COMPLETION AND PUMP TEST REPORT
A. P. D. SUPPLY BORE NO. 2

O. J. W. BOWERING

Department of Mines
South Australia —

DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY
ENGINEERING DIVISION

Rept.Bk.No. 73/22
G.S. No. 5028
Hyd. No. 2477
D.M. No. 100/72

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A.P.D. SUPPLY BORE NO. 2
Section 364 Hundred of Blanche

Client: Australian Processors & Distributors Pty. Ltd.

Location: General: Western side of town of Mt. Gambier
Region: 1
County: Grey
Hundred: Blanche
Section: 364

by

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23rd January, 1973.

CONTENTS

	PAGE
CLIENT	1
LOCATION	1
INTRODUCTION	1
CONSTRUCTION DETAILS	2
BOREHOLE GEOLOGY AND HYDROGEOLOGY	3
WATER SAMPLING	6
PUMPING TEST	6
CONCLUSIONS	8

PLANS

Number	Title	Figure
S10116	Locality Plan	1
S10145	Supply Bore No. 2 Casing Details	2
73-30	Drawdown vs Time (Pump Test)	3

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INTRODUCTION

When positive signs of pollution were encountered in water being obtained from the Gambier Limestone in supply bore No. 1 at Australian Processors and Distributors Pty. Ltd. factory, it was decided to investigate the possibility of obtaining an alternative source of supply from the sands of the Knight Formation, which underlies the limestone.

The bore was drilled without incident to total depth of 117 metres, but some difficulty was encountered with the installation of the sandscreen due to the instability of the confining clay.

The bore was developed for a period of eight hours and subsequently pump tested for twenty four hours to determine drawdown characteristics and safe yield.

CONSTRUCTION DETAILS

Drilling commenced on 6th March, 1972, and was carried out with a cable tool rig. The bore was commenced by drilling 38.10 cm (15 inch) hole to 5 metres followed by 30.48 cm (12 inch) hole to 34 metres. At this point drilling became more difficult due to unstable formation possibly resulting in part from a leaching effect of the original supply bore approximately 8 metres away. This necessitated the installation of 25.4 cm (10 inch) casing and drilling was continued with 23.5 cm (9¼ inch) under-reamer drills to keep the casing free and to ensure that a sufficient annulus was maintained outside the casing for pressure cementing. Drilling mud was also used to help stabilise the formation.

At 50 metres, the 25.4 cm (10 inch) casing became tight in hard limestone. It was decided to drill 25.4 cm (10 inch) open hole and this continued to 91 metres, the confining clay at the top of the Knight Formation being encountered at 74 metres. At this depth 20.3 cm (8 inch) casing was installed to the bottom of the hole and pressure cemented to surface using 3 400 litres of grout (5:1 mix) comprising 94 bags of cement and 2 100 litres of water. The cement was allowed to set for 24 hours before drilling out the plug.

Drilling was continued with a 20.3 cm (8 inch) star drill to a depth of 98 metres when 15.2 cm (6 inch) casing was inserted to penetrate, and enable continuous sampling of, the sands. The hole was drilled in this manner to the base of the sands at a depth of 117 metres.

The 15.2 cm (6 inch) casing was then withdrawn and the hole enlarged to 17.1 cm (6-3/4 inch) with a roller bit and FEDP rods, whilst drilling fluid was continuously circulated to stabilise the sands to a depth of 117 metres.

A 12 metre stainless steel, 15.2 cm (6 inch) pipe size sandscreen, with a 0.89 mm opening was installed from 104.24 metres to 116.59 metres with 15.2 cm (6 inch) casing from 88.09 metres to the top of the sandscreen. Rubber banded seals were attached to the 15.2 cm (6 inch) casing at 89.61 metres. A lead plug was lowered and swedged into position at the base of the screen.

Some difficulty was encountered with the screen installation due to the instability of the confining clay. The screen and liner had to be recovered and the hole enlarged to 18.4 cm (7¼ inches) before it could be installed. The bore was completed on the 13th May, 1972.

Development of the bore was carried out with a solid surger inside the screen, each section of the screen face being developed until sand free. The bore was further developed for eight hours prior to pump testing by a 15.2 cm (6 inch) by 12 stage Pomona pump.

A sketch of the bore and sandscreen is shown in Fig. 2.

BOREHOLE GEOLOGY AND HYDROGEOLOGY

Sludge samples were collected during drilling at 2 metres intervals or at a change of lithology noted by the driller. In addition, sand samples were taken at intervals of 50 cm from 98 metres to 117 metres for grain size analyses to enable the

correct sandscreen to be installed. The bore log is given in Appendix A.

