DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

Rept. Bk. No. 89/89

NEPABUNNA - PROPOSED ARTIFICIAL RECHARGE SCHEME

GEOLOGICAL SURVEY

by

R E READ

GROUNDWATER AND ENGINEERING

FEBRUARY, 1990

DME 1002/74

B00919

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DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

Rept. Bk. No. 39/89
D.M.E. No. 1002/74
B00919

NEPABUNNA - PROPOSED ARTIFICIAL RECHARGE SCHEME

ABSTRACT

Nepabunna's water supply has a salinity of 1300 mg/L and high carbonate hardness (550 mg/L). The latter causes severe scaling in pipes.

Artificial recharge was suggested as a means of introducing low salinity floodwaters into the aquifer to lower salinity and hardness.

Backhoe pitting in the stream bed confirmed the presence of thick clayey gravels and clays inhibiting natural recharge, but showed that they were too deep for modification of the stream bed to be economic.

Instead a scheme was proposed to divert some streamflow into an off-stream storage for later injection. A diversion weir and storage were designed by the Department of Agriculture and an injection well was drilled.

At this stage SACON reviewed the project and decided to proceed with water treatment rather than the artificial recharge scheme.

Subject to testing, the injection well may be suitable for equipping as a standby production well.

INTRODUCTION

Nepabunna is an Aboriginal village of 100 people in the north Flinders Ranges, about 65 km east of Copley by road (Fig 1). Aboriginal Works unit of SACON wished to undertake further drilling to establish a better quality water supply.

SADME advised against this for the following reasons:

A. SACON had spent a considerable amount running power lines to the existing wells, converting to electric motors and improving the headworks.

B. Experience showed that it was unlikely that a better quality supply could be developed in this area.

Although a new well might have a lower salinity than the existing well when drilled its salinity and hardness would almost certainly deteriorate under sustained pumping to about that of the existing well.

Instead it was suggested that an artificial recharge scheme might be a better solution.

This report documents SADME's role in the investigation of an artificial recharge scheme.

HISTORY

Up until 1983 Nepabunna had a long history of water supply problems as successive wells tapping limited local aquifers failed to meet demand (Read 1980 and 1983). At least 12 wells had been dug or drilled in attempts to provide Nepabunna with a reliable water supply.

In 1983 a well was drilled 2 km west of Nepabunna (Fig 2 & 3) to tap an extensive limestone aquifer. This ended the shortages in supply, but salinity, while better than the previous wells, was still poor and increased with time. The major problem is the high carbonate hardness (Table 1) which resulted in extensive scale deposition in pipes.

HYDROGEOLOGICAL SETTING

The production well taps an aquifer in the Parara Limestone, close to Mount McKinlay Creek (Fig. 2). Standing water level is about 45 m, showing that the regional gradient is gentle because of relatively high transmissivities and low recharge rates.

Groundwater in this area generally ranges from 1000 mg/L to 3000 mg/L, the better waters generally occurring close to creeks.

TABLE 1 WATER ANALYSES

Well	Date	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	SO_4^{2-}	Cl^{-}	Conductivity ECU	TDS mg/L	Comment
6636/101	25/1/86	320	60	214	4	495	335	554	3 200	1 740	Production Well
6636/149	13/5/83	142	76	85	5	472	259	153	1 547	954	Production Well
6636/149	26/10/84	188	74	109	4	569	295	177	1 790	990	
6636/149	23/1/86	196	77	130	5	591	320	218	2 100	1 190	
6636/149	5/6/87	210	86	125	3	612	365	193	1 950	1 083	
6636/149	28/2/89								1 930	1 066	
6636/209	13/5/89	152	69	130	4	423	310	179	1 740	982	Proposed Injection Well

WATER DEMAND

SACON have estimated water demand at 12 kL/day (approx 4 ML/year).

However estimates based on hours of pumping suggest an average of 57 kL/day (21 ML/year) (Appendix D). An annual consumption in the range 10 to 20 ML/year is considered likely.

PROPOSED RECHARGE SCHEME

Several options for artificial recharge were considered:

A. Modification of the stream bed to permit more rapid infiltration of stream flow.

B. Construction of filter intakes under the stream bed to conduct water to an injection well during stream flows.

C. Construction of a diversion weir and off stream storage for later injection by injection well.

Backhoe pitting showed (Appendix C) that permeabilities of the stream gravels and underlying weathered limestone were too low for 'A' or 'B' to be successful.

However preliminary investigations by Mr Moore of Department of Agriculture indicated that an off stream storage and diversion weir could be economically constructed near the production wells.

DRILLING

An injection well was drilled 45 m from the production well (Fig. 3). The geological logs are shown in Appendix A and the depth yield graph in Figure 4.

The first attempt was abandoned at 65 m when a hammer bit shanked off. It was left open as an observation well. The second attempt was successful. Details are in Table 2.

Although the well airlifted 20 L/s the aquifer is deep and apparently a finely fissured fault zone rather than the solution joints hoped for.

This makes the well more prone to clogging by larger particles. While most of the coarser suspended solids will settle in the dam, organic matter (algae, shield-shrimps) would develop and could rapidly clog the injection well.

TABLE 2 WELLS DRILLED 1989

Permit No	Unit No	Depth (m)	Yield L/s	Casing	Comments
252707	6636/165	65	0.3	4.5	Observation Well
952707	6636/209	101	20	98m of 125mm PVC slotted 14 to 98m	Injection well

DISCUSSION

After the injection well had been drilled SACON decided to review water supply options for Nepabunna.

The review concluded that the diversion and storage works needed to be much more substantial (and hence more costly) and that water treatment was more attractive.

Either reverse osmosis or ion-exchange softening could be used.

The former would require increased groundwater pumping. The latter would produce a high sodium water unsuitable for garden use.

CONCLUSIONS

1. The injection well as drilled should be capable of accepting about 10 L/s.

2. Tne injection well is liable to clogging.

3. As the recharge scheme is not to proceed the well drilled as an injection well may be suitable for use as a standby production well.

RECOMMENDATIONS

1. If the desalination option is proceeded with the production well should be test-pumped to confirm that the present well and pump-setting are adequate for the resulting increased demand.

2. If it is desired to equip the new well for production a pumping test should be carried out to determine the amount of interference.

3. Because of the location of the new well it must be sealed to prevent entry of floods.

R. E Read

R E READ

SENIOR GEOLOGIST

REFERENCES

Read, R.E., 1981. Nepabunna Water Supply, 1980 Drilling. SADME unpubl. report 81/13.

Read, R.E., 1984. Nepabunna Water Supply - 1983 Drilling, SADME unpubl. report 84/99.

