1977/46. Preliminary reconnaissance seismic survey, potential quarry site, Cascades Road, Burnie.

W.R. Moore

With the gradual phasing out of quarrying at Round Hill nearly complete, an alternative source for the supply of aggregate for Burnie has become important. The Round Hill quarries have been supplying the Burnie district with aggregate for over 70 years with the material being used by the Burnie Council and Department of Main Roads as a base course for road construction.

The source for this aggregate at Round Hill has been a thick talus deposit of presumed Pleistocene age and the sub-greywacke quartzite, slatey mudstone and slate of the Burnie Formation of Precambrian age (Moore, 1976*a*). This material has been quarried from Round Hill very inexpensively. Each quarry operator has cut a series of tracks and irregular benches on the side of Round Hill with heavy bulldozers, the material then being pushed down over the slope faces to the quarry floor where it is crushed and screened if desired for aggregate. Very little ripping by heavy machines or blasting appears to have occurred to date. The only area of any extensive deep rock drilling and subsequent blasting known to have been undertaken is in Holloways Quarry on the face above the crusher, where an unstable and dangerous face has resulted (plate 13, Moore, 1976*a*).

Consequently the cost of quarrying the material at the Round Hill quarries has been low with very little capital invested in heavy equipment or explosives as is normally required for hard rock quarrying. The other major economic advantage of the Round Hill quarries has been their closeness to Burnie. One of the alternative sites considered as a replacement for the Round Hill quarries is a small hill on the western side of the Emu River gorge at Cascades [DQ076484], 6 km south-west of Round Hill. A small gravel pit operated by W. Singline is located on this site.

CASCADES ROAD QUARRY SITE

Similar sediments to those at Round Hill are exposed in Singline's pit although the talus deposits appear to be very thin. The material was sampled by Threader (1977) and found to be suitable. The Cascades Road site could be developed into a suitable large scale planned quarry, mainly on the eastern flank of the hill. The western side of the hill would remain as a buffer zone between the Cascades residential area and the quarry face (fig. 1). If this western flank of the hill was planted in trees, the quarry would not be visible from the north and west. Once the 200 m (650 feet) contour had been reached by benching, the face would then become invisible from almost all directions. An access road to the north could be provided so that all laden quarry trucks would avoid all residential areas until the Ridgley-Burnie road was reached. With the quarry below the 200 m level, the noise and dust would be confined within the Emu River gorge, even if explosives were used regularly.

The major disadvantage of the site appears to be that some residential subdivision and building has already occurred next to the access track to the existing gravel pit. If development continues it will seriously restrict the width of the buffer zone and green belt which is desirable around any potential hard rock quarry. If only machinery is to be used with no regular, systematic blasting required, it is possible that a narrow buffer zone would be sufficient. In an attempt to establish a guide to rippability depth, a reconnaissance seismic survey was undertaken covering as much of the hill as feasible.