The sedimentary section penetrated by this bore consists of Eocene to Recent limestones, marls, sandstones, clays and minor siltstones, calcilutites etc. The section, in order of deposition is as follows:-

Knight Formation: 79-120 metres (T.D.) Middle Eocene. Sediments of this formation encountered in this bore consist essentially of sandstone and clay.

The sandstone section which forms the producing aquifer for this bore is 20 metres thick. It is essentially conglomeratic, ranging from medium to very coarse grained quartz which is sub-angular to subrounded, and contains minor feldspar and lithic fragments. The Knight Formation contains black claystone horizons interbedded with the sandstones and drilling ceased in the first such claystone horizon at the base of the producing aquifer, 3 metres being penetrated.

The sandstone section is overlain and confined in this location by 18 metres of claystone which is presumed to be the Burrungule Member (79-97 metres). This claystone is dark to very dark brown, soft and puggy, generally sandy, finely micaceous and lignitic throughout.

Gambier Limestone: 8-79 metres Oligocene - Miocene.

The deposition of the Gambier limestone, represents a marine transgression over the paralic sediments of the underlying Knight Formation.

This unit consists essentially of limestone but also contains a variety of lithologies ranging from coarse grained calcarenites, calcisiltites, calcilutites and marls. The sediments are comprised predominantly of bryozoal and foraminiferal remains with subordinate interbedded quartzose calcarenites. The lower part of the section becomes generally finer grained where the dominant lithologies consist of calcisiltites, calcilutites and marls. The total thickness of Gambier Limestone in this bore is 71 metres.

The Gambier Limestone in this area is an unconfined aquifer. Large supplies are obtainable from the limestone in the karstic region due to its cavernous nature. This factor, however, also allows rapid transmission of pollutants through the aquifer in this area. The salinity of the water in this aquifer is quite low, being 470 milligrams per litre.

The Knight Formation aquifer is confined by the uppermost claystone horizon (presumed Burrungule) and the overlying marly base of the Gambier Limestone. The aquifer in which the screen is set is the non-leaky type. The static water levels in the Gambier Limestone and the Knight aquifer are 26.0 and 19.02 metres respectively. The hydrostatic head of the producing aquifer is therefore approximately 7 metres above that of the Gambier Limestone indicating a very low degree of vertical hydraulic conductivity between the two aquifers. It is expected however, that prolonged pumping from this bore will reduce the difference in head between the two aquifers. The general salinity

of water in the producing aquifer is approximately 620 milligrams per litre and is not expected to change appreciably with time.

WATER SAMPLING

During drilling, water samples were taken regularly at approximately 5 metre (16.4 feet) intervals and subsequently analysed for approximate total dissolved salts. Samples were also collected at 2 hourly intervals during the pumping test and subsequently analysed.

A resume of the salinities recorded with depth are given in Appendix B. The results of the full analysis will be forwarded when available.

PUMPING TEST

At the conclusion of the development of the bore, it was subsequently pump tested for a period of 1450 minutes (24 hours, 10 minutes). The average pumping rate was 46.4 litres per second with deviation from this pumping rate no greater than 5%.

Water level readings were taken by means of an electric probe at the following time intervals:-

Start	to 10 minutes	:	1 minute intervals
10	to 30 minutes	:	2 minute intervals
30	to 50 minutes	:	5 minute intervals
50	to 100 minutes	:	10 minute intervals
100	to 200 minutes	:	20 minute intervals
200	to 1450 minutes	:	50 minute intervals

Measurements were made with a metric tape.

A graph showing the variation in drawdown plotted against the logarithm (base 10) of time is given in Figure 3. After about 6 minutes, the rate of change of drawdown appears approximately constant suggesting an approach to steady state conditions. The slope of this line in terms of drawdown per log cycle of time (Δs) is 1.15 metres.

An approximate value of the transmissivity (T) of the aquifer can be determined from this graph by the Jacob method using the formula:-

$$T = \frac{0.183 \times Q}{\Delta s}$$

where T = transmissivity ($ft^3/sec/ft$)

Q = pumping rate (in cusecs)

Δs = drawdown per log cycle (ft)

which on substitution gives

$$T = \frac{0.183 \times 1.600}{3.78}$$

$$= 7.75 \times 10^{-2} ft^3/sec/ft$$

$$= 6.22 \times 10^2 m^2/day$$

This calculation gives only an approximate value of transmissivity because of well loss through the screen and the inconstant pumping rate. Full penetration of the uppermost sandstone aquifer of the Knight Formation was achieved and the value of transmissivity obtained on this pump test, though approximate, can be considered to have a reasonable degree of accuracy.

