GROUNDWATER INVESTIGATION
MAJORCA BORE AREA (AILERON)
1982
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Synopsis

The second stage of groundwater investigations for a water supply for the proposed Central Australian Penal Institution was undertaken in August 1982. The Cainozoic aquifers, in particular the Waite Formation of the western margin of the Ti Tree Basin were investigated on the eastern extent of Aileron pastoral lease.

One bore has been left constructed for production use. Depending on the suitability of the water for agricultural use, the drilling of further production bores has been recommended. Treatment of the water is necessary for domestic use.
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GROUNDWATER INVESTIGATION

MAJORCA BORE AREA (AILERON)

1. INTRODUCTION

1.1 Background
A small investigation to determine the groundwater potential in the north east corner of Aileron pastoral lease was undertaken in August 1982 for a water supply for the proposed Central Australian Penal Institution. The area of interest was 6 km south of Majorca Bore, (Registered Number (RN) 11764), extending southwards 8 km, and approximately centred on the existing track joining Majorca Bore to the old section of the Sandover Highway (Fig. 1.1).

The investigation was requested and funded by the Correctional Services Division of the Department of Community Development. The first stage of the investigation (reference 1) was carried out in December 1981 - January 1982 along the North South stock route in the vicinity of Gillens Bore on Yambah. The location for this stage two investigation was chosen following discussions between the Correctional Services Division and the pastoral lessee. (Fegan, personal communication).

1.2 Water demand
Preliminary estimates of water demand were based on a proposed population of 100, and up to two hectares of irrigation (Reference 1). However enlargement of the size of the proposed irrigated area has increased the total demand from 5.4 litres per second (Ls⁻¹) to a value upwards of 30 Ls⁻¹.

1.3 Geological setting
The area is situated on the western edge of the Ti Tree Basin of Cainozoic age. Impermeable bedrock (granite, gneiss and granulites) forms the hills to the west (about 12 km), whilst outcrops of quartzite and sandstone of the Ngalla Basin sequence occur to the south west (Mt. Ewart area). Bureau of Mineral Resources (BMR) stratigraphic drilling along the old section of the Sandover Highway about 10 km south of the investigation area indicated shallow basement north and west of Mt. Byrne.

The Cainozoic deposits thicken north eastwards from the Mt. Ewart area, and recent drilling in the Ti Tree Basin (Reference 2) has proven the existence of chert-chalcedonic limestone aquifers within the Waite Formation north and east of the investigation area. This is believed to represent an old drainage channel running from the Ti Tree area to the Waite Basin in the Alcoota area. The Waite formation (Reference 4) has been included by Senior (Reference 3) as the middle member of the Alcoota Beds, a term used to classify the Cainozoic sediments of the Ti Tree Basin.
Beneath the Waite Formation, a mudstone-siltstone sequence, often green and grey, lies on weathered granitic bedrock in this area. Poorly sorted quartz sands and conglomerate with clay horizons have been grouped into the upper unit of the Alcoota Beds that overlie the Waite Formation.