APPENDIX A

GEOLOGICAL LOGS

CONTENTS

MF32

PROJECT Nepabunna-Recharge

DEPARTMENT OF MINES AND ENERGY—SOUTH AUSTRALIA

LOCATION OR COORDS

WATER WELL LOG

HOLE NO: PIV22702

SEC. HD. Out of

El. Surface m

El. Ref. Point m Datum

UNIT / NO. 6636/165

DME

AQUIFER SUMMARY:	DEPTH TO WATER CUT (m)	DEPTH TO STANDING WATER (m)	INTERVAL TESTED From:	To:	SUPPLY sec	Test Length hrs	Method	TOTAL DISSOLVED SOLIDS milligrammes/litre	Analysis No:
	59	45			small	Air lift while drilling			W —
	63				0.1	" "	" "		
	64				0.3	" "	" "		

DEPTH (m) From	To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia(mm)	From(m)	To(m)
0	3		Gravel	Light brown sandy gravel	Quaternary				
3	9		Limestone	Some nodules of medium-grey salty limestone, mostly weathered to yellow brown fariable siltstone.	Parara Limestone				
9	12		Limestone	Less weathered, but still some moderate brown silty limestone Weathered zone at 10m.	Cambrian				
12	39		Limestone	Medium grey, silty					
39	48		Limestone	As above, but still showing some staining.					
48	54		Limestone	Medium grey, silty limestone,					
54	65		Limestone	Dark grey, silty limestone with pyrite. Some with vein calcite.					

REMARKS

Drilling stopped at 65 m when bit shanked off.

* NOTE: sec 800gcs =

DRILL TYPE Rotary COMPLETED 11/5/89

CIRCULATION Air LOGGED BY R. Read

DATE 11/5/89 SHEET 1 OF 1

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PROJECT NEPABUNNA - recharge

MINES DEPARTMENT — SOUTH AUSTRALIA
ENGINEERING DIVISION

WATER WELL LOG

HOLE NO: P/N 95207

LOCATION OR COORDS

UNIT / STATE NO 6536/209

SEC. HD OUT OF EL Surface m EL Ref Point m Datum

DM

AQUIFER	DEPTH TO WATER CUT (m)	DEPTH TO STANDING WATER (m)	INTERVAL TESTED From:	INTERVAL TESTED To:	SUPPLY L/s	SUPPLY Test Length (hrs)	SUPPLY Method	TOTAL DISSOLVED SOLIDS milligrammes/litre	Analysis No.
SUMMARY:	53		0	55	0.8			977	W — 3182/89
	57		0	57	1·4			944	3183/89
	77		0	88	8.5			927	3184/89
	99		0	101.6	20+			958	3185/89

DEPTH (m) From	DEPTH (m) To	GRAPHIC LOG	ROCK / SEDIMENT NAME	GEOLOGICAL DESCRIPTION	FORMATION / AGE	DEPTH CORE SAMPLE	CASING Dia(mm)	CASING From(m)	CASING To(m)
0	3		Gravel	No samples, similar to PN 22702	Quaternary				
3	63		Limestone	Similar to PN 22702 Weathered zone at 31m, rapid drilling and yellow brown colour	Parara Limestone, Cambrian				
63	65		Limestone	Dark grey silty limestone					
65	66		Limestone	Weathered, to soft yellow brown rock, rapid drilling.					
66	76		Limestone	Dark grey, silty.					
76	77		Limestone	Broken, rapid drilling					
77	97		Limestone	Dark grey silty limestone					
97	99		Calcite vein	Fractured vein calcite with pyrite veinlets.					
99	101		Limestone	Dark grey, silty					

REMARKS:

* NOTE: 110 kl / day = 1000gals / hr.

* See depth yield graph for more detail

DRILL TYPE ROTARY

CIRCULATION: AIR

SHEET 1 OF 1

COMPLETED 15/5/89

LOGGED BY: R E READ

DATE: 13/5/89

APPENDIX B

MODELLING OF PROPOSED RECHARGE SCHEME

An attempt was made to model the behaviour of the proposed scheme using the following assumptions:

1. Storage volume of off stream storage is 10 ML.

2. Daily creek flow at the proposed site is 1/40 of flow at the gauging station at Wertaloona, when this is over 40 ML/day.

3. Injection rate is 500 kL/day.

The design volume of the dam is 13 ML. Allowing for losses by leakage and evaporation this has been assumed to be 10 ML.

The catchment area is 24 km^2 compared to 1010 km^2 at Wertaloona. Since the catchment upstream from Nepabunna is a better runoff generator than the catchment as a whole the estimate of creek flow as 1/40 of flow at Wertaloona should be conservative.

The streamflow record begins in September 1973. 1974 was a very wet year, and the recorder was out of action from May 1974 to November 1975. In the four months of 1974 for which records are available about 60 ML could have been recharged.

1974 was ignored and the period from February 1976 to December 1987 has been considered. Results indicate that an average of 7 ML/year could have been injected. This is considered a minimum estimate. Minor flows originating from thunderstorms in small catchments could provide sufficient flow to fill a 10 ML dam, but not reach the gauging station.

STREAMFLOW SALINITY

Information from Mr Steer of ETSA is that the salinity of water intake to Aroona Dam is under 200 mg/L.

The Aroona catchment includes some areas of shallow saline groundwater (e.g. Salt Creek) which could be expected to contribute more salt than the overall catchment. No such areas exist in the Nepabunna catchment.

200 mg/L is a reasonable estimate for the salinity of the water likely to be caught in the proposed dam.

QUALITY OF WATER WITHDRAWN

The average salinity of water pumped will be approximated by the following equation:

$$C = \frac{IC_1 + (E-I)\ C_2}{E}$$

where
- C is average salinity of water pumped
- C_1 is salinity of injected water
- C_2 is salinity of native groundwater
- E is annual volume pumped
- I is average annual volume injected for values of E greater than I.

C_1 and C_2 are assumed to be 200 mg/L and 1300 mg/L respectively. Neither the rate of pumping nor the rate of injection are known accurately.

Estimated salinities of extracted water for various ratios of injection to extraction are tabulated below.

I>E,	Salinity tends to	200 mg/L
I=0.5E,	"	750 mg/L
I=0.25E,	"	1000 mg/L

APPENDIX C

BACKHOE PITTING

Eight backhoe pits were dug in the bed of Mount McKinlay Creek and on the adjacent bank. Locations are shown in Figure 5 and the logs below.

The pits showed that in general 1 to 1.5m of loose relatively permeable gravels overlie about 1m of tight clayey gravels, which overlie clay derived from weathering the limestone.

The gravels appear to have a permeability of 1 to 2m/day. The permeability of the clayey gravels has not been estimated but would be low.

Infiltration rates in the weathered limestone were measured at about 0.5m/day, but this could decrease with time.

Infiltration rates in the weathered limestone were estimated by excavating small basins (~ 200 to 300 mm diameter) on the floor of backhoe pits, filling them with water and measuring the rate of decline of water level. Results are shown in Figures 6 to 8.

Average infiltration rates are about 0.5m/day, but could decrease with time. To be effective a direct infiltration system would need to be able to infiltrate 1000 m^3/day, that is an area of at least 2000 m^2. It would be necessary to move about 6000 m^3 of gravels out of the streambed. About 2000 to 3000 m^3 of the more permeable upper gravels would then have to be replaced giving a total of over 8000 m^3 to be moved.

Similarly construction of infiltration drains would be impractical using the low permeability river gravels. Permeable trenches backfilled with filter sand would be liable to scouring by floods.