The specific capacity ($^{Q}/Sp$) of the bore is a measure of the yield of the bore per unit of drawdown (litres/sec/metre) and decreases with the period of pumping as the drawdown continually increases. For this bore, the specific capacity is

$$\frac{\text{45.4 litres/sec flow rate}}{\text{5.06 drawdown}}$$

= 9.0 litres/sec/metre (after 24 hours of pumping).

It can be seen from the graph (Fig. 3) that an irregularity occurs in the drawdown curve between 600 and 700 minutes pumping time, followed by an increase in slope of the drawdown curve. This is interpreted as being due to the cone of drawdown in the potentiometric surface encountering an impermeable boundary or a zone of reduced permeability as it moves outward during the period of pumping.

CONCLUSIONS

1. The transmissivity of the Knight Formation sands in the A.P.D. bore is $7.75 \times 10^{-2} ft^3/sec/ft$ or $6.22 \times 10^2 m^3/day/metre$. This is the first such value obtained in the Mt. Gambier area.
2. The specific capacity of this bore is 9.0 litres/sec/metre. This figure is considered to be suitable for calculations of expected drawdown for various pumping rates.
3. To prevent migration of fine material towards the screen groundwater velocities must be maintained below a critical value. Consequently the bore should not be pumped at rates exceeding 30 litres per second for long periods.

4. The drawdown curve suggests the presence of a nearby hydrogeological boundary.

5. The coefficient of permeability (transmissivity divided by aquifer thickness) for the aquifer in this location is 31 metres per day.

6. The salinity of the groundwater pumped is not expected to vary significantly from about 620 milligrams/litre.

O.J. Bowering

6th February, 1973
OJWB:IA

O.J.W. BOWERING for DJ.

ASSISTANT SENIOR GEOLOGIST
NARACOORTE REGIONAL OFFICE

DEPARTMENT OF MINES — SOUTH AUSTRALIA

SHEET 1 OF 6

BORE LOG · HYDROGEOLOGY

Purpose of Bore: Water supply
State No. 2460364O3
Hundred: Blanche
Section: 364
Bore Serial No. 28/72
Owner: A.P.D. Ltd.
Address: Commercial Street, Mt. Gambier
Project No.
Driller: H. James
Docket No. 100/72
Commenced: 6.3.72
Completed: 13.5.72
R.L. Collar (M.S.L.)
Depth: 120 metres
Drill type: Percussion
Circulation
R.L. Surface
Co-ords E
Logged by: J. Bowering
Date: 7.12.72
Casing: 50.6m x 10" & 91m x 8"
A.M.G. Zone
N

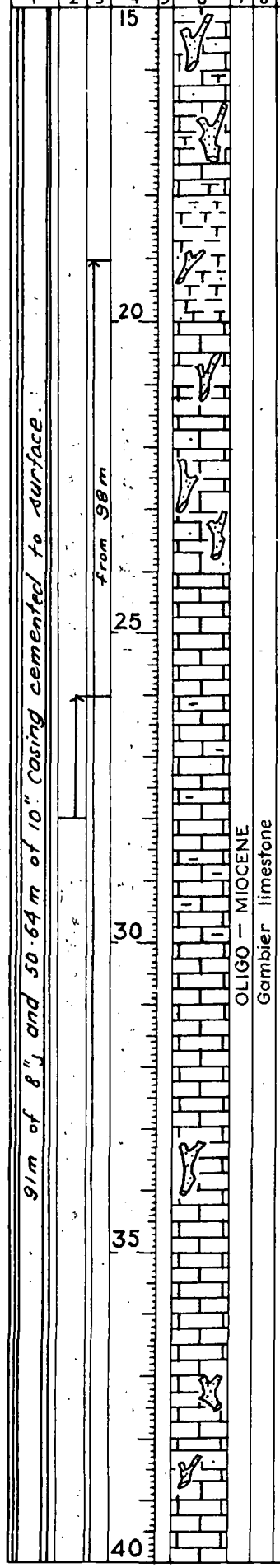
WATERS CUT

DEPTH (m)	WATER LEVEL (m)	SUPPLY - G.P.H.	HOW TESTED	TOTAL SALTS mg/ℓ	ANALYSIS No.
28 m	26.0 m	–		470	W 1753/72
98.0m	19.02m	36,000	pump	620	〃
				585	W 2291/72