0/8

SEISMIC SURVEYS
CASCADES ROAD QUARRY, BURNIE

GEOLOGIST: W. R. MOORE
SURVEYOR: G. BENN

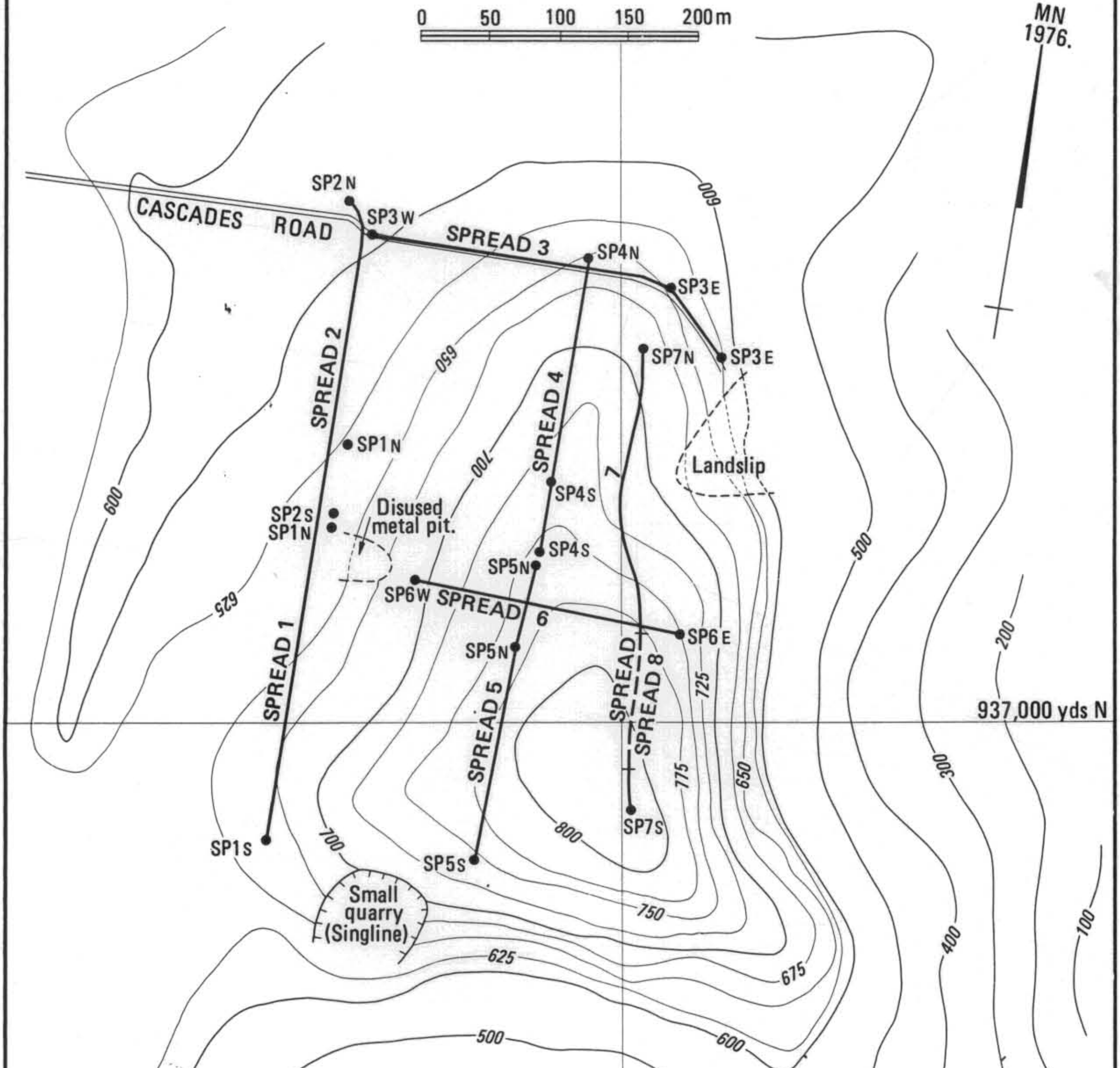

Figure 1.

5 cm

The survey was only of a reconnaissance nature, sufficient to give the Senior Mining Engineer, Burnie, a guide in his discussions with the Burnie Council on alternative sites to Round Hill. It should be followed at a later date with a full feasibility study, allowing for proper assessment of reserves.

SEISMIC SURVEY

In an attempt to establish the rippability depth, seven seismic spreads with a geophone spacing of 15 m and a weathering spread with a geophone spacing of 2 m were fired. These spreads covered enough of the area to give a representative coverage of the proposed quarry site. The location of the spreads is shown on Figure 1 and a summary of the results, with a geological interpretation of the layers, is given in Table 1. Three velocity layers were found in the quartzite and slate with an upper velocity layer ranging between 1000-2000 m/sec with the most common velocity present of 1600 m/sec. The second velocity layer had a range of 2200-2600 m/sec while the third layer had velocities in excess of 3000 m/sec. In the weathering spread, the surface layer could be further subdivided into an upper layer of 216 m/sec and an intermediate layer of 1100 m/sec overlying the 1600 m/sec layer. As the interface to these two upper surface layers was calculated to be less than one metre in depth, they were ignored in the calculations of the interfaces on the longer spreads. The velocities in most of the spreads were stepped and the likelihood of thicker faster horizons present in these three generalised velocity layers appears likely.