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DEPARTMENT OF MINES SOUTH AUSTRALIA
ENGINEERING DIVISION

EXCAVATION NO. 1

LOG OF EXCAVATION

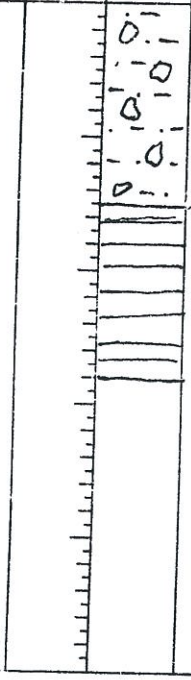
PROJECT NEPABUNNA

SECTION ... SURFACE ELEV ... LOCATION

HUNDRED Out of DATUM ... OR CO-ORDS ...

TYPE OF EXCAVATION Backhoe pit DATE 28/2/89

MAXIMUM DEPTH 2.8 m WIDTH ... m LENGTH ... m

FORMATION SOIL HORIZON	PROFILE ELEV. m / DEPTH m	PROFILE GRAPHIC LOG	UNIFIED SYMBOL	DESCRIPTION AND STRUCTURE (UNIFIED SOIL CLASSIFICATION)	WATER LEVEL	MOISTURE CONTENT	CONSISTENCY REL. DENSITY	TEST – * SAMPLE – ■
				0-1.5 Creek gravel, becoming more clayey with depth 1.5-2.8 Weathered limestone. Nodules of fresh grey limestone enclosed in red and yellow clay Logged R. Read				

PROFILE/REMARKS

WATER LEVEL	MOISTURE CONTENT	CONSISTENCY (CLAY)	RELATIVE DENSITY (ESTIMATED)	*TEST, ■SAMPLE DESCRIPTION	
Water level (date) Water cut SP=Seepage	D - Dry M - Moist W - Wet LL - Liquid limit PL - Plastic limit	S - Soft F - Firm St - Stiff H - Hard	oose MD Medium Dense D - Dense F - Friable		LOGGED ... DATE ... TRACED ... DATE ...
				SHEET ... OF ...	DRG. NO S

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DEPARTMENT OF MINES SOUTH AUSTRALIA
ENGINEERING DIVISION

EXCAVATION NO. 2

LOG OF EXCAVATION

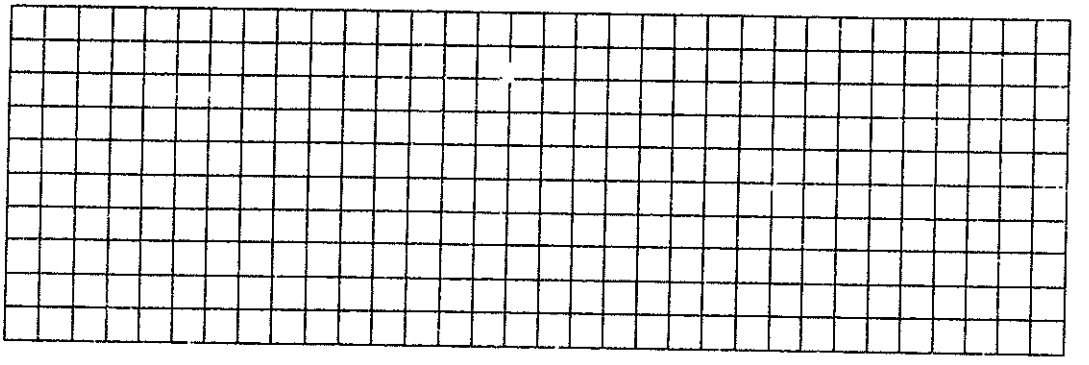
PROJECT NEPABUNNA

SECTION
HUNDRED Out of
SURFACE ELEV
DATUM
LOCATION
OR CO-ORDS

TYPE OF EXCAVATION
DATE 28/2/89
MAXIMUM DEPTH 2.2 m
WIDTH m
LENGTH m

FORMATION SOIL HORIZON	PROFILE: ELEV. m / DEPTH m	PROFILE: GRAPHIC LOG	UNIFIED SYMBOL	DESCRIPTION AND STRUCTURE (UNIFIED SOIL CLASSIFICATION)	WATER LEVEL	MOISTURE CONTENT	CONSISTENCY REL. DENSITY	TEST - * SAMPLE - ■
				0-0.6 Creek gravel with cobbles on irregular surface. Red-brown clayey gravel in deeper parts. 0.6-2.8 Beds of nodular limestone interbedded with soft silty material. Some irregular joints strike 130°T, dip 80°W. Bedding 060°T, 40°SE Logged R. Read				

PROFILE/REMARKS



WATER LEVEL	MOISTURE CONTENT	CONSISTENCY (CLAY)	RELATIVE DENSITY (ESTIMATED)	*TEST, ■SAMPLE DESCRIPTION	
Water level (date) Water cut SP=Seepage	D - Dry M - Moist W - Wet LL - Liquid limit PL - Plastic limit	S - Soft F - Firm St. - Stiff H - Hard	L - Loose MD Medium Dense D - Dense F - Friable		LOGGED DATE TRACED DATE SHEET OF DRG. NO. S

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DEPARTMENT OF MIN... SOUTH AUSTRALIA
ENGINEERI... DIVISION

EXCAVATION NO. 3

LOG OF EXCAVATION

PROJECT NEPABUNNA

SECTION | SURFACE ELEV | LOCATION

HUNDRED | DATUM | OR CO-ORDS

TYPE OF EXCAVATION | DATE 28/2/89

MAXIMUM DEPTH 1.8 m | WIDTH m | LENGTH m

FORMATION SOIL HORIZON	PROFILE ELEV. m DEPTH m	PROFILE GRAPHIC LOG	UNIFIED SYMBOL	DESCRIPTION AND STRUCTURE (UNIFIED SOIL CLASSIFICATION)	WATER LEVEL	MOISTURE CONTENT	CONSISTENCY REL. DENSITY	TEST - * SAMPLE - ■
				0-1.3 Loose creek gravels 1.3-1.8 Red-brown clayey gravel, over limestone Logged R. Read				

PROFILE/REMARKS

WATER LEVEL	MOISTURE CONTENT	CONSISTENCY (CLAY)	RELATIVE DENSITY (ESTIMATED)	*TEST, ■SAMPLE DESCRIPTION	
Water level (date) Water cut SP=Seepage	D - Dry M - Moist W - Wet LL - Liquid limit PL - Plastic limit	S - Soft F - Firm St. - Stiff H - Hard	L - Loose MD Medium Dense D - Dense F - Friable	SHEET ... OF ...	LOGGED ... DATE ... TRACED DATE ... DRG. NO. S