REMARKS

1 CASING	2 WATERS CUT	3 WATER LEVEL	4 DEPTH (m)	5 CORE	6 GRAPHIC LOG	7 AGE	8 UNIT	9 PENETRATION RATE	DESCRIPTION
91m of 8" and 50.64m of 10" casing cemented to surface.			0			RECENT			0-1 m: SOIL : dark brown sandy loam, organic 1-2 m: SILT : pale brown, argillaceous to sandy, strongly calcareous. 2-8 m: SILT : cream, argillaceous, slightly sandy with occasional coarse sand grains, strongly calcareous. Becoming more calcareous toward 8 m.
			5						
			10			OLIGO – MIOCENE	Gambier limestone		8-18 m: CALCARENITE : Cream, marly, poorly sorted. Consists essentially of bryozoal fragments with occasional quartzose grains & occasional silicified claystone fragments.
			15						

State No. 246036403 Bore Serial No. 28/72 SHEET 2 OF 6.



18-20 : MARL : pale cream - off white, silty with very fine bryozoal fragments & common coarse fragments of hard cemented marl & sandy quartz grains.

20-22 : LIMESTONE : dark cream-pale brown, fine sandy, bryozoal, some fine to medium quartzitic sandy grains.

22-24m: LIMESTONE : pale cream-off white, coarser bryozoal fragments. Common hard fragments of cemented marl.

24-30m: CALCARENITE : Off white, becoming finer grained & silty. Generally more even grained with few calcareous chips & fragments.

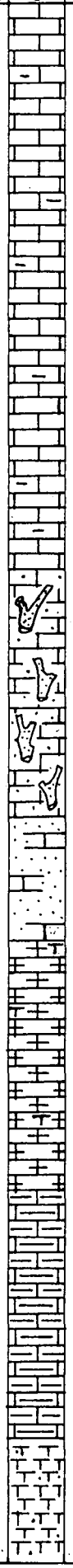
30-38m: CALCARENITE : pale brown-buff, moderately to well sorted, weakly cemented to friable, slightly silty in part. Occasional bryozoal fragments.

38-39m: LIMESTONE : Deep yellow-pale brown, hard, massive. Consists of hard fragments of possibly partly silicified limestone. Common coarse sandy grains & bryozoal fragments.

State No. 246036403 Bore Serial No. 28/72 SHEET 3 OF 6.

50.64m of 10" casing cemented to surface

91m of 8" casing.



39-47m: CALCARENITE : Medium yellow, medium-coarse grained mod. to well sorted, silty in pt. Comm. hard argillaceous fragments.

47-49m: As above, becoming more buff coloured.

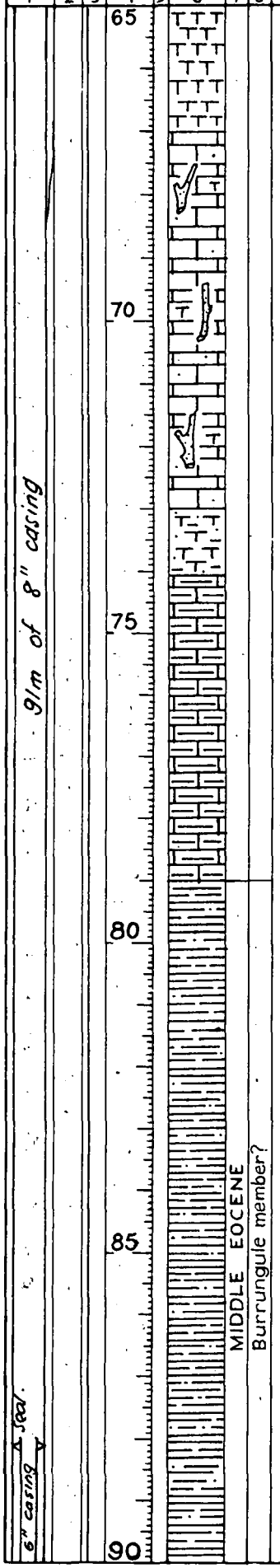
49-53m: CALCARENITE : pale brown, medium-coarse grained. Dominantly quartzose with abundant bryozoal fragments, moderately sorted. Some pink ferruginous staining.

53-55m: CALCARENITE : yellow, 70% quartz, 30% calcite.

