DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

Rept. Bk. No. 80/24

KALANGADOO TOWN WATER SUPPLY
Completion Report - Well No. 2

GEOLOGICAL SURVEY
Engineering Division

By

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&

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GEOLOGISTS
GROUNDWATER SECTION

MARCH, 1980.

Eng. No. 1977/Na17 &
MG 77-2B
D.M. No. 463/75

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DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

Rept. Bk. No. 80/24
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Completion Report - Well No. 2

ABSTRACT

This second well into the confined aquifer was drilled to a total of 117.5 m and completed with a well screen in an unconsolidated sand interval between 104.2 and 115.6 m.

A yield of 1 200 kl/day was obtained using the recently installed permanent pump with a drawdown of about 10 m. Analysis of the step drawdown and constant discharge test results shows that greater yields could be obtained without lowering the pump intake.

Although this well is almost identical with Kalangadoo TWS No. 1, improved screen design and more rigorous development has made TWS No. 2 a far more efficient well. It is therefore recommended that this well be used as the main production well with TWS No. 1 as the standby.

Water salinity remained constant at approximately 600 mg/l TDS throughout the test - about 150 mg/l higher than groundwater occurring in the overlying Gambier Limestone aquifer.

In this region, the head of the confined aquifer is about 14 m below that of the Gambier Limestone. It is thus theoretically possible for contamination to occur, particularly from drainage wells penetrating deeply into the Gambier Limestone.

INTRODUCTION

A request was received in 1974 from the Engineering and Water Supply Department to drill two wells to the confined aquifer in the township of Kalangadoo (Fig. 1) Accordingly funds were made available and drilling commenced in early 1977, the first well being completed by May (McNally, 1977) and the second, 22 m north east of the first, completed in August of that year. The wells are referred to as Kalangadoo town water supply (T.W.S.) No. 1 and 2 respectively. Kalangadoo T.W.S. No. 1 should not be confused with the petroleum exploration well Kalangadoo No. 1 drilled some years earlier. One well is to be used for production, the other for standby purposes. This report summarises the drilling and testing of Well No. 2.

HYDROGEOLOGY

The sequence intersected in Well No. 2 is similar to that in No. 1 as shown in Table 1. The well log appears in Appendix I.

Table I: Geological Summary

Interval		Unit
No. 1 (7022-690)	No. 2 (7022-3862)	
0 - 5.5	0 - 10	Topsoil/Pleistocene to Recent sands and clay - portion of unconfined aquifer.
5.5 - 86	10 - 88	Gambier Limestone - mainly bryozoal, minor silt & marl- unconfined aquifer.
86 - 93	88 - 93	Narrawaturk Marl/Mepunga Form'n - glauconitic marl & sandy clay - aquitard.
93 - 102	93 - 100	Burrungule Member of Dilwyn Form'n (Prev. Knight Group)- black clay - aquitard (main confining layer).
102 - 117	100 - 117	Dilwyn Form'n-sand-confined aquifer
117+	117+	Dilwyn Form'n - very clayey & silty sand - considered base of aquifer here.

McNally (1977) recommended that Well No. 2 should be drilled to a greater depth to explore for a better

Table 2: Summary of Well Details

Depth:	117.5 m
Casing:	see Well Construction Sketch in Appendix "B"
Standing Water Depth:	104.2 to 115.6 m
Interval tested:	104.2 to 115.6 m
Recommended yield:	well equipped with Pomona 6MC 9 stage line shaft turbine pump capable of about 1 200 Kl/day. Greater yields available if required.
Recommended pump depth:	pump set at 68.6 m
Pumping water level:	approx. 31 m below G.L. after 24 hrs. pumping
Salinity:	about 600 mg/1
Aquifer:	unconsolidated lensoid sand bodies of the confined Dilwyn Formation.

aquifer than the upper most sands intersected in Well No. 1. However, re-evaluation of results given in McNally (1977) indicated that with a change in screen design and more rigorous development, the uppermost sand interval would be capable of producing the required yield.

WELL CONSTRUCTION

The Drilling Superintendent's report appears in Appendix B and completion details are shown diagrammatically in Fig. 2. The well was drilled to 99m, then pressure cemented to surface and completed to 117m. Sand samples from the Dilwyn Formation were submitted for sieve analysis from the interval 100 - 117m.

Subsequent to sieve analysis, a total length of 11.4 m of wirewound stainless steel screen was selected for the interval 104.2 to 115.6 m. This is an increase in screen length of about 40% over that used in Well No. 1. Whereas, the entire 8.1 m of screen set between 104.9 and 113 m in Well No. 1 has an aperture of 0.5 mm, the top 8.3 m of screen in Well No. 2 has a 0.25 mm slot width and the bottom 3.1 m an opening of 0.5 mm. This increase is screen length, improvement in screen design and more rigo rous development has resulted in a significantly more efficient well than No. 1.

WELL DISCHARGE TESTS

Although the well was completed by the Dept. of Mines and Energy on 10th August 1977 it was decided to await equipping by the E. & W.S. Department before undertaking well production tests.

The well was subsequently tested between 30th July and 4th August 1979 using 5 x 40 minute step drawdown and 72 hr constant discharge test followed by 24 hr recovery. Results of the test, and a summary of well details are given in Table 2.

Before a discussion of pumping test results it is useful to point out some potential problems associated with testing an E. & W.S. Dept. equipped well:

1) The flanges of line shaft turbine pumps prohibit access to the annulus between well casing and pump column therefore an access pipe for a water level probe from the cement block into the casing below ground level is required (provided in this case).

2) The well needs generally to be pumped to waste so that the only head which changes significantly during the test is that due to aquifer response. The head caused by pumping into mains, elevator tanks etc. can change, particularly for long pumping times.

3) For the Step Tests, the pumping rate was changed by progressively opening the gate valve used for scour purposes. Gate valve flow characteristics are such that maximum flow is obtained almost within the opening turn. Therefore, some careful calibration of the valve prior to testing is required. For example, in this case, the first step valve opening was too great which meant that there were only very small increases in pumping rate available for the remaining four steps. As a consequence errors in discharge rate (obtained from the inline helix meter) become signficant.

4) If long discharge lines are required to dispose of the water produced, it is convenient to have a tap near the well head for water sampling.

A sketch of the test set up is shown on Fig. 2.

Step Tests

The well was subjected to a 5 x 40 minute step drawdown test with no recovery between steps. For the reasons stated above, only Steps 4 and 5 were used to compute the well equation. However, when fed with 72 hr constant discharge test data, the predicted curve showed good agreement with observed drawdown i.e. the equation can be considered reliable. Data are given in Fig. 2.

Well Equation:

$$s_t = 5.8Q + 2.4Q^2 + 1.71\log_{10}tQ$$

where s_t = drawdown at time t in metres

Q = discharge rate in m^3/min.

t = time in minutes

When compared with the equation obtained for Well No.1 viz.

$$s_t = 43.7Q + 5.5Q^2 + 1.41\log_{10}tQ \text{ (units as above)},$$

it can be seen that the values of a & c (see Fig. 2) related to well loss are significantly different ie for given values of Q and t Well No. 1 will have a considerably larger drawdown. The values of b however are very similar which indicate, as expected, that aquifer characteristics are similar for both wells.

The above comparision of well equations dramatically demonstrates the effect of improved screen design and more rigorous development.of Well No. 2.

In summary, Well No. 2 is the more efficient of the two wells and should be used as the main production well with Well No. 1 as its standby.

Constant Discharge Test

Following recovery of the well from the 5 x 40 min. step test it was tested for 72 hrs at a constant discharge rate with 24 hr recovery. The 3.5 Ml of water produced was disposed of in a shallow depression some 200 m distant. Data are presented in Figs. 3, 4, & 5.

From Fig. 3, a slight discharge boundary was intersected at about 30 minutes with a consequent decrease in aquifer Transmissivity (T) from 250 to 165 m^3/day/m. Similar behaviour is evident from the recovery plot from Fig. 3. The boundary is probably caused by intersection of the cone of depression with a lower transmissivity facies variant within the Dilwyn Formation - either reduced aquifer thickness or lower permeability.

The semilog plot of observation well data on Fig. 4 shows the same behaviour with a reduction in T from 219 to 152m^3/day/m. A value of 1.6×10^{-4} was obtained for Storage coefficient (S) using early time T and t_o values whilst a figure of 6.4×10^{-4} was obtained using late time values.

Fig. 5 shows the log-log plot of observation well drawdown data. Data obtained fit the Theis type curve with two match points obtained for less than 30 minutes and greater than 30 minute plots. Values of T and S agree well with those obtained from semi-log data displayed on Fig. 5.

In drawdown matching the Theis type curve, downward leakage through the thin confining bed as suggested in McNally (1977) was not evident in the test performed on Well No. 2. An explanation may be the problem in obtaining suitable unique match point(s) from the log-log plot. It is thought that the high initial drawdowns obtained in testing Well No. 1 and subsequent flattening off of the drawdown curve could be better explained by lower well efficiency than by leakage (see Step Tests above).

