POWER AND WATER AUTHORITY

ALICE SPRINGS
WATER SUPPLY
AUGMENTATION

ROE CREEK BOREFIELD
CONSTRUCTION AND RECONSTRUCTION OF
PRODUCTION BORES, 1987 - 1990

Report 65/1993
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D. Chua
N. Power
Water Resources Division
Darwin
May 1994
PREFACE

This report has been compiled by Michael Jamieson of Water Resources Division (WRD) Darwin, based on notes, drawings, and bore completion reports held by Peter Jolly and Darryl Chin, also of WRD Darwin, and bore location maps held by Avis Wiegele, WRD Alice Springs. The purpose of the report is to document the work done by WRD on the Roe Creek borefield in the period 1987 - 1990, including bore construction, bore rehabilitation, and recommendations concerning the operation of bores.
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LIST OF ABBREVIATIONS

AHD  Australian Height Datum

gms  grams

hrs  hours

ID  internal diameter of casing

L  litre

L/s  litres per second

m  metre

m2/day  (metres per day) for metres of depth

m3/min  cubic metres per minute

min  minutes

mm  millimetres

mg/L  milligrams per litre

OD  outside diameter of casing

Q  flow rate

RN  registered number of bore

s  drawdown

SE  south east

s.s  stainless steel

SWL  standing water level

t  time

TD  total depth

TDS  total dissolved solids

yr  year
1. INTRODUCTION

This report primarily summarises the results of work involving the construction of new production bores and the reconstruction of existing production bores within the Roe Creek borefield in the period 1987 to 1989. The Roe Creek Borefield provides the water supply for Alice Springs. Bores will be identified either by their Registered Number (RN) or their local borefield production number (eg P11). The reconstruction work evolved from recommendations made in the PAWA Report No 9/1987 titled "Alice Springs Water Supply Augmentation Study Roe Creek Borefield - Production Bore Rehabilitation Options".

Seven (7) bores were either constructed or reconstructed during this period. The seven bores were P11 - RN 10499, P12 - RN 10500, P13 - RN 10501, P24 - RN 14864, P25 - RN 14867, P26 - RN 15097, P27 - RN 15107.

Two bores - P7 (RN 6519) and P8 (RN 6520) were assessed as to their suitability for reconstruction in accordance with recommendations contained in Report No 9/1987. For P7 recommended option (c) from the report (recovering the pump that had been left in the bore) was attempted unsuccessfully with no alteration ensuing in the construction of the bore. For P8 recommended option (a) from the report (a new pump setting) was adopted and no further work was undertaken.

The performance of two bores - P22 (RN 13409) and P23 (RN 13408) - was reviewed on the basis of existing extraction and water level data. While these bores were not reconstructed, a revised drawdown-yield relationship was calculated for each bore.
2. HYDROGEOLOGY

The current borefield shown in Figures 1 and 2 has been developed since 1964. Production bores P1 to P21, P24 and P25 have been constructed to exploit water from the Mereenie Sandstone. Production bores P22 and P23 have been constructed to exploit water from the Pacoota Sandstone. It was originally considered that these bores obtained water from the base of the Pacoota Sandstone (Ferguson 1986). Recent work has indicated that they intersect the upper units of the Pacoota Sandstone (Lau 1989). Production bore P26 was constructed to exploit water from the Shannon Formation. Subsequent work has indicated that water is being exploited from the lower units of the Pacoota Sandstone (Lau 89). Monitoring of regional drawdown due to production from P22 and P23 has shown that the aquifer intersected in P22 and P23 is not in hydraulic connection with the aquifer intersected in P26. Production bore P27 was sited to extract water from either the Giles Creek Dolomite or the Jay Creek Limestone. Logging by Lau (89) has indicated the aquifer intersected by P27 is in the Upper Shannon Formation.

For consistency in the remainder of this report, Lau’s interpretation of the geology of the borefield will be used in relation to strata intersected in Production Bores P22, P23, P26 and P27.

Lau has sub-divided the Mereenie Sandstone into five units. Jolly, Prowse and Chin (90) have sub-divided the Mereenie Sandstone into three units; units 1, 2 and 3 of Lau equate to Unit A of Jolly et al; Unit 4 to Unit B, and Unit 5 to Unit C. In a hydrogeological context, it is considered more appropriate to use the sub-division of Jolly et al as Unit A represents the transition from a marine to a dominantly terrestrial environment.
Post-depositional diagenesis is dominated by the effects resulting from the Alice Springs Orogeny. Resultant fracturing and deep chemical weathering has resulted in highly transmissive aquifers being formed in each of the aforementioned formations. The extent of aquifer development has primarily been controlled by weathering associated with the development of (1) the Iwupataka erosion feature (Jolly et al) for the Mereenie and Pacoota Sandstones and (2) the Tertiary trough to the south-east of Alice Springs for the Upper Shannon Formation.

Variations in yield in Unit C of the Mereenie Sandstone between bores located west of Roe Creek and those located east of Roe Creek have been attributed to iron re-distribution during physical and chemical weathering associated with erosion and subsequent aerial exposure contemporaneous with the formation of the Iwupataka erosion feature. Subsequent deformation during the latter parts of the Alice Springs Orogeny in association with the effects of "mass wasting" on the flanks of the valley that existed where the Iwupataka erosion feature now exists, resulted in intense fracturing to the west of Roe Creek in Unit C. Where the Mereenie Sandstone was not eroded or exposed subsequent to the commencement of deposition of the Hermannsburg Sandstone, (ie to the east of Roe Creek), fracturing is not as intense in Unit C.

Formation stability problems encountered in Unit B of the Mereenie Sandstone and the Pacoota Sandstone are associated with the environments of deposition of these units and the deep chemical weathering that occurred during the Late Devonian (Alice Springs Orogeny) and Early Tertiary.

Decreases in yield in the Upper Shannon to the west of Roe Creek and resultant steep increases in potentiometric gradient are thought to occur as a result of deep chemical weathering primarily occurring in the Early Tertiary and then only adjacent to the Tertiary trough. The Iwupataka erosion feature does not transgress the Upper Shannon Formation.
Where deposition has been continuous through the Devonian period and where the Mereenie Sandstone is overlain by Pertnjara Group sediments to great depth (probably in excess of 500 metres), significant permeability is restricted to Unit B. The permeability of the Mereenie Sandstone at these depths is, however, at least 30 times lower than that found in the borefield area. A similar situation is expected to exist for the other aquifers.

Models of the aquifer systems within the Mereenie Sandstone and Upper Shannon Formation have been developed. Both systems are controlled by the specific yield of the aquifer material (i.e., the majority of water pumped has, or will, come from storage). The specific yield of the Mereenie Sandstone has been calculated at 20%. The performance of the aquifer exploited by P27 in the Upper Shannon Formation has been predicted based on specific yields in the range 1 to 3%. This range is representative of the dolomite and shale constituting the aquifer material which have no primary porosity. Aquifer specific yield is controlled by secondary porosity caused by fracturing and chemical weathering. It is expected that the aquifers in the Pacoota Sandstone will be similarly controlled by their specific yields, but to date no modelling of these aquifers has been carried out.
3. COMPLETION REPORTS

In this section brief comments have been made about work undertaken on each of the production bores referred to in Section 1. The locations of the bores referred to are shown in Figure 2. Completion reports for these production bores follow in the appendices.

3.1 F7 - RN 6519

Reconstruction work was attempted in October 1987, in accordance with recommendations contained in Report No 9/1987. Attempts were made to recover the pump that was at the bottom of this hole. However, a reduction in hole diameter of 12mm over the interval 132 to 132.6m and a problem with hole alignment below 157m rendered these attempts futile. The hole was retested in November 1987 and a new completion report issued. No further attempts at reconstructing this bore are recommended.

3.2 F8 - RN 6520

Recommendation (a) from Report No 9/1987 was adopted and no further work was undertaken as a new production bore, P24, had been drilled 230m south-east of P8.

An amended completion report was issued.

3.3 F11 - RN 10499

The procedure recommended in Report No 9/1987 was followed, with the following modifications:
(a) 335m ID steel casing was run to 180.7m
(b) Hole was deepened to 248.9m
(c) Bore was completed at 248.9m with 254mm ID stainless steel screens and steel casing packed back to the 335mm ID steel casing at 177.7m

It should be noted that this bore produced significant quantities of sand (ie greater than 10 mg/L) for the first six hours of a 25-hour duration test at 50 L/s and hence is recommended for continuous operation.
3.4 P12 - RN 10500

The procedure recommended in Report No 9/1987 was followed with the following modifications:
(a) 335mm ID steel casing was run to 174.1m
(b) Bore was completed at 190.1m with 219.1mm ID stainless steel screens and steel casing packed back to the 335mm ID steel casing at 172.6m.

It should be noted that this bore produced significant quantities of sand (ie >10 mg/L) for the first two hours of a 25-hour duration test at 53 L/s and hence is recommended for continuous operation.

3.5 P13 - RN 10501

The procedure recommended in Report No 9/1987 was followed with the following modifications:
(a) 335mm ID steel casing was run to 172.0m
(b) Bore was completed at 206.6m with 254mm ID stainless steel screens and steel casing packed back to the 335mm ID steel casing at 170.8m.

It would be expected that this bore would produce significant quantities of sand (ie > 10 mg/L) for the first two hours of operation, as did P12, however, no measurements of sand content were taken during testing.

3.6 P22 - RN 13409

This bore exploits an aquifer in the upper half of the Pacoota Sandstone. Long-term monitoring data has shown that this aquifer is not in significant hydraulic connection with the aquifer in the Mereenie Sandstone within the time frame of interest for this borefield (ie at least greater than 100 years).
The original completion report recommended a maximum continuous pumping rate of 85 L/s with a pump setting of 130m below ground level. The bore was equipped to pump 69 L/s with a pump setting of 123m. Based on water levels measured in observation bores, the sustainable yield of this bore has been reviewed and a new completion report issued recommending a sustainable yield of 40 L/s with a pump setting of 146m.

3.7 P23 - RN 13408

This bore exploits the same aquifer as P22. The original completion report recommended a maximum continuous pumping rate of 90 L/s with a pump setting of up to 148m below ground level. The bore was equipped to pump 31 L/s with a pump setting of 136m. Based on water levels measured in observation bores, the sustainable yield of this bore has been reviewed and a new completion report issued recommending a sustainable yield of 40 L/s with a pump setting of 146m.

3.8 P24 - RN 14864

This bore was completed in April 1987 and a bore completion report issued. This bore was completed in Unit C of the Mereenie Sandstone. Subsequent to the drilling of this bore, a diamond drill hole, RN 15020, was constructed adjacent to P24. This hole was drilled in mid-1987 to a depth of 403.5m at which depth drilling was abandoned due to NQ rods becoming stuck in the hole and subsequently parting at 368m. The core from this hole was logged by Lau (1989). During commissioning of the bore, the submersible pump and column unscrewed at the surface and dropped on to the top of the screen string. Extensive damage was done to the screen string during "fishing" operation. The hole was cleared and reconstructed ready for recommissioning by the end of August 1989. A report was completed by P Richardson as well as a video by the University of NSW on the fishing and reconstruction of this bore. On completion of all work a new completion report was issued.
3.9 P25 - RN 14867

This bore was completed in May 1987 in Unit C of the Mereenie Sandstone and a bore completion report issued. This hole was drilled at the direction of the client prior to completion of investigation work.

3.10 P26 - RN 15097

This bore was completed in April 1988 in the lower half of the Pacoota Sandstone and a bore completion report issued. The hole was drilled to a depth of 329m using mud drilling techniques, due to the unstable nature of the formation. The bore was sited approximately 200m south-west (down dip) of diamond drill holes RN 15022 and 15043. RN 15022 was drilled to a depth of 107.6m at which total loss of circulation occurred, resulting in the HQ rods becoming stuck in the hole. Subsequent fishing operations were unsuccessful and a new hole, RN 15043, pre-collared to a depth of 108m, was completed to a depth of 346.1m at a site 7 metres to the north of RN 15022. The data from these diamond drill holes was used to site investigation holes and the production bore.

