1980/4. Investigation of groundwater for a town supply at Winnaleah

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Abstract

Because the existing surface water supply for Winnaleah becomes heavily contaminated by fine red soil and clay washing into the reservoir during heavy rains, particularly in winter, the Ringarooma Municipal Council requested that groundwater be investigated as an alternative or supplementary water supply.

Winnaleah is situated on a dissected basalt plateau; the basalt is underlain by a thick sequence of unconsolidated clay, sand and fine gravel of Tertiary age. The Ringarooma River to the south has cut down through the basalt and the underlying soft Tertiary sediments to the basement rocks of the Mathinna Beds and granite.

Early drilling in 1974-75 indicated that a perched water table existed at the base of the basalt in some areas and that groundwater was present in variable amounts in the basalt. The permanent water table was at the bottom of the Tertiary sediments near the basement contact, where there appeared to be a good supply of water. However to drill and lift water from this depth would not have been economical. As granite usually has only low yields, any town supply source rocks would be restricted to basalt and Mathinna Beds.

The first investigation bore was drilled to test the Mathinna Beds. These rocks are in the contact aureole of the granite and quartz veining was encountered in this hole. These veins appear to seal many of the fractures in these rocks and the hole was dry. Attention was then turned to the basalt. A small sedimentary lense was found between the two basalt flows at Winnaleah. This lense acted as a small pressure aquifer that gave good quality groundwater and pumped at 150 *l*/min. The aquifer was found in another bore 600 m to the south-west and on pumping for three days gave identical drawdown and recovery curves. From this pump test, the aquifer was drained, being recharged from leakage from the overlying basalt at a slow rate.

A similar sedimentary lense was proved in another bore drilled one kilometre to the north-west in 1975, but pumping showed it was not connected with the lense beneath Winnaleah. A hole was drilled to locate the barrier between these sediments. A decomposed basalt layer was present in this hole, indicating two basalt flows, but no sediment was present. This bore gave 166 *l*/min of water during an eight hour pump test with a three metre drawdown. The water of this bore is slightly acidic, but could be treated and would be suitable for a town supply.

These two bores gave a pump capacity in excess of 300 *l*/min for short term pumping, compared to the 39 *l*/min being used in the existing system.

As it is not possible to estimate the long terms resources available from these bores, it is suggested that long term pump tests be conducted by connecting these two bores to Winnaleah's present water reticulation system and constantly monitoring the water levels for twelve months.

INTRODUCTION

In 1977 the Ringarooma Municipal Council first requested the Department of Mines to investigate the possibility of using groundwater as an alternative or as a supplement to the existing town supply for the small township of Winnaleah [EQ692498]. The problem with the existing surface supply is not one of water shortage but surface contamination. The water is pumped from a dam on a small stream below the basalt plateau on which Winnaleah is situated, and discolours badly from the red basalt-derived soil after heavy rains, particularly in winter. Surface bacterial contamination of this water is also likely. Seventy-nine households are connected to the existing reticulation system and all are metered. The annual consumption of water is about 20 million litres.

To 1978, four combined water bores and stratigraphic holes had been drilled within five kilometres of the town as part of the north-east Tasmania regional groundwater investigation. Geological mapping of the region was undertaken by Brown *et al.* (1977). From this work it was apparent that groundwater offered no immediate simple solution to Winnaleah's water supply problems. The Ringarooma Council, in conjunction with the Department, decided that a town supply investigation would continue within the framework of the Departments north-east groundwater investigation, the project being financed from these funds. It was realised that a continuous on-going investigation would be impossible. A long term disjointed programme was likely to result, as the controlling factors would be the availability of Departmental drilling rigs and field staff. Rather than apply for outside finance, these disadvantages were accepted by the Council, especially as the outcome of the investigation was not certain.

GEOLOGY

The regional geological mapping and the preliminary drilling prior to 1978 showed that the basalt plateau on which Winnaleah is situated is the residual area of more extensive basalt lava flows that filled an old Eocene river and lake system. This system included the Ringarooma, Winnaleah, Pioneer and South Mount Cameron areas. The basalt comprises a series of multiple flows, probably from different centres, which appear to have flowed from the south-west towards the north-east with a known thickness of 40-67 m. The Tertiary sediments on which the basalt flowed comprise about 105 to 135 m of unconsolidated sand, fine gravel and clay. These sediments rest on the basement rock of Devonian granite, or sandstone and mudstone (locally called slate) of the Mathinna Beds of Silurian-Devonian age.

North and west of Winnaleah the basalt flowed directly over the Mathinna Beds, while to the north and north-east it spilled over the edge of the valley on to the granite. The edge of this old Tertiary valley is probably just north of the township.

Little is known of the geological history through the remainder of the Tertiary until the Pleistocene, when the present landscape was formed and much of the basalt stripped from the Pioneer and South Mount Cameron areas. The present Ringarooma River cut down to its existing valley level, where the basement of granite and Mathinna Beds are exposed. The river became incised in a series of gorges cut into the basement rocks, isolating the basalt capped plateau areas of Ringarooma-Branxholm and Telita-Winnaleah. The hard basalt protects the underlying soft unconsolidated Tertiary sediments that filled the old valley system.