WATER QUALITY

Total Dissolved Solids (T.D.S.) within the Gambier Limestone aquifer is generally 100 to 150 mg/l higher than that obtained from the confined Dilwyn Formation. Kalangadoo has experienced water quality problems in the upper part of the water table aquifer because of septic tank drainage - one of the reasons why the town water supply is now obtained from the confined aquifer. There is no evidence so far that the confined aquifer is also polluted.

One important consideration is that Kalangadoo is in the area of recharge to the confined aquifer and there is a potential for downward leakage from the unconfined Gambier Limestone aquifer into the Dilwyn Formation. The head difference is about 14 m, with the confined aquifer the lower. It is critical therefore that contaminants not be introduced to any depth within the Gambier Limestone aquifer via drainage wells etc. as pumping will significantly increase the head difference and hence the potential for downward leakage through the thin confining bed.

During the 72 hr test of Well No. 2, T.D.S. varied through narrow limits and was in the order 600 to 650 mg/l. E.&W.S. Department sampled the well prior to completion of the test. Results are given in Appendix IV.

DISCUSSION

The geological logs of Wells 1 and 2 are almost identical, however there is a marked difference in well performance. Improved screen design and more rigorous development of Well No. 2 has made it by far the more efficient well. As a consequence, it is recommended that Well No. 2 be used as the main production well with No. 1 as the standby.

If required, the discharge rate of Well 2 could be significantly increased by equipping with a larger capacity pump without changing the pump intake depth, (See Fig. 6).

Management of the groundwater resources of the Kalangadoo township must recognise the lower head of the confined aquifers and hence the potential for pollution from drainage wells, particularly those completed towards the base of the Gambier Limestone aquifer.

Consideration could be given to the establishment of a common effluent scheme for septic tank overflow of a design similar to that operating in Penola.

ACKNOWLEDGEMENTS

The co-operation of the E. & W.S. Department, particularly Messrs Skinner, Keith and Puttnam is acknowledged with thanks.

U Wan Maung, a visiting Burmese drilling engineer plotted well discharge test data.

A.F. Williams supervised the drilling and development and P.C. Smith undertook well discharge testing.

PCS:AF

P.C. SMITH
GEOLOGIST

REFERENCES

McNally, G.H., 1977 Kalangadoo Town Water Supply - Well Completion Report - Kalangadoo T.W.S. No. 1 (MA94) unpub. S. Aust. Dept. Mines rept. 77/80

APPENDIX A

Well Log

A · 1

DEPARTMENT OF MINES — SOUTH AUSTRALIA
ENGINEERING DIVISION

BORE LOG

HOLE NO. MA99

UNIT/STATE NO: 7022994WW03862

SERIAL NO: 44/77

FOLDER NO.

PROJECT KALANGADOO TOWN WATER SUPPLY - WELL NO. 2

LOCATION OR CO-ORD Kalangadoo Township

EL Surface 69.528

EL ref. point 69.614

SEC. 414 HD GREY

Datum MSL(1)

DEPTH TO WATER CUT (m)	DEPTH TO STANDING WATER (m)	SUPPLY m³/day	SUPPLY Method of test	TOTAL DISSOLVED SOLIDS milligrammes/litre	TOTAL DISSOLVED SOLIDS Analysis W NO
6.5	6.5		72hr -	744 (F)	4994/77
101	20.1		72hr test pumping 5x40min step drawdown	(F)	3712/79

DEPTH (m) from	DEPTH (m) to	GEOLOGICAL DESCRIPTION OF SAMPLE	UNIT	AGE
0	0.6	TOPSOIL - silt, clayey & sandy, non calcareous abundant organic material, black to dark grey.	TOPSOIL	RECENT
0.6	10	SAND, quartz, mainly fine to med. grained, non calcareous, some ferruginous pebbles to 20mm 1-2m as above but yellow brown & 20% silt & clay, soft 2-3m as above, some v. well cemented 3-4m as above for 1-2m, some forams & carbonate grains, few moderately well cemented frag. Abundant silt 4-6m as above, well cemented, large shell frags fine subangular to coarse subrounded qtz Orange to yellow brown. 10-20% carbonate cement 6-8m as above-less silt (7%) Shell frags to 10mm+ 8-10m as above, qtz. to 3mm & rounded silt 3%	?	PLIO-PLEISTOCENE
10	88	LIMESTONE - 85% bryozoal, fine to coarse, some to 6mm, some forams, mod. cemented, 15% silt, pale whitish grey, some yellowish frags.	GAMBIER LIMESTONE	OLIGO-MIOCENE

*NOTE: 1000 gals./hr. = 110 m³/day

REMARKS Permit No. 1004 Driller : A.H. Anderson
Completed T.W.S. Production Well-see construction details in completion report

DRILL TYPE C/T

CIRCULATION Water

START: 8/6/77

FINISH: 9/8/77

LOGGED BY. AFW

DATE: 2/9/77

TRACED BY:

DATE:

SHEET 1 OF 6

DEPARTMENT OF MINES — SOUTH AUSTRALIA
ENGINEERING DIVISION

PROJECT: KALANGADOO TOWN WATER SUPPLY WELL NO. 2

BORE LOG

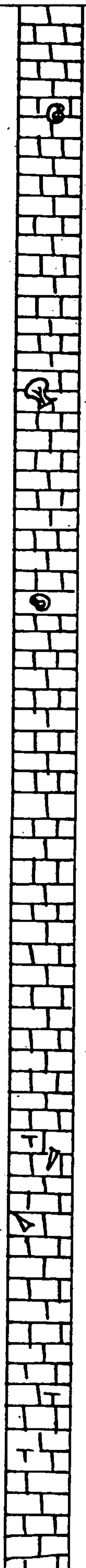
CONTINUATION SHEET

HOLE NO. MA99

UNIT/STATE NO: 7022994WW03862

HOLE DIA. DEPTH m	CORE	GRAPHIC LOG	DEPTH (m) from to	GEOLOGICAL DESCRIPTION OF SAMPLE	UNIT	AGE	CASING	WATERS CUT	WATER LEVEL

15 20 25 30 35



14-26m
as above with some flint or partly silicified nodules

26-28m
as above, finer grained, less bryozoa. Some subrounded quartz grains-whitish grey. Silt 10-15%. Minor glauconite stains.

28-30m
as above, 50% bryozoa, rest carbonate silty to coarse grained. 15-20% silt

30-32m
as above, pale grey

32-34m
as above, flint frags.

34-36m
as above, 10% marl

36-38m as above 5% marl

38-40m
as above, silty 10%, notmarl

UNIT: GAMBIER LIMESTONE

AGE: OLIGO - MIOCENE

DEPARTMENT OF MINES — SOUTH AUSTRALIA
ENGINEERING DIVISION

PROJECT: KALANGADOO TOWN WATER SUPPLY WELL NO. 2

BORE LOG

CONTINUATION SHEET

HOLE NO. MA99

UNIT/STATE NO. 7022994WW03862

HOLE DIA.	DEPTH m	CORE	GRAPHIC LOG	DEPTH (m) from	to	GEOLOGICAL DESCRIPTION OF SAMPLE	UNIT	AGE	CASING	WATERS CUT	WATER LEVEL
	40					40-42m as above,15% silt,whitish grey	GAMBIER LIMESTONE	OLIGO- MIOCENE			
						42-44m as above, 10% silt minor glauconite stains					
						44-46m as above,20% silt, very slightly sticky					
	45					46-50m as above,60% bryozoal remains,15% minor flint					
	50					50-52m as above,10% silt					
						52-56m as above, for 44-46m					
	55					56-58m as above but 10% marl& mid grey					
						58-62m as above,5-10% silt,rest med. to coarse grained,mainly bryozoa,mod. well cemented(better than above) some yellowish frags.,rest pale whitish grey with dark & pale grey frags of flint. Some forams. At 60-62m as above but some hard finer grained material					
	60					62-68m as for 56-58m but whitish grey,15-20% silt,10%marl					

A.4

DEPARTMENT OF MINES — SOUTH AUSTRALIA
ENGINEERING DIVISION

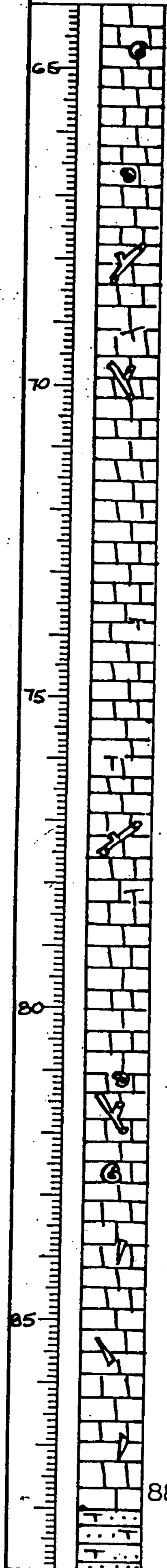
BORE LOG

CONTINUATION SHEET

PROJECT: KALANGADOO TOWN WATER SUPPLY WELL NO. 2

HOLE NO MA 99

UNIT/STATE NO: 7022994WW03862



DEPTH (m) from	to	GEOLOGICAL DESCRIPTION OF SAMPLE	UNIT	AGE	CASING	WATERS CUT	WATER LEVEL
		68-70m as above, pale grey	GAMBIER LIMESTONE	OLIGO - MIOCENE			
		70-72m as above, 10-15% silt, 5% marl					
		72-82m as above, 15-20% silt, 10% marl, minor glauconite. At 82m, reasonably clean calcarenite - bryozoal as above.					
		82-86m as above, large flint fragments					
		86-88m as above, passing into greenish grey glauconitic marl					
88	93	<u>MARL</u>, clay, glauconitic with fine dark green grains, 20-30% fine subangular qtz. forams, bryozoa gr y to live					