3.11 P27 - RN 15107

This bore was completed in June 1989 in the Upper Shannon Formation and a bore completion report issued. The bore was constructed 1004m north of P26 and 70m north of diamond drill hole RN 15091, which was completed to a depth of 400.6m. The data from this diamond drill hole and that from investigation holes RN 15100 (drilled to a depth of 619.2m) and 15102, was used to site the production bore.
4. REFERENCES

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POWER N., 1987

POWER N., 1987

POWER N., 1988
RICHARDSON P., 1989

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WATER RESOURCES DIVISION, 1988

Test Report - Bore RN 10501.

WATER RESOURCES DIVISION, 1988

Test Report - Bore RN 15097.

WATER RESOURCES DIVISION, 1989

Test Report - Bore RN 10499.

WATER RESOURCES, WATER DIRECTORATE, 1989

Bore Completion Report RN 15107 Roe Creek Borefield, Alice Springs Water Supply Augmentation Study. Power and Water Authority, N.T.
Appendices
Appendix A

P7 - RN 6519
COMPLETION REPORT FOR P7 (RN 6519)

Rehabilitation of the bore was attempted in October 1987. Details of this work appear in D. Miller’s report on the following page. The hole was found to be out of alignment below 157m depth and partially obstructed at 132m depth, preventing removal of the dropped pump from the bottom of the bore. This is explained in Figures P7.1 and P7.2.

The bore was retested in November 1987 resulting in the determination of a new drawdown yield equation for the bore.

Old equation (1969): \( s = (0.03 + 0.014 \log t) Q + 0.61 Q^2 \)

New equation (1987): \( s = (0.31 + 0.02 \log t) Q + 0.27 Q^2 \)

Non-linear head losses have decreased with time, indicating development of the bore. Also, transmissivity has decreased by about 30%, equivalent to the lowering of the water table from 97.6m in 1969 to 129.5m in 1987.

The expected pumping drawdowns from 1987 based on this new equation and accounting for the regional decline of the watertable are shown in Figure P7.3.
ATTEMPTED RE-HABILITATION OF P7 = RN 6519

On 12 October 1987 Rig 21 attempted to carry out re-habilitation work on P7.

The hole was cleaned out to 178.86 metres with a 270mm roller bit using air. During airlifting, pieces of cast, copper wire, metal hose clamps and other electrical wire was being blown up to the surface.

After cleaning out to the top of the pump at 178.86 metres we tried to run in a 4.00 metre length of 273mm outside diameter casing to wash over and clean around the pump. This casing would not go past 151.16 metres, i.e. the bottom of the 323mm ID casing. It was then decided to ream the hole below the casing to 311mm.

A 311mm roller bit and non-rotating stabilizers were run in the hole but would not go past 126 metres. This drill string was pulled out and the hole was then caliper logged to find out what was causing the obstruction. An obstruction was located at approximately 132 metres but we were unable to determine what it is.

It was decided to run a 279mm bit and ream out the hole with this. At 132 metres the bit did hit on something hard but did go past this depth and down to 151.16 metres. At the end of the casing string, 151.16 metres, we had to rotate the bit over an area of some 150mm for about 1 hour to enable the bit to pass freely through this section.

While reaming this section we were getting pieces of metal up which would indicate either the casing was folded over or we were drilling through the side of the casing at the shoe. After an hour of rotating, raising and lowering the drill string we were able to get past this section and the hole was reamed to 178.86 metres.

A 4.00 metre length of 273mm casing was again attempted to be run to the bottom of the hole but would not go past 157 metres. This would suggest the hole is slightly out of alignment.

It was then decided not to proceed with any further attempts to fish out the pump or to carry out any further re-habilitation work.

The rig was pulled off the hole and returned to the depot on 24.10.87

D MILLER
27 October 1987

DM:sm:300
PRODUCTION BORE P7
RN 6519

Fig. P7.1
CALIPER LOG OF P7 BETWEEN 125m AND 145m DEPTH, 30/10/87

Fig. P7.2
1987 PREDICTED DRAWDOWN WITH CONTINUOUS PUMPING FROM P7
Appendix B

P8 - RN 6520
COMPLETION REPORT FOR P8 (RN 6520)

P24 was drilled as a replacement for P8, 230m to the SE. No rehabilitation of this bore was undertaken, but as recommended in Report 9/1987, the pump setting was lowered in the bore.
COMPLETION REPORT FOR P11 (RN 10499)

This bore was originally constructed with 387.4mm ID steel casing to 120.7m depth. Due to the regional decline in the water table the water level in this bore fell to 128m in 1987, below the bottom of the casing. The pump was set below this level and the bore continued producing.

Report 9/1987 recommended test pumping and caliper logging this bore to determine the feasibility of reconstruction. Reconstruction was to be dependant on the success/failure of the reconstruction of P12 and P13.

P12 and P13 were reconstructed successfully so it was decided to reconstruct P11 as well. 335mm ID steel casing was run to 180.7m depth on 23/6/88, after which the hole had fallen in from 235m depth to 231.1m. The bore was test pumped on 9/7/88, with a significantly increased rate of drawdown compared to previous testing. Caliper logging had indicated a wash out/fracture zone around 121-123m which had been the first supply encountered in the bore when drilled. This zone had been dewatered (SWL 128m in 1987) and so the supply lost. On completion of pumping the bore had cleaned out to 234.45m.

Starting on 21/7/88 the bore was deepened to 262.4m, encountering fractures at 247.4m, 248 - 248.4m, 257.4m, and loss of circulation at 262m. The bore was constructed as shown in Figure P11.1, using 254mm ID 3.75mm aperture stainless steel screens to a depth of 248.9m.

The bore was again test pumped and produced significant amounts of sand for the first 6 hours of a 25 hour continuous rate test at 50L/s (see Figure P11.2). For this reason the bore should be pumped continuously at a constant rate, not greater than 50L/s until the bore is well developed (refer P. McDonald’s minute of 14th July 1989 on following pages).

Predicted drawdowns in the bore due to continuous pumping are shown in Figure P11.3 for rates of 40, 50, and 60 L/s. This figure shows two sets of curves, accounting for two estimates of the future regional decline in potentiometric levels (2m/yr and 3m/yr). The maximum recommended pump setting is 175m below the top of the casing, to be selected to suit the pump head range.
WATER RESOURCES DIVISION

TEST REPORT — BORE RN.  10499

Bore location: ROE CREEK BOREFIELD
Client/owner: PAWA
Client's reference: PI
Purpose of supply: TOWN WATER SUPPLY

Map: SF 53-14 ALICE SPRINGS
Grid reference:

RECOMMENDATIONS
Pumping rate: see curves L/s. Pump setting: see curves m below ground level.
General recommendations are given on the reverse side.
The aquifer and bore can/cannot sustain higher pumping rates with deeper pump settings or for short
periods in favourable seasons. Further advice can be obtained from:
WATER RESOURCES
NORTH STUART HIGHWAY
ALICE SPRINGS
(In all correspondence refer to the bore's RN number).

BORE DATA
Finished depth: 248.9 m Completion date: 21.6.89
Standing water level: 129.95 m on
Construction details:

<table>
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<th>Interval (m)</th>
<th>Description</th>
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(SEE ATTACHED)

Notes:
1. Top of casing as constructed was m above ground
2. All depths are measured from natural ground level
3. Test rates are not indicative of safe long term pumping rates.

WARNING: MINIMUM INTERNAL BORE DIAMETER IS mm

COMMENTS

1. Pumping rate drawdown curves for 40, 50 and 60 L/s are attached.
2. Annual regional drawdowns of 2 and 3 metres per annum have been superimposed on the pump drawdowns.
3. A maximum pump setting of 175 m below Top of Casing can be selected to suit the pump head range.

WATER QUALITY

See water laboratory report (Analysis No.)
RECOMMENDATIONS FOR FINISHING, OPERATING AND PROTECTING GROUNDWATER BORES

Attention to the following points will ensure a long and safe life for the bore supply and help prevent pollution of the groundwater resource.

1. Construct a concrete apron around the bore head to prevent surface flow, seepage and waste from entering the bore.
2. Seal the space between the casing and pump equipment to prevent entry of vermin, dirt and pollutants.
3. Maintain pumping equipment in good order to prevent pollution. Prevent spillage of fuel and oil on the ground around the bore. Store fertilizer and other chemicals at least 50 m away.
4. Keep stock away from the bore head. Discourage domestic activity at the bore. The first tap on the pipeline should not be less than 5 m from the bore head.
5. Pumping the bore at higher than recommended rates may fork the bore leading to instability or pump maintenance problems. Seek the professional advice of an hydrogeologist or groundwater engineer.
6. If the bore is no longer required, the casing is to be removed or securely capped and the bore backfilled with clayey material. A cement plug may be required in some instances.

In addition, please ensure that the BORE IDENTIFICATION TAG is retained securely at all times. The registered bore number is Water Resources Division's only reference to the scientific and engineering data on this bore, and hence important to WRD's further advice to bore owners.
POWER AND WATER AUTHORITY

MINUTE

To: AREA ENGINEER
From: WRSS
Subject: P11 PRODUCTION BORE - RETEST

Our file ref: 55.7C

1. P11 was tested on 21/06/89 by four constant rate tests of 30.5, 40, 50.3 and 60.2 L/s and 100 min duration each. On 22/06/89 it was subjected to a 25 hr constant rate test at 50.3 L/s.

2. Standing water levels and sand content were measured regularly throughout these tests. P11 production bore was not operated throughout the tests.

3. Measurements of the sand content are listed in the attached table and results of the 25 hr constant rate test are plotted in Figure 1. These results show that the sand content reduces to an acceptable level of 5 mg/L (see reference) after 15 hrs of pumping at a constant rate of 50.3 L/s.

The result for the 25th hour is above the acceptable limit. It is either erroneous, since field measurements indicate that it was approximately 4 mg/L and analysis of a 1L sample taken at the end of the test indicated a sand content of 0.75 mg/L, or not significant, since the general trend is for the sand content to reduce with continued pumping at a constant rate.

4. Comparison of results with those from P12 (see Figure 2) show that P11 has a higher sand content.

Comparison of the 100 min drawdowns with previous tests which were carried out before the bore was screened and cased (see Figure 3) show that P11 now has less drawdown for the same pumping rate.

Both of these comparisons indicate that P11 is still developing. It is expected that the bore will develop further with operation of the bore and that the sand content will reduce accordingly.

5. These results have been discussed with the Principal Engineer, Groundwater and it is recommended that P11 be equipped and operated on a continuous basis. The maximum recommended pump rate is 50 L/s, based on results of the 25 hr test, only. This confirms verbal advice given to Engineer Gibbons on 11/07/89.
The bore is capable of higher pumping rates, but these are not recommended until it has been further developed.

P MCDONALD
14 July 1989

Reference:-
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<th>Description/Time of Sample (Mins)</th>
<th>Weight of Sample (gms)</th>
<th>Sand Content (mg/L)</th>
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</tr>
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</table>

**PI1 - SAND CONTENT MEASUREMENTS**
P11  SAND CONTENT MEASUREMENTS

Date  22/6/89

\[ Q = 50.3 \text{ l/sec} \]

--- Recommended limit for homes, industry, institutions & municipalities

**Figure 1**
P11 & P12 - COMPARISON OF SAND CONTENT MEASUREMENTS

P11 - □ Q = 50.3 l/sec

P12 - × Q = 53 l/sec
  ○ Q = 40 l/sec

Recommended limit for homes, industry, institutions & municipalities.
Appendix D

P12 - RN 10500
COMPLETION REPORT FOR P12 (RN 10500)

This bore was originally constructed with 387.4mm ID steel casing to 121.9m depth. Due to the regional decline in the watertable the water level in this bore fell to 128m in 1987, below the bottom of the casing. The bore was decommissioned.

Report 9/1987 recommended test pumping and caliper logging this bore to determine the feasibility of reconstruction. Reconstruction was to be dependant on the success/failure of the reconstruction of P13.

P13 was reconstructed successfully so it was decided to reconstruct P12 as well. The bore was test pumped on 14/9/87, with significantly higher well losses compared to previous testing in 1973. 335mm ID steel casing was run to 174.1m depth, where the open hole diameter reduced from 381mm to 311mm. The casing settled 1.6m below 172.5m, the recorded depth at which the bore diameter decreased. Test pumping on 22/9/87 indicated that hydraulic conditions had not changed due to casing the hole.