55-59m: CALCISILTITE : pale brown, marly in part. Some orange Fe staining.

59-63 : CALCILUTITE : Med. grey, marly, occasional hard siliceous fragments.

63-67 : MARL : pale grey, soft & puggy, sandy in part.

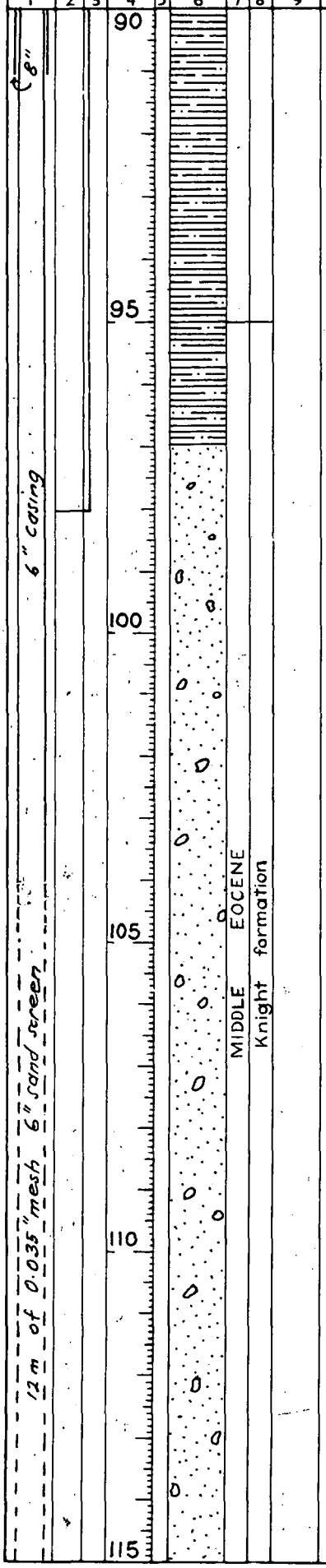


67-73 : LIMESTONE : off white-pale grey, bryozoal, sandy & marly in part

73-74 : MARL : Buff, soft, silty & sandy

74-79 : CALCILUTITE : Med-dark brown, becoming less silty.

79-95 : CLAY : dark-v. dark brown, soft & puggy. Generally slightly sandy throughout & finely micaceous. Becoming lignitic in part. Occasional pale brown calcareous inclusions.

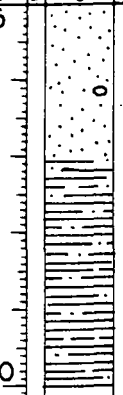


95-97m : CLAY : as above but becoming firmer & more blocky & sl. more sandy.

97-99 : SANDSTONE : pale-med. grey, poorly sorted, medium-v. coarse grained. Conglomeratic, subangular to subrounded, clear to cloudy quartz, occasional felspar. Common lithic fragments.

99-115m: SANDSTONE : As above but generally medium brown. Conglomeratic, unconsolidated & friable.

bail down shoe and plug



115-117 : SANDSTONE : As above but becoming dark grey and dirtier with increasing argillaceous matter.

117-120m: CLAY : Dark-v. dark brown, soft & puggy, moderately sandy with fine to medium grained quartz. Trace very fine mica.