DEPARTMENT OF MINES SOUTH AUSTRALIA
ENGINEERING DIVISION

EXCAVATION NO. 4

LOG OF EXCAVATION

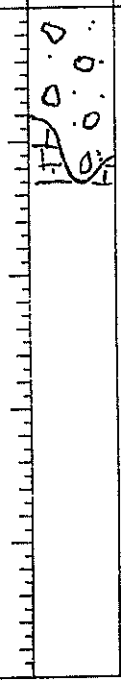
PROJECT . NEPABUNNA

SECTION . . . . SURFACE ELEV . LOCATION

HUNDRED . . . DATUM OR CO-ORDS

TYPE OF EXCAVATION . . . . . DATE 28/2/89

MAXIMUM DEPTH . . 1.3 m WIDTH . . m LENGTH . m

FORMATION SOIL HORIZON	PROFILE ELEV. m / DEPTH m	PROFILE GRAPHIC LOG	UNIFIED SYMBOL	DESCRIPTION AND STRUCTURE (UNIFIED SOIL CLASSIFICATION)	WATER LEVEL	MOISTURE CONT/FNT	CONSISTENCY REL. DENSITY	TEST - * SAMPLE - ■
				Gravels 0.8 to 1.3 m thick with an irregular contact with hard limestone Logged R. Read				

PROFILE/REMARKS

WATER LEVEL	MOISTURE CONTENT	CONSISTENCY (CLAY)	RELATIVE DENSITY (ESTIMATED)	*TEST. ■SAMPLE DESCRIPTION	
Water level (date) ▶ Water cut SP=Seepage	D - Dry M - Moist W - Wet LL - Liquid limit PL - Plastic limit	S - Soft F - Firm St. - Stiff H - Hard	L - Loose MD Medium Dense D - Dense F - Friable		LOGGED . . . . . DATE . . . . . TRACED . . . . . DATE . . . . . DRG. NO S

SHEET . . OF . .

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DEPARTMENT OF MINES SOUTH AUSTRALIA
ENGINEERING DIVISION

EXCAVATION NO. 5

LOG OF EXCAVATION

PROJECT NEPABUNNA

SECTION . . . SURFACE ELEV . . . LOCATION

HUNDRED . . . DATUM . . . OR CO ORDS

TYPE OF EXCAVATION . . . . . DATE . . .

MAXIMUM DEPTH 3 . m WIDTH . n LENGTH . m

FORMATION SOIL HORIZON	PROFILE ELEV. m DEPTH m	PROFILE GRAPHIC LOG	UNIFIED SYMBOL	DESCRIPTION AND STRUCTURE (UNIFIED SOIL CLASSIFICATION)	WATER LEVEL	MOISTURE CONTENT	CONSISTENCY REL. DENSITY	TEST * SAMPLE ■
				0-1.3 Brown loose creek gravel				
				1.3-2.4 Red-brown tough silty gravel				
				2.4-3.0 Yellow to yellow-brown calcareous clay				
				Logged R. Read				

PROFILE/REMARKS

WATER LEVEL	MOISTURE CONTENT	CONSISTENCY (CLAY)	RELATIVE DENSITY (ESTIMATED)	*TEST, ■SAMPLE DESCRIPTION	
Water level (date) / Water cut / SP=Seepage	D - Dry M - Moist W - Wet LL - Liquid limit PL - Plastic limit	S - Soft F - Firm St. - Stiff H - Hard	L - Loose MD Medium Dense D - Dense F - Friable		LOGGED . . . . DATE . . . . TRACED . . . . DATE . . . . SHEET . . . OF . . . . DRG. NO S

DEPARTMENT OF MINES SOUTH AUSTRALIA
ENGINEERING DIVISION

EXCAVATION NO. 6

LOG OF EXCAVATION

PROJECT . NEPABUNNA

SECTION . . . . . SURFACE ELEV. . . . . LOCATION

HUNDRED . . . . . DATUM . . . . . OR CO-ORDS .

TYPE OF EXCAVATION . . . . . DATE . . . . . .

MAXIMUM DEPTH . . 2.2 . . m WIDTH . . . . m LENGTH . . . . m

FORMATION SOIL HORIZON	PROFILE ELEV. m / DEPTH m	PROFILE GRAPHIC LOG	UNIFIED SYMBOL	DESCRIPTION AND STRUCTURE (UNIFIED SOIL CLASSIFICATION)	WATER LEVEL	MOISTURE CONTENT	CONSISTENCY REL. DENSITY	TEST - * SAMPLE - ■
				0-0.9 Loose brown silty gravel 0.9-1.2 Tough reddish-brown silty gravel 1.2-2.2 Yellow clay, with some bands of hard limestone Logged R. Read				

PROFILE/REMARKS

WATER LEVEL	MOISTURE CONTENT	CONSISTENCY (CLAY)	RELATIVE DENSITY (ESTIMATED)	*TEST, ■SAMPLE DESCRIPTION	
Water level (date) / Water cut	D - Dry	S - Soft	L - Loose		LOGGED . . . .
SP=Seepage	M - Moist	F - Firm	MD Medium Dense		DATE . . . .
	W - Wet	St. - Stiff	D - Dense		TRACED . . . .
	LL - Liquid limit	H - Hard	F - Friable		DATE . . . .
	PL - Plastic limit			SHEET . . OF . . .	DRG. NO. S

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DEPARTMENT OF MINES SOUTH AUSTRALIA
ENGINEERING DIVISION

EXCAVATION NO. 7

LOG OF EXCAVATION

PROJECT NEPABUNNA

SECTION . . . . . SURFACE ELEV. . . . . LOCATION

HUNDRED . . . . . DATUM . . . . . OR CO-ORDS . . . .

TYPE OF EXCAVATION . . . . . DATE . . . . . .

MAXIMUM DEPTH 3.0 m WIDTH . . . . . m LENGTH . . . . . m

FORMATION SOIL HORIZON	PROFILE ELEV. m / DEPTH m	PROFILE GRAPHIC LOG	UNIFIED SYMBOL	DESCRIPTION AND STRUCTURE (UNIFIED SOIL CLASSIFICATION)	WATER LEVEL	MOISTURE CONTENT	CONSISTENCY REL. DENSITY	TEST * / SAMPLE ■
	0 / 0			0-0.6 Silty cobble gravel				
	0.6 / 0.6			0.6-1.1 Pebbly silty sand				
	1.1 / 1.1			1.1-1.3 Cobble gravel				
	1.3 / 1.3			1.3-1.5 Brown silty sand				
	1.5 / 1.5			1.5-1.7 Brown silty gravel				
	1.7 / 1.7			1.7-3.0 Red-brown silty gravel				
	3.0 / 3.0			Logged R. Read				

PROFILE/REMARKS

WATER LEVEL	MOISTURE CONTENT	CONSISTENCY (CLAY)	RELATIVE DENSITY (ESTIMATED)	*TEST, ■SAMPLE DESCRIPTION	
Water level (date) / Water cut / SP=Seepage	D - Dry M - Moist W - Wet LL - Liquid limit PL - Plastic limit	S - Soft F - Firm St. - Stiff H - Hard	L - Loose MD Medium Dense D - Dense F - Friable	SHEET . . OF . .	LOGGED . . . . . DATE . . . . . TRACED DATE . . . . . DRG. NO. S

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DEPARTMENT OF MINES SOUTH AUSTRALIA
ENGINEERING DIVISION

EXCAVATION NO. 8

LOG OF EXCAVATION

PROJECT Nepabunna

SECTION | SURFACE ELEV | LOCATION

HUNDRED | DATUM | OR CO ORDS

TYPE OF EXCAVATION | DATE 28/2/89

MAXIMUM DEPTH m | WIDTH m | LENGTH m

FORMATION SOIL HORIZON	PROFILE: ELEV m / DEPTH m	PROFILE: GRAPHIC LOG	UNIFIED SYMBOL	DESCRIPTION AND STRUCTURE (UNIFIED SOIL CLASSIFICATION)	WATER LEVEL	MOISTURE CONTENT	CONSISTENCY REL DENSITY	TEST * / SAMPLE ■
	0			Gravels varying from 0.8 to 1.1m thick.				
	1			Hard yellow-brown limestone interbedded with limestone weathered to soft white silt.				