The bore had been drilled to 193.5m in 1972 but only cleaned out to 190.5m during reconstruction. The hole then backfilled to 190.0m, and the open hole was screened. Stainless steel screens of 203mm ID with 4mm aperture size were used as shown in Figure P12.1 to a depth of 190.1m.

The bore was again test pumped on 13/10/87, after the screens were run and this indicated that screening of the bore had resulted in only a slight loss of hydraulic efficiency for the bore.

The bore produced significant amounts of sand and so was tested again in 1989. The bore produced excessive sand for the first 2 hours of a 25 hour continuous rate test at 53L/s (see Figure P12.2). For this reason the bore should be pumped continuously at a constant rate, not greater than 50L/s until the bore is well developed (refer P. McDonald’s minute of 14th July 1989 in section P11).

Predicted drawdowns in the bore due to continuous pumping are shown in Figure P12.3 for rates of 30, 40, and 50 L/s. This figure assumes a future regional decline in potentiometric levels of 2.5m/yr and 1.5m pumping interference from other bores. The maximum recommended pump setting is 169m below the top of the 335mm ID casing, to be selected to suit the pump head range.
TEST REPORT — BORE RN.10500

Bore location: ROE CREEK BOREFIELD

Map: ALICE SPRINGS SP53.14

RECOMMENDATIONS

Pumping rate: see curves L/s. Pump setting: see curves m below ground level

General recommendations are given on the reverse side.

The aquifer and bore cannot sustain higher pumping rates with deeper pump settings or for short periods in favourable seasons. Further advice can be obtained from:

Water Resources
North Stuart Highway
Alice Springs

Client/owner: PAWA
Client's reference:
Purpose of supply: TOWN WATER SUPPLY

BORE DATA

Finished depth: 190.1 m
Completion date: 
Standing water level: 127.5 m on 9.10.87
Construction details:

<table>
<thead>
<tr>
<th>Interval (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-16.7</td>
<td>508 mm OD blank steel casing</td>
</tr>
<tr>
<td>0-121.9</td>
<td>406.4 mm OD/387.4 mm ID blank steel casing</td>
</tr>
<tr>
<td>0-174.1</td>
<td>355.6 mm OD/335 mm ID blank steel casing</td>
</tr>
<tr>
<td>172.6-172.9</td>
<td>Neoprene packer</td>
</tr>
<tr>
<td>172.9-176.0</td>
<td>219.1 mm OD/203.2 mm ID stainless steel screens.</td>
</tr>
<tr>
<td></td>
<td>4mm aperture</td>
</tr>
</tbody>
</table>

Notes:
1. Top of casing as constructed was m above ground
2. All depths are measured from the top of 335 mm ID casing
3. Test rates are not indicative of safe long term pumping rates.

WARNING: MINIMUM INTERNAL BORE DIAMETER IS 203.2 mm

AQUIFER TEST

Test date: 9.10.87
Test rates: 40 L/s
Test duration 1.6 days

<table>
<thead>
<tr>
<th>Interval (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>176.0-179.5</td>
<td>219.1 mm OD/203.2 mm ID blank steel casing</td>
</tr>
<tr>
<td>179.5-188.6</td>
<td>219.1 mm OD/203.2 mm ID stainless steel screens.</td>
</tr>
<tr>
<td></td>
<td>4 mm aperture</td>
</tr>
<tr>
<td>188.6-190.1</td>
<td>219.1 mm OD/203.2 mm ID blank steel casing (sump)</td>
</tr>
</tbody>
</table>

COMMENTS

1. Pumping rate drawdown curves at 30, 40 and 50 L/s are attached.
2. An annual regional drawdown of 2.5 m per annum has been superimposed on the pump drawdowns.
3. A pump setting up to a maximum depth of 169 m (measured from top of 335 mm ID casing) can be selected to suit the pump head range.

WATER QUALITY

See water laboratory report (Analysis No.)
RECOMMENDATIONS FOR FINISHING, OPERATING AND PROTECTING GROUNDWATER BORES

Attention to the following points will ensure a long and safe life for the bore supply and help prevent pollution of the groundwater resource.

1. Construct a concrete apron around the bore head to prevent surface flow, seepage and waste from entering the bore.

2. Seal the space between the casing and pump equipment to prevent entry of vermin, dirt and pollutants.

3. Maintain pumping equipment in good order to prevent pollution. Prevent spillage of fuel and oil on the ground around the bore. Store fertilizer and other chemicals at least 50 m away.

4. Keep stock away from the bore head. Discourage domestic activity at the bore. The first tap on the pipeline should not be less than 5 m from the bore head.

5. Pumping the bore at higher than recommended rates may fork the bore leading to instability or pump maintenance problems. Seek the professional advice of an hydrogeologist or groundwater engineer.

6. If the bore is no longer required, the casing is to be removed or securely capped and the bore backfilled with clayey material. A cement plug may be required in some instances.

In addition, please ensure that the BORE IDENTIFICATION TAG is retained securely at all times. The registered bore number is Water Resources Division's only reference to the scientific and engineering data on this bore, and hence important to WRD's further advice to bore owners.
Fig. P12.1
P12 - MEASUREMENTS OF SAND CONTENT
Date 31/5/89

***** Q=53L/s
□□□□ Q=40L/s
--- Limit for borewater pumping to storage facility
--- Limit for homes, industry & municipalities

SAND CONTENT (mg/L)

TIME SINCE PUMPING COMMENCED (minutes)
Before considering Annual Regional Drawdown

Continuous pumping with
(i) 2.5m Annual Regional Drawdown
(ii) 1.5m Interference from other bores

MAXIMUM AVAILABLE DRAWDOWN - PUMP SETTING OF 169m

CONTINUOUS PUMPING CURVE
RN 10500

Standing Water Level 127.5m October 1987
Appendix E

P13 - RN 10501
COMPLETION REPORT FOR P13 (RN 10501)

This bore was originally constructed with 387.4mm ID steel casing to 121.4m depth. Due to the regional decline in the watertable the water level in this bore fell to 128m in 1987, below the bottom of the casing. The bore was decommissioned.

Report 9/1987 recommended test pumping and caliper logging this bore to determine the feasibility of reconstruction.

The bore was test pumped on 1/10/87, with significantly lower well losses compared to previous testing in 1972. Transmissivity was much lower, due to the lowering of the potentiometric surface over this period. 335mm ID steel casing was run to 172m depth. Further test pumping indicated that hydraulic conditions had not changed due to casing the hole.

The bore had been drilled to 215.5m in 1972 and backfilled to 206.7m with a cement plug. After casing the hole to 172m the open hole was screened to 206.6m. Stainless steel screens of 254mm ID with 3 and 4mm aperture sizes were used as shown in Figure P13.1.

The bore was again test pumped on 9&10/3/88, after screening of the bore, and this indicated that well losses had increased slightly (about 1m additional drawdown at 60L/s).

It is expected that the bore will produce significant amounts of sand as P11 and P12 do (see Figure P11.2 and P12.2), but no measurements of sand content in the pumped water have been made for P13. For this reason the bore should be pumped continuously at a constant rate, not greater than 50L/s until the bore is well developed (refer P. McDonald's minute of 14th July 1989 in section P11).

Predicted drawdowns in the bore due to continuous pumping are shown in Figure P13.3 for rates of 60, 70, and 80 L/s. This figure assumes a future regional decline in potentiometric levels of 2.5m/yr and 0.4m pumping interference from other bores. The maximum recommended pump setting is 167m below the top of the 335mm ID casing, to be selected to suit the pump head range.
TEST REPORT — BORE RN. 10501

Bore location: PIB QUARANTINE RESERVE
ROE CREEK BOREFIELD

Map: SF 53-14, ALICE SPRINGS
Grid reference: 158033

Client/owner: PAWA
Client's reference:
Purpose of supply: TOWN WATER SUPPLY

RECOMMENDATIONS

Pumping rate: see comments here. Pump setting: see comments below. General recommendations are given on the reverse side.

The aquifer and borefield cannot sustain higher pumping rates with deeper pump settings or for short periods in favourable seasons. Further advice can be obtained from Water Resources (in all correspondence refer to the bore's RN number).

North Stuart Highway
Alice Springs

BORE DATA

Finished depth: 206.61 m  Completion date: 9.10.87
Standing water level: 127 m on 7.4.88
Construction details:

Interval (m) Description
0 - 14.02 508mm OD/489mm ID Welded line casing
0 - 121.40 406.4mm OD/387.4mm ID Welded line casing
0 - 172.03 355.6mm OD/335mm ID Blank steel casing
170.78 - 189.47 Neoprene packer
189.47 - 200.77 273mm OD/254mm ID stainless steel screens, 3mm aperture
(see below for continuation of above)

Notes:
1. Top of casing as constructed was 0.20 m above ground
2. All depths are measured from natural ground level
3. Test rates are not indicative of safe long-term pumping rates.

WARNING: MINIMUM INTERNAL BORE DIAMETER IS 335 mm above packer

AQUIFER TEST

Test date: 10.3.88 - 7.4.88
Test rates: 50, 60, 70, 80; 80.1 L/s
Test duration 4 x 100 mins; 48 hrs

Descriptlon
508mm OD/489mm ID Welded line casing
406.4mm OD/387.4mm ID Welded line casing
355.6mm OD/335mm ID Blank steel casing
273mm OD/254mm ID stainless steel screens, 3mm aperture

(see below for continuation of above)

189.47 - 200.77 273mm OD/254mm ID stainless steel screens, 4mm aperture
200.77 - 206.61 273mm ID Blank steel casing sump

COMMENTS

1. Pumping rate drawdown curves at 60, 70 and 80 L/s are attached.
2. An annual regional drawdown of 2.5m per annum has been superimposed on the pump drawdowns.
3. An allowance for interference due to pumping from the other bores in the borefield has been made.
4. A pump setting up to a maximum depth of 167m (measured from top of 335mm ID casing) can be selected to suit the pump head range.

WATER QUALITY

See water laboratory report (Analysis No. )
REHABILITATION WORK ON
BORE P13 RN 10501, 9/10/87

Fig. P13.1
TIME (minutes)

DRAWDOWN (metres)

INTERMITTENT PUMPING CURVE
RN 10501

- (i) P13 pumping intermittently (12hr cycle)
- (ii) 0.4m interference from borefield
- (iii) 2.5m annual decline

TIME (years)
FIG. 13.3

CONTINUOUS PUMPING CURVE RN 10501

DRAWDOWN (metres)

TIME (years)

10^{-3}

10^{-6}

10^{-7}

Pump continuously

(ii) 0.4m interference from borefield

(iii) 2.5m annual decline

(i) P13
Appendix F

P22 - RN 13409
REASSESSMENT OF PUMPING STRATEGY FOR P22 (RN 13409)

The following sections summarise the bore construction, water quality, the reassessment of the bore’s pumping regime, and the new pumping recommendations for the bore. Bore construction is shown in Figure P22.1. Predicted drawdown in the bore is shown in Figure P22.2.

(a) Construction Details:

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<tr>
<td>Total Depth:</td>
<td>279.5 m, backfilled with gravel to 227.0 metres.</td>
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<td>Standing Water Level:</td>
<td>88.2 m 27 May 83</td>
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Casing Details

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<td>m</td>
<td>m</td>
<td>mm</td>
<td>mm</td>
<td></td>
</tr>
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<td>7.6</td>
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<td>590.9</td>
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<tr>
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<td>169.0</td>
<td>355.6</td>
<td>335.0</td>
<td>blank casing</td>
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<td>590.9</td>
<td>335.0</td>
<td>neoprene packer</td>
</tr>
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<td>170.1</td>
<td>219.1</td>
<td>203.2</td>
<td>blank casing</td>
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<td>3.5 mm screens</td>
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<tr>
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<td>3.5 mm screens</td>
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<td>227.1</td>
<td>219.1</td>
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(b) Groundwater Hydraulics.

The caliper log run by T Ritchie indicated that there were fractured zones between the intervals 175 to 186 and 264 to 275 metres.

The drawdown yield equation based on the results of the step test is

\[ s = (1.06 + 0.68 \log t)Q + 0.156Q^2 \]

where \( Q \) is m3/min and \( t \) in min.