END OF HOLE 120m

LOCALITY PLAN

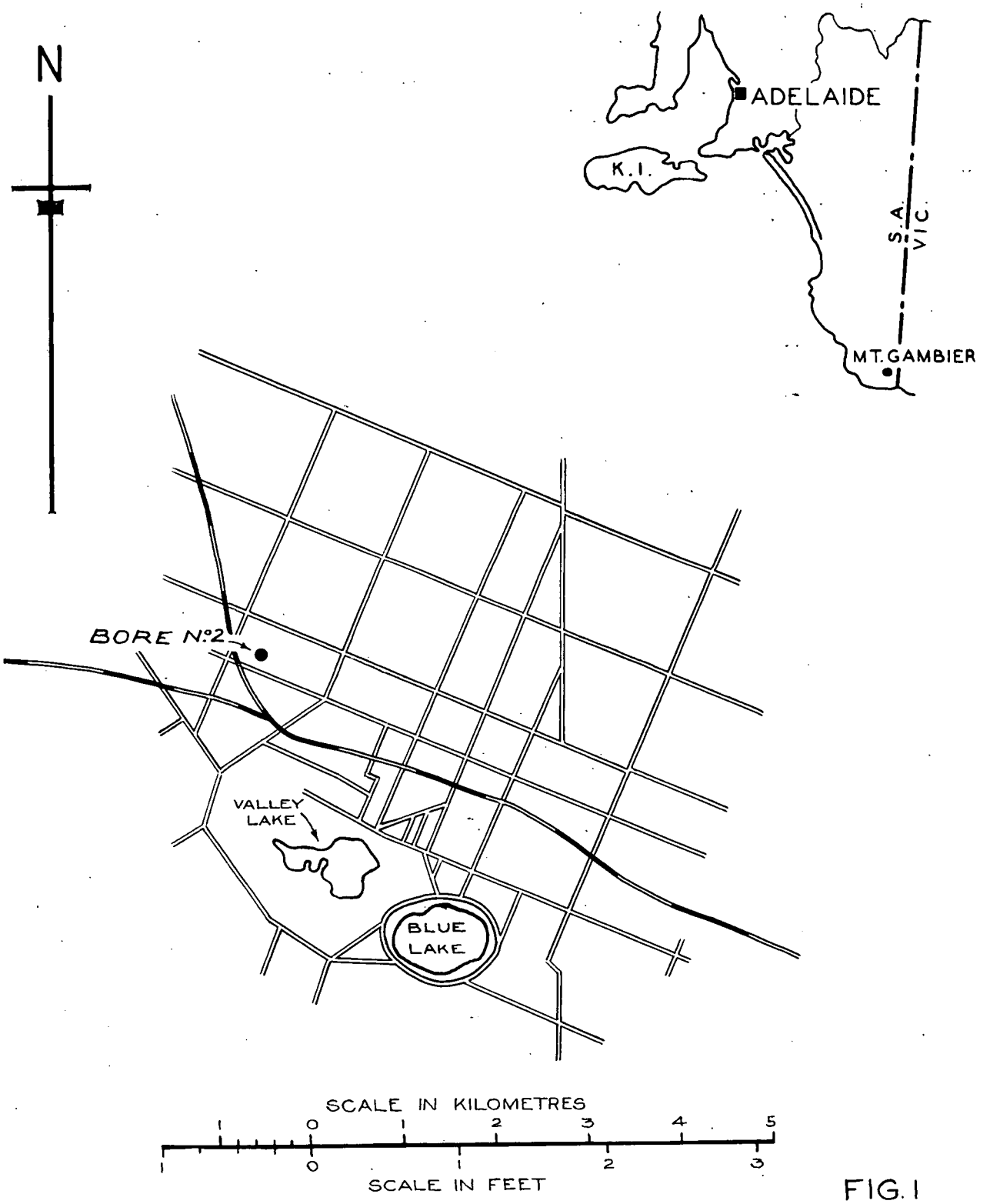


FIG. 1

HYDROGEOLOGY SECTION	**DEPARTMENT OF MINES – SOUTH AUSTRALIA**	Scale: 1:63360 (ORIG)
Compiled: O.J.W.B.	A.P.D. SUPPLY BORE N°2 SECTION 364 HD. BLANCHE LOCALITY PLAN	Date: 22ND. JAN. 1973
Drn. A.G.R. | Ckd. A.F.		Drg. No. S10116 Kd 17

