

1982/47. A groundwater test hole at Hagley Station Lane

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Abstract

Drilling on a property at Hagley has shown that estimates by a private contractor of the likely output of a water bore were probably far too high. Electric logging equipment should be available if further contract drilling is to be undertaken in the Longford Basin in areas where there are fine-grained aquifers.

INTRODUCTION

Following considerable difficulties installing a successful bore with screen using PVC casing on J.W. Broomby's property at Hagley Station Lane [DP920997], an attempt was made to repeat the procedure using slotted steel casing with a gravel pack between the casing and the bore walls.

A private contractor's operations had previously suggested that there was a considerable quantity of water available to the depth drilled, but the contractor had been unsuccessful in setting up a bore to deliver the water. All the pump and air flow tests undertaken had produced large quantities of sand with the water, according to the property owner. No tests were carried out with the sand aquifer in a stabilised condition, which is the only way a reliable estimate of the bore output could be made. From these tests, the contractor had estimated that a bore should be capable of delivering 600-760 l/min (8000-10 000 gal/hr) of water.

DRILLING PROCEDURE

Previous drilling had indicated that there were sand beds between about 61-73 m depth and this was the prospective zone to be examined. The initial hole of about 200 mm diameter was reamed to 300 mm diameter. A log of the samples obtained from the drilling is given in Appendix 1. Some thin hard bands were struck at various levels, particularly within the zone where the sand beds occur.

Casing, approximately 150 mm in diameter, was installed in the hole with about 10.7 m of closely slotted casing at the bottom. The slot width varied from about 1.3 mm to 2 mm. Difficulty was experienced in pushing the casing down the final 1.2 m, and initially it was thought that the casing was on the bottom of the hole. About 0.75 m³ of coarse water filter sand (fig. 1) was poured down between the casing and bore walls, and a start was made on cleaning up the bore by bailing out the mud. It was found after a time that a considerable quantity of gravel pack material was being bailed from the bottom of the hole, a favourable sign that the material had reached the area of the slotted casing and had not bridged or got stuck further up the hole, but unfavourable from the aspect that probably 0.03 m³ was bailed out, and unless corrected could pose a problem. It was at this stage that the casing was pushed again, with the result that it dropped a further 1.2 m, the depth to which it was originally expected to go.

With the casing in its new position it was only possible to get a 110 mm diameter 3.1 m long bailer to 64 m, or about 9 m from the bottom, although it was possible to get a shorter, smaller diameter bailer to the bottom. Bailing brought some sand into the hole, with very little gravel pack material. It is probable that the hole went off-vertical at the

harder bands near the bottom and forcing the casing caused it to bend sufficiently to prevent a larger bailer entering.

Bailing was undertaken over a considerable period in an attempt to clean up the hole, but the water level continued to be drawn down. Calgon was used in further attempts to remove any mud from between the casing and the walls of the bore and the hole was surged using a larger bailer (125 mm casing and about 6 m long). Using this bailer it was possible to draw the water level down to at least 45 m from the surface and it was estimated that the output of the bore could not be greater than about 75 l/min (1000 gal/hr) and was probably less. The property owner, requiring much larger quantities, was not interested in having the bore left open.

DISCUSSION

The bore, when not delivering sand with the water, gave a much smaller quantity of water than the private contractor had indicated. It is not completely certain that the mud cake was completely removed from the walls of the bore, but all the normal procedures were used to clean up the hole. The fact that some sand was brought into the hole when the casing was pushed right down indicates that at least part of the aquifer was in direct contact with the inside of the bore.

Previous investigation bores drilled in the late 1960s and early 1970s (Matthews, 1983) which encountered only Tertiary sediments are two kilometres or more distant. These were drilled to 150 m and were pump tested at 115-150 l/min, and it is unlikely that the maximum output from these bores would have been greater than about double this quantity and would be probably somewhat less. The general area appears to have less sand beds to 150 m depth than many other areas throughout the Longford Basin, and if the results of these investigation holes are to be taken as a guide to the output for the area, it is unlikely that the previously estimated outputs for Broomby's hole to 73 m would be obtained.

During rotary drilling, contamination of samples arriving at the surface is widespread and clay pellets are more easily sampled than fine sand. It is difficult from an examination of the samples collected to determine where prospective water-bearing zones are situated within the hole. This is illustrated by the fact that a preliminary series of five holes was drilled between Oaks Station and Carrick in about 1966 (Matthews, 1983, Appendix 1; Holes IHA to IHE) to a maximum depth of 164 m. Four holes penetrated only Tertiary sediments, the other entering dolerite. The four sedimentary holes were said to be unproductive even though some samples of sandy clay were obtained. A hole (IH34) drilled nearby later in the investigation was pumped at 130 l/min and it is very likely that the earlier holes would have given a similar quantity, if developed.

At the time the Longford Basin area was being investigated, electric logging equipment was available and this was useful in accurately defining the location of aquifers which is essential if screens are to be used in the hole. Variations in aquifer permeability can also be deduced from these logs, which is also essential in placing screens. Logging equipment has not been available in the Department of Mines for some years now, although it is likely that working equipment may be assembled in the near future. Further contract drilling in the fine-grained sediments of the Longford Basin is not recommended unless electric logging equipment is available. With experience, the drillers involved in the earlier investigation holes became adept at defining the aquifer zones accurately from

drilling rates, which made use of electric logs unnecessary in most cases. With much less experience of drilling in these kinds of conditions at present, electric logging to aid in the location of likely aquifers should be undertaken.