Aquifer transmissivity based on short term pump testing is of the order of 300-350 m2/day. The above equation is valid for early time drawdowns (initial 48 hours) however long term monitoring of the aquifer drawdown indicates a transmissivity of half the short term value. Consequently
the above drawdown yield equation cannot be used to predict long term aquifer drawdown. The pumping curve for P22 has been constructed by using the drawdown yield equation to predict the initial drawdown in the well and then assuming a transmissivity of 150 m²/day, which was derived from analysis of long term monitoring results, to predict the long term rate of change of drawdown.

The theory on which the drawdown yield equation has been derived enables constants to be assigned to the equation for the prediction of long term drawdowns. The effect of halving the transmissivity is to double the constant “b” in the drawdown yield equation. Therefore the pumping curve for P22 can be approximately represented by:

\[ s = (1.06 - 1.36 \log t)Q + 0.156Q^2 \]

(c) Pumping Rates:

P22 was initially recommended at 85 L/sec.

This bore was pumped for 45 weeks during the 85/86 financial year at an average rate of 54.3 L/sec at pump setting 123 m in March 87. The maximum rate pumped from the bore during this period was 67.5 L/sec.

Subsequent re-analysis of the pump test results and analysis of the long term monitoring data has enabled an estimate to be made for the aquifer parameters. With the consideration of these parameter values (transmissivity = 150 m²/day, specific yield = 5.0E-3) a revised pumping rate and setting has been made.

It is recommended that the pumping rate for P22 be 40 L/sec at a corresponding pump setting of 146m.

(d) Water Quality:

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<tr>
<th>DATE</th>
<th>COND.</th>
<th>HARD.</th>
<th>SO4</th>
<th>TEMP</th>
<th>Q</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td>mg/L</td>
<td>mg/L</td>
<td>°C</td>
<td>L/sec</td>
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<td>304</td>
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<td>70</td>
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<td>63</td>
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</table>
PRODUCTION BORE P22
RN 13409

Fig. P22.1
AVAILABLE DRAWDOWN WITH PUMP SETTING 146m
AND SWL ON 8/5/89 = 443.82m AHD

LEGEND
- 40L/s without interference
- 40L/s with interference from P23 pumping at 40L/s

CONTINUOUS PUMPING CURVE P22

Fig. P22.2
Appendix G

P23 - RN 13408
REASSESSMENT OF PUMPING STRATEGY FOR P23 (RN 13408)

The following sections summarise the bore construction, water quality, the reassessment of the bore's pumping regime, and the new pumping recommendations for the bore. Bore construction is shown in Figure P23.1. Predicted drawdown in the bore is shown in Figure P23.2.

(a) Construction Details:

Date Drilled: May 84
Total Depth: 230.4 m
Standing Water Level: 89.9 m 23 May 84

Casing Details

<table>
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<tr>
<th>From</th>
<th>To</th>
<th>O.D.</th>
<th>I.D.</th>
<th>Comments</th>
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<td>335.0</td>
<td>blank casing</td>
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<td>149.8</td>
<td>150.2</td>
<td></td>
<td></td>
<td>neoprene packer</td>
</tr>
<tr>
<td>150.2</td>
<td>188.5</td>
<td>219.1</td>
<td>203.2</td>
<td>blank casing</td>
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<tr>
<td>188.5</td>
<td>208.9</td>
<td>219.1</td>
<td>203.2</td>
<td>3.5 mm screens</td>
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<tr>
<td>208.9</td>
<td>230.4</td>
<td>219.1</td>
<td>203.2</td>
<td>blank casing</td>
</tr>
</tbody>
</table>

(b) Groundwater Hydraulics.

The caliper log run by T Ritchie demonstrated that fracture zones were present in the intervals 171 to 200, 202 to 205, 221 to 224 and 230 to 231 metres.

The drawdown yield equation based on the results of the step test is

\[ s = (0.05 + 0.3 \log t)Q + 0.09Q^2 \]

where \( Q \) is \( m^3/min \)
and \( t \) is \( min \).

Aquifer transmissivity based on short term pumping tests is of the order of 500 \( m^2/day \). The above equation is valid for early time drawdowns (initial 48 hours) however long term monitoring of the aquifer drawdown indicates an aquifer transmissivity of only 150 \( m^2/day \). Consequently the above equation cannot be used to predict long term aquifer drawdown. The pumping curve for P23 has been constructed by using the drawdown yield equation to predict the initial drawdown in the well and then assuming a transmissivity of 150 \( m^2/day \), which has been derived from long term monitoring results, to predict the long term rate of change of drawdown.
As with P22, the theory on which the drawdown yield equation is based enables the long term reduction in transmissivity to be compensated for by altering the constants of the equation. The pumping curve for P23 can therefore be approximately represented by:

\[ s = (0.05 + 1.0 \log t)Q + 0.09Q^2 \]

(c) Pumping Rates:

This bore was initially recommended for pumping at 90 L/sec. P23 was not pumped during the 85/86 financial year. The pump is set at 136 metres and was pumped at 31 L/sec.

Subsequent re-analysis of the pump test results and analysis of long term monitoring data has enabled an estimate to be made for the aquifer parameters. With the consideration of these parameter values (transmissivity = 150 m²/day, specific yield = 5.0E-3) a revised pumping rate and setting has been made.

It is recommended that the pumping rate for P23 be 40 L/sec at a corresponding pump setting of 146m.

(d) Water Quality:

<table>
<thead>
<tr>
<th>DATE</th>
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<th>SO4</th>
<th>TEMP</th>
<th>Q L/sec</th>
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</table>
PRODUCTION BORE P23
RN 13408

Fig. P23.1
AVAILABLE DRAWDOWN WITH PUMP SETTING 146m AND SWL ON 8/5/89 = 447.03m AHD

LEGEND
- 40L/s without interference
- 40L/s with interference from P22 pumping at 40L/s

CONTINUOUS PUMPING CURVE P23
Appendix H

P24 - RN 14864
BORE COMPLETION REPORT
RN 14864
ROE CREEK BOREFIELD
ALICE SPRINGS WATER SUPPLY
AUGMENTATION STUDY

N Power
Senior Engineer Groundwater
July 1987
1. **INTRODUCTION**

In line with the brief of the Alice Springs Water Supply Augmentation Study this is the first of four production bores to be drilled in the Roe Creek borefield to meet the projected peak day demand of Alice Springs.

The bore has been constructed south of production bore RN 6520 (P8) and will ultimately replace it.

2. **GEOLOGY**

Bore 14864 has been constructed down dip of bore 6520 in the upper unit of the Merenie Sandstone Formation. The current augmentation study has divided the Merenie Sandstone Formation into two units. When the job brief was written it was thought that the main producing zone in fractured sandstone of the upper unit, identified in the other production bores west of Roe Creek as being between approximately 150m - 200m below ground level, would follow the dip of the Formation. Under this interpretation the bore casing was to be set at a minimum depth of 200m and water extracted from the aquifer below this depth. The investigation drilling to locate suitable sites for the four production bores determined, however, that the main producing zone did not follow the dip of the Formation but stayed at the same topographic level below ground level as defined above.

Bore 14864 has been constructed as shown in the Appendix with the casing set at 174.8m. The bore extracts water from the main producing zone between 176.9 - 212.8m. From this zone the bore is hydraulically capable of yielding in excess of 100 L/s for pump drawdowns of approximately 5m. Testing of an investigation borehole beside 14864 indicates that with casing set at 200m and the borehole deepen to around 290m, the bore would be hydraulically less efficient with a pump drawdown of around 12m at 85 L/s. Investigation drilling and testing, however, indicate that this result is not uniform across the aquifer west of Roe Creek.

3. **WATER QUALITY**

Chemical water quality analysis is attached in the Appendix. The quality is typical of the water being extracted from the aquifer in this part of the borefield.
4. BOREFIELD PERFORMANCE

The surveyed ground level of the bore is RL 552.505m AHD. The top of casing level is 552.716m AHD.

Increasing extraction from the Merenie Sandstone since 1964 has established a "Mining" situation where the potentiometric surface (water level) is being drawn down across the borefield West of Roe Creek. This rate of decline is around 2.5m per year. In April 1987 the standing water level in 14864 was 132.5m below ground level (RL 420.00m AHD). As the drawdown in 14864 due to pumping will be approximately 5m at the operational pumping rates, the main determinant of the pump setting and ultimate life of the bore is the rate of decline of the potentiometric surface. The following recommendations on pumping rates and pump setting are framed with this situation in mind.

5. RECOMMENDATIONS

PUMPING RATE

The prediction of the performance of RN 14864 is based on short term pumping tests up to 78 L/s. It is hydraulically possible to pump the bore at higher rates but field testing will be required to confirm the drawdowns and hole stability at these rates. A specific pumping rate has not been recommended but rather a drawdown versus time curve for three pumping rates 60, 75 and 84 L/sec and indicative drawdown curves at 100, 120 and 150 L/s. These curves are shown in the Appendix. The curves have been prepared under three sets of pumping conditions which are:

(1) Continuous pumping without regional drawdown.
(2) Continuous pumping with 2.5m per year regional drawdown.
(3) Intermittent pumping for 8 hours per day with a 2.5m per year regional drawdown.

For pumping rates up to 84 L/s the curves include an allowance of 1m drawdown due to interference from pumping of the nearby production bores. For the higher rates an allowance of 1.5m drawdown due to interference has been allowed which assumes the neighbouring bores are also pumping at similar rates.
PUMP SETTING

A pump setting of 150.5m has been recommended. This setting should be sufficient for five years before the pump needs to be lowered. A two metre submergence over the pump intake has been included in this recommended pump setting.

Water Resources should be contacted to recommend a further pump setting in five years time so that the bores performance and expected lifetime can be re-assessed.

Provision should be made to fit a water level measuring device such as an airline when equipping the bore.
APPENDIX

TEST REPORTS
WATER RESOURCES DIVISION

TEST REPORT — BORE RN. 14864

Bore location: Roe Creek Borefield
Client/owner: NT Government
Client's reference: P24
Purpose of supply: Town Water

Map: SF 53.14
Grid reference: 379 350 ME 7366 350 mN

RECOMMENDATIONS
Pumping rate: see curve L/s. Pump setting: 150.5 m below ground level
General recommendations are given on the reverse side.
The aquifer and bore can sustain higher pumping rates with deeper pump settings or for short periods in favourable seasons. Further advice can be obtained from: Water Resources (In all correspondence refer to the bore's RN number), North Stuart Hwy Alice Springs

BORE DATA
Finished depth: 227 m Completion date: 1/4/87 Test date: 22/4/87
Standing water level 132.5m on 13/4/87 Test rates: 66 L/s
Construction details:

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<td>173.4 - 173.8</td>
<td>Packer</td>
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<td>173.4 - 176.9</td>
<td>254 mm ID Blank Casing</td>
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<tr>
<td>176.9 - 212.84</td>
<td>3.5 mm Aperture Stainless Steel Screens</td>
<td></td>
</tr>
<tr>
<td>212.84 - 227.0</td>
<td>254 mm Blank Casing with sub 2 7/8&quot; IF pin on</td>
<td></td>
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</tbody>
</table>

Notes:
1. Top of casing as constructed was 0.25 m above ground bottom
2. All depths are measured from natural ground level
3. Test rates are not indicative of safe long term pumping rates.

WARNING: MINIMUM INTERNAL BORE DIAMETER IS 254 mm

COMMENTS
SEE ATTACHED COMMENTS

WATER QUALITY
See water laboratory report (Analysis No.)
RECOMMENDATIONS FOR FINISHING, OPERATING AND PROTECTING GROUNDWATER BORES

Attention to the following points will ensure a long and safe life for the bore supply and help prevent pollution of the groundwater resource.

1. Construct a concrete apron around the bore head to prevent surface flow, seepage and waste from entering the bore.
2. Seal the space between the casing and pump equipment to prevent entry of vermin, dirt and pollutants.
3. Maintain pumping equipment in good order to prevent pollution. Prevent spillage of fuel and oil on the ground around the bore. Store fertilizer and other chemicals at least 50 m away.
4. Keep stock away from the bore head. Discourage domestic activity at the bore. The first tap on the pipeline should not be less than 5 m from the bore head.
5. Pumping the bore at higher than recommended rates may fork the bore leading to instability or pump maintenance problems. Seek the professional advice of an hydrogeologist or groundwater engineer.
6. If the bore is no longer required, the casing is to be removed or securely capped and the bore backfilled with clayey material. A cement plug may be required in some instances.