PROFILE/REMARKS

WATER LEVEL	MOISTURE CONTENT	CONSISTENCY (CLAY)	RELATIVE DENSITY (ESTIMATED)	*TEST, ■SAMPLE DESCRIPTION
Water level (date) / Water cut / SP=Seepage	D - Dry M - Moist W Wet LL - Liquid limit PL - Plastic limit	S - Soft F Firm St. - Stiff H - Hard	L Loose MD Medium Dense D - Dense F - Friable	SHEET OF

LOGGED R Read
DATE 28/2/89
TRACED
DATE

DRG NO S

APPENDIX D

WATER CONSUMPTION AT NEPABUNNA

The estimate is based on readings of the hour meters on the pumps at Nepabunna and the assumption that the pumps are running at the design rate of 1.2 L/s.

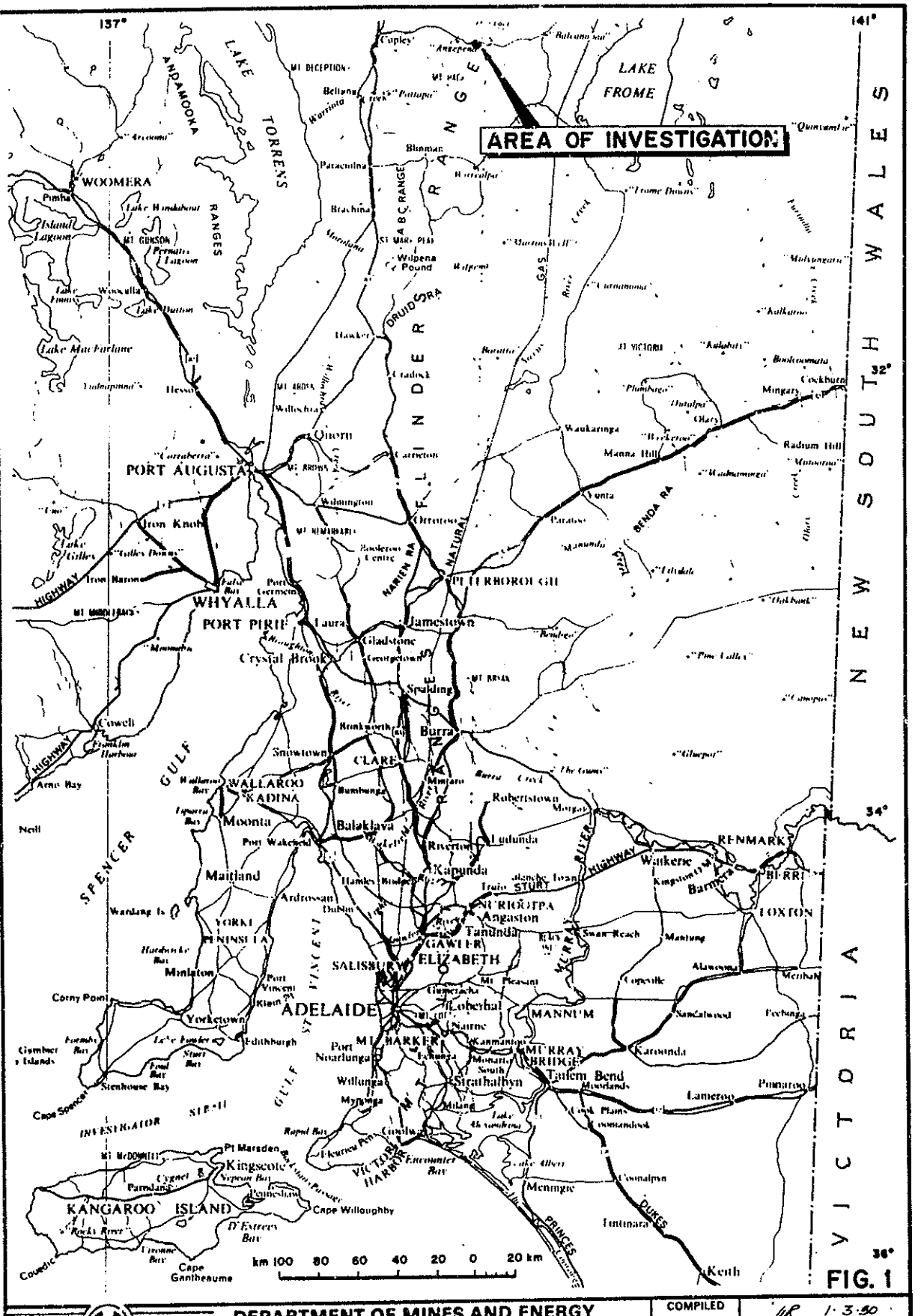
Date	New-Bore 'No 2'	Bore No 1	
Sept 88	Pumps electrified	-	meters at '0'
11/5/89	2439 hrs	-	(Read by R. Read)
22/9/89	3646 hrs	1175 hrs	(Read by J. Coulthard)

From the above it appears that 20 800 kl have been pumped in 12 months, an average of 57 kL/day.

This is an average daily consumption of about 570 L per person, which is reasonable compared with 780 L per person at Leigh Creek.

The peak weekly demand is not known. Using the ratio between average and peak use at Leigh Creek gives about 90 kL/day.

A reasonable guess is that a system should be designed for a peak demand of about 75 kL/day, and an annual consumption of 21 ML.