HOLE NO. MA99

UNIT/STATE NO: 7022994WW03862

PROJECT: KALANGADOO TOWN WATER SUPPLY WELL NO. 2

BORE LOG

CONTINUATION SHEET

HOLE Dia. DEPTH m	CORE	GRAPHIC LOG	DEPTH (m) from	to	GEOLOGICAL DESCRIPTION OF SAMPLE	UNIT	AGE	CASING	WATERS CUT	WATER LEVEL
90					90-92m as above, becoming very sandy with abundant fine quartz & brown to green glauconite. Buff to yellow-brown qtz stained yellow-brown to clear, forams & bryozoa	MEPUNGA / NARAWAL	Mid to LATE EOCENE			
			93	100	as above passing into Clay at about 93.5m. Sticky silty, black to brown, micaceous, abundant fine grained subangular qtz. sand. Bit sample at 94m 94-100m as above with some glauconite & fossil remains					
95										
100			100	116	SAND, 30% silt, 5% clay, weakly cemented fine to med. grained qtz, some coarse to 1mm-subangular. Micaceous, pyritic, fossiliferous with forams & bryozoa stems 102-103m as above, minor clay, silt 15% 103-112m as above, silt 5%	DILWYN FORMATION	EOCENE			
105										
110					112-113m as above with 20-30% more coarse material 113-115m as above, some pyritic wood frags.					

DEPARTMENT OF MINES — SOUTH AUSTRALIA
ENGINEERING DIVISION

HOLE NO. A-8 MA99

UNIT/STATE NO: 7022994WW03862

PROJECT: KALANGADOO TOWN WATER SUPPLY WELL NO. 2

BORE LOG

CONTINUATION SHEET

HOLE Dia.	DEPTH m	CORE	GRAPHIC LOG	DEPTH (m) from	to	GEOLOGICAL DESCRIPTION OF SAMPLE	UNIT	AGE	CASING	WATERS CUT	WATER LEVEL
	115					115-116m as above, 5-10% silt	DILWYN FORM'N	EOCENE			
				116	117.5	SAND - very fine grained, 10% silt, weakly cemented, very slightly clayey, brown to dark grey. Micaceous, pyritic Core description - see below END OF HOLE 117.5					

CORE DESCRIPTION

DEPTH (m) from	to	
117	117.5	Top: SAND, very fine with minor medium & coarse (pockets with grains to 1mm). Mostly qtz and subangular. Pyritic, micaceous glauconitic, weakly cemented, minor silt, few forams, some black carbonaceous material

Bottom: as above

APPENDIX B

Drilling Superintendants Report &

Well Construction Sketch

TO THE CHIEF DRILLING & MECHANICAL ENGINEER
THROUGH THE DRILLING ENGINEER

Completion of drilling
Kalangadoo
Temp. Bore No. MA 99

E. & W.S. Dept.
Permit No. 1004 (2 Wells)

A second town water supply well was constructed on Section 414, Hundred of Grey.

The well was drilled 254 mm diameter to 100 m and lined with 254 mm casing to 15.95 m.

203 mm casing was installed to 99 m and pressure cemented to surface. 2820 litres of grout was used, comprising 80 bags of cement and 1 820 litres of water, 5 - 1 mix.

The cement plug was drilled out & 152 mm casing was installed and the sand formation was sampled for sieve analysis at 1 m intervals to 117.50 m. A tube sample was obtained at 117.00 m.

A stainless steel sandscreen was installed from 104.22 m to 115.57 m with 127 mm Australian steel casing from 89.36 m to top of screen.

The 152 m casing was withdrawn and a 152 m sealpiece was placed at 89.20 m.

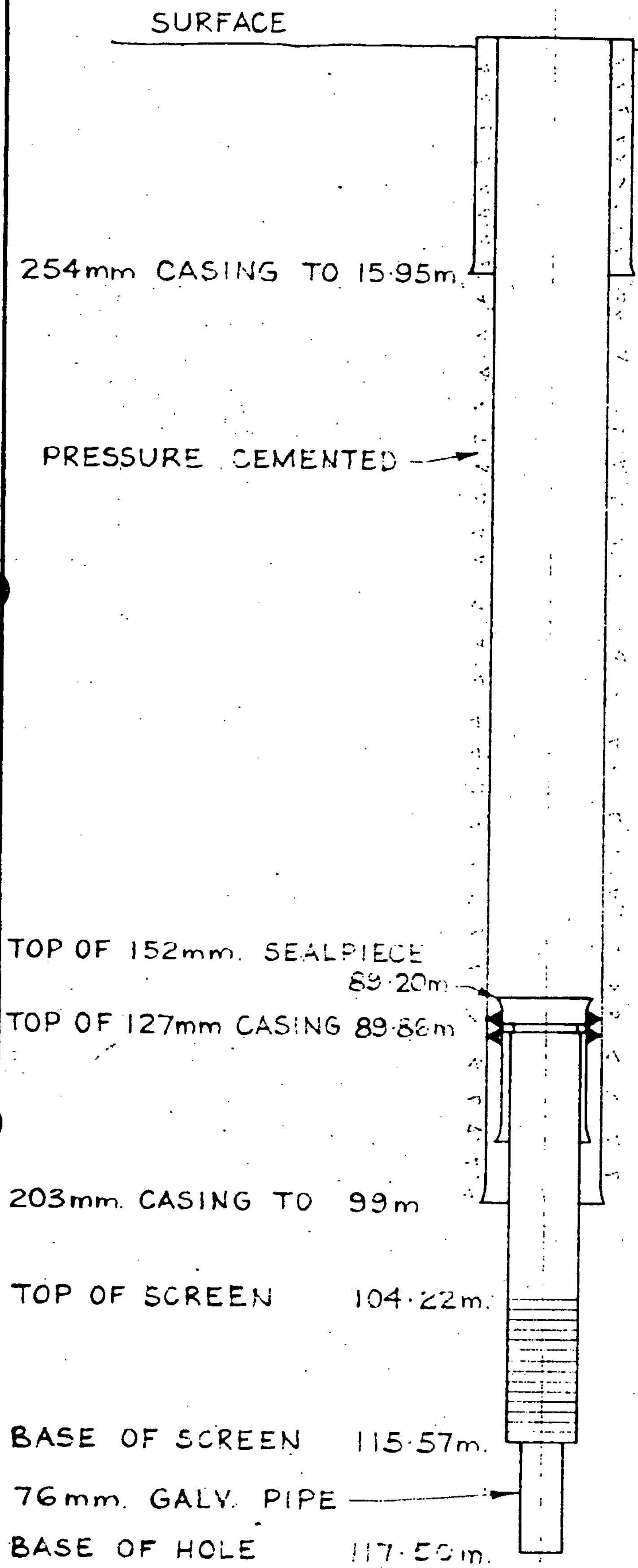
The screen was developed by airlifting and surging the face of the screen for 47 hours.

Details fo the completed well are as follows:-

Commenced	-8.6.77
Completed	-10.8.77
Depth drilled	-117.50m
254mm casing	-Sur. to 15.95m
203mm casing	-Sur. to 99 m
152mm sealpiece (127mm-203mm)	-Set with top at 89.20m
127mm casing	-89.36 to 104.22m
127mm sandscreen	-104.22 to 115.57m
76mm galv. pipe	-115.57 to 117.50m
Water cut	-6.50m - 101m
Standing Wate Level	-6.00m - 20.70m
Developed for	-47 hours
Plant hours - 2 wells	-483
Screen aperture details	8.26m - 0.25mm
	3.11m - 0.50mm
Total length-	11.35m

WDW/YMW
16/8/77

W.D. WILSON
DRILLING SUPERINTENDANT



DETAILS OF ASSEMBLY

152mm. SEALPIECE FROM 127mm TO 203mm. CASING – SET 16cm ABOVE 127mm. CASING

127mm. CASING WITH SEAL TO 152mm	1·61m.
127mm. CASING	6·63m.
" "	6·62m.
127mm SCREEN	11·37m.
76mm PIPE TAILPIECE	2·00m.
OVERALL	28·23m.
EFFECTIVE	28·14m.

SET FROM 89·36m TO 117·50m.

DETAILS OF SCREEN

TYPE: "SURESCREEN" STAINLESS STEEL

3 SECTIONS FROM TOP

	LENGTH (INC. COUPLINGS)	O.D.	I.D.	APERTURES
(1)	4·16m.	127mm.	112mm.	·25mm.
(2)	4·10m.	"	"	"
(3)	3·11m	"	"	·5mm.

O.D. OF COUPLINGS — 137mm.