300–6.72 C5552

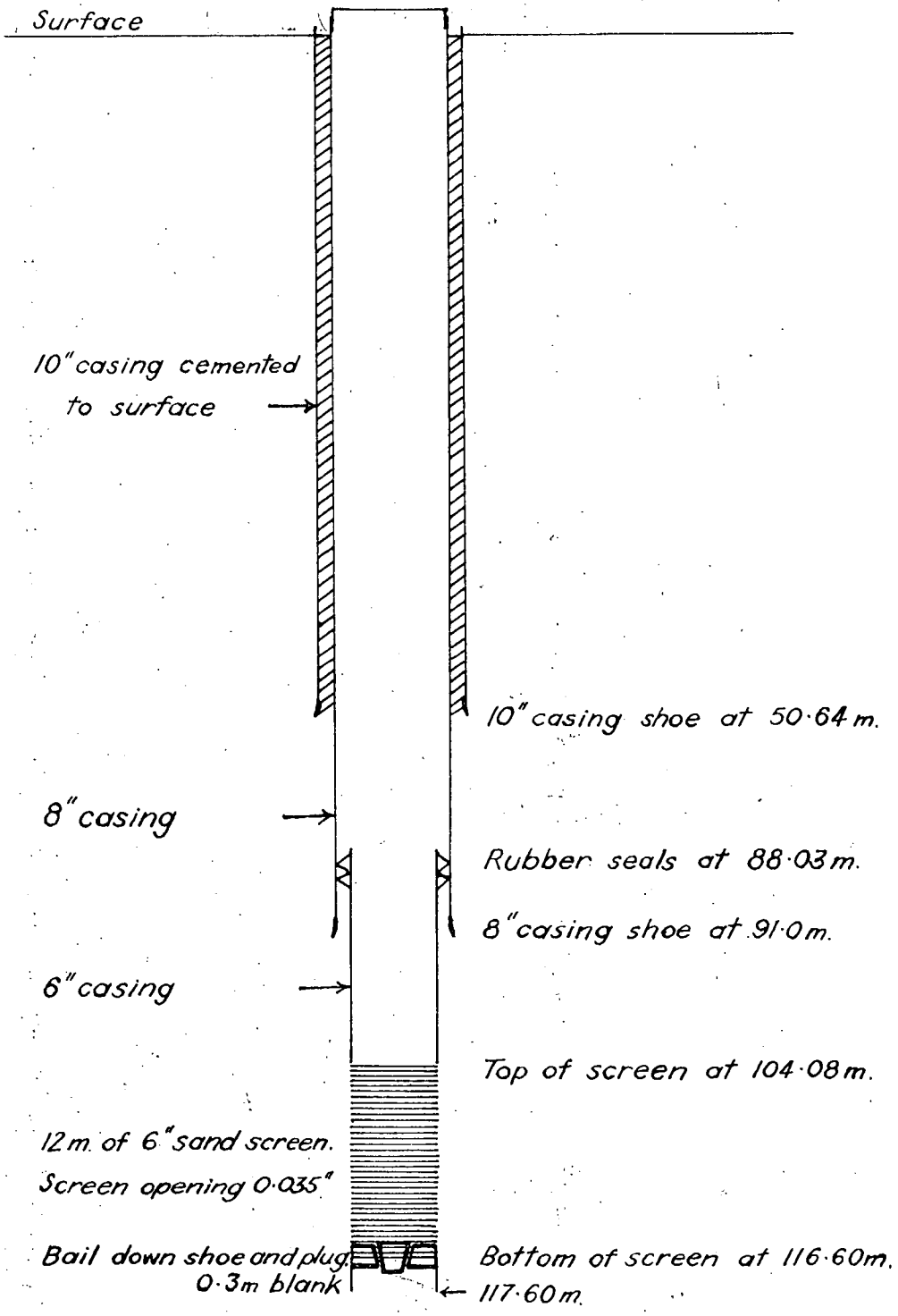
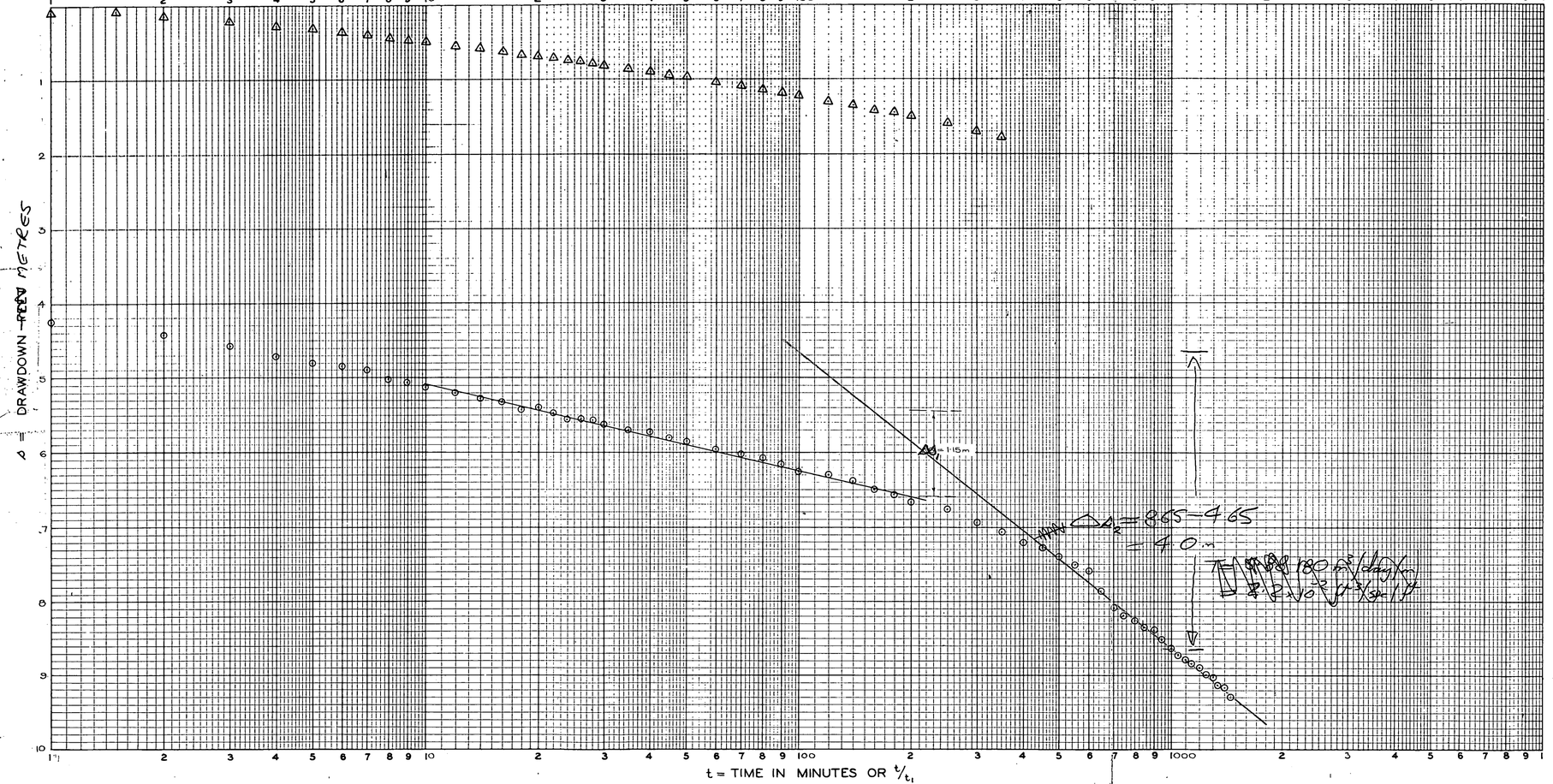