Much of the basalt and Tertiary sediment cover was removed by erosion in the Pleistocene and in recent geological times a deep red soil cover developed over the remaining basalt. Shallow streams have cut into the top of the plateau, forming a rolling topography of shallow streams, lagoons and swamps in the vicinity of Winnaleah.

REGIONAL HYDROGEOLOGY

In north-east Tasmania all the rock types found in the Winnaleah area, basalt, Tertiary unconsolidated gravel, sand and clay, sandstone and mudstone of the Mathinna Beds, and granite, have yielded supplies of groundwater. The Tertiary sediments, where thicker than 100 m, are high yielding elsewhere in the north-east, but are overlain by thick basalt at Winnaleah. The permanent water table in the Tertiary sediments is likely to be very deep, probably near the level of the Ringarooma River. Drilling and lifting water from this level is not economical and for this reason the sediments have not been drilled in this investigation.

The granite is an unreliable and generally low yielding rock fracture aquifer in north-east Tasmania and its nearest outcrops are 2 km north of Winnaleah. This distance is considered too far, even if suitable supplies were located in this rock type. The Mathinna Beds sediments crop out immediately west of Winnaleah near the existing water supply dam and collecting reservoir tank. Therefore any supplies for a bore in this rock type could be pumped directly into the reservoir.

The Mathinna Beds are the most reliable, low yielding rock fracture aquifer in north-east Tasmania, with yields of 38-150 *l*/min. However the groundwater from certain areas in north-east Tasmania (*e.g.* Gladstone and Pipers River) has an iron content which makes the water unsuitable for drinking. Where quartz veining is common, as at Lefroy, and particularly near granite or granite contacts (as at Waterhouse), quartz veins commonly seal the fractures in which the groundwater collects in the Mathinna Beds. These metamorphosed sediments give little or no groundwater. The Mathinna Beds to the west and north of Winnaleah were mapped as contact metamorphosed rocks, and yields were anticipated to be low. The basalt is very variable in yield and the groundwater distribution very patchy in the north-east, which is in marked contrast to north-west Tasmania. In the Telita-Winnaleah area the yields are higher than in the Ringarooma-Legerwood area. Yields vary between 15-190 *l*/min.

Around the Winnaleah basalt plateau are a series of permanent springs at the base of the basalt and top of the Tertiary sediments. Such a series of springs occur along the railway east of Winnaleah where the railway formation winds down to Davids Creek. These springs indicate the presence of a perched water table at or near the base of the basalt beneath Winnaleah township. If an impervious layer, such as a clay layer, was present at the top of the Tertiary sediments and was widespread and continuous, it would stop the drainage of water from the basalt into the underlying Tertiary sediments. The basalt is thus an attractive source of groundwater. The quality of water from the basalt has none of the problems associated with the groundwater from the Mathinna sediments. One major difficulty with drilling in the basalt was the presence of open joints and boulders below the deep red soil on the surface jamming the drill.

SUBSURFACE INVESTIGATION

Cable tool - percussion drilling 1974-75

Four holes had been drilled on the red soil area at Winnaleah prior to 1978. This drilling was part of the regional reconnaissance drilling and the holes were drilled in an attempt to penetrate through the basalt and Tertiary sediments and reach basement. It was hoped that these holes would aid the interpretation and act as control for a series of long resistivity probes to estimate the thickness of the basalt and Tertiary sediment and depth to basement (Leaman, 1974), as well as allowing the formulation of a north-south geological cross section across the plateau from Wagners Hill to Winnaleah and Derby (Brown *et al.*, 1977).

Only one of these holes (Lesters) reached basement at a depth of 175.3 m in Mathinna Beds after passing through 67 m of basalt and 105 m of Tertiary unconsolidated sand, gravel and clay. The second hole, on Radio Hill, was stopped when the drill could not penetrate the basalt beyond 62 m. The third hole at Steeles, east of Winnaleah, passed through 40 m of basalt with one metre of sediment within the basalt at 25 m. After drilling 135 m of Tertiary sediment (at a depth of 175 m) the drill became jammed, reportedly in sandstone of the Mathinna Beds.

The fourth hole of this series was at Farquhars at the base of Wagners Hill in the headwaters of the Little Boobyalla River. No basalt was encountered except surface red soil. The drill stopped at 104 m still in Tertiary sediment because of fine sand running into the hole due to underground water pressure.

This drilling indicated that:

(1) all the basalt gave some water but in limited amounts from 60 *l*/min to less than 15 *l*/min. The water was of good quality, with less than 200 mg/*l* TDS.

(2) the perched water table at the bottom of the basalt was limited. There is no continuous impervious clay layer at the top of the Tertiary sediments beneath the Winnaleah basalt. No clay was present at the base of the basalt in Lesters bore and when the basalt was penetrated by the drill the water drained rapidly down the hole and was lost.