In addition, please ensure that the BORE IDENTIFICATION TAG is retained securely at all times. The registered bore number is Water Resources Division’s only reference to the scientific and engineering data on this bore, and hence important to WRD’s further advice to bore owners.
STANDING WATER LEVEL
132.5m APRIL 1987

MAXIMUM AVAILABLE DRAWDOWN - PUMP SETTING OF 170m

LEGEND

60 L/sec
72 L/sec
84 L/sec
100 L/sec
120 L/sec
150 L/sec

2.5 metres per year regional drawdown

INTERMITTENT PUMPING CURVE
(8 HOURS P/DAY)
RN 14364
**WATER ANALYSIS**

Department of Transport & Works
Water Division, Darwin N.T.

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<th>Laboratory Register No.</th>
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**LOCATION AND DETAILS**

Roe Creek production bore RN 14864 Depth 150m, Bore ID 85mm Temp 32°C, Cond 720, Flow No 7653

Proposed water use - Domestic, Stock, Irrigation, other (specify) RSP157

**ANALYSIS - PHYSICAL**

- pH 7.8
- Colour (Hazen units)
- Specific conductance (mhos at 25°C) 840
- Turbidity (NTU)
- Total dissolved solids (mg/L by evaporation at 180°C) 475
- Suspended solids (mg/L)

**ANALYSIS - CHEMICAL (mg/L)**

- Sodium (Na) 77
- Chloride, Cl 0.8
- Potassium, K 6
- Sulphate, SO₄ 20
- Calcium, Ca 14.6
- Nitrate, NO₃ 9
- Magnesium, Mg 25
- Bicarbonate, HCO₃ 39.4
- Carbonate (as CaCO₃) 21.8
- Chloride (as Cl⁻) 0.5
- Iron, total Fe 0.1
- Nitrate, NO₃ 0.1
- Sodium, Na 14
- Fluoride, F 11.2

**ANALYSIS - ADDITIONAL (mg/L)**

- Copper, Cu
- Lead, Pb
- Arsenic, As
- Mercury, Hg
- Zinc, Zn
- Cadmium, Cd
- Nickel, Ni
- Cobalt, Co

**THE SAMPLE AS ANALYSED COMPLIES/DOS NOT COMPLY WITH NORTHERN TERRITORY DRINKING WATER STANDARDS AS RECOMMENDED BY THE NORTHERN TERRITORY DEPARTMENT OF HEALTH**

Boxes marked thus ☒ indicate levels considered undesirable for drinking water by the Northern Territory Department of Health.

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REHABILITATION OF PRODUCTION
BORE NO P24 RN 14864
ALICE SPRINGS
1989
REPORT ON REHABILITATION WORK
CARRIED OUT ON PRODUCTION BORE P24 RN14864

Background

Production bore no P24 RN14864 was drilled in the Roe Creek borefield at Alice Springs by PA WA drill rig no 16. Drilling was completed on the first of April 1987 to a total depth of 227 metres.

A 660 mm hole was drilled to 9.4 metres and cased with 508 mm casing. A 445 mm hole was drilled to 198 metres and cased to 175 metres with 406 mm casing. The 406 mm casing could not be run to the bottom of the 508 mm hole due to a slight deviation caused by the extremely fractured formation. A 311 mm hole was drilled from 193 metres to 227 metres, the hole was constructed as follows. 273 metres casing from 173.4 metres to 176.9 metres. A packer was fitted at the top of this casing to seal between it and the 406 mm surface casing. Stainless steel bore screens were set against the aquifer between 176.9 metres and 212.8 metres and 273 mm blank casing from 212.8 metres to 227 metres.

The bore was equipped by contract. During commissioning of the bore the pump and column became unscrewed at the surface and was lost down the bore.

A Darwin oilfield supply company TRI-STATE OILTOOLS were engaged to recover the lost equipment. The pump and column were recovered (photo A) however, the motor had broken from the pump on impact and was still in the bore. While recovering the pump and column the flange at the base of the pump caught beneath the 406 mm casing due to the oversize hole underneath. A very high pull was required to move the stuck pump and in doing so the bottom of the 406 mm casing was damaged. A swaging tool was manufactured by TRI-STATE to resize the damaged section of casing. While swaging was being carried out the tool unscrewed from the drill pipe and fell onto the pump motor. An overshot was manufactured by TRI-STATE to fish the swaging tool. The overshot had a 4 1/2" IF pin connection fitted internally to screw into the top of the swaging tool once the tool was located inside the overshot. Attempts to locate the swaging tool inside the overshot were unsuccessful as the swaging tool was not sitting centrally in the hole. Attempts were made to drive the overshot over the tool using heavy drill collars, this also was unsuccessful.

After considerable effort TRI-STATE abandoned their attempts at rehabilitation works. A drill rig and crew were dispatched from Darwin to carry out this work. The operations were directed and oversighted by the Drilling Superintendent.
Recovery Work

When we commenced recovery operations there remained down hole the swageing tool, below that was the pump motor, this was sitting on top of the 3 metre section of 273 mm casing which had the packer attached to it. Below the packer was 36 metres of 273 mm OD stainless steel bore screens and below the screens was 14 metres of 273 mm steel casing.

It was expected that the screens would be badly damaged and compressed due to the impact from the pump and column and the driving by TRI-STATE on the swageing tool.

On the 2nd March 1989 a down hole video camera was run in P24 by personnel from the University of New South Wales (photo B & C). A number of different lenses were used. The runs were recorded on tape.

The camera revealed the top of the swageing tool (the fish) at 178.4 metres, the shoulder of the tool joint showed some damage and the tool was seen to be leaning hard against one side of the hole. It was decided to use the overshot which was manufactured by TRI-STATE to fish the swageing tool rather than waste time manufacturing our own. The tool was despatched from Darwin. Because TRI-STATE were unable to locate the tool over the fish in its original configuration, it was decided to modify the tool and to make a wall hook to guide the fish into the overshot. The modified overshot (photo 1 & 2) was run on the 4th March, using rotation we were able to hook onto the fish but were unable to shift it.

A hook arrangement was manufactured from 38 mm dia round steel bar. The idea was to hook in behind the neck of the fish and by applying pull the fish should be forced into the centre of the hole. The hook was run on the 5th March, we were able to hook the fish as planned but when the pull was applied the hook straightened. This confirmed earlier thoughts that the fish was jammed very tightly due to the driving carried out by TRI-STATE.

On the 7th March the camera was again run, this revealed that the swageing tool had been driven down along side the motor and was hard against one side of the hole.

A tool was manufactured to position the fishing string off centre and hard against the side of the hole so it could be stabbed into the swageing tool (photo 3). A 4 1/2" IF pin connection was fitted to the bottom of this tool to screw directly into the tool joint on the swageing tool.
This offset tool was designed so that when the drill string is rotated anti-clockwise, the whole tool is rotated thus allowing it to be positioned onto fish. When the drill string is rotated clockwise, only the drill string rotates and thus allows the threaded connection which was fitted to the bottom of this offset tool, to be screwed into the fish.

This tool was run on March 9th. We were able to stab the tool joint on the fish, but due to the angle of the fish the threads pulled out when weight was applied.

The same string was then run with a tappered tap on the bottom in place of the threaded connection. The tap was screwed into the fish and the swaging tool was recovered from the hole (photo 4).

The camera was run again on the 10th March to check the position and condition of the motor. It was revealed that the motor was lying hard against the side of the hole and that the flange on top which mates to the pump was broken. It was decided to attempt to catch the motor by the remaining section of the flange as there was no section to catch onto on the flush exterior of the motor body. An overshot was manufactured from 135 mm casing with internal catchers to grab onto the flange. This tool was run on the 11th March. The overshot was positioned over the motor however the catchers were straightened out when pull was applied. This overshot was then modified (photo 5), the length was increased and the catchers were replaced with heavy spring steel sections. The modified tool was run on the 14th March, the tool was again positioned over the motor but again failed to pick it up. Further modifications were carried out and the tool was run again on the 15th March, again without success.

A new tool was manufactured from 300 mm diameter casing (photo 6) which was designed to catch the motor externally by a friction grip. This tool was run on the 16th March. The fish was engaged and the tool was driven over the fish for the required distance. When pull was applied the hoisting winch was incapable of lifting the string of tools. The kelly and hoist lines were both hooked to the string and maximum pull was applied, the tool then let go and pulled off the fish. It was now evident that the motor was jammed tightly inside the 273 mm casing, and that the string of casing and screens were wedged tightly in the hole. The force which was applied on this last tool was more than sufficient to lift the pump, casing and screens had they not been tightly jammed.
I then contacted oilfield suppliers in search of a short catch overshot which would catch onto the short drive shaft which was protruding from the top of the motor. TRI-STATE were able to source a tool from Sale Victoria, the grapples to suit were available ex Singapore. This tool was ordered on a rental basis on the 17th March. The overshot arrived on the 20th March and the grapples the following day (photo 7).

When assembling the tool it was found that the parts were not compatible and that the wrong tool had been sent from Sale. The correct tool was again ordered and arrived on the 22nd March. While waiting for the overshot a tool was manufactured in which the overshot was to be mounted. (photo 8 & 9). This tool has a wall hook to position it over the motor, centralisers were fabricated into tool to centralise motor and to guide it into the overshot. This tool was run on the 22nd March. This proved successful and the motor was recovered from the hole (photo 10 & 11). Darwin crew returned home on the 23rd March.

Work commenced again on the 15th April. A Bowen casing spear was rented to pick up the string of 273 mm casing and screens. The casing spear was run on the 15th April but could not be positioned inside the casing. The camera was run on the 16th April to inspect the top of casing, this showed that the top of the packer was damaged and the casing was lying hard against the side of the hole. This section of the hole was very fractured and much larger than the hole originally drilled.

A tapered guide was made and fitted to the casing spear (photo 12) the spear was again run in conjunction with the "offset tool" (photo 3). We were still unable to engage the casing. A "side hill" type guide was made and fitted to the casing spear (photo 13). This was still unsuccessful. A hook was manufactured to hook around the casing and position it more centrally in the hole (photo 14). This hook was run on the 21st April to centralise casing. The casing spear with the side hill guide (photo 13) was run again on the 22nd April, this time the spear was run into the casing.

When casing was pulled the top of the packer caught under the 406 mm casing because of the larger hole below. The RO300 rig which was being used to date did not have sufficient pulling power to move the casing further.

Our Bourne 2000 rig was bought in and positioned over the hole, when the additional pull of this rig was applied the spear pulled out of the casing.
The camera was again run on the 26th April. This showed the packer wedged under the 406 m casing. The casing spear was run again on the 26th, the casing was hooked and the top 3 metres were recovered. This had parted where it was joined to the screens (photo 15).

The camera was run on the 27th to check the condition of the stainless steel screens. It was decided to wash over the screens and pick them up externally with an overshot which would be made from 355 mm casing. A milling shoe with tungsten carbide particles brazed onto the cutting edge was manufactured (photo 16 & 17).

This was welded onto a 12 metre section of 355 mm casing (photo 18) which was then adapted to the drill pipe. Milling commenced but the arrangement was torqueing up so badly that this method could not be continued. A hardened steel drive shoe was then made. Attempts were then made to drive the 355 mm casing over the screens but they were so badly damaged that this was unsuccessful.

A spear was made to be driven into the damaged screens by welding a series of barbs made from 38 mm round steel onto a drill collar (photo 19).

A number of mechanical problems developed with both drilling rigs during this period.

The spear was run on the 13th May and a section of the screen was recovered. The spear was repaired and run again on the 15th May and another section of screens was recovered.

Due to further mechanical problems with the rigs I returned to Darwin until repairs were carried out.

Work commenced again on the 29th June. The spear was run and another section of screen was recovered. The spear was again run, this time the rig was unable to pull string. A 50 tonne crane was ordered on the 30th June. Attempts to pull the string with the crane were unsuccessful. The rig was moved back over hole and further attempts proved successful and the last of the screens were recovered.