FIG. 2

	DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale:
Compiled: O.J.W.B.	A.P.D. FROZEN FOODS	Date: 11 July 1972
Drn. J.M.B. | Ckd.	SUPPLY BORE NO. 2.	Drg. No. S 10145 Kd 17
	CASING DETAILS	

1M—2.70 A1810



BOREHOLE STATE Nº 246036403 — TYPE OF PUMP POMONA

DEPTH TO WATER LEVEL 19·0m — DISCHARGE STARTED AT 10·15 ON 11-5-72

AT TEST START (l_2) _____ (L) ** — " STOPPED AT 10·25 ON 12-5-72

PUMP INTAKE DEPTH (l_1) _____ (L) — AQUIFER FROM 97·0m TO 117·0m (L)

*AVAILABLE DRAWDOWN 5m (L) — HOLE DEPTH 120m (L)

EQUATIONS

$$T = \frac{0.183 \times Q}{\Delta s} \qquad S = \frac{2.25 \times T t_o}{r^2}$$

In which

T = Transmissivity ($L^3/t/L$)

Q = Pumping Rate (L^3/t)

Δs = Drawdown per log cycle. (L)

S = Storage Coefficient

t_o = Zero drawdown time- (t)

r = Distance to Observation Bore- (L)

1 day = 8.64×10^4 secs.

DATA

Q	Δs_1	t_o
1.600 Cusec	5.06ft = 1.15m	
	Δs_2 13·12ft = 4·0m	

CALCULATIONS

$$T_1 = \frac{0.183 \times 1.600}{3.78} = 7.74 \times 10^{-2}\ ft^3/sec/ft = 630\ m^3/day/m$$

$$T_2 = \frac{0.183 \times 1.600}{13.12} = 2.2 \times 10^{-2}\ ft^3/sec/ft = 179\ m^3/day/m$$

** L = unit of length.
t = time unit.

* Available drawdown = $l_1 - (l_2 + \_\_\_\_\_)$

FIG. 4

HYDROGEOLOGY SECTION	DEPARTMENT OF MINES—SOUTH AUSTRALIA	DM. 231/69
COMPILED: [illegible] TDW	APEC FROZEN FOODS SUPPLY BORE No 2 PUMPING TEST	DATE: [illegible]
DRN. A.R. CHD. A.F.		DRG. No. [illegible]

P.F. No. 69—953 MH