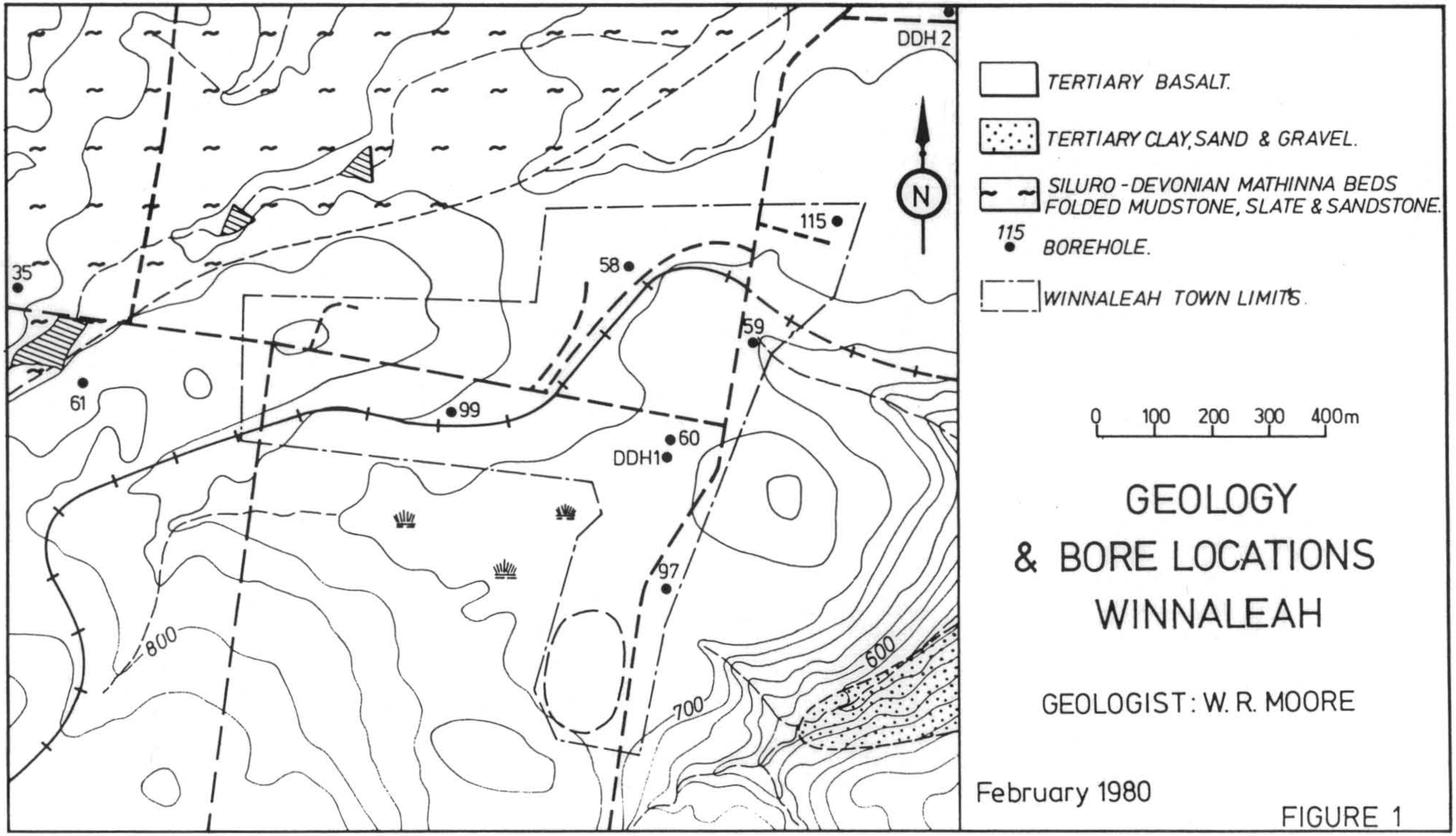
(3) the permanent water table was low near the basement contact in both Lesters and Farquhars bores. In the latter bore a limited pump test gave supplies well in excess of 150 *l*/min before the pump became clogged with sand.

Rotary drilling at West Winnaleah, 1977

Two further holes were drilled at the foot of Hardmans Hill basalt ridge near the Mathinna Beds/basalt contact west of Winnaleah. The first was drilled entirely in Mathinna sediments and gave 38 *l*/min, and second in the basalt reaching the underlying Mathinna beds yielded 150 *l*/min.

Failing rotary rig drilling, October 1977

The first bore of the investigation (Hole 35) was drilled at the town's reservoir tank to test the grey soil areas which are underlain by sedimentary rocks of the Mathinna Beds. At this location, as in several other isolated areas of north-east Tasmania, the sediments were dry because of the abundance of quartz veins which apparently seal the fractures in which the groundwater collects. This hole was thought, at this time, to eliminate the wide area of the contact zone of Mathinna Beds north-east and north of the town (fig. 1).



TERTIARY BASALT.
TERTIARY CLAY, SAND & GRAVEL.
SILURO-DEVONIAN MATHINNA BEDS FOLDED MUDSTONE, SLATE & SANDSTONE.
115 BOREHOLE.
WINNALEAH TOWN LIMITS.
N
0 100 200 300 400m
GEOLOGY & BORE LOCATIONS WINNALEAH
GEOLOGIST: W. R. MOORE
February 1980
DDH 2
115
58
35
59
61
99
60
DDH1
97
800
700
600

FIGURE 1

5 cm

Gemco auger drill, April-May 1978

A series of shallow auger holes were drilled on four lines around Winnaleah township to delimit the area of basalt that occurs beneath the red soil areas of Winnaleah. This work was to verify previous magnetometer and resistivity geophysical surveys marking the basalt boundary. A Gemco trailer mounted rig was used.

