TR15_78_83

## 21. Report on drilling, Pipers River dam site 10

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The preceding report dealt with the preliminary geological and geophysical examination of four possible dam sites along the Pipers River. Site 10 was examined more closely at that time and a drilling programme recommended. The positions of the boreholes are as follows:

Hole 1: At the top of a small bench about 18 m above the river on the west bank and on the proposed centreline.

Hole 2: About 24-30 m downstream of the centreline and close to the river. West bank.

Hole 3: About 12-15 m upstream of the centreline and about 6 m above the river. West bank.

Hole 4: About 24-30 m south of Hole 1 on bench.

The first three holes were selected according to the original programme in order to examine the basalt boulder-covered knoll to be used as the west abutment. The fourth hole was selected following drilling of the first three.

DRILLING RESULTS

*Hole 1*

| Depth (*m*) | Core Recovery (*m*) | % Recovery | Description |
|---|---|---|---|
| 0 - 6.93 | 0.35 | 5.1 | Clay, basalt fragments. |
| 6.93 - 7.85 | 0.85 | 93.5 | Clay zone (7.32-7.47 m); core basalt. |
| 7.85 - 8.61 | 0.73 | 96 | Clay zone (8.41-8.47 m); core basalt. |
| 8.61 - 10.08 | 1.47 | 100 | Very broken basalt at 9.98 m. |
| 10.08 - 10.42 | 0.34 | 100 | Basalt, jointed at 10.36-10.42 m. |
| 10.42 - 11.55 | 0.85 | 71 | Dry iron oxide weathering, jointed at 11.25 m. |
| 11.55 - 12.07 | 0.40 | 76 | Basalt with iron oxide coating. |
| 12.07 - 13.05 | 0.67 | 67 | Basalt, joint density 10 per metre. |
| 13.05 - 13.90 | 0.49 | 57 | Basalt, joint density 7 per metre. Suspected removal of much clay and weathering material from joints. Position of joints and deposits not known with accuracy. |
| 13.90 - 15.03 | 0.70 | 62 | Jointed basalt, joint density 20 per metre. |

*Hole 1 - continued*

| Depth (*m*) | Core Recovery (*m*) | % Recovery | Description |
|---|---|---|---|
| 15.03 - 15.51 | 0.12 | 25 | Very broken, fragmented basalt, joint density more than 33 per metre. |
| 15.51 - 16.79 | 0.92 | 78 | Basalt blocks with limonite coatings. Joints 10 per metre. |
| 16.79 - 17.07 | 0.30 | 20 | Basalt blocks, very jointed (13 per metre). |
| 17.07 - 17.65 | 0.27 | 47 | Basalt block, iron oxide coated, 13 joints per metre at about 60° to core. |
| 17.65 - 18.56 | 0.76 | 83 | Oxide coated amygdaloidal basalt. |
| 18.56 - 18.71 | 0.15 | 100 | Oxide coated; 3-7 joints per metre. |
| 18.71 - 19.71 | 0.62 | 69 | Weathered basalt; 10 joints per metre. Shattered at 18.71 m. |
| 19.71 - 19.99 | 0.28 | 100 | Weathered basalt, clay zone at 19.99 m. |
| 19.99 - 21.43 | | | Scoriaceous basalt, very weathered. |
| 21.43 - 23.62 | 0.27 | 12 | Clay (50 mm), wood fragments (50 mm), brown basaltic clay with quartz fragments (80 mm) and quartz blocks (80 mm) |
| 23.62 - 24.99 | 0.38 | 30 | Quartz boulders (?) |
| 24.99 - 25.22 | 0.23 | 100 | Quartz boulders (?) |
| 25.22 - 25.80 | 0.15 | 26 | Weathered, fragmented slate. |
| 25.80 - 28.37 | 0.18 | 71 | Shattered slate. |

Much of the core loss is due to removal of the silt and clay fraction which has been packed between the blocks of basalt. Much of this material was preserved in core from Holes 2 and 3.