SEALPIECE 127mm. TO 203mm.

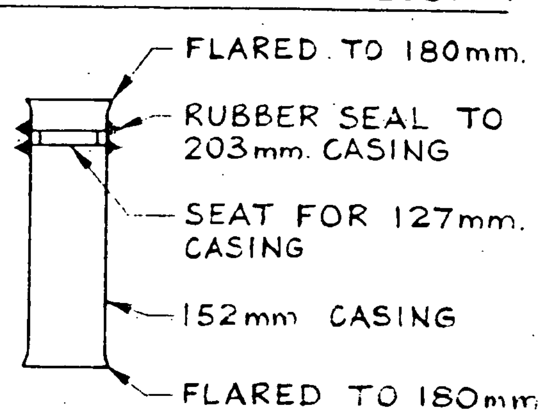


FIG. B-1

Compiled:	DEPARTMENT OF MINES–SOUTH AUSTRALIA	Scale: N. T. S.
Drn. MN. Ckd.	E & W.S. DEPT. KALANGADOO TOWN WATER SUPPLY – WELL No. 2	Date: 5 · 9 · 77
		Drg. No. SK-840

500—6.76 G6584 O

APPENDIX C

Screen Selection Criteria

1. Summarised sieve analysis results:

Interval (m)	% thro' T28 ie. 0.589mm	% thro' T35 ie. 0.417mm	% thro' T48 ie. 0.295mm	40% retained size (mm) (approx)	90% retained size (mm) (approx)	*Coefficient of uniformity
101-102	12	26	49	0.35	0.07	5
102-103	4	23	53	0.35	0.07	5
103-104	9	26	55	0.35	0.18	2
104-105	36	59	76	0.59	0.21	3
105-106	6	18	56	0.35	0.15	2.5
106-107	4	16	58	0.35	0.15	2.5
107-108	4	17	62	0.35	0.15	2
108-109	4	16	59	0.35	0.18	2
109-110	3	13	54	0.33	0.15	2
110-111	3	14	56	0.33	0.15	2
111-112	12	33	60	0.40	0.15	2.5
112-113	46	71	76	0.59	0.15	4
113-114	62	85	90	0.70	0.30	2.5
114-115	59	85	91	0.70	0.30	2.5
115-116	55	72	76	0.70	0.12	6
116-117	15	20	20	0.1?	?	-

$$\text{*Coefficient of uniformity (to nearest 0.5)} = \frac{\text{40\% retained size}}{\text{90\% retained size}}$$

For sands which are well sorted, i.e. have a coefficient of uniformity of ≤2 (40% retained size/90% retained size = <2); the screen aperture should be selected conservatively to retain 55%-60% of the sand sizes. Where the sands are less well sorted, the screen aperture can be selected back to 40% retained.

2. Screen design alternatives:

(i) Screen 112-115 aquifer interval with 0.5 mm aperture (aquifer becomes clayey below 115.5m).

(ii) Screen 104-115m aquifer interval with 0.25 mm aperture

(iii) Screen 104-115m aquifer interval with 0.25 mm aperture for 104-112 m and 0.5 mm aperture for 112-115 m

The screen must retain 60% of aquifer sands as the overlying sediments are weak i.e. migration of fines may occur if too much aquifer material is removed in development and subsequent well use.

Alternative (i) - 3 m screen 112-115 m

Screen diameter 127m
Screen type - Standard pattern Mark II
Screen aperture opening suitable to retain 60% is 0.5 mm
Open area (in cm^2) per unit length (m) = 1057 cm^2/m
ie. total open area = $1057 \times 10^{-4} \times 3$
$= 0.32\ m^2$
Aquifer permeability is less than 20 $m^3/day/m^2$ - about 12 m to 15 $m^3/day/m^2$ from McNally (1977).

Therefore entrance velocity should be less than 0.01 m/sec (Sure screen data).
This restricts pumping rates to below

$0.01 \times 0.32 \times 10^{+3}$ 1/sec
i.e. 3.2 1/sec = 230 m^3day

Alternative (ii) - 11m screen 104-115m

Screen diameter, type as above
Screen aperture opening suitable to retain 60% is 0.25mm (10 thou)
Open area (in cm^2) per unit length (m) = 609 cm^2/m

ie. total open area = $609 \times 10^{-4} \times 1$
= 0.67 m^2
and pumping rates must be below

$0.67 \times 0.01 .10^3$ 1/sec

ie. 6.7 1/sec = 580 m^3/day

Alternative (iii) - 8m screen 104-112m, 3m screen 112-115m

Screen diameter, type as above
Screen aperture opening suitable to retain 60% is 0.25 m for 104-112m and 0.5m for for 112-115m
Open area (in cm^2) per unit length = 609 cm^2/m for 0.25mm
and 1057 cm^2/m for 0.5mm

Therefore total open area = $609 \times 10^{-4} \times 8 + 1057 \times 10^{-4} \times 3$
= 0.49 + 0.32
= .81 m^2
Therefore pumping rates must be below
$0.81 \times 0.01 \times 10^3$ 1/sec
ie. 8.1 1/sec = 700 m^3/day

3. Comments

For the greatest yield, the alternative (iii) is preferred. However extensive development is required to ensure efficient operation of the screen.

It should be noted that the permeability value used above is that obtained for the aquifer in an undeveloped state. Development in the vicinity of the screen could raise this value 5 to 10 times reducing entrance velocities similarly and enabling a greater pumping rate. It is therefore likely that the desired pumping rate of 860 to 1300 m^3/day (approx 10-15 1/sec) would result in screen entrance velocities of less than 0.01 m/sec.

APPENDIX D

Water Quality Data

DEPARTMENT OF MINES — SOUTH AUSTRALIA

SUMMARY OF WATER ANALYSES

Progressive depth of bore (m)	Sampling depth (m)	Water level (m)	Total dissolved solids (Milligrammes/litre)	Analysis W. No.	Remarks
					pH
			During Drilling		
6.5	6.5	6.5	744	4994/77*	7.1 Water at in Tmg
60	-	-	620	4995/77	6.9 Tmg
80	-	-	715	4996/77	7.1 Tmg
93	-	-	740	4997/77	7.2 5 mm, boiling
93	-	-	715	4998/77	7.6 15 mm "
93	-	-	765	4999/77	7.7 30 mm, "
93	-	-	788	5000/77*	7.4 30 mm, "
			During Development		
117.5	104-115	-	530	5829/77	7.4 During Development
"	"	-	477	5830/77*	8.2 End of Development of sand screen
			Production Testing (samples)		
	104-115		622	3715/79*	15 mins after start of Step 1
	"		605	3711/79	7.2 End of Step 5
	"		605	3710/79	7.2 Start 72 hr. test
	"		519	3712/79*	End of 72 hr test
			Production Testing (field conductivity)		
			645		Start 72 hr test
			645		after 4 hrs
			635		" 8 hrs
			645		" 12 hrs
			645		" 16 hrs
			630		" 20 hrs
			625		" 24 hrs
			655		" 28 hrs
			630		" 32 hrs
			625		" 36 hrs
			635		" 40 hrs
			605		" 44 hrs
			615		" 48 hrs
			625		" 52 hrs
			620		" 56 hrs
			625		" 60 hrs
			655		" 64 hrs
			625		" 68 hrs
			625		" 72 hrs

*Denotes full analysis by AMDEL

Borehole State No. 7022 994 mm 3892

Drn: Sheet 1 of 2

Date: Bore Folder No.

PF Nº S10538 MH

APPENDIX D

Full Chemical Analyses Kalangadoo TWS No. 2

Ca	Mg	Na	K	Fe	HCO_3	SO_4	Cl	NO_3	PO_4	T.D.S.	pH	W.No.	Remarks
125	17	142	2	-	424	35	207	7	-	744	7.1	4994/77	Cambier Limestone - 6.5m
115	22	152	5	-	411	43	247	2	-	788	7.4	5000/77	Nirranda Gp. - 93m
63	20	85	4	-	248	47	133	3	-	477	8.2	5830/77	Dilwyn Form'n - end of Development.
125	24	90	2	0.01	483	11	132	<1	0.02	622	7.5	3715/79	Prod'n Test - Step 1
120	23	90	2	0.03	483	12	132	<1	0.01	619	7.6	3712/79	" " - end 72hr
E. & W.S. Dept. Analysis													
125	26	90	2.8	0.30	494	14	142	0.04	0.03	620	7.00		End 72 hr prod'n test lab ref 07566/79