Failing rotary rig, May-June 1978 (Bores 58, 59, 60 and 61)

Four holes using down the hole hammers on the Failing rig were drilled on the auger lines around the margins of Winnaleah township in the basalt. Two of these bores, one behind Crawford's garage (Hole 60), and another near the saleyards railway crossing (Hole 59), located a thin gravel aquifer 0.5-1.0 m thick below 17-19 m of basalt. The bores were given the routine four-hour pumping and recovery test and yielded between 150-180 *l*/min with a quick recovery. The aquifer was under pressure as the water was struck at 17-19 m at the base of the basalt and rose to 2-3 m below ground level.

The water clarity was excellent and the chemical analyses showed both bores as having a total salt or mineral content of 150-160 mg/*l*. The detailed analyses are given in Appendix I.

Of the other two holes, the basalt was thin with no water in Hole 58, while Hole 61 near the basalt-Mathinna bed contact west of Winnaleah gave less than 15 *l*/min of water.

Though encouraging, more information was required and the following geological problems required to be answered:

(a) was the aquifer at the railway crossing and Crawford's garage the same gravel and was it a continuous layer or separate isolated lenses?

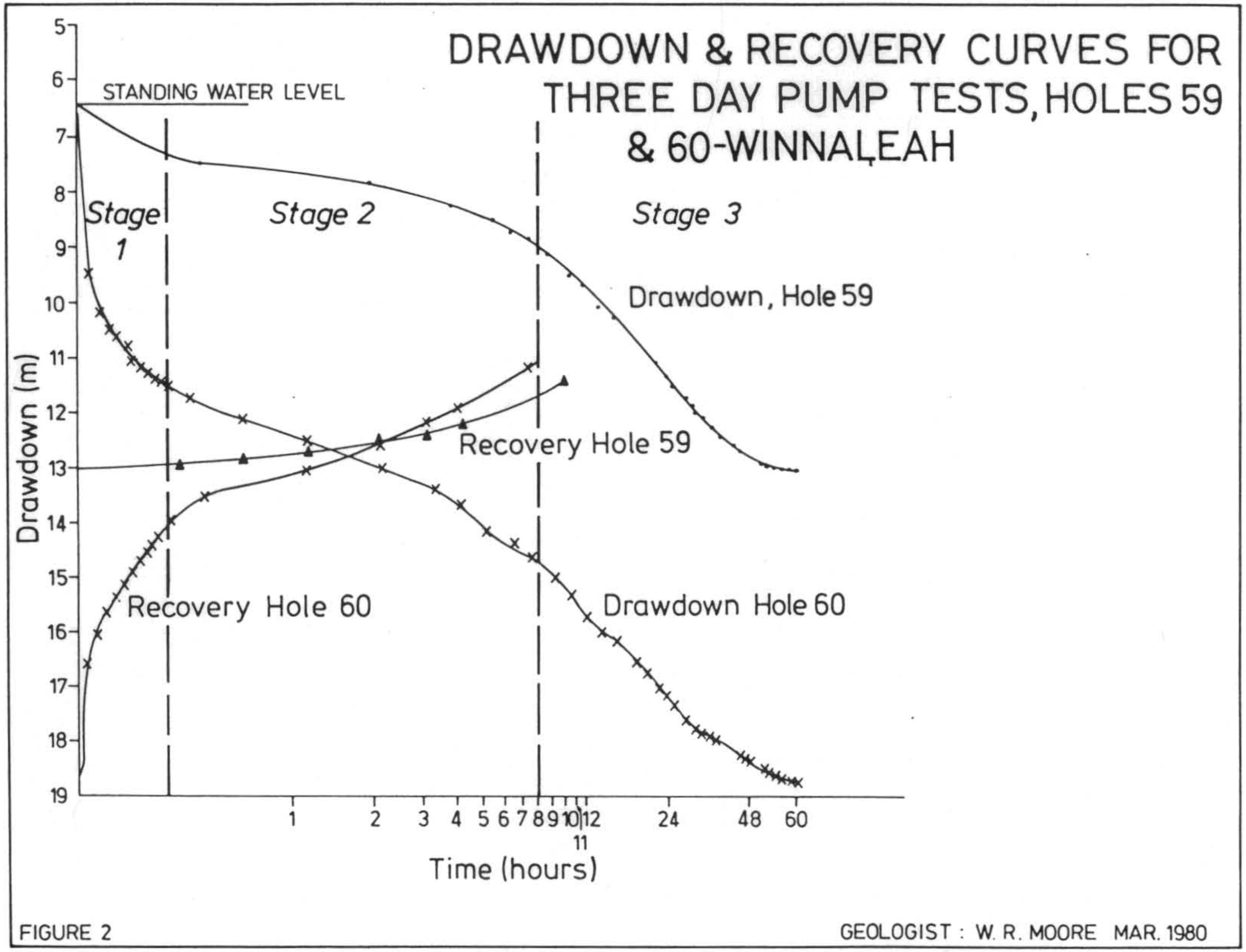
(b) is the gravel and clay layer a thin lens within the basalt, as found at Steeles in East Winnaleah, or a thin layer on top of a thick sequence of gravel, sand and clay as found at Lesters, south of Winnaleah, in the 1974 regional drilling programme?

(c) how far does this aquifer extend laterally beneath the basalt in the Winnaleah township area and in what directions?