Seismic velocities are at best only a general guide to rippability, but this is more so in these complexly folded and alternately bedded quartzite and argillites, where the thickness of the banded quartzite may vary from less than 0.3 m to 4 m in bedding thickness. As well as the thickness of the beds, the attitude of the bedding, the amount of jointing and tightness of these joints all influence the ability of heavy machinery to rip these rocks. From the evidence at Holloway's Quarry at Round Hill, where a series of seismic spreads were fired on the existing quarry benches that had been ripped, the upper limit of complete rippability for Precambrian quartzites and argillites appears to be in the order of 2400 m/sec. Above this velocity, the rock would appear to be marginally rippable and above 3000 m/sec is thought to require continuous drilling and explosives to be quarried.

As the lithologies and folding seen in the two small gravel pits and the landslip at the eastern end of seismic Spread 3 were similar to Round Hill, the above velocity limits at Holloway's Quarry can be used as a guide to rippability depth at the Cascades Road sites. The V_1/V_2 interface is used as the approximate rippable depth, which is calculated to be between 35-60 m, with an average depth of 40 m. Depths of this order would allow the rock to be removed by using machinery, rather than explosives, to the edge of the gorge at the 200 m contour.

CONCLUSIONS

This seismic survey indicates that the quartzite and mudstone at the Cascades Road site have similar seismic velocities to the same rock types at Round Hill.

The material at Cascades Road appears rippable to a minimum depth of 30 m, with thicker quartzite beds making it marginally rippable to depths as great as 60 m. Such a depth appears, on geophysical evidence, to infer an adequate supply of rippable material at the Cascades site.

The talus deposit and the upper zone of deeply weathered rock, which gave low velocities of 600-900 m/sec at Round Hill, are only found in the weathering spread at Cascades Road, where the thickness was less than 2 m. Such low velocities were not seen in the longer spreads, indicating that the talus deposits are thin and variable in distribution. This is in striking contrast to Round Hill, where thick localised deposits of talus can still be seen even after the extensive quarrying.

The velocity plots of the Cascades area are stepped as was found to be a characteristic at the Round Hill quarries and also in similar folded sediments on the Murchison Highway at Cam River (Moore 1976*b*). This stepping makes it difficult to be precise in any depth calculation between interfaces, as the velocities must be averaged to eliminate the steps. As well as being caused by thicker quartzite beds, it is also thought to represent openings caused by relaxation of joints in these highly folded rocks. Such joint openings or relaxations allow the material to be rippable to greater depths than could normally be anticipated for rocks with high velocities.

RECOMMENDATIONS

If the Cascades Road quarry is to be considered as a serious alternative to the Round Hill quarries, a more detailed assessment of future reserves should be undertaken. This assessment would require:

(1) The trenching of several pits with a back-hoe over the site to establish the thickness and presence of the talus deposits.

(2) A more detailed seismic survey with at least two diamond drill holes for control. Up-hole seismic as well as velocity measurements on the core would allow for correlation of the stepping in seismic velocities with change in lithologies or joint frequency.

(3) The diamond drill holes could be pressure tested as a guide, through their potential leakage, to the tightness of joints at depth.

Such a programme would allow for some calculation of the available reserves of the upper talus deposits, the rippable rock and the hard rock requiring explosives. Only when such figures are available could a useful comparison between the existing quarries at Round Hill and the potential site at Cascades Road be made.

REFERENCES

MOORE, W.R. 1976*a*. Engineering geology and slope stability analyses of Round Hill quarries, Burnie. *Unpubl.Rep.Dep.Mines Tasm.* 1976/31.

MOORE, W.R. 1976*b*. Engineering geology investigation of a proposed cutting on the Murchison Highway at Somerset. *Unpubl.Rep.Dep.Mines Tasm.* 1976/41.

THREADER, V.M. 1977. The quarrying of rock-making material in the Burnie district. *Tech.Rep.Dep.Mines Tasm.* 20:37-44.