It was noted that when the spear was run into the 273 mm casing below the screens that the top of the casing was damaged.

A tapered reamer was manufactured and welded to the drill collar which was used to spear the screens (photo 20 & 21). This was run to re-size the casing prior to running the casing spear (photo 12).
The casing spear was then run and engaged into the casing. The casing proved to be so tightly wedged in the hole that the rig was unable to pull it.

A crane was ordered on the 6th July and the casing was lifted. The rig was then used to recover the last of the casing string.

The recovery operations were completed on the 6th July. New screens were purchased and the bore was reconstructed on the 12/8/89.

It was decided to use 355.6 mm screens in the top section of the aquifer and reduce to 273 mm screens in the bottom section of the hole. The larger diameter screens would produce a more efficient bore and the minimal additional cost was justified. It was also decided against using the 3 metre blank section of casing on top of the screens as severe corrosion was detected in the section of casing which was recovered.

A material which would not promote corrosion would be required in this area, various materials including fibreglass casing were considered. It was decided to use additional stainless steel screens as this material would be strongest and most effective.

The final construction details are shown on final page of this report.

Costs

The total cost of the recovery operations, excluding hire of downhole video camera is $148,548.00. This is broken down as follows.

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<th>Description</th>
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<tr>
<td>Recovery of swageing tool (Tri-State error)</td>
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<td>Remainder of recovery operations</td>
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<td>Cost of new construction</td>
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**TOTAL COST:** $148,548

Additional cost of new construction is: $4,280

P. RICHARDSON
Drilling Superintendent

17 September 1989
A

PUMP AND COLUMN RECOVERED BY TRI-STATE.

B

BORE HOLE INSPECTION UNIT FROM THE UNIVERSITY OF N.S.W.
MODIFIED OVERSHOT USED TO FISH FOR SWAGEING TOOL
"OFFSET TOOL" USED TO POSITION THE FISHING STRING AGAINST SIDE OF HOLE.

SWAGEING TOOL RECOVERED FROM HOLE USING "OFFSET TOOL" AND TAPERED TAP.
OVERSHOT USED TO TRY TO FISH PUMP MOTOR. SPRING LEAVES WERE USED AS CATCHERS TO TRY TO CATCH UNDER FLANGE OF MOTOR.

ANOTHER OVERSHOT USED TO TRY TO FISH MOTOR. THIS TOOL WAS DRIVEN OVER MOTOR TO CATCH BY FRICTION GRIP.
SHORT CATCH OVERSHOT (UNASSEMBLED) USED TO CATCH SHAFT ON TOP OF MOTOR.

SHORT CATCH OVERSHOT WAS FITTED INTO THIS CENTRALIZER GUIDE MADE FROM 305mm CASING.
SHORT CATCH OVERSHOT INSIDE CENTRALIZER GUIDE.

MOTOR WAS RECOVERED USING SHORT CATCH OVERSHOT MOUNTED INSIDE CENTRILIZER.
HOOK USED TO CENTRALIZE 273mm CASING AND SCREEN PACKER.

TOP SECTION OF 273mm CASING WITH REMAINS OF SCREEN PACKER.
MILLING SHOE USED TO TRY TO WASHOVER SCREENS.

MILLING SHOE FITTED TO 355mm CASING
SPEAR MADE TO FISH SCREENS. 38mm DIA STEEL BARBS WERE WELDED TO 4.5 DRILL COLLAR.

TAPERED REAMER USED RESIZE BOTTOM SECTION OF 273mm CASING SOME SECTIONS OF SCREENS WERE RECOVERED FROM INSIDE CASING.
Tapered reamer used to resize 273mm casing edges were hardfaced.
Appendix I

P25 - RN 14867
POWER AND WATER AUTHORITY
WATER DIRECTORATE
WATER RESOURCES GROUP

BORE COMPLETION REPORT
RN 14867
ROE CREEK BOREFIELD
ALICE SPRINGS WATER SUPPLY
AUGMENTATION STUDY

N Power
Senior Engineer Groundwater
July 1987
1. INTRODUCTION

In line with the project brief of the Alice Springs Water Supply Augmentation Study this is the second of two production bores drilled in 1987 to meet the projected peak day demand in 1987/88 of Alice Springs.

The first bore was RN 14864 for which a separate bore completion report has been issued. The bore has been constructed between current production bores 11361 (P14) and 11334 (P15) where better quality water of lower Total Dissolved Solids had been struck in 11361 (P14), than further west in the borefield.

2. GEOLOGY

The geology of the borefield west of Roe Creek was summarised in the bore completion report for RN 14864. RN 14867 has been constructed similarly in the Mereenie II unit. The bore extracts water from a zone of major fracturing between 164m and 206m. Below this depth to 280m geophysical caliper logging indicated significantly less fracturing of the Mereenie Sandstone. As noted in the bore completion report for 14864, the most efficient water yields from this aquifer are obtained from this zone of major fracturing. Therefore the casing was set above this zone at 164.1m as shown in the Appendix.

The bore is capable of yielding around 80 L/s with acceptable pumping heads.

3. WATER QUALITY

Chemical water quality analysis is attached in the Appendix. The quality is typical of the water being extracted from the aquifer in this part of the borefield.

4. BOREFIELD PERFORMANCE

The surveyed ground level of the bore is RL 551.072m AHD. The top of casing level is RL 551.108m AHD.

Increasing extraction from the Mereenie Sandstone since 1964 has established a 'Mining' situation where the potentiometric surface (water level) is being drawn down across the borefield West of Roe Creek. This rate of decline is around 2.5m per year. In April 1987 the standing water level in 14867 was 127.8m below ground level (RL 423.272m AHD). The main determinant of the life of the bore is the rate of decline of the potentiometric surface. The following recommendations on pumping rates and pump setting are framed with this situation in mind.
5. RECOMMENDATIONS

The prediction of the performance of RN 14867 is based on short term pumping tests up to 78 L/s. This bore is also affected by interference drawdown of up to 2.6m from bores 11361 (P14), 11334 (P15) and 13407 (P21) at current pumping rates.

A specific pumping rate has not been recommended but rather a drawdown versus time curve for pumping rates of 50, 60, 70, 75 and 80 L/s. The curves are shown in the Appendix. The curves have been prepared under five sets of pumping conditions which are:

1) Continuous pumping without regional drawdown.

2) Continuous pumping with 2.5m per year regional drawdown without interference from other production bores.

3) Intermittent pumping for 8 hours per day with a 2.5m per year regional drawdown without interference from other production bores.

4) Continuous pumping with 2.5m per year regional drawdown with interference from production bores 11361 (P14) at 55 L/s, 11334 (P15) at 79 L/s and 13407 (P21) at 85 L/s.

It is recommended that 14867 not be pumped simultaneously with bores 11361 (P14), 11334 (P15) and 13407 (P21) to maximise its operational life.

PUMP SETTING

A pump setting of 160m is recommended which allows 2.8m above the top of the packer for the pump motor.

Once the potentiometric water level has fallen to the manufacturer's recommended minimum submergence level, the feasibility of extending the life of the bore by deepening the borehole and running smaller diameter casing should be investigated.

Provision should be made to fit a water level measuring device such as an airline when equipping the bore.
WATER RESOURCES DIVISION

TEST REPORT — BORE RN. 14867

Bore location: Roe Creek Borefield  Client/owner: NT Government
Client's reference: P 25
Purpose of supply: Town Water

Map: Alice Springs 1:100 000 Sheet No: 5650
Grid reference:

RECOMMENDATIONS
Pumping rate: See curves L/s. Pump setting: 160 m below ground level
General recommendations are given on the reverse side.
The aquifer and bore CANNOT sustain higher pumping rates with deeper pump settings or for short
periods in favourable seasons. Further advice can be obtained from:
(In all correspondence refer to the bore's RN number).

BORE DATA
Finished depth: 205.81 m  Completion date:
Standing water level: 127.9 m on 23/5/87  Test date: 27/5/87
Construction details:

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<th>Interval (m)</th>
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<td>0 - 164.14</td>
<td>400 mm OD Blank Steel Casing/387 mm ID</td>
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<td>162.8 - 163.27</td>
<td>Stainless Steel Packer</td>
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<td>163.27 - 194.07</td>
<td>254 mm ID, 3.5 mm Aperture Stainless Steel Screens</td>
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Test rates: 73 L/s  Test duration: 3 days

Notes:
1. Top of casing as constructed was 0.45 m above ground
2. All depths are measured from natural ground level
3. Test rates are not indicative of safe long term pumping rates.

WARNING: MINIMUM INTERNAL BORE DIAMETER IS 254 mm

AQUIFER TEST

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<th>Interval (m)</th>
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<tr>
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<td>254 mm ID, 3.5 mm Aperture Stainless Steel Screens</td>
</tr>
<tr>
<td>201.11 - 202.76</td>
<td>254 mm ID Blank Steel Casing</td>
</tr>
<tr>
<td>202.76 - 205.81</td>
<td>254 mm ID, 3.5 mm Aperture Stainless Steel Screens</td>
</tr>
</tbody>
</table>

with Sub 3½" IF Box welded to base.

SEE ATTACHED COMMENTS

WATER QUALITY

See water laboratory report (Analysis No. 86/87/2213)
RECOMMENDATIONS FOR FINISHING, OPERATING AND PROTECTING GROUNDWATER BORES

Attention to the following points will ensure a long and safe life for the bore supply and help prevent pollution of the groundwater resource.

1. Construct a concrete apron around the bore head to prevent surface flow, seepage and waste from entering the bore.
2. Seal the space between the casing and pump equipment to prevent entry of vermin, dirt and pollutants.
3. Maintain pumping equipment in good order to prevent pollution. Prevent spillage of fuel and oil on the ground around the bore. Store fertilizer and other chemicals at least 50 m away.
4. Keep stock away from the bore head. Discourage domestic activity at the bore. The first tap on the pipeline should not be less than 5 m from the bore head.
5. Pumping the bore at higher than recommended rates may fork the bore leading to instability or pump maintenance problems. Seek the professional advice of an hydrogeologist or groundwater engineer.
6. If the bore is no longer required, the casing is to be removed or securely capped and the bore backfilled with clayey material. A cement plug may be required in some instances.

In addition, please ensure that the BORE IDENTIFICATION TAG is retained securely at all times. The registered bore number is Water Resources Division’s only reference to the scientific and engineering data on this bore, and hence important to WRD’s further advice to bore owners.
508mm OD STEEL CASING

400mm OD STEEL CASING/387mm ID

SWL 130m APRIL 1987

PACKER 162.8 - 163.2

3.5mm APERTURE STAINLESS STEEL SCREEN

254mm ID BLANK CASING

SUB 3½IF BOX WELDED TO BASE

ROE CREEK RN 14867
Before considering Annual Regional Drawdown

Drawdown due to pumping plus interference from other bores at pumping rates in 1987
TIME (minutes)

INTERMITTANT PUMPING CURVE
WITHOUT INTERFERENCE
(8 H/DAY) RN 14867

2.5 metres per year regional drawdown

50 L/sec

60 L/sec

70 L/sec

80 L/sec

TIME (years)

DEPTH BELOW GROUND LEVEL (metres)

DRAWDOWN (metres)
Technical Report WRD93065

ANALYSIS

Department of Transport & Works
Water Division, Darwin N.T.