3-day pump test, December 1978

A three day continuous pump test was run using Crawford's bore (Hole 60) as a pump bore and Stevens bore (Hole 59) as an observation bore. The pump was run at 150 *l*/min and in the pump bore the water level fell 6.3 m to 18.6 m and in the observation bore from 3.2 m to 8.0 m after 76 hours of pumping. On stopping the pump the recovery was rapid in the pump bore and the water level rose to 12.6 m after one hour and at the end of 8 hours had recovered to 11.1 m. In the observation bore no recovery was visible until 15 minutes after stopping the pump and was slow, recovering to 6.5 m after 8 hours (fig. 2, 3).

This test showed that the same aquifer had been penetrated by the two bores and that the gravel of the aquifer was receiving water from the overlying basalt rock. Consequently any estimate of the water quantity based on the thickness of the aquifer alone would be unreliable and underestimated. Equally, the drawdown curve of the pump and observation bore and slow re-


DRAWDOWN & RECOVERY CURVES FOR THREE DAY PUMP TESTS, HOLES 59 & 60-WINNALEAH
STANDING WATER LEVEL
Stage 1
Stage 2
Stage 3
Drawdown, Hole 59
Recovery Hole 59
Recovery Hole 60
Drawdown Hole 60
Drawdown (m)
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
1
2
3
4
5
6
7
8
9
10
11
12
24
48
60
Time (hours)
FIGURE 2
GEOLOGIST : W. R. MOORE MAR. 1980
5 cm

covery of the observation bore indicated that the amount of water present was limited and controlled by the amount of recharge from the overlying basalt. Therefore any long term overpumping at this test pumping rate could result in a permanent lowering of the water table making its recovery too costly for town supply.

The drawdown curves have three segments: the first section one of rapid decline indicating the emptying of the bore; the second stable phase of approximately 8 hours of de-watering the sediment aquifer; and a third stage of decline where the water was leaking from the overlying basalt into the sediments. The observation bore parallels the pump bore and also has these three stages, although these are not as well developed in the recovery curve.

Samples were collected for bacterial analysis during the pump test and recollected in January to see that no bacterial pollution was filtering through the basalt from surface lagoons or septic tanks. The results of these tests, and a comparison of tap water collected from the existing supply are given in Appendix 2.

Cable tool and Failing with down the hole hammers, December 1978 - February 1979 (Bores 97, 98 and 99)

To trace the aquifer by drilling alone was not considered feasible with the number of holes probably required at the existing drilling costs. In an attempt to overcome the major drilling problems associated with the project, two types of drills, a cable tool and a Failing rotary drill, were used in combination on a series of holes east of Winnaleah near Wagners Hill where similar drilling problems had been encountered.

Although good supplies of groundwater were found in one bore (Bore 98 with 180 *l*/min) no success was really achieved with this drilling experiment. Both drills got jammed in the heavy boulders and jointed basalt close to surface or when breaking through the basalt into the underlying sediment. Core recovery from the underlying sediments was minimal. Holes 97 and 99, west and south of Crawford's, gave less than 15 *l*/min and the sediment lens could not be located. Both drills were withdrawn from the Winnaleah area, the cable tool at the end of December, and the Failing in mid-February.

Diamond drill hole 1 (Crawfords), July-August 1979

A Departmental diamond drill became available for groundwater investigation in north-east Tasmania in July 1979. It was moved into Crawford's yard with the aim of drilling a hole through the basalt into the underlying sediments from which water was being derived. It was hoped that the drill would continue through these sediments and establish the underlying rocks as either further basalt or Tertiary sediment.

Because of the ability to recover core with this drill, it was hoped to establish the type of sediments forming the aquifer. The hole passed through 19 m of basalt, then into 2.5 m of fine gravel and clay and then a further 18 m of basalt. The hole then passed into further clay, probably the top of the Tertiary sequence of sediments, and finished at a depth of 43 m.

Clearly the aquifer is a lens of sediment, probably a small lagoon or lake with an associated stream bed at the top. From the pump test, it was established that this lens extends as far as Hole 59 at the edge of the town (fig. 3).