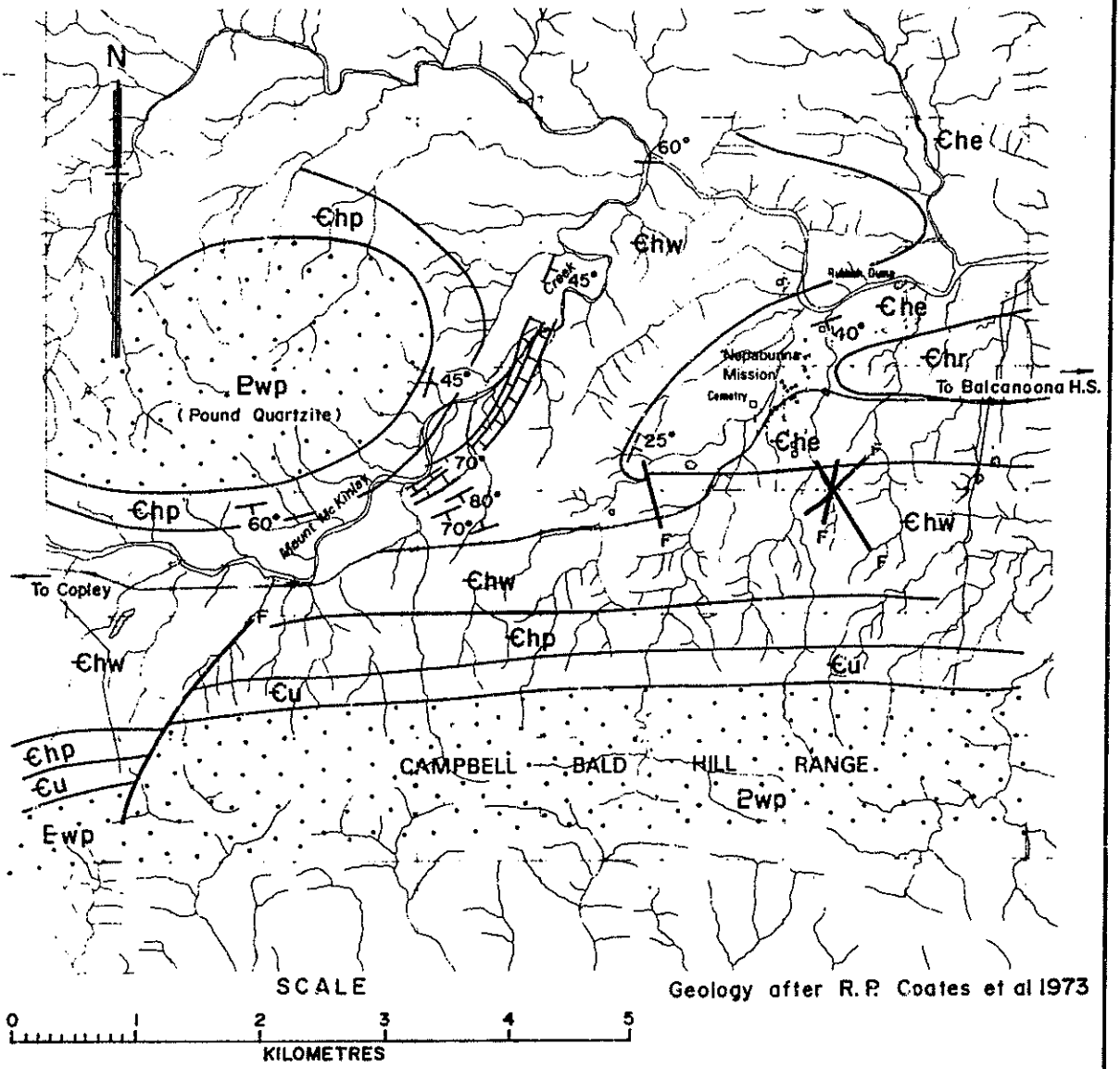


DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

NEPABUNNA
PROPOSED ARTIFICIAL RECHARGE SCHEME
LOCALITY PLAN

COMPILED R. Read	1·3·90 CDO DATE
DRAWN E. Calabio	SCALE 1: 2,500,000
DATE Nov. '89	PLAN NUMBER S 21154
CHECKED	

4935



LEGEND

Chr	PARARA LIMESTONE: Dark grey nodular shaly limestone.
Che	NEPABUNNA SILTSTONE: Dark blue-grey calcareous siltstone.
Chw	WILKAWILLINA LIMESTONE: Silty limestone, nodular limestones with interbedded siltstones, flaggy limestone and siltstone, calc-siltstones with interbedded clean massive limestones. Clean massive limestone.
Chp	PARACHILNA FORMATION: Sandstone, partly pyritic.
Cu	URATANNA FORMATION: Chiefly shales.