The establishment of successful and efficient water bores in fine sand aquifers interbedded at depth with clay sediments is a very skilled procedure, as it requires a knowledge of mud preparation to keep the hole open, the use of methods to define aquifers accurately, sizing of aquifer material for screen and gravel pack selection, and bore development once the system is established. It is one of the most difficult types of bores to install and there is no comparison in the degree of difficulty to the installation of a bore in hard rock, such as Permian sediments or basalt. Drillers with virtually no water boring experience have been successful in setting up bores in hard rock over the last few years, but it is extremely unlikely that they would be successful in setting up a deep bore in fine unconsolidated sediments.

As the Department of Mines is the authority responsible for underground water, drillers and geologists should be skilled in all facets of bore installation in all the conditions that prevail throughout the State.

CONCLUSIONS

The bore, as established with slotted casing, was probably not capable of delivering more than 75 l/min of water and estimates of output from previous drilling on the property are almost certainly far too high.

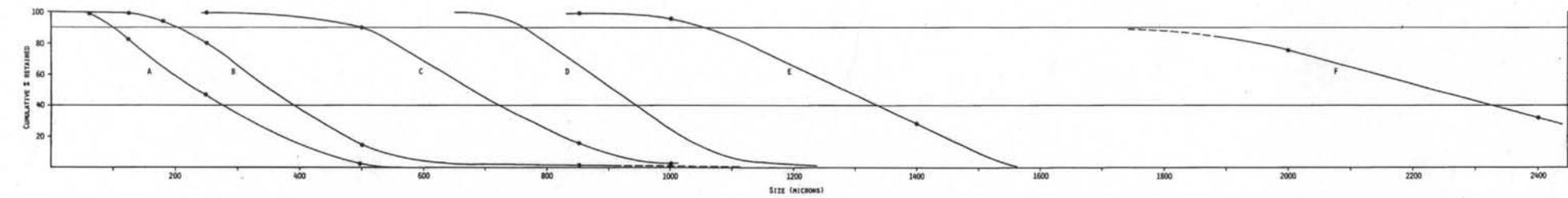
When electric logging equipment is available, consideration should be given to establishing bores in known areas of the Longford Basin using the operators of the two rotary drills. Without the pressure of trying to keep costs down for a contract hole, they could experience the procedures of drilling a hole, defining aquifers, choosing a screen (or slotted casing) size and gravel pack, installing casing, cleaning the bore prior to pump testing, and finally pump testing. This would take each driller about two weeks to perform.

When further contract holes are undertaken in the area, the quickest method of establishing the potential of a location would be to rotary drill a small diameter hole and record electric logs. This should take no longer than about 1½ days for a hole to 150 m. Combining sample examination, drilling rates and electric log information, it should be possible to determine whether development of the hole is worthwhile. If it is, the hole would then be reamed to the selected size and developed in the normal manner.

REFERENCE

MATTHEWS, W.L. 1983. Geology and groundwater resources of the Longford Tertiary Basin. *Bull.geol.Surv.Tasm.* 59.

[21 December 1982]



- A - Sand blown from hole
- B - Aquifer material in pump
- C - Industrial Sands 16-32
- D - Most suitable gravel pack for screen size
- E - Industrial Sands 10-16 (gravel pack used with 30/1000 screen)
- F - Industrial Sands 8-10 (gravel pack used for slotted casing)

Uniformity coefficients:

Aquifer	2.75
Aquifer in pump	2.0
16-30	1.45
10-16	1.26

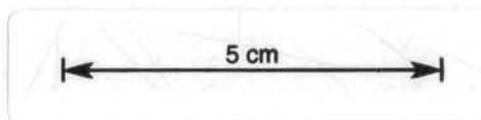


Figure 1. Grading curves of materials.

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APPENDIX 1

Log of drill hole and chemical analysis of a water sample

<i>Depth (m)</i>	<i>Description</i>
0- 2	Brown silty clay with abundant iron oxide fragments
2-12	Brown plastic clay, occasional iron oxide fragments
12-16	Brown-grey plastic clay
16-30	Grey-brown plastic clay
30-52	Grey silty clay, some harder pellets of silty clay, clay
52-58	Darker grey clay - fairly plastic (except 54-56 m which is lighter in colour)
58-60	Light grey plastic clay, a little sandy
60-70	Light grey clayey sand, some wood fragments
70-72	Mainly grey sand
72-76	Clayey sand, some soft black iron oxide? spheres about 3 mm in diameter

A hard band at about 40 m produced a few small angular fragments which were shown by X-ray analysis to be siderite. This material probably constitutes the hard bands between 60 m and 74 m. X-ray analysis of clayey samples from 10-12 m, 20-22 m, 30-32 m, 36-38 m, 38-40 m, 42-44 m, 46-68 m, 50-52 m, 54-56 m, 58-60 m, and 64-66 m shows montmorillonite, illite, kaolinite, and quartz in all samples in varying amounts. As bentonite was used in the drilling this could have contributed largely to the peaks for montmorillonite. Gibbsite occurs in the first five samples, with faint signs of this mineral at lower levels.

Chemical analysis of water sample

pH		7.0
Conductivity ($\mu\text{S}/\text{cm}$ at 25°C)		1220
CO ₃	mg/l	nil
HCO ₃	"	255
Cl	"	360
SO ₄	"	15
SiO ₂	"	9.9

Appendix 1 (continued)

Ca	mg/l	64
Mg	"	47
Fe	"	<0.1
Al	"	<0.2
K	"	16
Na	"	70
P	"	1.1
TDS	"	990
Hardness -		
Permanent		145
Temporary		210
Alkalinity as		
CaCO ₃		210