LOCATION AND DETAILS
Roe Creek Borefield R/N 14867 Depth 160m
Disch 65 LPS Temp 29°C Cond 70°C RWT 881 RSP 157

Proposed water use - Domestic, Stock, Irrigation, other (specify)

ANALYSIS - PHYSICAL

- Specific conductance (microsiemens cm at 25°C)
- Total dissolved solids (mg L^-1 by evaporation at 180°C)
- pH
- Colour (Hazen units)
- Turbidity (NTU's)
- Suspended solids (mg L^-1)

ANALYSIS - CHEMICAL (mg/L)

- Sodium, Na
- Chloride, Cl
- Potassium, K
- Sulphate, SO4
- Calcium, Ca
- Nitrate, NO3
- Magnesium, Mg
- Bicarbonate, HCO3
- Total Hardness (as CaCO3)
- Carbonate, CO3
- Total Alkalinity (as CaCO3)
- Fluoride, F
- Iron (total) Fe
- Orthophosphate, PO4
- Silica, SiO2

ANALYSIS - ADDITIONAL (mg/L)

- Copper, Cu
- Lead, Pb
- Arsenic, As
- Zinc, Zn
- Cadmium, Cd
- Nickel, Ni
- Cobalt, Co

THE SAMPLE AS ANALYSED COMPLIES WITH NORTHERN TERRITORY DRINKING WATER STANDARDS AS RECOMMENDED BY THE NORTHERN TERRITORY DEPARTMENT OF HEALTH
Appendix J

P26 - RN 15097
COMPLETION REPORT FOR P26 (RN 15027)

The bore was completed in April 1988 and was thought originally to have been constructed in the Shannon Formation. The bore was sited based on information from diamond drill holes RN's 15022 and 15043. Subsequent interpretation of the core from these diamond drill holes by Lau (1989) and Jolly et al (1990) has shown that this bore is in fact constructed in the lower half of the Pacoota Sandstone.

A test report issued in 1988 follows. Construction of the bore is detailed in Figure P26.1. The bore was recommended for continuous pumping at 40L/s with a pump setting of 120m depth. Monitoring of the bore’s performance and reappraisal of the pumping strategy was recommended after 12 months of operation (refer to N. Power's minute of August 1988 included in the following pages). The predicted performance of the bore from 1988 under the recommended pumping regime is shown in Figure P26.2.
POWER AND WATER AUTHORITY

REF: 4-68-328

REGIONAL MANAGER ALICE SPRINGS
ATTEN: A/SENIOR ENGINEER CONSTRUCTION ALICE SPRINGS
SENIOR ENGINEER GROUNDWATER/PROJECT MANAGER

ALICE SPRINGS WATER SUPPLY AUGMENTATION STUDY
ROE CREEK BOREFIELD: MacDONNELL YARDS RN 15097 (P26)

Attached is a Test Report for bore RN 15097 which details the bore's construction, equipping details and recommended operational pumping strategy. A Bore Completion Report is in preparation which will detail the hydrogeology of the aquifer and will incorporate the data in this Test Report.

RN 15097 was targeted to extract water from the Shannon Formation. As it is the first production bore constructed in this resource the bore's long term hydraulic performance and the aquifer response has been predicted from short term test pump results. These can only be confirmed after longer term operational pumping. Extraction from the Shannon Formation will not be as efficient as from the Merreenie Sandstone west of Roe Creek, which is more suitable for short duration, high extraction rate pumping strategies. This resource will be more suited to continuous pumping providing a base load.

To define and confirm the long term extractable yield from the resource, its water quality and the hydraulic performance of RN 15097 the following recommendations are made for its operation.

1. RN 15097 be pumped continuously (24 hour per day) at 40 L/s.
2. A water level recording device be installed on 15097 when equipped and water level readings be taken daily.
3. A chemical water quality sample be taken every three months.
4. Water Resources Group take water levels from observation bores 15043, 15092, 11861, 11857, 15693.
5. The performance of RN 15097 and the aquifer be reassessed after twelve months operation.

34:CDVT2
In line with the recommended continuous pumping operation a pump drawdown curve at 40 L/s is attached. This has been predicted for up to 5 years continuous pumping subject to the recommended annual review of its performance.

If you have any queries regarding the bore contact Neil Power on 89 8316.

N POWER
August 1988
WATER RESOURCES DIVISION

TEST REPORT — BORE RN. 15097

Bore location: MacDONNELL YARDS
ROE CREEK BOREFIELD

Client/owner: PAWA

Map: ALICE SPRINGS

Grid reference: 807 674

RECOMMENDATIONS

Pumping rate: 40 L/s. Pump setting: 120 m below ground level

General recommendations are given on the reverse side.

The aquifer and bore cannot sustain higher pumping rates with deeper pump settings or for short periods in favourable seasons. Further advice can be obtained from: SENIOR ENGINEER

(In all correspondence refer to the bore's RN number) GROUNDWATER, DARWIN OR ALICE SPRINGS

BORE DATA

Finished depth: 329 m Completion date: 20.4.88 Test date: 13.5.88 - 25.5.88

Standing water level: 90.2 m on 13.5.88 Test rates: 20 L/s

Construction details:

Interval (m) Description

SEE ATTACHMENT

Notes: 1. Top of casing as constructed was 0.4 m above ground
2. All depths are measured from natural ground level
3. Test rates are not indicative of safe long term pumping rates.

WARNING: MINIMUM INTERNAL BORE DIAMETER IS 203.2 mm

COMMENTS

Refer to minute by Senior Engineer Groundwater File 4-68-328.

Bore should be pumped continuously (24 hr/day)

This Test Report should be reassessed after 12 months pumping and/or if further production bores are constructed in this aquifer.

WATER QUALITY

See water sample report (Technical No. 97/012155)
TEST REPORT - BORE RN 15097

**BORE DATA**

<table>
<thead>
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<th>INTERVAL (m)</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 34.1</td>
<td>387.4mm ID Steel casing</td>
</tr>
<tr>
<td>0 - 209.9</td>
<td>305.2mm ID Steel casing</td>
</tr>
<tr>
<td>208.0 - 208.3</td>
<td>Stainless steel packer</td>
</tr>
<tr>
<td>208.3 - 211.24</td>
<td>203.2mm ID Blank steel casing</td>
</tr>
<tr>
<td>211.24 - 217.34</td>
<td>203.2mm ID, 4mm aperture stainless steel screens</td>
</tr>
<tr>
<td>225.37 - 238.0</td>
<td>203.2mm ID, 4mm aperture stainless steel screens</td>
</tr>
<tr>
<td>237.0 - 263.4</td>
<td>203.2mm ID, 4mm aperture stainless steel screens</td>
</tr>
<tr>
<td>304.08 - 315.08</td>
<td>203.2mm ID, 4mm aperture stainless steel screens</td>
</tr>
<tr>
<td>318 - 321.04</td>
<td>203.2mm ID Blank steel casing</td>
</tr>
<tr>
<td>321.04 - 329.0</td>
<td>screen intervals interconnected by 203.2mm ID steel casing</td>
</tr>
</tbody>
</table>
BORING CONSTRUCTION - P26

- 34.10m x 38.7mm I.D. STEEL CASING at 0m
- 209.20m x 305.2mm I.D. STEEL CASING
- Top of packer 208m
- Screens:
  - 211.24m to 217.34m
  - 225.37m to 238.00m
  - 257.00m to 263.10m
- 203.2mm I.D. STEEL CASING
- 304.08m to 315.08m
- 318.00m to 321.04m
- 89mm REG. PIN WELDED TO SUMP

NOTE: SCREENS ARE 203.2mm I.D. STAINLESS STEEL WITH 4mm APERTURES

Fig. P26.1
STANDING WATER LEVEL

89.8m MAY 1988

40 L/s

CONTINUOUS PUMPING CURVE RN15097
## ANALYSIS - PHYSICAL

- **pH**: 7.3
- **Electrical conductivity (at 25°C)**: 565
- **Total dissolved solids (measured by evaporation at 180°C)**: 605
- **Suspended solids (mg/l)**: 0

## ANALYSIS - CHEMICAL (mg/l)

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<tbody>
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<tr>
<td>Potassium, K</td>
<td>2</td>
</tr>
<tr>
<td>Calcium, Ca</td>
<td>64</td>
</tr>
<tr>
<td>Magnesium, Mg</td>
<td>31</td>
</tr>
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<td>Total Hardness (as CaCO3)</td>
<td>295</td>
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<tr>
<td>Total Alkalinity (as CaCO3)</td>
<td>25</td>
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<tr>
<td>Iron (total Fe)</td>
<td>0.3</td>
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<tr>
<td>Silica, SiO2</td>
<td>25</td>
</tr>
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</table>

## ANALYSIS - ADDITIONAL (mg/l)

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<th>Value</th>
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<tr>
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</tr>
<tr>
<td>Lead, Pb</td>
<td></td>
</tr>
<tr>
<td>Arsenic, As</td>
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<td>Manganese, Mn</td>
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<td>Cadmium, Cd</td>
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<tr>
<td>Zinc, Zn</td>
<td></td>
</tr>
<tr>
<td>Cadmium, Cd</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- Boxes marked with a check indicate levels are within the limits as quoted in the "Guidelines for Drinking Water Quality in Australia", 1987, issued by the National Health and Medical Research Council and the Australian Water Resources Council.
- Levels exceed non-health related limits.
COMPLETION REPORT FOR P27 (RN 15107)

The bore was completed in June 1989 in the Upper Shannon Formation. The bore was sited based on information from diamond drill hole RN 15091 and investigation holes RN's 15100 and 15102.

A bore completion report issued in 1989 follows. Construction of the bore is detailed in Figure P27.1. The bore was recommended for a continuous pumping rate of 25L/s with a pump setting of 160m depth.

The predicted performance of the bore from 1989 under the recommended pumping regime is shown in Figure P27.2. This figure shows a range of performance curves, performance being dependent on physical aquifer properties that had not been precisely determined in 1989. Monitoring of the bore performance was to allow future reappraisal (recommended annually), and hence more accurate estimation of the aquifer properties and the long term performance of the bore.
**Fig. P27.2**

**Composite Log of Bore 15107**

- **Interpretation:**
  - Clay: white and light brown sandy clay and coarse quartz sand with bands of hard quartz and ferrilite from 24 to 35m.
  - Clay: white, brown and red clays and quartz. Bands of ferrilite from 30 to 35m.
  - Clay: interbedded multicoloured clays and brown sandstone hard drilling from 114 to 133m.
  - Shale: interbedded grey shale and grey and brown clay. Bands of dolomite from 142 to 152m and 172 to 202m.
  - Dolomitic: black and brown dolomite, fractured from 202 to 230m.
  - Dolomitic: interbedded dolomite and brown and blue grey shale. Some of shale 255 to 287m, 312 to 272m, 352 to 326m and from 340 to 349.5m. Dolomite fractured from 334 to 327m.

**Log Details:**
- **Depth:** 0
- **Hole Construction:**
  - 38.7m ID
  - 30.5mm ID
  - Steel Casing
  - 15m Cement Plug
  - 200mm Open Hole

**Water Struck:**
- 3 L/s
- 3 L/s
- 20 L/s
- 3 L/s
COMPLETION REPORT BORE REGISTERED (RN) NUMBER 15107

Roe Creek Borefield, Alice Springs
Water Supply Augmentation Study

Recommendations

Pumping Rate

The initial bore performance predictions for 15107 (continuous pumping curves) are based on a short term pumping test of 15107 (4 x 100 minutes step test and 24 hr constant rate test) and also a four day constant rate pump test on 15102.

The maximum rate at which the bore was tested was 40 L/s. The drawdown after 1 day at 33.2 L/s was 54 m from an initial SNL of 83.86 m. Although it is hydraulically possible to pump this bore at 40 L/s it is recommended that it not be pumped at more than 25 L/s. This decision is based on the regional modelling.

Pumping curves are shown in Figures 1 and 2.

Pump Setting

At a recommended rate of 25 L/s a pump setting of 160 m below ground level is recommended. This corresponds to an available drawdown of 76.14 m with the SWL at 83.36 m as measured 13 September 1989.

Provision should be made to fit a water level measuring device when equipping the bore.
Fig. 1

PUMPING CURVE FOR 15107 (P27) INITIAL 24 HRS

25L/s Initial 24 hrs pumping
1. Introduction

As part of the Alice Springs Water Supply Augmentation Study production bore 15107 has been constructed to help meet the water supply demand of Alice Springs. It has been drilled 1004 m to the north of 15097 (P26) and exploits an aquifer in a Cambrian Aged dolomite. This is the first production bore to exploit this aquifer and should assist in relieving some of the pumping stress currently being placed on the Mereenie Sandstone aquifer.

2. Geology

Bore 15107 was targeted to exploit thick bedded dolomite beds within predominant mudstone/shales of the Cambrian Aged Peraoorrta Group. Further work in reporting is required to define the stratigraphy of these Amadeus Basin Sediments.

Nevertheless the lithologies are predominantly cream and white mudstones/shales representing the weathered profile, overlying dark grey mudstones/shales which grade into paler coloured and distinctive bedded dolomites at around 250 metres. A gradation to reddish shale interbeds and interlaminations also occurs.