*Hole 2*

| Depth (*m*) | Core Recovery (*m*) | % Recovery | Description |
|---|---|---|---|
| 0 - 2.08 | 0.91 | 38 | Weathered basalt, coated with iron oxides. Much brown clay material also recovered. |
| 2.08 - 4.48 | 0.91 | 45 | Weathered basalt with clay. |

*Hole 2 - continued*

| Depth (*m*) | Core Recovery (*m*) | % Recovery | Description |
|---|---|---|---|
| 4.48 - 7.19 | | | Very weathered scoriaceous, amygdaloidal basalt. No fresh material. |
| 7.19 - 11.78 | 1.67 | 23 | Black, green and white silty clay. |
| 11.78 - 13.88 | 0.46 | 22 | Quartz fragments. Very broken fragments of slate. |
| 13.88 - 15.29 | 1.67 | 76 | Shattered slate. Cleavage about 60° to core. Jointing at a steep angle to cleavage. Most joints mineralised. Negligible mineralisation along cleavages. Joints coated with a dry, white powder. |
| 15.29 - 16.31 | 0.91 | 90 | As for 13.88-15.29 m section. |
| 16.31 - 17.75 | 1.37 | 95 | Slate. Mineralised at 17.66 m and shattered 17.66-17.98 m. |
| 17.75 - 18.99 | 1.24 | 100 | Slate. Shattered at 18.29-18.90 m. |
| 18.99 - 19.71 | 0.72 | 100 | Slate. |
| 19.71 - 19.81 | 0.10 | 100 | Shattered slate. |

Jointing is variable throughout the slate but the frequency of joints is more than 40 per metre in broken and shattered zones and less than 10 per metre elsewhere.

*Hole 3*

| Depth (*m*) | Core Recovery (*m*) | % Recovery | Description |
|---|---|---|---|
| 0 - 0.91 | | No core | |
| 0.91 - 1.80 | 0.62 | 80 | 53 cm basalt, remainder brown clay containing fragments of weathered basalt. |
| 1.80 - 3.61 | 1.25 | 71 | Three sections of basalt 0.65, 20, 40, 30 cm in length and two clay bands 20, 15 cm in length. The exact placement of the clay zones is not known due to core loss. The basalt is massive with few joints. |

*Hole 3 - continued*

| Depth (*m*) | Core Recovery (*m*) | % Recovery | Description |
|---|---|---|---|
| 3.61 - 5.88 | 2.27 | 100 | Very broken basalt, all joints weathered and coated with limonite. Joints at 45° to core. |
| 5.88 - 7.96 | 0.91 | 40 | Contact basalt/slate at 5.98 m. The slate is white in colour, powdery and weathered. No scoria zone near the base of the basalt. Cleavage at 60° to core. |
| 7.96 - 8.76 | 0.55 | 70 | Grey slate. |
| 8.76 - 9.98 | 1.22 | 100 | Slate, with pyrite on many joint surfaces. |
| 9.98 - 11.48 | 1.29 | 89 | Slate. |
| 11.48 - 12.70 | 1.04 | 87 | Grey slate. |
| 12.70 - 13.75 | 0.76 | 70 | Slate, very broken at 12.80 m. |
| 13.75 - 14.48 | 0.73 | 100 | Grey slate, mineralised joints at 14.33 m. |
| 14.48 - 17.65 | 3.17 | 100 | Grey slate. |
| 17.65 - 19.19 | 0.81 | 52 | Grey slate. Shattered at 19.19 m. |
| 19.19 - 19.54 | 0.35 | 100 | Grey slate. Minor mineralisation along cleavages. Joints at 0°, 60° to core. |

*Hole 4*

| Depth (*m*) | Core Recovery (*m*) | % Recovery | Description |
|---|---|---|---|
| 0 - 6.10 | 0.12 | 25 | 60 cm weathered basalt pieces coated with iron oxides, and more than 60 cm of brown clay. Joint density in basalt more than 20 per metre. |
| 6.10 - 6.60 | 0.35 | 70 | Weathered basalt and clay. |
| 6.60 - 9.27 | 1.07 | 40 | Weathered basalt, joints coated and at 60° to core. Some 15 cm of brown clay recovered. |
| 9.27 - 11.74 | 2.13 | 87 | Basalt, joints at 0°, 60° to core and coated thickly with limonite. Some brown clay recovered. |