[11 October 1977]

Table 1. *SEISMIC RESULTS, CASCADES ROAD QUARRY SITE*

Spread	Geophone spacing (m)	Shot point distance (m)	Velocity layers (m/s)	Calculated depth to interface (m)	Shape of velocity plot	Geological interpretation	Rippability of layers	Remarks
1	15	SP North 500, 100 SP South 30	V_0 1600-2000 V_1 2600-2800 V_2 3000-3600	V_0/V_1 = 10-15 V_1/V_2 = 35-42	Stepped, symmetrical	V_0 open jointed weathered quartzite and argillite V_1 closely jointed quartzite joints sprung V_2 tightly jointed quartzite and argillite	V_0 Rippable V_1 Marginally rippable V_2 Not rippable	
2	15	SP North 30 SP South 15	V_0 1600-2000 V_1 2600-2800 V_2 3000-3600	V_0/V_1 = 6-11 V_1/V_2 = 18-25 (Not reliable)	Assymmetrical. Large step from 3000-5000 m/s between V_0-V_1 at geophones 3 and 6	V_0 open jointed and weathered quartzite and argillite V_1 closely jointed quartzite with joints open and sprung. Step may indicate hard layer of thicker quartzite within this zone V_2 closely tightly jointed argillite and quartzite	V_0 Rippable V_1 Marginally rippable but thick layer of quartzite not likely to be rippable V_2 Not rippable	Depth calculation V_1/V_2 interface not reliable because of the large step
3	15	SP West 30 SP East 30, 77	*West end* V_0 = 800 *East end* V_0 = 1500 V_1 = 2200-2400 V_2 = 3600-4400	*West end* V_0/V_1 = 10-15 $V_1/V2$ = 22-30 *East end* V_0/V_1 = 11-15 V_1/V_2 = 40-48	Assymmetrical. Large step from 3000-5000 m/s velocity in middle of the spread	*West end* V_0 Basalt talus and red soil *East end* V_0 open joined and weathered argillite V_1 closely joined quartzite and argillite Joints open and sprung V_2 tightly joined argillite and quartzite	As above for spread 2	

Table 1. *(continued)*

Spread	Geophone spacing (m)	Shot point distance (m)	Velocity layers (m/s)	Calculated depth to interface (m)	Shape of velocity plot	Geological interpretation	Rippability of layers	Remarks
4	15	SP North 30 SP South 30, 90	V_0 = 1400 V_1 = 2200-2600 V_2 = 3600-4200	V_0/V_1 = 12-16 V_1/V_2 = 33-43	Symmetrical, stepping at west end	V_0 weathered and open jointed quartzite and argillite V_1 open jointed argillite and quartzite V_2 closely jointed and tight argillite and quartzite	V_0 and V_1 appear mostly rippable with heavy machinery	
5	15	SP North 30, 90 SP South 30	V_0 = 1000-1600 V_1 = 2600 V_2 = 3000	*North end* V_0/V_1 = 18-20 *South end* V_0/V_1 = 18-24 V_1/V_2 = 40-60	Assymmetrical some small stepping present	As above	As above	First layer slope makes for over estimation of depth of V_1/V_2 interface
6	15	SP West 30 SP East 30	V_0 = 1200-1600 V_1 = 2600 V_2 = 3000+	V_0/V_1 = 8-14 V_1/V_2 = 35-38	Symmetrical little stepping present	As above	As above	
7	15	SP North 30 SP South 152	*North end* V_0 = 800 V_1 = 1600 V_2 = 2800 *South end* V_1 = 1600 V_2 = 2800 V_3 = 5000-7000	*North end* V_0/V_1 = 2-3 V_1/V_2 = 13-20 *South end* V_1/V_2 = 70-80 (Not reliable)	Symmetrical stepped No 800 m/s layer seen at South end	As above	As above	This spread required further shooting. No further explosives available
8	2	SP North 3 SP South 3	V_0 = 214 V_1 = 610 V_2 = 1670	V_0/V_1= <1 V_1/V_2= 1.5-2	Symmetrical not stepped	V_0 surface soil V_1 Talus and quartzite V_2 open jointed and weathered argillite and quartzite	All V_0,V_1,V_2 rippable by light machinary	Weathering spread