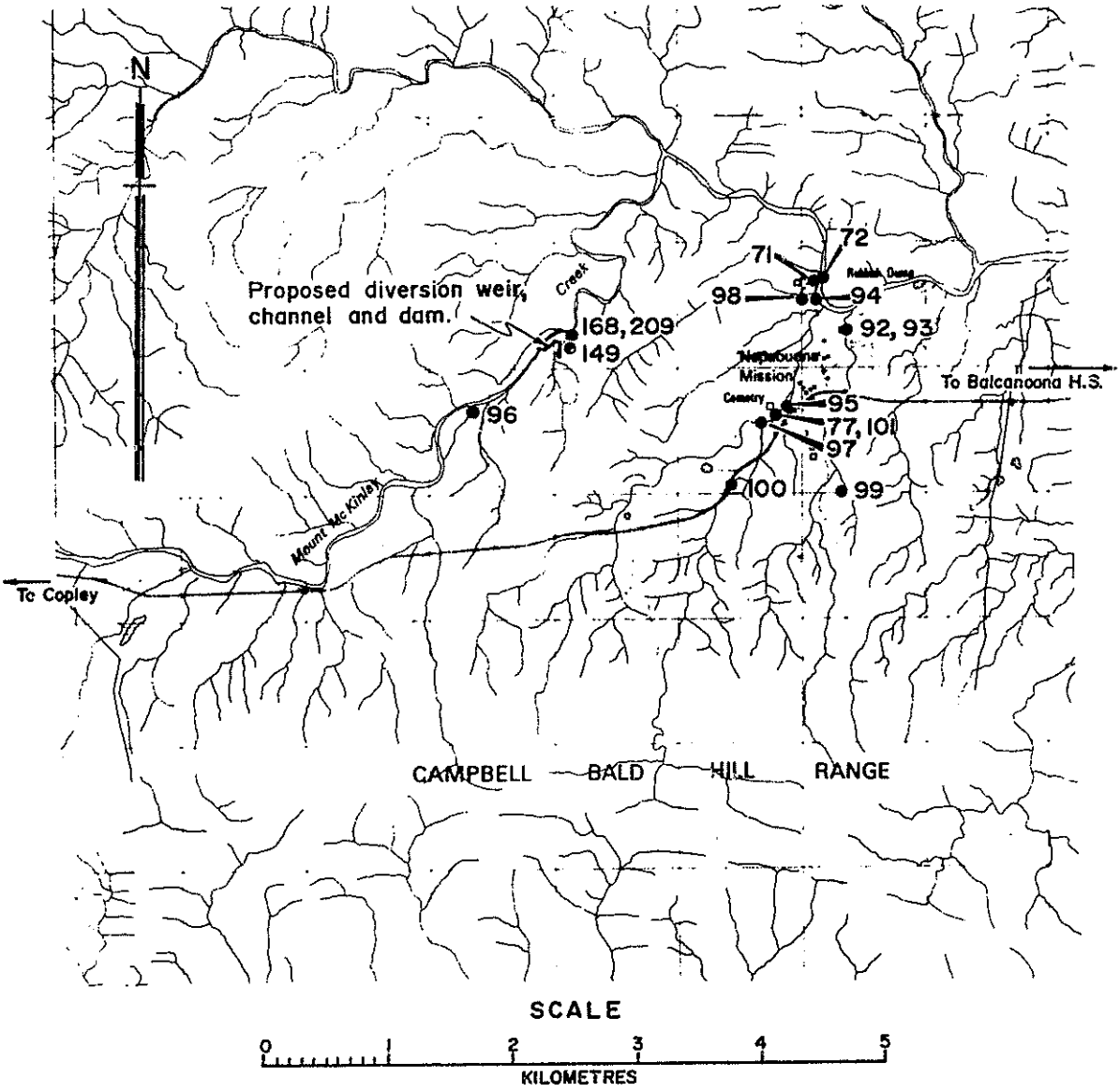
FIG. 2

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

NEPABUNNA
PROPOSED ARTIFICIAL RECHARGE SCHEME
REGIONAL GEOLOGY

COMPILED R. Read	CDG 1-3-90 DATE
DRAWN E. Calabio	SCALE 1:50 000
DATE Nov.'89	PLAN NUMBER S 21155
CHECKED	

4935



LEGEND

Water well location with:

• 100— Number (to obtain Unit No. prefix with 6636001WW00___)

FIG. 3

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA		COMPILED R. Read	CDO 1·5·90 DATE
NEPABUNNA		DRAWN E. Calabio	SCALE 1:50000
PROPOSED ARTIFICIAL RECHARGE SCHEME		DATE Nov. '89	PLAN NUMBER S 21156
WELL LOCATION PLAN		CHECKED	