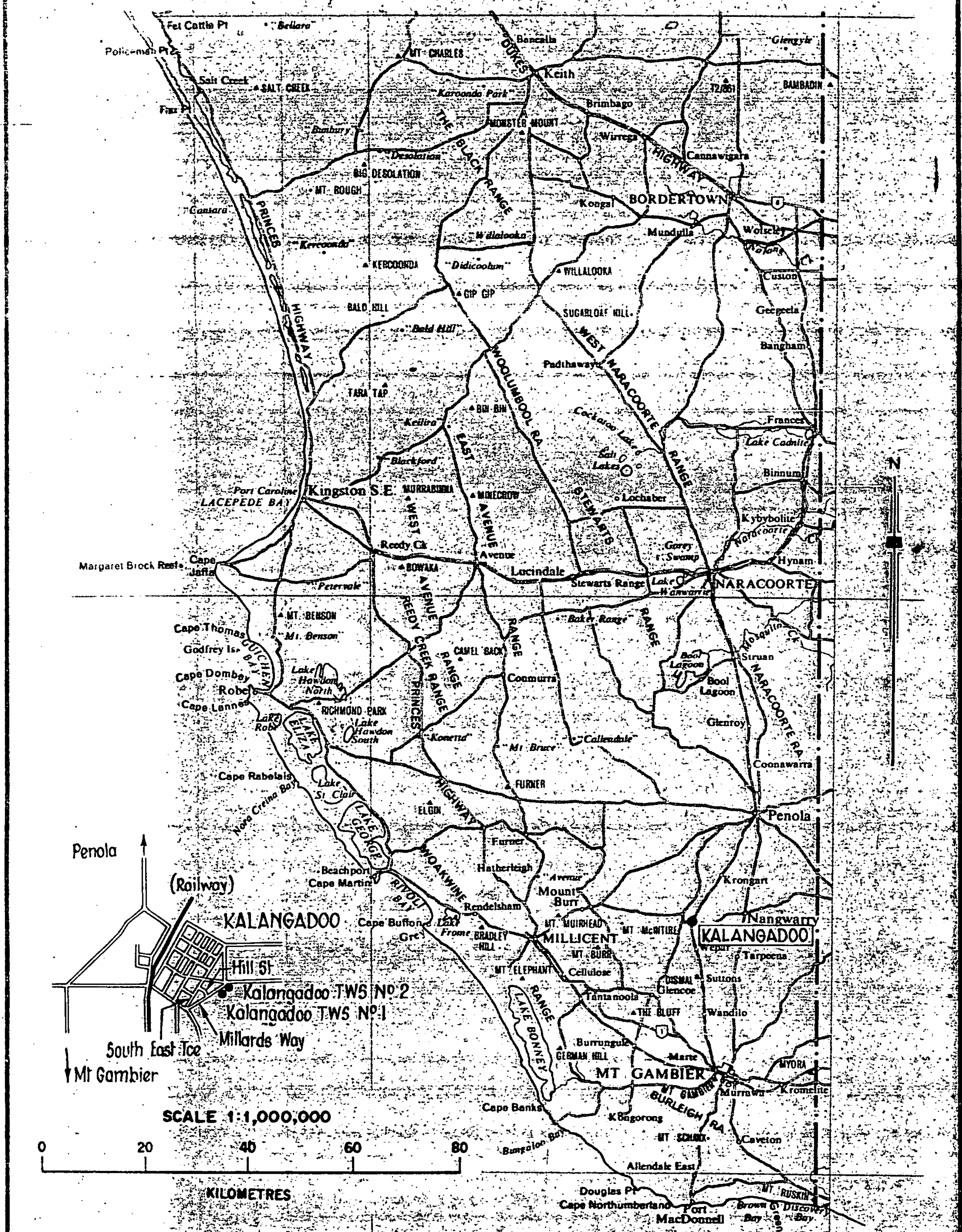
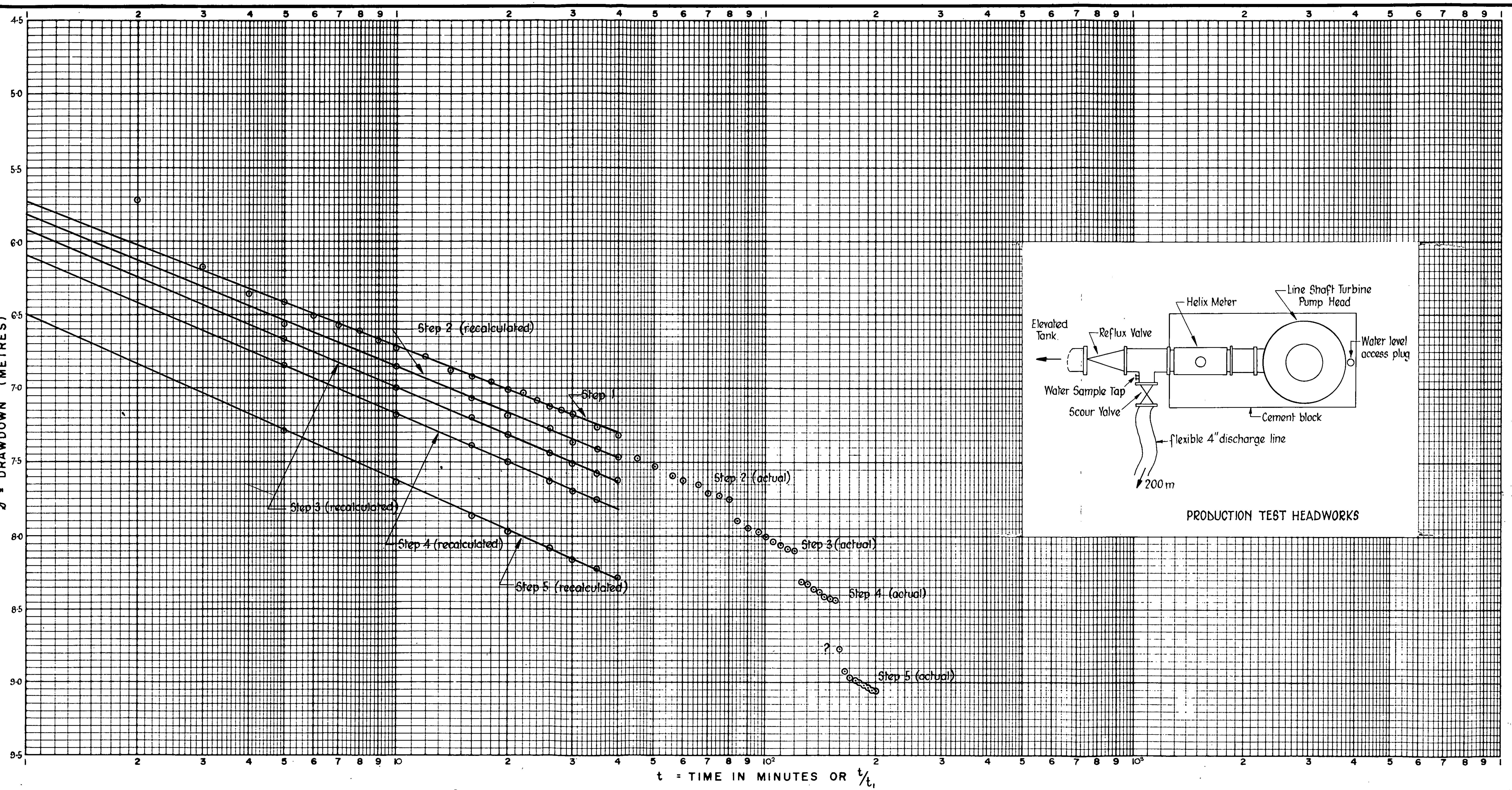


Figure 1

	DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	SCALE 1:1,000,000
COMPILED P.C. SMITH	KALANGADOO TOWN WATER SUPPLY INVESTIGATION	DATE SEPT. '79
DRN C.J.W. | CKD	WELL No 2 - UNIT No 7022994WW03862 LOCALITY PLAN	PLAN NUMBER S 14544



PRODUCTION TEST HEADWORKS

STATE/UNIT No. OF WELL 7022994 WW03862

REF. PT. approx 0·4 (m) above ground

AQUIFER FROM 104·2 TO 115·6 (m)

HOLE DEPTH 117·5 (m)