*Hole 4 - continued*

| Depth (*m*) | Core Recovery (*m*) | % Recovery | Description |
|---|---|---|---|
| 11.74 - 12.39 | 0.65 | 100 | Solid, relatively unweathered basalt, 6 joints per metre. |
| 12.39 - 14.63 | 0.69 | 30 | Weathered basalt, joints coated with limonite and containing scoria zones. |
| 14.63 - 14.78 | 0.15 | 100 | Shattered basalt. |
| 14.78 - 18.59 | 0.29 | 8 | Small pieces of basalt with clay and sand. Joints in basalt 45-60° to core; density 13 per metre. |
| 18.59 - 19.38 | 0.02 | 2 | Basalt fragments, clay and sand. |
| 19.38 - 21.03 | 0.30 | 18 | Sand, slate fragments. |
| 21.03 - 25.76 | 4.57 | 95 | Slate. |

GEOLOGICAL SUMMARY

The basalt has been proved throughout to be blocky, block size generally about 30 cm, and not massive. In practice the blocks are separated by, and held together with a dense brown clay which after drilling contains small fragments of weathered basalt. Generally the joint frequency is less than 6-10 per metre, with the joints orientated at 45°, 60°-80° and 0° to the core. Joints at 60° are the commonest. The basalt contains amygdales and scoria zones, but as Hole 3 showed these are not confined to the base of the flows. Much of the 'cementing' brown clay is washed out on drilling and it is then not possible to state exactly where such clay zones occurred.

The slate is generally a massive tight formation displaying about 1 m of weathering near the basalt interface where it becomes white and powdery. The cleavage is at about 60° to the core and the main joint direction is at about 70° to the cleavage. The joints have been mineralised, often with pyrite and quartz.

Sub-basalt sediments include sandy clay, quartz gravels and contain wood fragments. Recovery is generally poor.

HYDROLOGICAL SUMMARY

The effective permeability of the basalt is very high. There has been no water return during drilling of it and it can comfortably pass 1,400 l/h (300 g/h) even when injected through casing with no other point of loss than the bottom of the casing. No water loss tests have been possible on the basalt, or sediments due to difficulty in obtaining a seal. However, it is to be expected that heavy losses would occur through the sediments.

A section of the valley in the region of the western abutments is shown on Figure 19. Holes 1-4 indicate that an old course of Pipers River passed along the line of Holes 1 and 4 and that the river bed contains gravels and sands. It is likely that this buried channel trends a little to the south-west from the site. Under a head of 15-18 m such as a dam would create anticipated water losses in the order of 3 $Ml/d/m^2$ (70,000 $gal/d/ft^2$).

Unless a deep cut-off was employed or the materials could be successfully grouted (a doubtful possibility) water losses will be high. The nature of the weathering around some of the basalt blocks suggests that substantial open fractures exist to some depth and that for much of the time the faces are exposed to the atmosphere. It is likely that cement would not take in such a situation and would be easily flushed out. Problems would also arise in the grouting of the quartz gravels, which would have large pore spaces, be water saturated and by being at or below the present river level would also present water flow problems.

The feasibility of this site thus reduces to feasibility of sealing the abutment rocks. A dam could be built with the western abutment of the knoll provided the load is well distributed. The underlying rocks are uniform and homogeneous on the scale of the knoll with no fundamental structural weaknesses. Hydrologically the abutment is extremely porous. If it is feasible to seal these rocks satisfactorily a further drilling programme should be mounted to:

(1) Check the eastern abutment.

(2) Determine the width of the channel to the west.

## CORRELATION WITH SEISMIC SURVEY

On survey line BB (fig. 18) slate was predicted at 4 m. Considering the irregularities in shooting down slope and with an irregular basalt-slate interface this was a fair correlation.

Interpretation of line AA suggested slate at a maximum depth of 13 m. However, examination of the core in this region reveals a continuous section of basalt, although jointed, from about 8-10.5 m. Such a layer of massive continuous basalt of velocity up to 2,700 m/s would be sufficient to conceal lower velocity materials below. Velocities of 1,200-2,100 m/s are typical of clay packed basalt. Similar conditions prevailed in the region of the line CC.

## REFERENCE

LEAMAN, D.E. 1972. Preliminary examination of Pipers River dam sites 7, 7A, 10, 12. *Tech.Rep.Dep.Mines Tasm.* 15: 61-65.