1.4 Previous drilling

Prior to this investigation little water bore information existed within a ten kilometre radius. Majorca Bore (RN 11764), although drilled and equipped as a drought relief bore, is now abandoned. The bore is infilled to 36 metres, and no data is available on the original depth, supply or quality of the water. Drilling in the Ti Tree Basin investigation (Reference 2) ten kilometres east of the area, Bore RN 12591 obtained 8 Ls\(^{-1}\) of good quality water (Total Dissolved Solids (TDS) 1020 milligrams per litre (mgL\(^{-1}\)), although excessive in nitrate (NO\(_3\)) (129 mgL\(^{-1}\)). The aquifer was intersected within the Waite Formation at a depth of 70 metres below ground level. About 15 km to the north west of the investigation area, Bore RN 12158 obtained 7 Ls\(^{-1}\) of good quality water (TDS 1000 mgL\(^{-1}\)) although excessive in NO\(_3\) (94 mgL\(^{-1}\)). Existing water bore data is summarised in Table 1.4, and bore locations are shown on Figure 1.4.
<table>
<thead>
<tr>
<th>Bore Registered Number</th>
<th>Bore Name</th>
<th>Pastoral Lease</th>
<th>Total Depth (m)</th>
<th>Standing Water Level (m)</th>
<th>Aquifer Depth (m)</th>
<th>Yield (Litres per second)</th>
<th>Specific Conductance</th>
<th>Nitrate Concentration (mg L⁻¹)</th>
<th>Aquifer Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>2791</td>
<td>Drought Relief No.1</td>
<td>Bushy Park</td>
<td>46.6</td>
<td>nk</td>
<td>nk</td>
<td>Dry</td>
<td>nk</td>
<td>nk</td>
<td>Chalcedony</td>
</tr>
<tr>
<td>2793</td>
<td>Drought Relief No.2</td>
<td>Bushy Park</td>
<td>70.7</td>
<td>nk</td>
<td>nk</td>
<td>1.8 (A)</td>
<td>nk</td>
<td>166</td>
<td>Chalcedony</td>
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<td>4487</td>
<td>Top Corner Bore</td>
<td>Bushy Park</td>
<td>76.2</td>
<td>41.1</td>
<td>41.5</td>
<td>1.5 (A)</td>
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<td>nk</td>
<td>Sand</td>
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<td>7487</td>
<td>Spinifex Bore</td>
<td>Bushy Park</td>
<td>76.2</td>
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<td>1.0 (A)</td>
<td>nk</td>
<td>nk</td>
<td>Chalcedony</td>
</tr>
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<td>11356</td>
<td>BMR Alcoota No.2</td>
<td>Bushy Park</td>
<td>194.0</td>
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<td>2.0 (A)</td>
<td>nk</td>
<td>nk</td>
<td>Chalcedony</td>
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<td>11387</td>
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<td>Aileron</td>
<td>44.0</td>
<td>nk</td>
<td>44.0</td>
<td>2.0 (A)</td>
<td>nk</td>
<td>nk</td>
<td>Sand</td>
</tr>
<tr>
<td>11388</td>
<td>BMR Alcoota No.5</td>
<td>Aileron</td>
<td>61.0</td>
<td>nk</td>
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<td>Dry</td>
<td>nk</td>
<td>nk</td>
<td>Sand</td>
</tr>
<tr>
<td>11389</td>
<td>BMR Alcoota No.6</td>
<td>Aileron</td>
<td>78.0</td>
<td>nk</td>
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<td>nk</td>
<td>nk</td>
<td>Sand</td>
</tr>
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<td>11390</td>
<td>BMR Alcoota No.7</td>
<td>Aileron</td>
<td>122.0</td>
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<td>Sand</td>
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<td>11764</td>
<td>Majorca Bore</td>
<td>Aileron</td>
<td>nk</td>
<td>nk</td>
<td>nk</td>
<td>nk</td>
<td>nk</td>
<td>nk</td>
<td>Chalcedony</td>
</tr>
<tr>
<td>11878</td>
<td>Five Mile Dud</td>
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<td>nk</td>
<td>nk</td>
<td>Dry</td>
<td>nk</td>
<td>nk</td>
<td>Sand</td>
</tr>
<tr>
<td>11881</td>
<td>Allawalla Bore</td>
<td>Woodgreen</td>
<td>53.7</td>
<td>15.3</td>
<td>45.8</td>
<td>nk</td>
<td>1500</td>
<td>190</td>
<td>Sand</td>
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<td>12158</td>
<td>Aileron</td>
<td>175.7</td>
<td>37.9</td>
<td>70-102 (P)</td>
<td>7.0 (P)</td>
<td>1650</td>
<td>94</td>
<td>Limestone</td>
<td></td>
</tr>
<tr>
<td>12579</td>
<td>Aileron</td>
<td>108.0</td>
<td>nk</td>
<td>84, 107</td>
<td>10.0 (A)</td>
<td>1990</td>
<td>96</td>
<td>Limestone</td>
<td></td>
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<td>12590</td>
<td>Bushy Park</td>
<td>96.0</td>
<td>nk</td>
<td>96.0</td>
<td>3.0 (A)</td>
<td>1665</td>
<td>169</td>
<td>Limestone</td>
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<tr>
<td>12591</td>
<td>Bushy Park</td>
<td>106.6</td>
<td>45.0</td>
<td>70, 106</td>
<td>8.0 (P)</td>
<td>1850</td>
<td>129</td>
<td>Limestone</td>
<td></td>
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<tr>
<td>13336</td>
<td>Sandover Hwy. Bore</td>
<td>Bushy Park</td>
<td>90.0</td>
<td>52.0</td>
<td>63, 81</td>
<td>1.9 (A)</td>
<td>1780</td>
<td>148</td>
<td>Sand</td>
</tr>
</tbody>
</table>

nk = not known
(A) = airlift supply
(P) = test pump supply
2. THE PRESENT INVESTIGATION

2.1 Results

Initially drilling was programmed at four sites within the investigation area (Sites A to D, Figure 1.1). Drilling commenced on August 13th at Site C with Bore RN 13522. Unweathered granitic bedrock was intersected, and the bore was abandoned at 94 metres with no supply of water. Bore RN 13523, at Site A, intersected a large supply of water (10 Ls⁻¹) in a chalcedonic limestone aquifer between 57 and 75 metres, and terminated in granite at 109 metres. Specific conductance of the water was 2000 microsiemens per centimetre. A pump test on the bore at a constant rate of 12.25 Ls⁻¹ for 24 hours resulted in a maximum drawdown of 8.74 metres; most of this drawdown consisted of well loss. Test analysis yielded an aquifer transmissivity of over 1000 square metres per day (m²d⁻¹). The bore is constructed with 152 mm diameter casing, perforated opposite the aquifer. The high well loss of this bore results from this type of construction. This bore can be pumped at a long term rate of 15 Ls⁻¹.