AQUIFER TYPE confined

LITHOLOGY unconsolidated sand

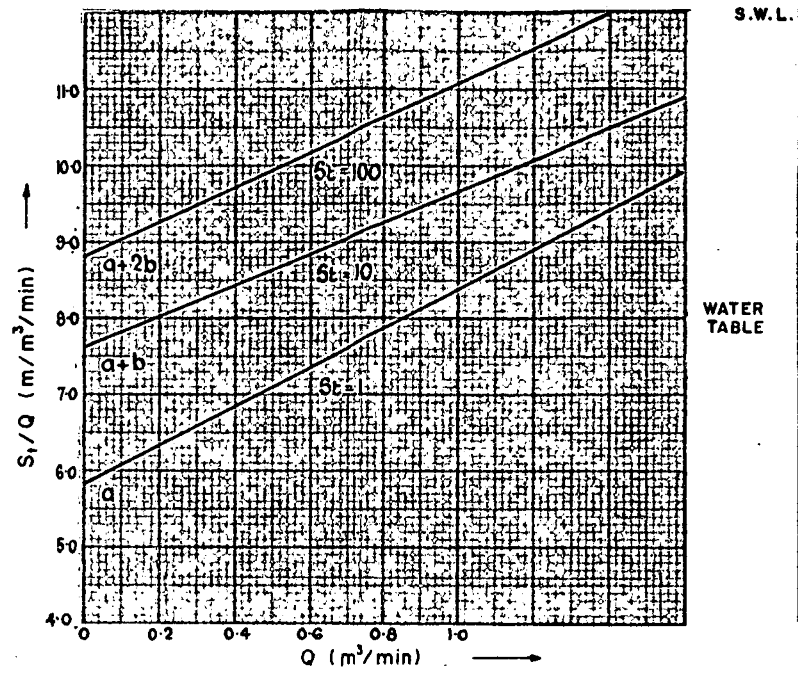
TYPE OF PUMP Giles & Gaskin Turbine

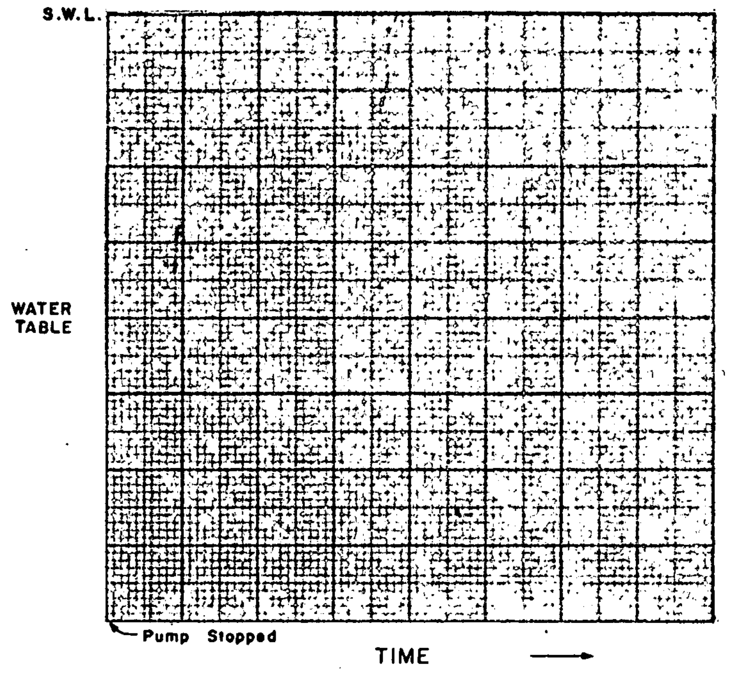
LENGTH OF TEST 5 x 40 min step 5

DEPTH PUMP INTAKE (ℓ_1) 68·6 (m)

DEPTH WATER LEVEL AT TEST START (ℓ_2) ≏ 21 (m)

AVAILABLE DRAWDOWN 47·6 (m)





	Q (m³/min)	$S_1 = 1$	$\frac{S_1 = 1}{Q}$	$S_1 = 10$	$\frac{S_1 = 10}{Q}$	$S_1 = 100$	$\frac{S_1 = 100}{Q}$	Δs	$\frac{\Delta s}{Q}$
STEP 1	0·71	5·73	8·07	6·72	9·46	7·68	10·82	0·99	1·39
STEP 2	0·74	5·82	7·86	6·85	9·26	7·88	10·65	1·03	1·39
STEP 3	0·75	5·92	7·89	7·00	8·33	8·05	10·73	1·08	1·44
STEP 4	0·78	6·09	7·81	7·18	9·21	8·25	10·58	1·09	1·40
STEP 5	0·82	6·49	7·91	7·62	9·29	8·74	10·66	1·13	1·38
									Ave 1·40 = b

WELL EQUATION $S_t = aQ + cQ^2 + bQ\log_{10}t$

or $S_t/Q = (a + b\log_{10}t) + cQ$

From S_t/Q versus Q: a = 5·8, b = 1·7, c = 2·4

TRANSMISSIVITY $= \frac{0{\cdot}183Q}{\Delta s}$ = (m³/day/m)

THEREFORE WELL EQUATION $S_t = 5{\cdot}8Q + 2{\cdot}4Q^2 + 1{\cdot}7\log_{10}t\,Q$

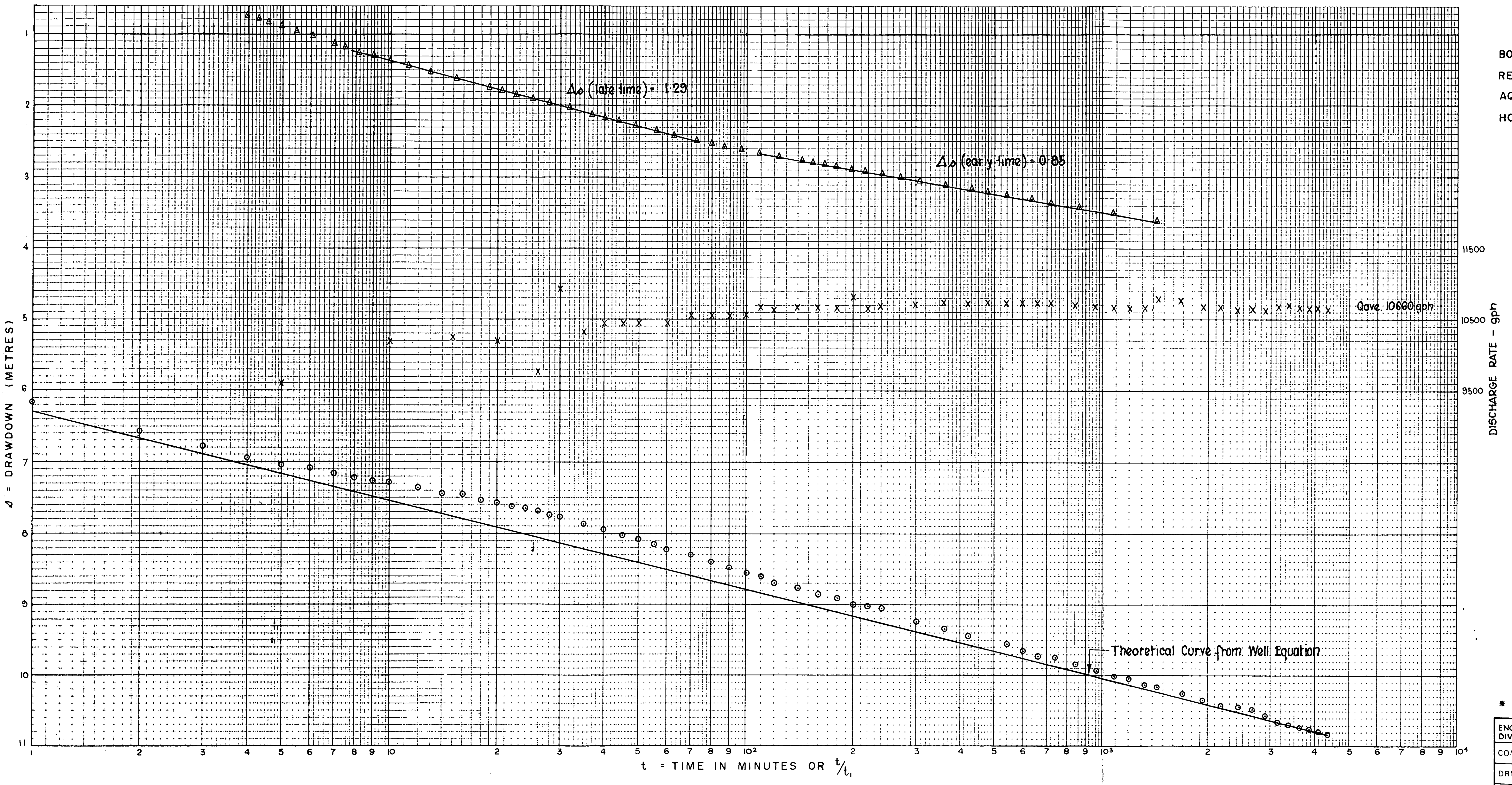
Note: Well Equation obtained using Step 4 and 5 values only

Figure 2

	DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	SCALE AS SHOWN
COMPILED P.C. SMITH	KALANGADOO TOWN WATER SUPPLY INVESTIGATION	DATE SEPT. '79
DRN C.J.W. / CKD	WELL Nº 2 — UNIT Nº 7022994WW03862	PLAN NUMBER 80-23
	STEP DRAWDOWN TEST	

1782

P.F. No. 69—953 MH



BOREHOLE STATE/UNIT No. 7022994WW03862

REF. PT. 1·217 (m) above ground

AQUIFER FROM 104·2 TO 115·6 (m)

HOLE DEPTH 117·5 (m)

TYPE OF PUMP GMC 9 Stage Pomona Line Shaft

LENGTH OF TEST 72 hrs

DEPTH WATER LEVEL AT TEST START (ℓ_2) .... (m)

DEPTH PUMP INTAKE (ℓ_1) 68·6 (m)

* AVAILABLE DRAWDOWN .... (m)

EQUATIONS

$$T = \frac{0.183 \times Q}{\Delta_s} \qquad S \; \frac{2.25 \times T t_0}{r^2}$$

In which

T = Transmissivity (m^3/day/m) S = Storage Coefficient

Q = Pumping Rate (m^3/day) t_o = Zero drawdown time (mins)

Δ_s = Drawdown per log cycle (m) r = Distance to Observation Bore (m)

1 day = 8.64×10^4 secs.