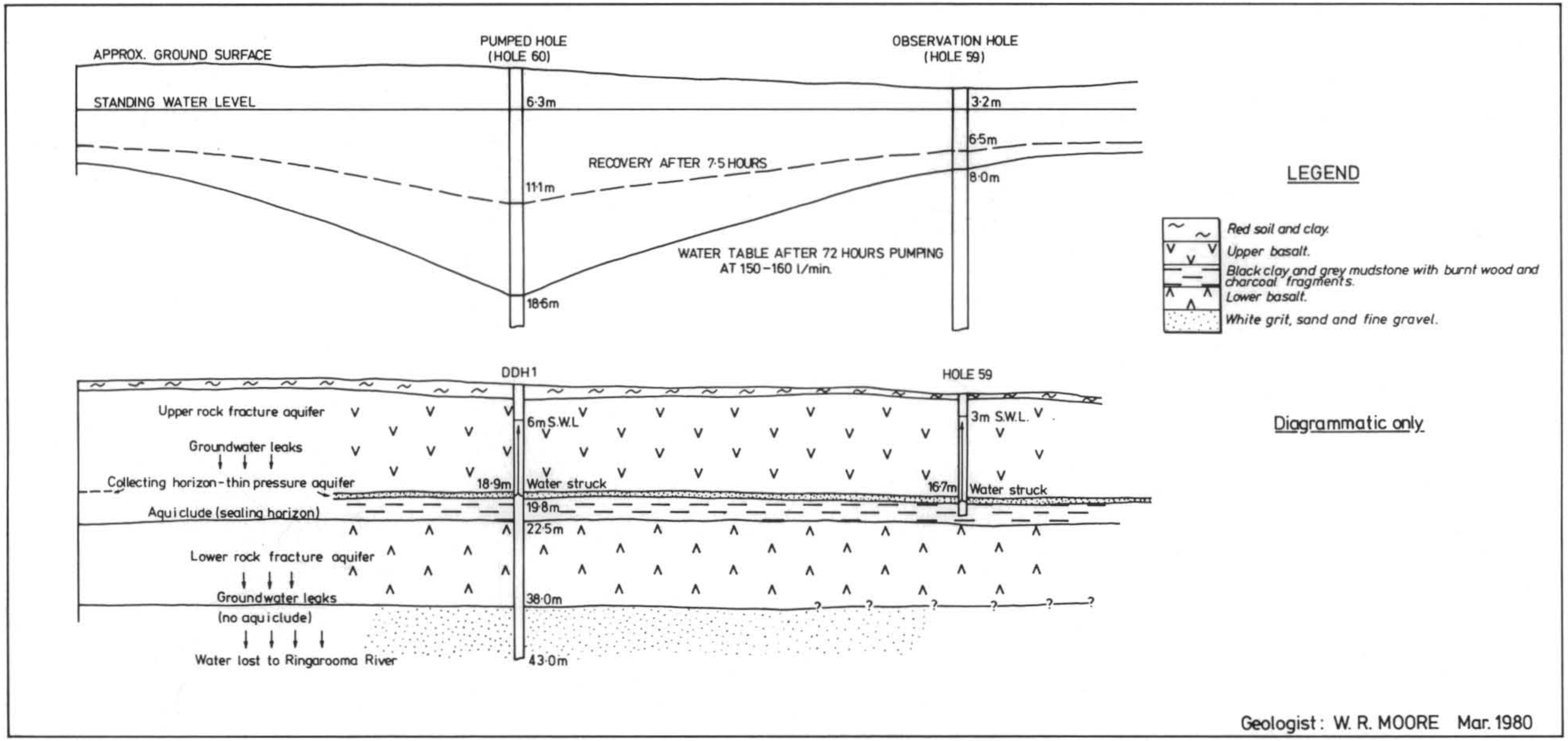
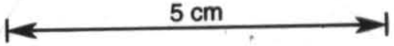


Figure 3. *Diagrammatic section, Winnaleah.*



It was possible that the lens of sediment found in Holes 59 and 60 was the same lens of sediment thought to be between the two basalt flows at Steeles, 2 km to the east, from the early cable tool drilling of 1975. If such a link could be established between these holes, the thin sediment aquifer would be sufficiently widespread that the area of recharge from the overlying basalt would be adequate for Winnaleah's long term needs.

Diamond drill hole 2 (Steeles) and further pump tests, September-October 1979

With this view, it was proposed to drill a diamond drill hole at Steeles close to the 1975 cable tool hole location. This diamond drill hole would allow a comparison of the lithology of the two basalt flows and intervening sedimentary layer. When completed, it would then be used as an observation bore to test hydraulic interconnection of the lenses by pumping at DDH 1.

The diamond drill hole at Steeles passed through 26 m of basalt into two metres of sediment then into a further 17 m of the second basalt. Below this basalt was clay and the hole stopped at 47 m. The sequence and sediments of the lenses were similar to that of Holes 59 and 60. The rotary drill was brought back to Winnaleah and set up over DDH 1. This hole was pumped for 24 hours, but no movement occurred in the water level of DDH 2.

This pump test showed that no hydraulic connection exists between the two sedimentary lenses in the two holes and a barrier exists between Holes 59 and 60 and DDH 2. The two sedimentary lenses were probably laid down as separate localised lagoons which were not interconnected by any stream.

Magnetometer survey and Hole 115 (Smith's), November-December 1979

A magnetometer survey was run on a series of lines to form a grid that covered the area between DDH 1 and DDH 2. This survey established that the upper basalt was continuous between the two holes.

A further hole (Hole 115) was drilled in the middle of this grid. In this bore two basalt flows were encountered, with a decomposed basalt layer at 16.7 m at the top of the lower basalt which was drilled to 24.4 m. No sediment was present between the two basalt flows establishing that a barrier was present between the sedimentary lenses in Holes 59-60 and DDH 2.

During an 8-hour pump test at 165 *l*/min on Hole 115, the water level fell from nine metres to 12 m and recovered to 9.7 m in one hour. A longer test was planned but was stopped by a breakdown. During the test the water levels in Holes 59 and 60 and DDH 2 were measured, but no change in their levels was observed. This test showed that this bore was not hydraulacally connected with the pressure aquifer in Holes 59 and 60, nor the sedimentary lens in DDH 2.