Further drilling at one kilometre intervals from Bore RN 13523 yielded a large variation in specific conductance from 3460 microsiemens per centimetre in Bore RN 13463 (to the west) to 1850 microsiemens per centimetre in Bore RN 13465 (to the north) and in depth to granite bedrock (up to 156 metres). At site B, Bore RN 13466 obtained only 2 Ls⁻¹ of poor quality water (Specific Conductance 4650 microsiemens per centimetre). These bores were cased with 50 mm water pipe for monitoring purposes. Drilling results are summarised in Table 2.1 and bore locations shown on Figure 1.4.

2.2 Interpretation

2.2.1 Water availability

Within the area only aquifers within the Waite Formation are capable of supplying the quantity of water required. The extent of the Waite Formation and the depths to aquifers within it are plotted in Figure 2.2.1, based on the results of this investigation and the regional Ti Tree investigation (Reference 2). Throughout the extent of the Waite Formation aquifers are normally encountered between 57 metres and 84 metres, and also around 102 to 106 metres. Although there is insufficient data to calculate aquifer parameters with a high degree of accuracy, an order of magnitude for these parameters can be derived. In this area depth to the potentiometric surface lies between 40 and 45 metres. Since survey work has not been carried out, it is not possible to quantify the shape of the potentiometric surface. Considering a six kilometre width of aquifer, of transmissivity 500 m²day⁻¹, and a hydraulic gradient of one metre per
### TABLE 2.1 PRESENT INVESTIGATIONS DRILLING RESULTS

<table>
<thead>
<tr>
<th>Bore Number</th>
<th>Location Description</th>
<th>Total Depth (m)</th>
<th>Standing Water Level (m)</th>
<th>Aquifer Depth (m)</th>
<th>Yield (Litres per second)</th>
<th>Specific Conductance</th>
<th>Aquifer Type</th>
</tr>
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<tbody>
<tr>
<td>13522</td>
<td>Site C</td>
<td>94.0</td>
<td></td>
<td></td>
<td>Dry</td>
<td>2000</td>
<td>Chalcedonic Limestone</td>
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<tr>
<td>13523</td>
<td>Site A</td>
<td>109.0</td>
<td>41.7</td>
<td>57 to 75</td>
<td>10.0 (A)</td>
<td>3410</td>
<td>Chert</td>
</tr>
<tr>
<td>13463</td>
<td>1 km west of Site A</td>
<td>83.7</td>
<td>42.3</td>
<td>57 to 62.4</td>
<td>6.0 (A)</td>
<td>2380</td>
<td>Chert</td>
</tr>
<tr>
<td>13464</td>
<td>1 km south of Site A</td>
<td>156.9</td>
<td>44.4</td>
<td>62</td>
<td>2.0 (A)</td>
<td>2800</td>
<td>Sand</td>
</tr>
<tr>
<td>13465</td>
<td>1 km north of Site A</td>
<td>147.8</td>
<td>40.6</td>
<td>57 to 66</td>
<td>8.0 (A)</td>
<td>1780</td>
<td>Limestone</td>
</tr>
<tr>
<td>13466</td>
<td>Site B</td>
<td>110.9</td>
<td>45.0</td>
<td>75</td>
<td>4.0 (A)</td>
<td>4500</td>
<td>Chert</td>
</tr>
</tbody>
</table>

(A) = Airlift supply
LEGEND

- 57-62 Water bore with depth in metres of aquifer beneath ground level
- Extent of Waite Formation

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EXTENT OF WAITE FORMATION AND DEPTH TO AQUIFER

FIG. 2.2.1
kilometre, a groundwater throughflow within the aquifer of 3000 cubic metres per day \( (\text{m}^{-3} \text{day}^{-1}) \) is indicated. This equates to an instantaneous throughflow of 35 Ls \( \text{m}^{-2} \) and an annual throughflow of one million cubic metres. An estimate of storage can be obtained by considering a volume of aquifer six kilometre square, twenty metres thick and having a storage coefficient of 0.1. