PUKALKI OUTSTATION
Warumungu A.L.T.
Bore Completion Report
RN 16928, RN 16929 & RN 16931

S Burton
Consulting Hydrogeologist
Dames & Moore

WATER RESOURCES BRANCH, ALICE SPRINGS

June 1996
Subject
Aboriginal Community Water Supply

Geology
Georgina Basin
Gum Ridge Formation
Warramunga Group

Location
Pukalki Outstation
Warumungu Aboriginal Land Trust
Tennant Creek 1:250,000 Sheet
Barkly Highway
The Pukalki Outstation has been established on the Warumungu Aboriginal Land Trust. The Outstation is located approximately 50 km north east of Tennant Creek by road via Stuart Highway and Barkly Highway. The outstation is located in gently undulating lightly vegetated land.

Three bores were drilled at Pukalki, and one of these (RN 16931) was completed as a production bore. RN 16928 and RN 16929 were abandoned and capped. All three bores intersected the Gum Ridge Formation (silicified and unaltered sandstone and siltstone) overlying the Warramunga Group rocks (porphyry and siltstone). RN 16928 and RN 16929 intersected brackish to saline groundwater (salinities of approximately 7,200 mg/L TDS and 4,200 mg/L TDS respectively). RN 16931 intersected fresh to brackish groundwater during drilling with a yield during air development of 1 L/s.

RN 16931 can sustain continuous pumping at 0.3 L/s and the groundwater salinity is 2,300 mg/L TDS. Both nitrate and fluoride concentrations are within guideline limits and the groundwater is not potable. The groundwater may be suitable for use as a secondary supply but drinking water should be obtained externally or by desalination.
# TABLE OF CONTENTS

**KEYWORDS**

<table>
<thead>
<tr>
<th>Subject</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geology</td>
<td>1</td>
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**SYNOPSIS**

2

**TABLE OF CONTENTS**

3

**LIST OF TABLES**

4

**LIST OF FIGURES**

4

**LIST OF APPENDICES**

4

**LIST OF ABBREVIATIONS**

5

**DISTRIBUTION LIST**

5

1.0 INTRODUCTION

6

2.0 DATA REVIEW

6

2.1 GEOLOGY

6

2.2 GEOMORPHOLOGY

7

2.3 HYDROGEOLOGY

7

3.0 BORE SITING

7

4.0 FIELD INVESTIGATION

8

4.1 Drilling Methodology and Bore Construction

8

4.2 Hydraulic Testing

9

4.2.1 Testing Programme

9

5.0 RESULTS

10

5.1 Site Geology

10

5.2 Site Hydrogeology

10
5.2.1 Aquifer Hydraulics
5.2.2 Recommended Pumping Rate
5.2.3 Hydrochemistry

6.0 CONCLUSIONS

7.0 RECOMMENDATIONS

8.0 REFERENCES

Table 1. Drilling Target Locations
Table 2. Hydrogeological Summary of Pukaki Bores.

Figure 1. Location Map
Figure 2. Regional Geology
Figure 3. Bore Locations

LIST OF APPENDICES

Appendix A. RN 16928, RN 16929, RN 16931 - Bore Completion Diagrams
Appendix B. RN 16931 - Hydraulic Testing Plots
Appendix C. RN 16931 - Test Report
Appendix D. Hydrochemistry - Laboratory Analysis Report
### LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AMG</td>
<td>Australian Map Grid</td>
</tr>
<tr>
<td>kL</td>
<td>Kilolitres</td>
</tr>
<tr>
<td>km</td>
<td>Kilometres</td>
</tr>
<tr>
<td>L/s</td>
<td>Litres per second</td>
</tr>
<tr>
<td>L/head/day</td>
<td>Litres per head per day</td>
</tr>
<tr>
<td>m</td>
<td>Metres</td>
</tr>
<tr>
<td>mm</td>
<td>Millimetres</td>
</tr>
<tr>
<td>mBTOC</td>
<td>Metres below the top of the casing (bore water levels)</td>
</tr>
<tr>
<td>m²/d</td>
<td>Square metres per day</td>
</tr>
<tr>
<td>m³</td>
<td>Cubic metres</td>
</tr>
<tr>
<td>mg/L</td>
<td>Milligrams per litre</td>
</tr>
<tr>
<td>PVC</td>
<td>Polyvinyl chloride</td>
</tr>
<tr>
<td>RN</td>
<td>Registered Number</td>
</tr>
<tr>
<td>SWL</td>
<td>Standing Water Level</td>
</tr>
<tr>
<td>TDS</td>
<td>Total Dissolved Solids</td>
</tr>
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</table>

### DISTRIBUTION LIST

- Rural Operations, Power and Water Authority, Tennant Creek: 2
- Water Resources Branch Library, Power and Water Authority, Alice Springs: 3
- Water Resources Branch Library, Power and Water Authority, Darwin: 1
- Power and Water Authority Library, Darwin: 1
- Principal Engineer Groundwater, Power and Water Authority, Darwin: 1
- Author: 1
- Dames & Moore: 2
1.0 INTRODUCTION

The Water Resources Branch (WRB) of the Power and Water Authority (PAWA) in Alice Springs were requested by Rural Operations (Tennant Creek) of PAWA to develop a groundwater supply by drilling a bore for the proposed Pukalki Outstation within the Warumungu Aboriginal Land Trust. The bore was to supply 0.3 L/s of potable groundwater in the long term.

Pukalki is located approximately 25 km east of Threeways along the Barkly Highway and is approximately 45 km from Tennant Creek (Figure 1). The site lies several kilometres south of the Barkly Highway, although the location of the community has not been finalised.

Dames & Moore were engaged by WRB to provide a hydrogeologist for project management and implementation of this and other minor projects.

The drilling programme was carried out in conjunction with four other potable groundwater development drilling programmes for Aboriginal Community Living Areas excised from pastoral leases and for an outstation on an Aboriginal Land Trust. Drilling works were carried out by Gorey and Cole Drillers Ltd, an Alice Springs based private water-well drilling contractor. Hydraulic testing was undertaken by the Water Resources Division of PAWA. The contractual aspects of the works were supervised by a Bore Inspector of WRB and a Dames & Moore hydrogeologist supervised the hydrogeological aspects.

2.0 DATA REVIEW

The data reviewed during desktop studies prior to fieldwork included:

- Tennant Creek 1:250,000 Bore Location Map.

The objective of the review was to develop knowledge of the hydrogeology of the Pukalki region to aid in selection of the most prospective exploration drilling sites.

2.1 GEOLOGY

Figure 2 indicates the location of Pukalki with respect to the regional geology.

Pukalki lies near the western margin of the Georgina Basin. The Palaeoproterozoic Warramunga Group (of the Tennant Creek Block) is exposed to the west of Pukalki and the geometry of its contact with the Georgina Basin sediments is not fully understood.
The Georgina Basin, near Pukalki, is represented by the Cambrian Gum Ridge Formation which comprises impure lime mudstone and massive limestone which have been extensively silicified and lateritised under subaerial exposure. Regionally, the Gum Ridge Formation unconformably overlies the Cambrian Helen Springs Volcanics which comprise amygdaloidal or vesicular tholeiitic basalt (Donnellan et al., 1995). The Cambrian units overlie the Palaeoproterozoic Warramunga Group which locally comprises greywacke, siltstone, shale and gneiss (Donnellan et al., 1995).

Quaternary alluvium and sand cover much of the Pukalki area, the Gum Ridge Formation is locally exposed as a strike ridge trending approximately west-north-west to east-south-east.

2.2 GEOMORPHOLOGY

Pukalki lies in a gently undulating plain punctuated by resistant silicified remnants of the Tennant Creek Surface (Donnellan et al., 1995). Surface drainage is locally unco-ordinated and generally easterly. The Gosse River Floodout lies approximately 25 km to the east.

2.3 HYDROGEOLOGY

Of the local rocks, primary permeability is probably most significant in the Gum Ridge formation, and both the Gum Ridge Formation and the Helen Springs Volcanics could be expected to exhibit some secondary permeability through dissolution and fracturing, and fracturing, respectively.

Bore records held at WRB indicate that of approximately 15 bores drilled within the Pukalki region, only two bores yielded marginally potable groundwater and yields are generally below 0.3 l/s (most bores were dry or supplied brackish to saline groundwater). The bores with better quality groundwater and higher yields intersected the Gum Ridge Formation and were located near the Gosse River Floodout (which lies approximately 25 km east-south-east of Pukalki).

The Warramunga Group is considered to be unprospective for potable groundwater.

3.0 BORE SITING

Records of existing bores in the area indicate a complex relationship between the Warramunga Group and the Gum Ridge Formation. To increase the likelihood of intersecting the Gum Ridge Formation and the underlying Helen Springs Volcanics, drilling targets have been chosen nearer the exposure of the Gum Ridge Formation indicated by Donnellan et al. (1995). Aboriginal traditional owners were consulted in finalisation of the target locations.

The locations of the targets are indicated in Table 1.
Table 1. Drilling Target Locations

<table>
<thead>
<tr>
<th>Target</th>
<th>Easting (mAMG)</th>
<th>Northing (mAMG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>53 436 000</td>
<td>7 845 000</td>
</tr>
<tr>
<td>2</td>
<td>53 437 800</td>
<td>7 843 828</td>
</tr>
</tbody>
</table>

4.0 FIELD INVESTIGATION

Permission for the work was granted by the Aboriginal Areas Protection Authority prior to commencement of work.

Drilling was conducted between 7 June 1996 and 12 June 1996. Hydraulic testing was conducted between 18 June 1996 and 20 June 1996.

Two holes were drilled at the targets indicated in Section 3.0. RN 16928 (Target 1) yielded 1 L/s of saline groundwater (approximately 7,200 mg/L TDS) from a depth of 72 mBGL. RN 16929 (Target 2) yielded 0.5 L/s of groundwater with a salinity of 4,200 mg/L TDS from a depth of 54 m. Both bores were abandoned on the basis of the high groundwater salinity.

A further site, located at 53 440 104 mE, 7 842 803 mN, was selected on the basis of the salinity gradient inferred from RN 16928 and RN 16929 and clearing of access to this site was conducted in the presence of the traditional owners. RN 16931 was drilled and intersected groundwater with an initial salinity (determined during drilling) of 1550 mg/L TDS increasing to 1900 mg/L TDS and an appreciable yield (air circulation was lost throughout much of the drilling). RN 16931 was completed as a production bore.

4.1 Drilling Methodology and Bore Construction

Rotary air-percussion drilling was utilised as it enabled significant penetration rates and collection of good hydrogeological information in the anticipated consolidated rocks. The drill string comprised a tungsten carbide button bit fitted to a 154 mm diameter down-the-hole pneumatic hammer and a 200 mm stabiliser to ensure bore-hole straightness. Unconsolidated surface materials were supported by installation of a 203 mm ID steel surface casing and drilling commenced at 200 mm diameter to the total depth. Bores RN 16928, RN 16929 and RN 16931 intersected chalcedony, sandstone and clayey materials overlying weathered porphyry. Air circulation was lost between 28 and 78 mBGL during drilling at RN 16931.

Airlift yields were measured periodically by collecting volume/time measurements of discharge at the end of a 150 mm PVC pipe sealed to a stuffing box at the surface casing. Losses are considered to be less than 2% with this method.

Both RN 16928 and RN 16929 were abandoned and the steel surface casing was capped with a welded steel plate. RN 16931 was completed as a production bore with the interval between 42 and 72 mBGL slotted on-site using oxygen-acetylene cutting equipment. A blank steel sump extends between 72 and 78 mBGL and the bottom of the casing is open.
RN 16931 was developed by airlifting for 2 hours until the discharge water was clear and sediment free. A concrete block was constructed at the borehead and the production casing was sealed with a welded steel plate to protect the bore from vandalism.

Bore completion diagrams are presented in Appendix A.

4.2 Hydraulic Testing

The hydraulic testing programme adopted for RN 16931 was designed to allow determination of:

- The aquifer hydraulics
- The sustainable yield
- The quality of the groundwater which will be supplied by the bore in the long term

The testing programme was based on an airlift yield during bore development of 1 L/s. A minimum water requirement of 0.3 L/s for the residents of Pukalki has been specified by Rural Operations of PAWA.

Hydraulic testing data are presented in Appendix B.

4.2.1 Testing Programme

Hydraulic testing comprised a step drawdown test (on 18 June 1996) with four consecutive steps of 30 minutes duration at pumping rates of 0.3 L/s, 0.6 L/s, 0.8 L/s and 1.0 L/s. The data collected during step testing were used to select a suitable pumping rate for the constant discharge test.

A constant discharge test (on 20 June 1996) with a duration of 8 hours and a discharge rate of 0.16 L/s was conducted, followed by a recovery period monitored for 2 minutes, when the water level had completely recovered. A low discharge rate was selected to limit ingress of potentially more saline groundwater during testing.

During pumping, the discharge rate was monitored by volume/time checks. The discharge was directed away from the bore and it is considered that recharge to the production aquifer (at a depth of approximately 35 mEGL) during the test would have been negligible.
5.0 RESULTS

5.1 Site Geology

Geological data are available from logging of drill-cuttings collected during drilling of RN 16928, RN 16929 and RN 16931.

A thin cover of soil extends to between 3 and 6 metres depth and the Gum Ridge Formation is expose south of Pukalki. RN 16928 and RN 16929 intersected sandstone and chalcedony, assigned to the Gum Ridge Formation (and overlying weathering products), in the upper 27-30 metres depth. The materials intersected below this depth grade from soft, smooth-textured clay to hard, slightly weathered porphyry. The clay represents intensely weathered porphyry and the primary rock textures become apparent with increasing depth. Groundwater intersections indicate that the porphyry is somewhat fractured at the base of the weathering profile (and may also be fractured at greater depths).

Air drilling operations at RN 16931 were plagued by loss of circulation. Samples were returned only for the intervals 0-33 mBGL and 42-48 mBGL. The latter samples are considered to be unreliable. The samples returned from the upper part of the hole comprised sandstone (ranging from poorly sorted, weakly indurated fine to medium sandstone to clean, hard fine-grained sandstone with siliceous cement). Chalcedonic quartz made up a small part of the sandstone. A sample collected from the bottom of the hole (during airlift development of the hole) comprised mainly chalcedonic quartz and traces of schistose and porphyritic bedrock which are assigned to the Warramunga Group. The instability of the fractured chalcedonic quartz horizons cause them to be over-represented in the samples. The depth of the contact between the Gum Ridge Formation and the Warramunga Group at RN 16931 is not known.

5.2 Hydrogeology

Hydrogeological details of the three bores drilled at Pukalki are summarised on Table 2.

Table 2. Hydrogeological Summary of Bores Drilled at Pukalki.

<table>
<thead>
<tr>
<th>Bore</th>
<th>Easting (mAMG)</th>
<th>Northing (mAMG)</th>
<th>Total Depth (mBGL)</th>
<th>SWL (mBGL)</th>
<th>Electrical Conductivity (μS/cm)</th>
<th>Yield (L/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RN 16928</td>
<td>436240</td>
<td>7848906</td>
<td>72</td>
<td>41.5</td>
<td>12,000</td>
<td>1</td>
</tr>
<tr>
<td>RN 16929</td>
<td>437900</td>
<td>7844028</td>
<td>54</td>
<td>35.5</td>
<td>7,000</td>
<td>0.5</td>
</tr>
<tr>
<td>RN 16931</td>
<td>440104</td>
<td>7842803</td>
<td>78</td>
<td>35.8</td>
<td>3,000</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Note: Yield for RN 16928 and RN 16929 was determined by airlift yield during drilling. Yield for RN 16931, determined by hydraulic testing, was selected to minimise groundwater quality degradation.
The main aquifer at Pukalki is fractured porphyry of the Warramunga Group near the base of the weathering profile at approximately 60 metres depth. The standing water level in bores drilled at Pukalki is between approximately 35 and 41.5 mBGL and indicates possible confinement of the aquifer by clayey weathering products. The regional hydraulic gradient is unknown. The aquifer contains brackish to saline groundwater and the salinity varies spatially.

5.2.1 Aquifer Hydraulics

Hydraulic testing data are presented in Appendix B.

The step test indicated that constant discharge testing at approximately 2 L/s would be appropriate, however, due to concern regarding the groundwater salinity, the constant discharge test was conducted at approximately 0.16 L/s. Variation in the pumping rate throughout the constant discharge test has rendered the data unsuitable for rigorous hydraulic analysis.

The drawdown at the end of the constant discharge test was 0.14 m and the total available drawdown is 6.2 m. The test response, taking into account the pumping rate variation, was considered to be near steady-state.

Logan's Approximation indicates a transmissivity of approximately 120 m²/day.

The aquifer thickness could not be estimated during drilling as a lost circulation zone (or zones) prevented collection of reliable groundwater yield data. Circulation was first lost (at 28 mBGL) above the potentiometric surface (35.8 mBGL) and it is thought that the materials below this depth, while permeable, may not be cavernous.

The recovery trend indicates complete recovery of the water level within the duration of the constant discharge test. Aquifer dewatering will probably not occur with low pumping rates (less than 0.5 L/s). It may be a consideration should higher pumping rates (greater than 2 or 3 L/s) be required.

5.2.2 Recommended Pumping Rate

An accurate recommended maximum pumping rate for the bore could not be derived from the test data. Based on the relationship between the drawdown and the pumping rate an approximation of the maximum sustainable pumping rate from this bore is 3 L/s. Pumping at this rate may induce deterioration of the quality of the groundwater drawn from the bore and pumping at 0.3 L/s is recommended on this basis.

A Bore Test Report for RN 16931 is presented as Appendix C.
5.2.3 Hydrochemistry

RN 16931 supplied groundwater with a field-determined salinity, based on the assumed relationship between electrical conductivity and salinity, of 2400 mg/L TDS during drilling. The salinity was stable throughout testing and the final (laboratory determined) salinity was 2300 mg/L TDS.

The groundwater supplied by RN 16931 is a brackish, sodium-chloride type water with slightly alkaline pH. It has high hardness (699 mg/L as CaCO₃) and will probably cause encrustation of water heating appliances.

The salinity of the groundwater yielded by RN 16931 significantly exceeds guideline limits for drinking water. A number of individual chemical constituents also exceed guidelines limits. The water supplied from RN 16931 may be suitable as a secondary water supply (for washing and other non-consuming activities) but is not suitable for long term consumption. Potable water may be sourced from Tennant Creek, some 50 km from the site. Groundwater supplied by RN 16931 may be suitable as feed water for desalination, but this has not been established.

The laboratory analysis report for a groundwater sample collected at the end of hydraulic testing at RN 16931 is presented as Appendix D.
6.0 CONCLUSIONS

Under the direction of a consulting hydrogeologist of Dames & Moore, WRB have conducted a production bore drilling programme intended to provide a potable groundwater supply to the proposed Pukalki Outstation on the Warumungu Aboriginal Land Trust. Pukalki is approximately 45 km from Tennant Creek via the Barkly Highway. Three bores were drilled at the site and one has been constructed to production bore standards and tested.

RN 16928, RN 16929 and RN 16931 intersected sandstone and chalcedony of the Gum Ridge Formation overlying weathered to near-fresh porphyry of the Warramunga Group.

RN 16928 intersected an aquifer yielding 1 L/s of groundwater with a salinity of approximately 7,200 mg/L TDS and was abandoned and capped. RN 16929 intersected an aquifer yielding 0.5 L/s of groundwater with a salinity of approximately 4,200 mg/L TDS and was abandoned and capped.

RN 16931 intersected a zone of lost circulation with intermittent water samples returning a salinity of approximately 1,550 mg/L TDS increasing to 1,900 mg/L TDS during pilot hole drilling. A production bore was constructed at RN 16931 which yielded in excess of 1 L/s during airlift development (with partial loss of air circulation) and the salinity had risen to 2,300 mg/L TDS.

Analysis of hydraulic testing indicates that RN 16931 can sustain continuous abstraction of 0.3 L/s. The long term salinity is not expected to deteriorate significantly if the bore is managed within the recommendations provided.

The groundwater supplied by RN 16931 is not potable, but may be useable as a secondary supply. Suitability as feed water for desalination has not been established.

7.0 RECOMMENDATIONS

Bore RN 16931 should be equipped to provide a daily maximum water supply equivalent to 0.3 L/s. The pump inlet should be set at 42 metres below the ground surface. A facility for measuring water levels in the bore should be installed at the time of pump installation.

To minimise the risk of aquifer contamination, building construction, waste dumping and other potential sources of groundwater pollution should not be allowed within 300 m of the bore site.

Bi-annual determinations of the groundwater chemistry should be made.

Bi-annual measurements of the non-pumping water level should be recorded and the aquifer performance reviewed after three years of pumping. The review should include a summary and assessment of abstraction, groundwater levels and groundwater chemistry and should provide recommendations for further monitoring.
Annual bacteriological counts for water samples collected at the bore and from the reticulation network (when installed) should be undertaken to provide early warning of potential biological contamination.

8.0 REFERENCES


Figures
TEMPORARY
CZa Alluvium
Czs Sand, soil, colluvium, gravel
-Cmg Chert, chert breccia, limestone — Gum Ridge Formation
-Slh Vesicular basalt, tuff — Helen Springs Volcanics
-Bgt Fine Granite
-Bgu Coarse porphyritic granite
-Ews Greywacke, siltstone, shale — Bemborough Formation
-Ewb Acid lava, tuff, tuffaceous greywacke
-Eww White to grey, medium to coarse quartz sandstone — Whippet Sandstone
-Ew Greywacke, siltstone, shale

PUKALKI OUTSTATION
on Warumungu Aboriginal Land Trust

LOCAL GEOLOGY
(after Dodson & Gardener, 1978)

FIGURE 2
FIGURE 3

PUKALKI OUTSTATION
ON
WARUMUNGU
ABORIGINAL LAND TRUST
BORE LOCATION MAP
WATER RESOURCES
COMPOSITE LOG OF BORE

<table>
<thead>
<tr>
<th>DEPTH (m)</th>
<th>BORE CONSTRUCTION</th>
<th>GRAPHIC LOG</th>
<th>STRATA DESCRIPTION</th>
<th>GROUNDWATER INTERSECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td>0-3m Alluvium, red/brown, lateritic</td>
<td></td>
</tr>
<tr>
<td>3-12m</td>
<td></td>
<td></td>
<td>3-12m Sandstone, off-white mottled orange/red, silt to medium quartz sand poorly sorted.</td>
<td></td>
</tr>
<tr>
<td>12-21m</td>
<td></td>
<td></td>
<td>12-21m Chalcedony, weakly laminated, very hard</td>
<td></td>
</tr>
<tr>
<td>21-27m</td>
<td></td>
<td></td>
<td>21-27m Chalcedony chert, mustard, very hard</td>
<td></td>
</tr>
<tr>
<td>27-30m</td>
<td></td>
<td></td>
<td>27-30m Clay, brown, pink, Reflect igneous textures</td>
<td></td>
</tr>
<tr>
<td>30-37m</td>
<td>Porphyry, red/brown, reflect amphiboles, feldspar in microporphyritic texture. Soft grading hard.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>57-69m</td>
<td>Claystone - red/brown, firm, finely laminated quartz grains</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>59-78m</td>
<td>Siltstone, red/brown, hard, quartz grains</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>78m</td>
<td>EOH</td>
<td></td>
<td>SWL 41.5m</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td></td>
<td></td>
<td>78m 1.0 L/s</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td></td>
<td></td>
<td>EC 12,000 µS/cm</td>
<td></td>
</tr>
</tbody>
</table>

ABANDONED BORE
DATE DRILLED 7/6/96

PUKALKI OUTSTATION
RN 16928

APPENDIX A1
POWER
WATER
AUTHORITY

WATER RESOURCES
COMPOSITE LOG OF BORE

DEPTII
BORE
CONSTRUCTION
GRAPHIC
LOG
DEPTII
STRATA
DESCRIPTION
GROUNDWATEII
INTERSECTIONS

0-6m Alluvium, Red/brown, weathered
sandstone chips

6-18m Sandstone, white, mottled tan, fine
to medium quartz sand, argillaceous,
massive, hard

18-30m Chalcedony, grey-white, very hard

30-36m Clay, tan/cream/brown, soft

36-54m Porphyry, brown/green, 1-2mm
grains, microporphyritic. Brown groundmass,
green phenocrysts

54m EOH

SWL 35.5m

54m 0.5 L/s
EC 7000 µS/cm

54m 0.5 L/s
EC 7000 µS/cm

ABANDONED BORE
DATE DRILLED 8/6/96

PUKALKI OUTSTATION
RN 16929

APPENDIX A2
# WATER RESOURCES

## COMPOSITE LOG OF BORE

<table>
<thead>
<tr>
<th>DEPTH (m)</th>
<th>BORE CONSTRUCTION</th>
<th>GRAPHIC LOG</th>
<th>STRATA DESCRIPTION</th>
<th>GROUNDWATER INTERSECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td>0-5m Alluvium, Red/brown silty sand</td>
<td>0</td>
</tr>
<tr>
<td>5-18m</td>
<td></td>
<td></td>
<td>5-18m Sandstone, red/brown/cream, dirty very fine to medium sand quartz grains, weakly indurated minor chalcedonic quartz</td>
<td></td>
</tr>
<tr>
<td>18-24m</td>
<td></td>
<td></td>
<td>18-24m Sandstone, white, fine sand quartz grains, argillaceous to siliceous cement (firm to hard)</td>
<td></td>
</tr>
<tr>
<td>24-33m</td>
<td></td>
<td></td>
<td>24-33m Sandstone, pale khaki to orange, very hard, massive to finely laminated. Minor vuggy chalcedony</td>
<td></td>
</tr>
<tr>
<td>33-42m</td>
<td></td>
<td></td>
<td>33-42m Lost circulation</td>
<td></td>
</tr>
<tr>
<td>42m</td>
<td></td>
<td></td>
<td>33-42m Sandstone/chalcedony, unreliable sample</td>
<td></td>
</tr>
<tr>
<td>48-78m</td>
<td></td>
<td></td>
<td>48-78m Lost circulation</td>
<td></td>
</tr>
<tr>
<td>Note:</td>
<td></td>
<td></td>
<td>Airlift development of completed bore yielded chips of porphyritic and schistose mafic rock</td>
<td></td>
</tr>
</tbody>
</table>

**PRODUCTION BORE**

DATE DRILLED 14/6/95

PUKALKI OUTSTATION

RN 16931

APPENDIX A3
Appendix B1
Warumungu Aboriginal Land Trust

Pukalk Outstation

RN 16931 - Step Drawdown Test

Q = 0.3 L/s
Q = 1.6 L/s
Q = 0.8 L/s
Q = 1.0 L/s

Drawdown (m)

Time (min)

18/6/1996

1 10 100 1000
Note: Variations in the discharge rate have altered the quality of the data.

Recovery complete in 2 minutes

rn 16931 - constant discharge test

19/6/1996, Q=0.16 L/s

Pukalki Outstation
Warumungu Aboriginal Land Trust

Appendix B2
RN 16931 - Constant Discharge Test

100
10
1

Time (min)
19/6/1996, Q=0.16 L/s

Pukalk Outstation
Warumungu Aboriginal Land Trust

Appendix B3
WATER RESOURCES DIVISION
TEST REPORT - BORE RN 16931

Bore Location: Pukalki O/S, Warumungu A.L.T.
Client: Rural Operations, PAWA, Tennant Creek
Intended Use: Domestic
Map: Tennant Creek, SF53-14, 1:250,000
Grid Reference: 53 437900 mE, 7844008 mN
RECOMMENDATIONS

Pumping Rate: 0.3 L/s  Pump Setting: 42 m  below Ground Level.

General recommendations are given on the reverse side. The aquifer and bore can sustain higher pumping rates for short periods only. Further advice can be obtained from:

Water Resources Branch, Nth Stuart Highway, ALICE SPRINGS, N.T., 0870
(In all correspondence please refer to bore’s RN number)

COMPLETION DETAILS

Finished depth: 78.0 m
Completion Date: 12/6/96
Standing Water Level: 35.8 m on 12/5/96

BORE CONSTRUCTION

<table>
<thead>
<tr>
<th>Interval (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0-6.0</td>
<td>219mm ID Blank steel</td>
</tr>
<tr>
<td>0.0-42.0</td>
<td>152mm ID Blank steel</td>
</tr>
<tr>
<td>42.0-72.0</td>
<td>152mm ID Slotted steel</td>
</tr>
<tr>
<td>72.0-78.0</td>
<td>152mm ID Blank Steel</td>
</tr>
</tbody>
</table>

Warning: Minimum internal bore diameter is 152mm.

Notes:
1. Top of casing as constructed was 0.5m above ground level.
2. All depths are measured from natural ground level.
3. Test rates are not necessarily indicative of sustainable long term pumping rates.

COMMENTS

The recommended pumping rate is based on a short-term testing programme comprising a step-drawdown test and a 8 hour constant discharge test.

The recommendations made above assume that hydrogeological conditions will remain similar during long term pumping as the conditions at the end of the constant discharge test.

Facility to monitor the water level, pumping rate, total pumped volume and to collect water samples should be included at the time of pump installation. A log book should be kept on-site to record the data. Water samples for chemical and microbiological analysis should be sent to the Laboratory at the above address.

The total depth of the bore and the standing water level should be recorded each time the pump is removed and the results forwarded to W33, Alice Springs.

Water Quality (20/6/96) - EC = 3800μS/cm

Prepared by: S. Burton (Dames & Moore)

boredata

APPENDIX C
### ANALYSIS - PHYSICAL

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td></td>
<td>7.4</td>
</tr>
<tr>
<td>Electrical conductivity</td>
<td>µS/cm</td>
<td>3790</td>
</tr>
<tr>
<td>Total dissolved solids</td>
<td>mg/L</td>
<td>2270</td>
</tr>
<tr>
<td>Field Temp °C</td>
<td></td>
<td>30±5</td>
</tr>
<tr>
<td>Field pH</td>
<td></td>
<td>7.4</td>
</tr>
<tr>
<td>Field Conduct. (µS/cm)</td>
<td></td>
<td>4020</td>
</tr>
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</table>

### ANALYSIS - CHEMICAL (mg L⁻¹)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium, Na</td>
<td>mg/L</td>
<td>471</td>
</tr>
<tr>
<td>Potassium, K</td>
<td>mg/L</td>
<td>39</td>
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<tr>
<td>Calcium, Ca</td>
<td>mg/L</td>
<td>41</td>
</tr>
<tr>
<td>Magnesium, Mg</td>
<td>mg/L</td>
<td>153</td>
</tr>
<tr>
<td>Iron, total Fe</td>
<td>mg/L</td>
<td>1.3</td>
</tr>
<tr>
<td>Total Hardness (as CaCO₃)</td>
<td></td>
<td>854</td>
</tr>
<tr>
<td>Chloride, Cl</td>
<td>mg/L</td>
<td>845</td>
</tr>
<tr>
<td>Sulphate, SO₄</td>
<td>mg/L</td>
<td>320</td>
</tr>
<tr>
<td>Nitrate, NO₃</td>
<td>mg/L</td>
<td>28</td>
</tr>
<tr>
<td>Bicarbonate, HCO₃</td>
<td>mg/L</td>
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</tr>
<tr>
<td>Carbonate, CO₃</td>
<td>mg/L</td>
<td>0</td>
</tr>
<tr>
<td>Hydroxide, OH</td>
<td>mg/L</td>
<td>0</td>
</tr>
<tr>
<td>Fluoride, F</td>
<td>mg/L</td>
<td>0.2</td>
</tr>
<tr>
<td>Total Alkalinity (as CaCO₃)</td>
<td>mg/L</td>
<td>1380</td>
</tr>
<tr>
<td>Silica, SiO₂</td>
<td>mg/L</td>
<td>29</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>mg/L</td>
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</tr>
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</table>

### ANALYSIS - ADDITIONAL (mg L⁻¹)

<table>
<thead>
<tr>
<th>Parameter</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Copper, Cu</td>
<td>mg/L</td>
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</tr>
<tr>
<td>Manganese, Mn</td>
<td>mg/L</td>
<td></td>
</tr>
<tr>
<td>Zinc, Zn</td>
<td>mg/L</td>
<td></td>
</tr>
</tbody>
</table>

This report relates specifically to the "sample tested as received".


Boxes marked thus indicate:
- Levels are within the limits as quoted in the "Guidelines for Drinking Water Quality in Australia", 1987 N.R.C. & M.R.C. and the A.W.R.C.
- Levels exceed non-health related limits.
- Levels exceed health related limits.

APPENDIX D