4935

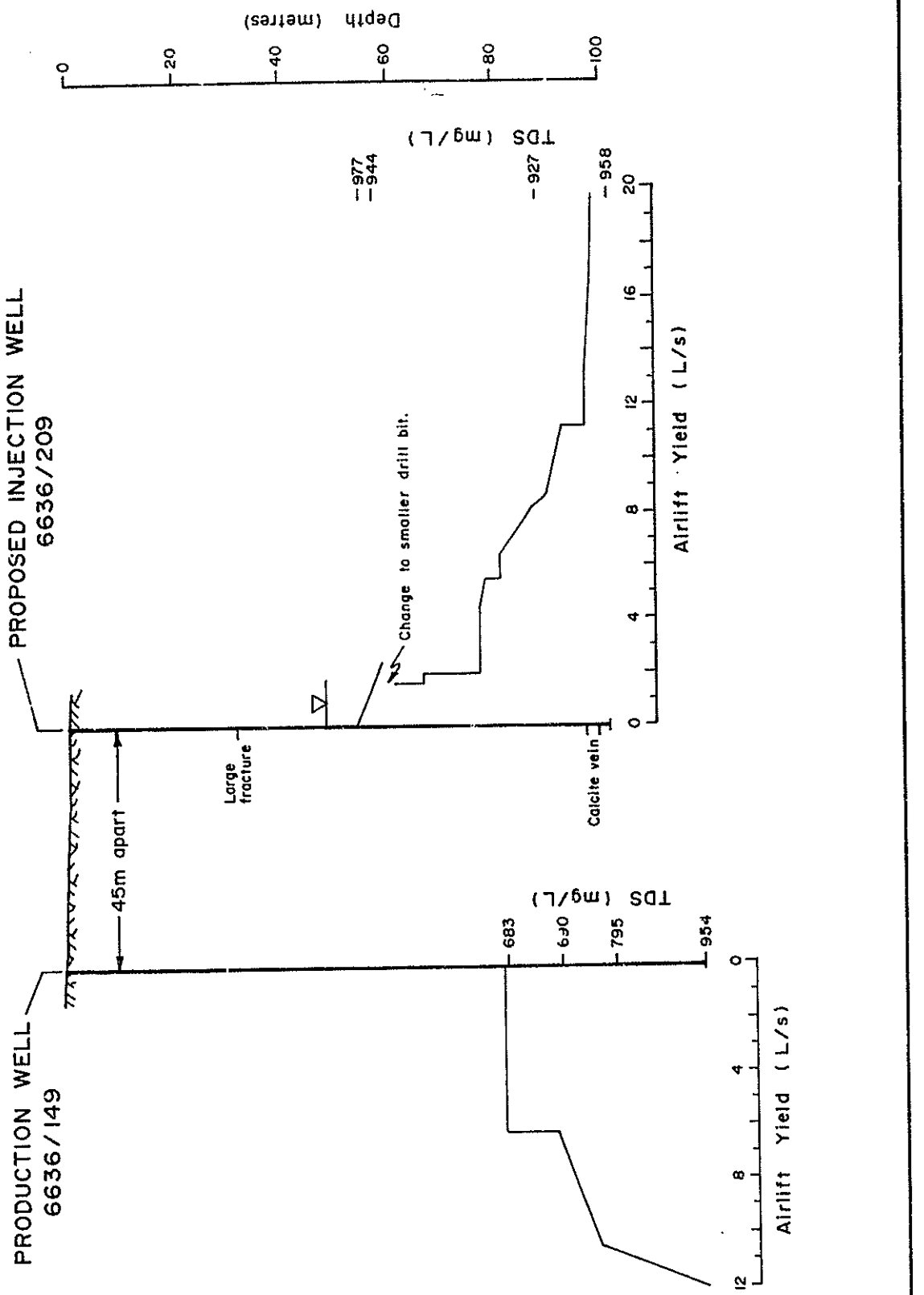


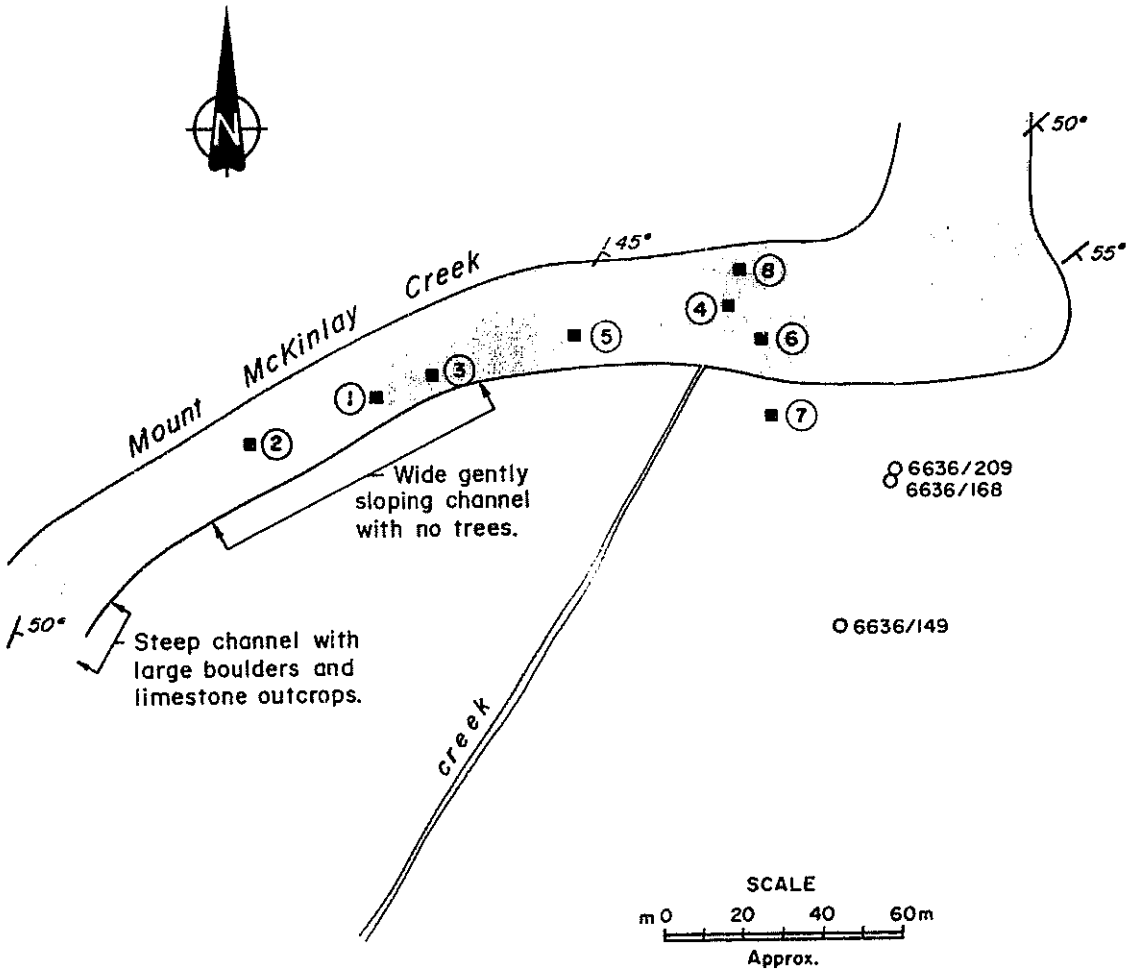
FIG. 4

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

NEPABUNNA
PROPOSED ARTIFICIAL RECHARGE SCHEME
DEPTH YIELD GRAPHS

COMPILED R. Read	C.D.O 1·3·90 DATE
DRAWN E. Calabio	SCALE graph
DATE Nov. '89	PLAN NUMBER S 21157
CHECKED	

4935



Note: Pace and compass survey.

Backhoe pit with number..... ■ (5)

Strike and dip of outcrops..... ∠ 55°

Water well location and number..... ...O 6636/168

FIG. 5

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED R. Read	C.D.O. 1-3-90 DATE
NEPABUNNA	DRAWN E. Calabio	SCALE As shown
PROPOSED ARTIFICIAL RECHARGE SCHEME	DATE Nov. '89	PLAN NUMBER S 21158
BACKHOE PIT LOCATIONS	CHECKED	

4935

4935

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

NEPABUNNA
PROPOSED ARTIFICIAL RECHARGE SCHEME
INFILTRATION TESTS

COMPILED R. Read	C.D.O. 1.3.90 DATE
DRAWN J.A.G.	SCALE
DATE Dec. 1989	PLAN NUMBER
CHECKED	S 21168

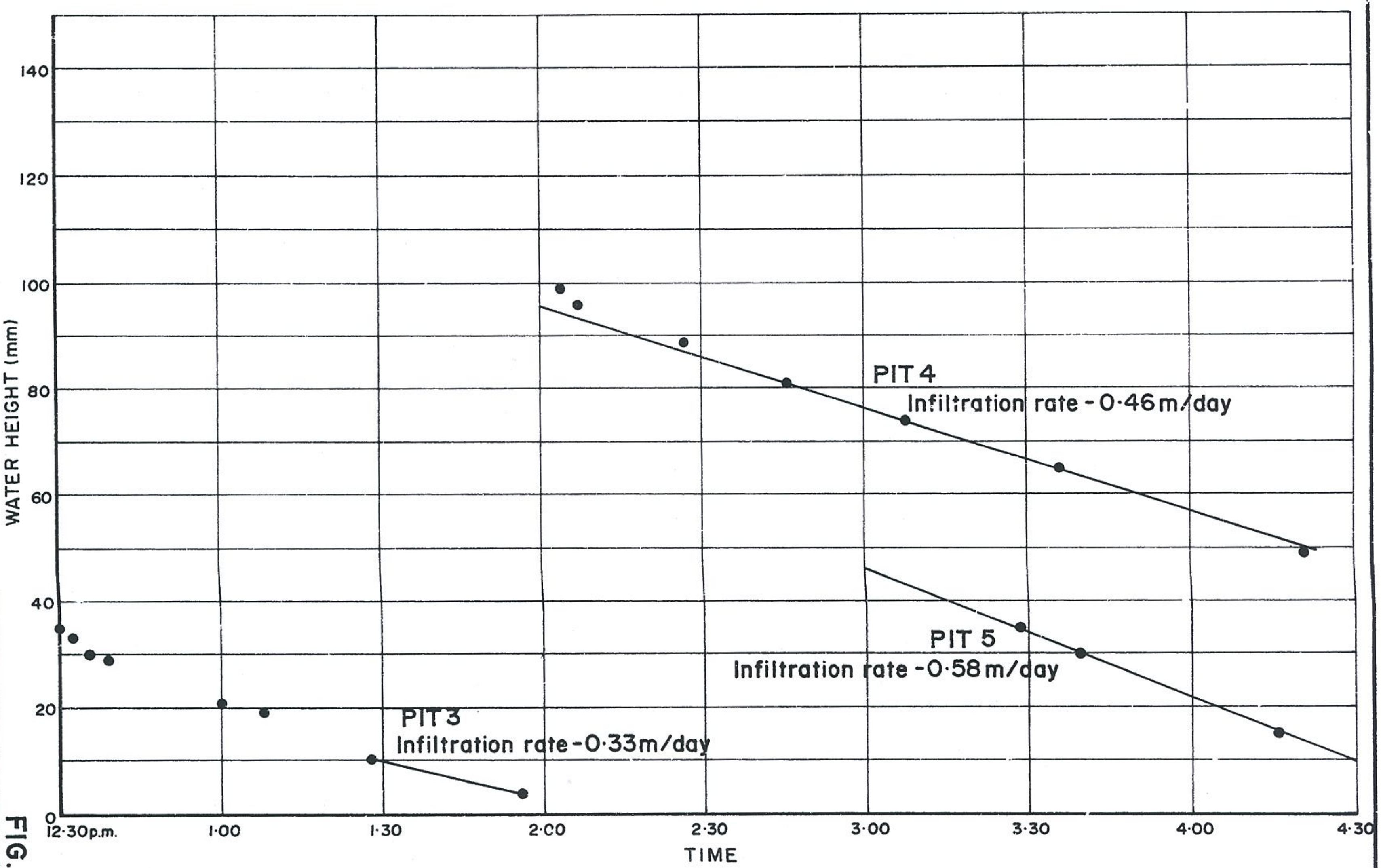


FIG. 6