DATA

Qave	Δ_s	
10660 gph.	0·85 (early Rec)	T = 250 m^3/day/m
1162 m^3/day	1·29 (late Rec)	T = 165 m^3/day/m
0·807 m^3/min		

CALCULATIONS

Well Equation $S_t = 5.8Q + 2.4Q^2 + 1.7 \log t \, Q$

where S_t = drawdown at Time t in metres
Q = Discharge Rate in m^3/min
t = Time in minutes

⊙ Drawdown - m
▵ Recovery - m
× Discharge Rate - gph

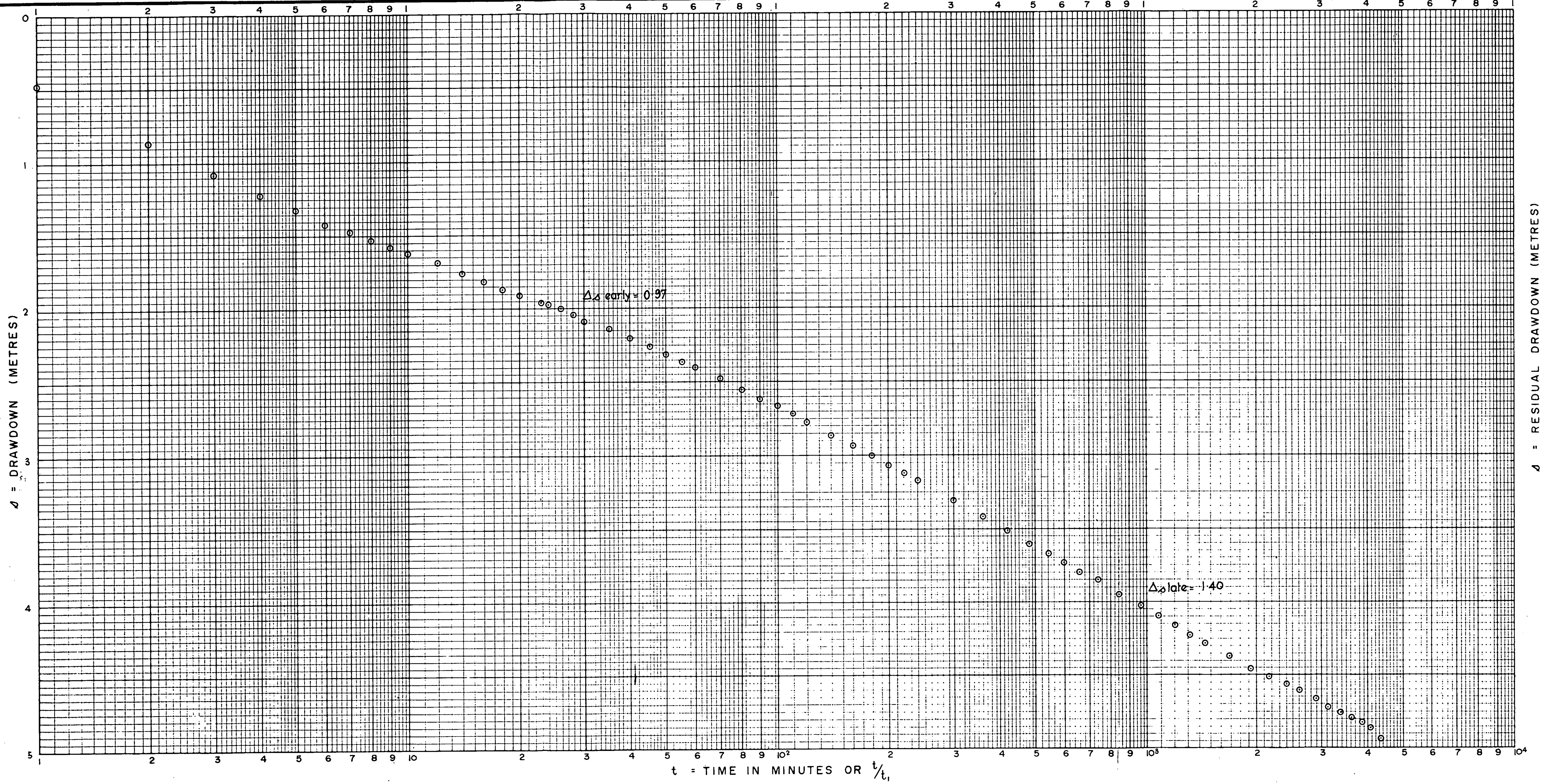
* Available drawdown = $\ell_1 - \ell_2$

Figure 3

ENGINEERING DIVISION	DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	D.M. 463/75
COMPILED P.C. SMITH	KALANGADOO TOWN WATER SUPPLY INVESTIGATION	DATE SEPT '78
DRN C.J.W. CKD	WELL No 2 - UNIT No 7022 994 WW 03862 TIME/DRAWDOWN SEMI-LOG 72 HOUR TEST	PLAN NUMBER 80-24

1782

P.F. No. 69-953 MH



BOREHOLE STATE/UNIT No. 7022 994 WW 00690

REF. PT. approx 0·4 (m) above ground

AQUIFER FROM 104·9 TO 113·0 (m)

HOLE DEPTH 117·8 (m)

TYPE OF PUMP Giles & Goskin Turbine

LENGTH OF TEST 72 hours

DEPTH WATER LEVEL AT TEST START (ℓ_2) 20·672 (m)

DEPTH PUMP INTAKE (ℓ_1) .... (m)

* AVAILABLE DRAWDOWN .... (m)

EQUATIONS

$$T = \frac{0{\cdot}183 \times Q}{\Delta_s} \qquad S = \frac{2{\cdot}25 \times T t_o}{r^2}$$

In which

T = Transmissivity (m^3/day/m)

Q = Pumping Rate (m^3/day)

Δ_s = Drawdown per log cycle (m)

S = Storage Coefficient

t_o = Zero drawdown time (mins)

r = Distance to Observation Bore (m)

1 day = $8{\cdot}64 \times 10^4$ secs.

DATA

Q ave	Δ_s	t_o (day)	r (m)
1162 m^3/day	0·97 (early)	$1{\cdot}53 \times 10^{-4}$	22
	1·4 (late)	$9{\cdot}38 \times 10^{-4}$	

CALCULATIONS

T early = 219 m^3/day/m

T late = 152 m^3/day/m

$$S = \frac{2{\cdot}25 \times 219 \times 1{\cdot}53 \times 10^{-4}}{(22)^2} = 1{\cdot}6 \times 10^{-4}$$ using early time t_o and T

$$S = \frac{2{\cdot}25 \times 152 \times 9{\cdot}38 \times 10^{-4}}{(22)^2} = 6{\cdot}6 \times 10^{-4}$$ using late time t_o and T

* Available drawdown = $\ell_1 - \ell_2$

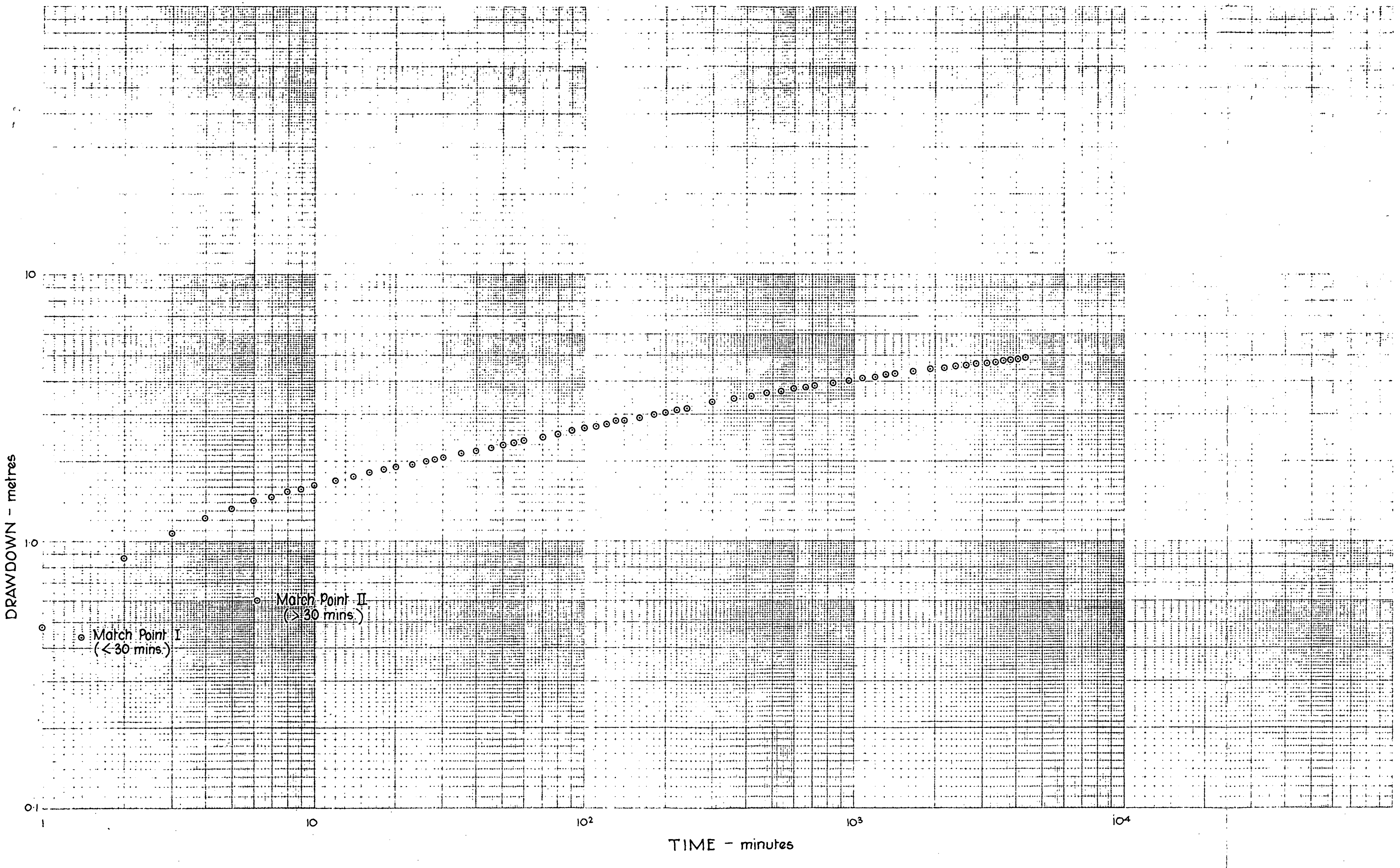
Note: Observation at Kalangadoo Town Water Supply No. 1