The water quality of 410 mg/*l* was not as good as that from Holes 59 and 60, but would be suitable for a town supply with treatment, as it is slightly acidic. A bacterial analysis showed recent faecal surface contamination. As the bore casing was at ground surface level and uncemented into the rock with no concrete flooring present, contamination could be expected. This contamination should be eliminated when a permanent production bore is established with a pump shed and concrete pump apron.

SUMMARY OF INVESTIGATION RESULTS

(1) Groundwater is present in the basalt rocks which underlie the red soil plateau area at Winnaleah. The groundwater is a perched water table, either in small sedimentary lenses within the basalt or in the vesicles of the basalt. A clay layer at the base of the basalt and top of the Tertiary sand and clay acts as a localised aquitard and stops the perched water from draining rapidly to the regional groundwater level at the Ringarooma River, some 100 m lower in level.

The yields of the bores in the basalt are extremely variable, ranging from 15-180 *l*/min.

The quality, clarity and taste of the groundwater is high (see Appendix 1).

(2) Beneath the township is a small sedimentary lens between two thick basalt flows. From the drill core it appears to be lagoonal sediment with small gravel and a broken basalt zone near its contact. This sediment lens acts as a collector for the overlying basalt, a leaky aquifer, and forms a pressure aquifer giving 150-160 *l*/min of water.

The extent of this aquifer is not known, as it has been found only in two bores 600 m apart. Another bore two kilometres away, with a sedimentary lens in the basalt, is not connected with the Winnaleah aquifer. It is a different lake or stream and hydraulic system.

A bore drilled between the two areas with sedimentary lenses showed evidence of two basalt flows with a weathered zone, but had no sediments present. This bore produced 166 *l*/min and was not hydraulically connected with either of the bores with the sedimentary lenses.

(3) No geophysical method has been found to date that allows any reasonable prediction of a bore's yield in the basalt or trace the presence of any sedimentary lens within the basalt.

(4) A three day pump test was run on the small pressure aquifer. It had three distinct phases in the drawdown curves of both the pump bore and observation bore (fig. 2). The initial bore drainage was completed in 15 minutes of pumping followed by a period of stability of some 6-8 hours. During this period the small aquifer was being drained and because of its higher transmissivity the drawdown was slow. After 8 hours the drawdown increased and continued to fall at a faster rate. No equilibrium was reached and in this long period the water was leaking into the underlying sediment from the overlying basalt. As this leakage was slower than the removal the drawdown was faster and the overlying aquifer was being mined. The recovery of the pump bore shows the same three stages. In the observation bore the initial quick recovery stage was not measured (fig. 2).

Any storage estimate based on the calculated storage coefficient as well as its transmissitivity could be misleading because it could result in over optimistic estimates of the reserves of groundwater present in the basalt and available to its underlying collector. The vesicularity of the basalt, as indicated by variability of bore yields, varies within short distances and the small pressure aquifer is not likely to have a symmetrical cone of depression because the aquifer shape is probably a narrow lagoon or stream. The cone may have met such a boundary condition causing the increase in the rate of the drawdown. Because of the likely asymmetrical shape of the aquifer it is more likely to act as a pipe or drainage conduit at the base of the basalt.

(5) Nothing is known of the long period recharge of the basalt. Winnaleah has an average annual rainfall of 1016 mm, consequently the recharge should be high, as indicated by the number of permanent springs around the periphery of the basalt plateau.

(6) A long term evaluation of the supplies available in the basalt is not possible from the 3-day pump test on Hole 60, nor the 8-hour pump tests on the other bores. The supply in the long term will depend on the recharge. Such an evaluation of the long term recharge will require long term pump testing with regular monitoring of water levels. Such long term pump tests are outside the resources of the Department of Mines, nor is it the function of the north-east Tasmania groundwater investigation. It requires permanent production bores with electric pumps and permanent water level recording devices. It appears to the author that this would be best carried out when the bores were being used on town supply and the measurements supervised by the Winnaleah Water Supply Committee members over a long period of time, up to one year's duration. Over such a period some estimation of the recharge would then be possible and any regional decline in water levels measured.

(7) On the existing metered surface supply 20 million litres of water were used in 1979 by the township of Winnaleah, with 79 household connections. This is 56 043 litres per day or 2335 litres per hour or 709 litres per day per household. If, as no doubt will occur because of the improved quality of water, the amount used per household increases to 900 litres per day, the total used is about 73 000 litres per day. A total of 8 hours pumping at 150 *l*/min, the rate used for the three day pump test on Hole 60, would be required to supply sufficient water. This rate is at the beginning of the drawdown curve where the aquifer is starting to be mined and drawdown is at 14 m. In Hole 115, the drawdown for the eight hour pump test was 12 m.

(8) Boulders and open joints at the top of the basalt gave frequent drilling problems, making drilling very expensive and time consuming around Winnaleah. Further drilling investigation does not appear warranted or necessary until the two existing bores have had a long term test.

(9) A recent geophysical investigation and drilling of two bores in the Mathinna Beds for a farmer west of Hole 35 gave good yields of 174 *l*/min in one bore and in excess of 455 *l*/min in the other, with good quality water in both bores. These bores indicate that the zone of quartz veining struck in the reservoir tank area is a narrow belt. The conclusion made that any bore in the metamorphic zone of the Mathinna Beds would be dry similar to the reservoir tank bore may be incorrect. Therefore an unexplored alternative aquifer is probably available for any future expansion of any town supply in the Mathinna Beds to the north and west of the town (fig. 1).

