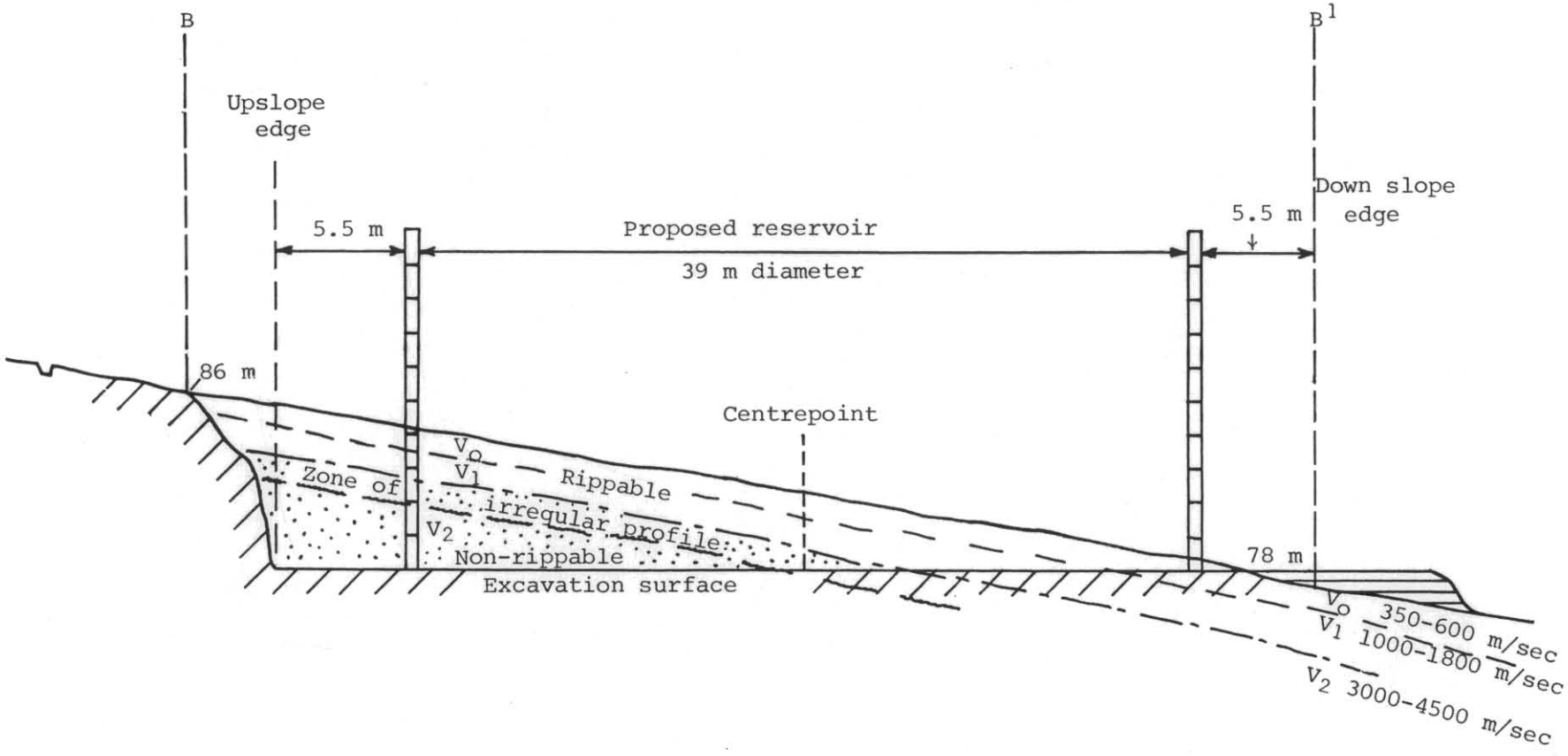

Figure 3. *Diagrammatic cross-section of reservoir site (not to scale).*

unlikely that the latter rock type will be encountered at this site, unless as an inclusion of baked sedimentary beds between the dolerite sheets.

(3) To reach the required maximum depth of eight metres, the high seismic velocities indicate that blasting will be required. The average rippable depth without prior blasting is calculated at 2.5 - 3.8 m, but the base of this rippable material is likely to be irregular and ill-defined.

(4) The top seismic layer of soil and dolerite boulders is thin, with a calculated thickness of 0.8 - 1.1 m, and with such a limited thickness is probably not considered worthwhile recovering and stock piling.

RECOMMENDATIONS

(1) Both reservoir sites should be excavated together.

(2) The heaviest type of machinery will be required to rip and excavate both sites to the calculated depth of 2.5 - 3.8 metres.

(3) Blasting will be required to reach the required depth of eight metres. Considerable thought should be given to the method of blasting the site because of the close proximity of the houses in Lanena Street and the underlying shallow high velocity rock present on the site and on which these houses are also built.

(4) Pre-splitting of the rear wall of the excavation followed by choke blasting the site before ripping is the most suitable method geologically for this proposed site.

(5) Because of the close proximity of the houses modifications of the above method will be required. Pre-drilling and firing of the site, using a limited amount of explosives in a few drill holes at a time, has been suggested by the Department of Mines Explosive Engineer P. Allan. When this drilling and blasting has been completed, the site could then be ripped.

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