3. Water Quality

A water quality analysis of the water from 15107 is included in the appendix of this report. The analysis indicates a hard water-Total Hardness as CaCO₃ > 300 mg/L. The hardness of the water is indicative of a carbonate environment and with the ratio of calcium to magnesium ions approaching unity a dolomite aquifer is probable. The electrical conductivity is reasonably high at 1020 µS/cm and is most likely due to the presence of chloride (105 mg/L) and sulphate (182 mg/L).

4. Borefield Performance

The surveyed ground level of the bore is RL 551.58 m AHD. The top of casing level is 552.16 m AHD.

5. Computer Modelling

As an aside to the usual method of analysis of short term pumping test results to predict long term bore and aquifer performance a numerical computer model was also used to attempt to predict the long term performance of the aquifer. An initial model was established to investigate the ranges of hydraulic parameters to best reproduce the results of the pump test of RN 15102. Parameters from this calibrated model were then used in a second model, adjusted to take into account the probable change in aquifer response in the long term (from a confined to an unconfined response), to predict the long term performance of the aquifer system. The conceptual model, upon which the computer model is based, is one of an aquifer in fractured and vuggy dolomite with interbeds and interlaminations of shale. The aquifer sequence has an interpreted thickness in 15107 of 200 m (from 200 m to 400 m depth), an east west strike and dips from north to south at 30.5 degrees. The formation is truncated to the east by a tertiary valley infill and is continuous to the west. To what depth the fracturing and vugs extend is unknown and since this determines the southern
boundary of the aquifer it was initially postulated to be 1000 m (based on current work for weathering in the Mereenie Sandstone). Refer Figure 3 for a schematic diagram of the conceptual model.

The initial model (refer Figure 4), set up to reproduce the results of the short term pump test on 15102, had its boundaries as determined above with the model western boundary set 1800 m west of 15102. The model width was 1700 m and its length 3600 m. The 340 m wide unconfined section of the aquifer (as determined from outcrop) had initial parameters $S_y = 3 \times 10^{-2}$ and $T = 1000 \, \text{m}^2/\text{d}$. The remaining confined section of the aquifer had $Sc = 3 \times 10^{-3}$ and $T = 250 \, \text{m}^2/\text{d}$ (as determined from analytical analysis). From subsequent runs and adjustments to this model it was found that the boundary locations had most influence on the shape of the drawdown curves and that the western boundary had to be extended and the southern and eastern boundaries brought in closer to reproduce the observed changes in rate of drawdown. The best match achieved was with a model of length 12600 m, width 720 m, (which equates to maximum depth of weathering of 424 m which indicates aquifer development controlled by Tertiary weathering which is further justified by examination of regional data - eg Irupatoka Water Supply Investigation - R Read, Water Division, Department of Transport and Works, 1978. Report No.6/1979), uniform transmissivity of 250 m²/d, $Sc$ of $1 \times 10^{-5}$ and $Sy$ of $1 \times 10^{-2}$, (see Figure 5).

However it was thought that a storage coefficient of $1 \times 10^{-5}$ was unreasonably low and that the model should be reconceptualised. Since 15102 is located in the confined area of the aquifer and upon examination of the aquifer response in the pumped and observation bores during the pump test it was determined that for the duration of the pump test the aquifer response was of a confined nature. A second model was then set up with the entire model confined, an initial storage coefficient of $3 \times 10^{-3}$ and a uniform transmissivity of 250 m²/d (as determined from analytical analysis), what became immediately obvious, as with the previous model, was that the shape of the drawdown curves depended principally on the distances the boundaries were from the pumped bore.

The calibration runs with this model achieved a best fit with a model width of 1120 m (maximum weathering depth of 660 m), length of 12600 m, transmissivity of 300 m²/d and a storage coefficient of $1 \times 10^{-3}$. The results are plotted on Figures 7 to 10 which show measured and model drawdowns for four observation bores.

This model was then adjusted to enable the simulation of long term pumping from the aquifer system. The main adjustment made was to include a 340 m strip of unconfined aquifer along the northern edge of the model, corresponding to the area of outcrop. The model was then in agreement with the conceptual model. The north, south and east boundaries were maintained from the calibration model along with the hydraulic properties of the remaining confined section of aquifer. The western boundary was moved further to the west in order to reduce boundary effects from it (see Figure 6). This is valid as the formation is continuous. However a lower transmissivity of 30 m²/d was used from 12 km west of P27 to the western boundary. This is a consequence of much less and shallower chemical
weathering as reported on by R Read - Iwupataka Water Supply Investigation. The model then was used to predict the aquifer drawdowns for a range of specific yield values (1%, 2% and 3%). Monitoring of the observation bores once production begins will enable the correct regime to be determined.

As described previously in Section 2, this bore is exploiting an aquifer in an older lithology than both the Mareenie and Facoota Sandstones which are intersected in the other bores of the Roe Creek Borefield. Predictions for the long term performance of this aquifer can only confidently be made after pumping and monitoring has been carried out. A reassessment of both aquifer and bore performance should be made annually once monitoring data becomes available.
Fig. 3 Conceptual Model

Fig. 4 First Model

Fig. 5 Second Model

Fig. 6 Long-Term Predictive Model
Fig. 7
Fig. 9
APPENDIX
- Bore Test Report
- Bore Composite Log
- Geophysical Borehole Logs
- Water Chemical Analysis
WATER RESOURCES DIVISION

TEST REPORT — BORE FN. 15107

Bore location: ROE CREEK BOREFIELD
Client/owner: NT GOVERNMENT
Client’s reference: P07
Purpose of supply: TOWN WATER

Map: SP 53.14
Grid reference: 380 765.8 mE 736850.3 mN

RECOMMENDATIONS
Pumping rate: 25 L/s. Pump setting see comments on below ground level
General recommendations are given on the reverse side.
The aquifer and bore can accept sustained higher pumping rates with deeper pump settings or for shorter periods in favourable seasons. Further advice can be obtained from: WATER RESOURCES
(In all correspondence refer to the bore’s FN number: 15107-1)

BORE DATA
Finished depth: 349.3m Completion date: 15.3.89 Test date: 10-14.9.89
Standing water level: 83.86 m on 13.9.89 Test depth: 10.2.20.1.30.40;33.2 L/s
Construction details:

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<th>Interval (m)</th>
<th>Description</th>
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<tr>
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<td>430.9 mm ID Steel Surface Casing</td>
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<tr>
<td>0 - 11.7</td>
<td>387.4 mm ID Blank Steel Casing (cemented)</td>
</tr>
<tr>
<td>0 - 200</td>
<td>305.4 mm ID Blank Steel Casing</td>
</tr>
<tr>
<td>200 - 349.3</td>
<td>200 mm Dia Open Hole</td>
</tr>
</tbody>
</table>

Notes: 1. Top of casing as constructed was 0.86 m above ground
2. All depths are measured from natural ground level
3. Test rates are not indicative of safe long term pumping rates

WARNING: MINIMUM INTERNAL BORE DIAMETER IS 305.4 mm above open hole

COMMENTS

- Pumping curves are attached showing predicted bore performance.
- As the recommended pumping rate of 25 L/s a pump setting of 160 m below ground level is recommended.

WATER QUALITY

See water laboratory report (Analysis No. 89/90/0351

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Viewed at 20:02:56 on 17/02/2010 Page 127 of 131.
RECOMMENDATIONS FOR FINISHING, OPERATING AND PROTECTING GROUNDWATER BORES

Attention to the following points will ensure a long and safe life for the bore supply and help prevent pollution of the groundwater resource.

1. Construct a concrete apron around the bore head to prevent surface flow, seepage and waste from entering the bore.

2. Seal the space between the casing and pump equipment to prevent entry of vetra, dirt and pollutants.

3. Maintain pumping equipment in good order to prevent pollution. Prevent spillage of fuel and oil on the ground around the bore. Store fertilizer and other chemicals at least 50 m away.

4. Keep stock away from the bore head. Discourage domestic activity at the bore. The first tap on the pipeline should not be less than 5 m from the bore head.

5. Pumping the bore at higher than recommended rates may fork the bore leading to instability or pump maintenance problems. Seek the professional advice of an hydrogeologist or groundwater engineer.

6. If the bore is no longer required, the casing is to be removed or securely capped and the bore backfilled with clayey material. A cement plug may be required in some instances.

In addition, please ensure that the BORE IDENTIFICATION TAG is retained securely at all times. The registered bore number is Water Resources Division's only reference to the scientific and engineering data on the bore, and hence important to WRD's further advice to bore owners.
### Power and Water Authority

**Composite Log of Bore 15107**

<table>
<thead>
<tr>
<th>Depth</th>
<th>Construction</th>
<th>Lithology</th>
<th>Descriptions</th>
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</thead>
<tbody>
<tr>
<td>411.7m</td>
<td>Cemented Casing</td>
<td>Sand, white and light brown sandy clay and coarse quartz sand with bands of hard quartz and ferri-cases from 34 to 35m.</td>
<td></td>
</tr>
<tr>
<td>305.7m CD</td>
<td></td>
<td>Clay, white, brown and red clays and quartz. Bands of ferri-cases from 32 to 35m.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Steel Casing</td>
<td>Clay, interbedded multicoloured clays and brown siltstones. Hard drilling from 124 to 125m.</td>
<td></td>
</tr>
<tr>
<td>15m Cement Plug</td>
<td></td>
<td>Sand, interbedded grey shale and grey and brown clay. Bands of dolomites from 142 to 155m and 170 to 203m.</td>
<td></td>
</tr>
<tr>
<td>200m</td>
<td></td>
<td>Dolomite, black and brown dolomite, fractured from 204 to 230m.</td>
<td></td>
</tr>
<tr>
<td>200m Open Hole</td>
<td></td>
<td>Dolomite, interbedded dolomite and brown and blue grey shale. Sand of shale 251 to 257m, 272 to 273m, 302 to 306m and from 340 to 349.5m. Dolomite fractured from 334 to 337m.</td>
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Viewed at 20:02:56 on 17/02/2010 Page 129 of 131.
ANALYSIS — PHYSICAL

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<th>Date Sampled</th>
<th>Date Received in Lab</th>
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<td>27/9/89</td>
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**Location and Details**
Raf Creek More Field R/N 15
Depth 15m
Subch 83.2 LPS Map 070°

**G.R. 380700E 7368430N Temp 29° C PA 7.08 Cond 720**

**ANALYSIS — CHEMICAL (mg L⁻¹)**

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<th></th>
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</thead>
<tbody>
<tr>
<td>Sodium, Na</td>
<td>80</td>
</tr>
<tr>
<td>Potassium, K</td>
<td>F</td>
</tr>
<tr>
<td>Calcium, Ca</td>
<td>76</td>
</tr>
<tr>
<td>Magnesium, Mg</td>
<td>14</td>
</tr>
<tr>
<td>Total Hardness (as CaCO₃)</td>
<td>258</td>
</tr>
<tr>
<td>Total Alkalinity (as CaCO₃)</td>
<td>203</td>
</tr>
<tr>
<td>Iron, Total Fe</td>
<td>0.11</td>
</tr>
</tbody>
</table>

**ANALYSIS — ADDITIONAL (mg L⁻¹)**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper, Cu</td>
<td></td>
</tr>
<tr>
<td>Lead, Pb</td>
<td></td>
</tr>
<tr>
<td>Arsenic, As</td>
<td></td>
</tr>
<tr>
<td>Manganes, Mn</td>
<td></td>
</tr>
<tr>
<td>Zinc, Zn</td>
<td></td>
</tr>
<tr>
<td>Cadmium, Cd</td>
<td></td>
</tr>
</tbody>
</table>

This report relates specifically to the “Sample tested as received”.


Hollow marked boxes indicate:
- Levels are within the limits as quoted in the “Guidelines for Drinking Water Quality in Australia”, 1987 N.H. & M.R.C. and the A.W.P.C.
- Levels exceed non-health related limits.
- Levels exceed health related limits.

DATE: _/__/13
CHECKED: [Signature]
SIGNATORY: [Signature]

This laboratory is registered by the National Vc
Testing Authorities, Australia. The N.V. V. T. A. have been performed in accordance with the guidelines.