CONCLUSIONS

No long term evaluation of the supplies of groundwater available for town supply is possible without long term pumping and a history of water table measurements. The period for such an evaluation could be as much as 12 months. Consequently the water for this test period could be used in the town supply.

This long term test is best carried out by alternatively using the two types of aquifers in the basalt, the aquifer in Hole 60 with the sedimentary lens between the two basalt flows and the two basalt flows without a lens of sediment as in Hole 115. The tested capacity of these two bores is 300 *l*/min, which is far in excess of the present usage of Winnaleah on the existing surface supply of 39 *l*/min.

Further investigation drilling does not appear warranted, as it would only add to the short term available groundwater supplies and would not help solve the problem of long term estimation of the available supply. This supply is ultimately dependent on the recharge in the area covered by the basalt. Further supplies are probably available in the basalt around Winnaleah and possibly in the Mathinna Beds to the west and north. If these are exploited for irrigation by excessive drilling, the dewatering of these perched water tables is conceivable and very likely.

The groundwater is of good quality and has far greater clarity and appears to the author and members of the Winnaleah Water Supply Committee to be better tasting than the existing surface supply. From the analyses taken the bacterial count of the groundwater is lower than the town supply water. No increase in bacterial count occurred after the three days' pump test in Hole 60. The surface bacterial contamination in Hole 115 should be rechecked after the installation of a concrete apron around the bore and its casing cemented into the ground.

RECOMMENDATIONS

(1) A report be obtained from the Department of Health or Department of Agriculture as to the biological suitability of the groundwater and a comparison made with the existing town supply.

(2) As a long term risk exists that the groundwater supplies may decline with such fragile aquifers, the existing surface water scheme should be kept operational.

(3) Two electric production bore pumps be installed in two bores, one at Hole 60, and the other at Hole 115. Both the property owners have acknowledged to the Council that the bores could be used for town supply. Some simple continual chart recording and monitoring device for measuring water level should be installed in these bores. These monitors would be installed by the Department of Mines in the diamond drill holes next to the pump bores, one of which already exists.

(4) These two bores be connected to the existing reticulation system of Winnaleah and pumped alternatively over long periods of approximately one month. The author has been assured by the Winnaleah Water Supply Committee that this can be done inexpensively, with no further pumps or pipeline to allow the water to travel in a reverse direction to the existing surface supply to the concrete reservoir tank to the west of the town.

(5) Rivers and Water Supply Commission engineers should establish the cost and feasibility of such a reverse circulation alternative groundwater scheme for the Ringarooma Council in order that an application can be made for financial assistance from the Minister for Water Resources. This scheme should be as simple and as economical as possible with the major cost being two bore pumps with a capacity of 150 *l*/min and the necessary lift.

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Thanks must be expressed to all the farmers of Winnaleah who allowed access onto their properties over the years, even with heavy machinery in winter and the Director of Mines who sanctioned the investigation.

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[19 February 1979]

APPENDIX 1

Chemical analyses of groundwater from bores at Winnaleah

Constituent	781286 mg/l	781287 mg/l	791907 mg/l
CO_3	Nil	Nil	Nil
HCO_3	91	75	36
Cl	35	35	28
SO_4	5	5	<5
SiO_2	31	31	30
Ca	9	8	10
Mg	11	9	11
Fe	0.3	0.3	<0.1
Al	0.3	0.3	<0.2
K	2	2.5	0.9
Na	19	18	20
Total dissolved solids	160	150	210
Hardness - permanent	Nil	Nil	41
- temporary	68	58	29
Alkalinity	75	61	29
pH	6.1	6.2	5.6
Conductivity (μS/cm)	230	230	25
Bore number	59	60	115

For locations of bore holes see Figure 1.

Analyses by Department of Mines laboratory, Launceston

APPENDIX 2

Bacteriological examination of groundwater from bores at Winnaleah

Item	Hole 60	Hole 60	Hole 115	Town supply Winnaleah
Sample date	13.12.78	25.1.79	30.10.79	13.12.78
Colony count per ml - 37°	96	3	240	25
20°	300	38 000	9 700	300
Presumptive coliform count per 100 ml MPN	<1	<1	40	60
Presumptive E. coli count per 100 ml MPN	<1	<1	9	10
Faecal streptococcus/ enterococcus count per 100 ml	<1	<1	<2	30

Analyses by Department of Agriculture Bacteriology Laboratory, Launceston

Samples from Holes 115 and 117 indicate recent faecal contamination as shown by presence of E. coli organisms

APPENDIX 3

Logs of drill holes

Hole	*Drillers log*	*Water*	*Total depth (m)*
35	Slate, Mathinna Beds	Dry	65
58	Red soil-basalt-clay	Dry	23
59	Basalt-gravel-clay	180 *l*/min	18
60	Basalt-gravel-clay	160 *l*/min	21
61	Weathered basalt-clay	>150 *l*/min	33
97	Basalt-clay-gravel	150 *l*/min	46
99	Boulders	Dry	11
DDH 1	0-19 basalt, 19-21.5 sediment, 21.5-39.5 basalt, 39.5-43 clay		43
DDH 2	0-26.5 basalt, 26.5-28.5 sediment, 28.5-45.5 basalt, 45.5-47 clay		47