Table 1. *SEISMIC RESULTS, CASCADES ROAD QUARRY SITE*

Spread	Geophone spacing (m)	Shot point distance (m)	Velocity layers (m/s)	Calculated depth to interface (m)	Shape of velocity plot	Geological interpretation	Rippability of layers	Remarks
1	15	SP North 500, 100 SP South 30	V_0 1600-2000 V_1 2600-2800 V_2 3000-3600	V_0/V_1 = 10-15 V_1/V_2 = 35-42	Stepped, symmetrical	V_0 open jointed weathered quartzite and argillite	V_0 Rippable	
						V_1 closely jointed quartzite joints sprung	V_1 Marginally rippable	
						V_2 tightly jointed quartzite and argillite	V_2 Not rippable	
2	15	SP North 30 SP South 15	V_0 1600-2000 V_1 2600-2800 V_2 3000-3600	V_0/V_1 = 6-11 V_1/V_2 = 18-25 (Not reliable)	Assymmetrical. Large step from 3000-5000 m/s between V_0-V_1 at geophones 3 and 6	V_0 open jointed and weathered quartzite and argillite	V_0 Rippable	Depth calculation V_1/V_2 interface not reliable because of the large step
						V_1 closely jointed quartzite with joints open and sprung. Step may indicate hard layer of thicker quartzite within this zone	V_1 Marginally rippable but thick layer of quartzite not likely to be rippable	
						V_2 closely tightly jointed argillite and quartzite	V_2 Not rippable	
3	15	SP West 30	*West end* V_0 = 800	*West end* V_0/V_1 = 10-15 $V_1/V2$ = 22-30	Assymmetrical. Large step from 3000-5000 m/s velocity in middle of the spread	*West end* V_0 Basalt talus and red soil	As above for spread 2	
		SP East 30, 77	*East end* V_0 = 1500 V_1 = 2200-2400 V_2 = 3600-4400	*East end* V_0/V_1 = 11-15 V_1/V_2 = 40-48		*East end* V_0 open joined and weathered argillite		
						V_1 closely joined quartzite and argillite Joints open and sprung		
						V_2 tightly joined argillite and quartzite		

Table 1. *(continued)*

Spread	Geophone spacing (m)	Shot point distance (m)	Velocity layers (m/s)	Calculated depth to interface (m)	Shape of velocity plot	Geological interpretation	Rippability of layers	Remarks
4	15	SP North 30 SP South 30, 90	V_0 = 1400 V_1 = 2200-2600 V_2 = 3600-4200	V_0/V_1 = 12-16 V_1/V_2 = 33-43	Symmetrical, stepping at west end	V_0 weathered and open jointed quartzite and argillite V_1 open jointed argillite and quartzite V_2 closely jointed and tight argillite and quartzite	V_0 and V_1 appear mostly rippable with heavy machinery	
5	15	SP North 30, 90 SP South 30	V_0 = 1000-1600 V_1 = 2600 V_2 = 3000	*North end* V_0/V_1 = 18-20 *South end* V_0/V_1 = 18-24 V_1/V_2 = 40-60	Assymmetrical some small stepping present	As above	As above	First layer slope makes for over estimation of depth of V_1/V_2 interface
6	15	SP West 30 SP East 30	V_0 = 1200-1600 V_1 = 2600 V_2 = 3000+	V_0/V_1 = 8-14 V_1/V_2 = 35-38	Symmetrical little stepping present	As above	As above	
7	15	SP North 30 SP South 152	*North end* V_0 = 800 V_1 = 1600 V_2 = 2800 *South end* V_1 = 1600 V_2 = 2800 V_3 = 5000-7000	*North end* V_0/V_1 = 2-3 V_1/V_2 = 13-20 *South end* V_1/V_2 = 70-80 (Not reliable)	Symmetrical stepped No 800 m/s layer seen at South end	As above	As above	This spread required further shooting. No further explosives available
8	2	SP North 3 SP South 3	V_0 = 214 V_1 = 610 V_2 = 1670	V_0/V_1= <1 V_1/V_2= 1.5-2	Symmetrical not stepped	V_0 surface soil V_1 Talus and quartzite V_2 open jointed and weathered argillite and quartzite	All V_0,V_1,V_2 rippable by light machinary	Weathering spread