Figure 4.

ENGINEERING DIVISION	DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	D.M. 463/75
COMPILED: P.C. SMITH	KALANGADOO TOWN WATER SUPPLY INVESTIGATION	DATE SEPT '79
DRN C.J.W. / CKD	OBSERVATION WELL - UNIT Nº 7022 994 WW 00690 TIME/DRAWDOWN SEMI-LOG PLOT 72 HOUR TEST	PLAN NUMBER 80-25

1782

P.F. No. 69-953 MH



WELL No. 7022 994 WW 00690

TYPE OF PUMP Giles & Gaskin Turbine

DISCHARGE STARTED AT 10 a.m.
ON 31.7.79

DISCHARGE STOPPED AT 10 a.m.
ON 3.8.79

INTERVAL TESTED 104·9 TO 113·0 m

HOLE DEPTH 117·8 m

CALCULATIONS

Match Point I

$s = 0{\cdot}44\,m$

$t = 1{\cdot}4$ mins. $= 9{\cdot}7 \times 10^{-4}$ days

$L(u,v) = 1$

$u = 10^{-1}$

$Q = 1162\ m^3/day$

$r = 22\,m$

$$T = \frac{Q}{4\pi} \cdot \frac{L(u,v)}{s} = \frac{1162}{4\pi} \cdot \frac{1}{0{\cdot}44} = 210\ m^3/day/m$$

$$S = \frac{4Tut}{r^2} = 1{\cdot}7 \times 10^{-4}$$

Match Point II

$s = 0{\cdot}61\,m.$

$t = 6{\cdot}2$ mins. $= 4{\cdot}3 \times 10^{-3}$ days

$L(u,v) = 1$

$u = 10^{-1}$

$Q = 1162\ m^3/day$

$r = 22\,m$

$$T = \frac{1162}{4\pi} \cdot \frac{1}{0{\cdot}61} = 152\ m^3/day/m$$

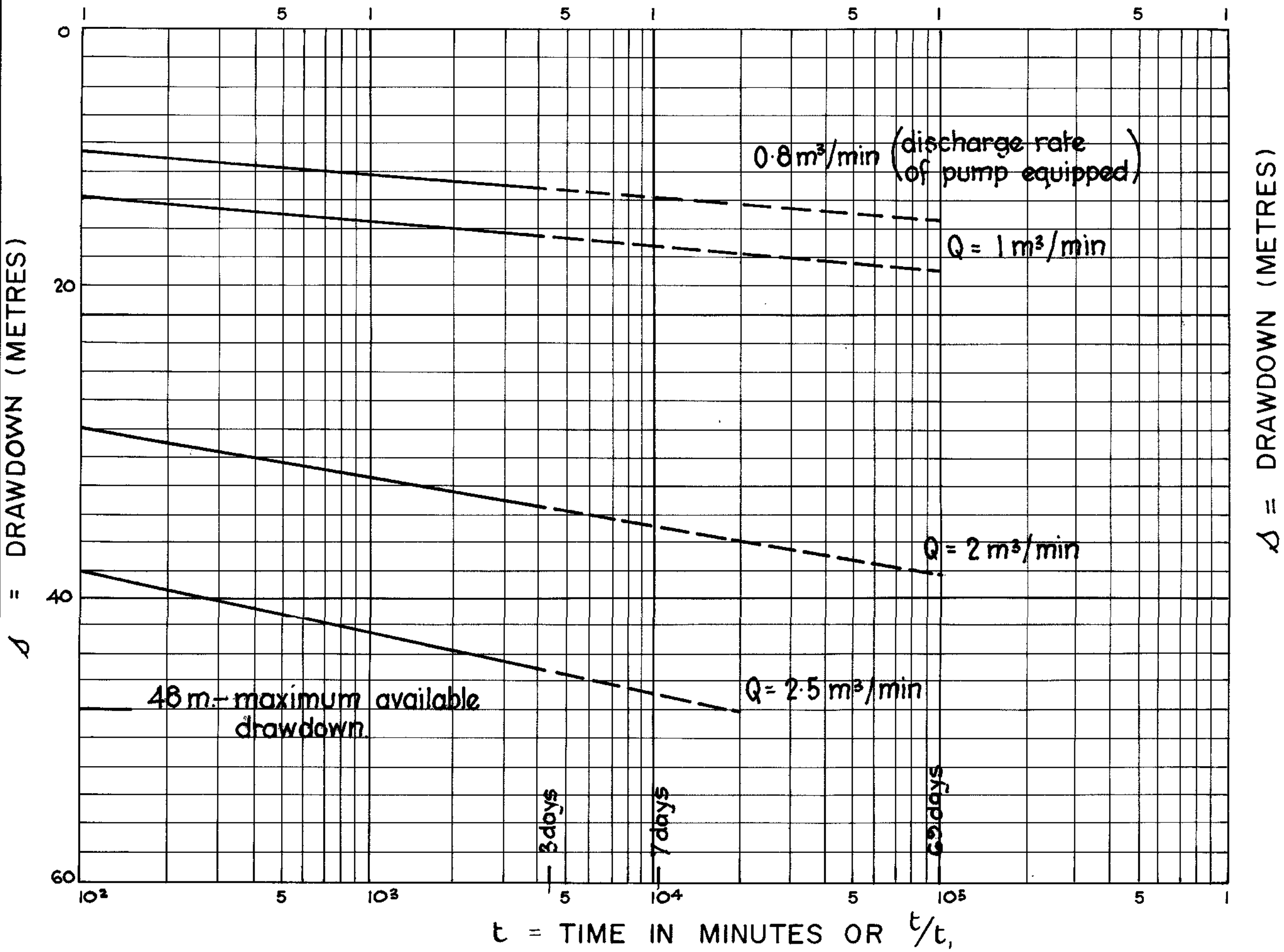
$$S = \frac{4 \times 152 \times 10^{-1} \times 4{\cdot}3 \times 10^{-3}}{(22)^2} = 5{\cdot}4 \times 10^{-4}$$

Figure 5

ENGINEERING DIVISION		DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	SCALE: AS SHOWN
COMPILED: P.C.SMITH		KALANGADOO TOWN WATER SUPPLY INVESTIGATION	DATE: SEPT '79
DRN: C.J.W	CKD:	OBSERVATION WELL - UNIT Nº 7022 994 WW 00690 LOG- LOG PLOT 72 HOUR TEST	PLAN NUMBER 80-26

1782

1782



STATE/UNIT No. 7022 994 WW03862

PRODUCTION/OBSERVATION WELL

INTERVAL TESTED

From 104·2 m. to 115·6 m.

HOLE DEPTH 117·5 m.

AQUIFER THICKNESS 11·4 m.

DEPTH OF PUMP INTAKE 68·6 m.

DEPTH OF WATER LEVEL AT TEST START approx 21 m.

AVAILABLE DRAWDOWN 47·6 m.

$$\delta t = 5{\cdot}8Q + 2{\cdot}4Q^2 + 1{\cdot}7 \log_{10} t\, Q$$

δt = drawdown in metres at time t

Q = discharge rate in m³/min

t = time in minutes

Note:
1) m³/min x13210 = gph.
2) Maximum available drawdown 48 m.
3) Values reliable to 3 days – extrapolation thereafter.

* Check applicability of this method

Figure 6

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

KALANGADOO TOWN WATER SUPPLY INVESTIGATION
WELL No 2 - UNIT No 7022 994 WW03862
PREDICTED DRAWDOWN VERSUS TIME CURVES

COMPILED P.C.SMITH | DRN C.J.W | CKD

SCALE AS SHOWN | DATE SEPT '79 | PLAN NUMBER 514545

MF 89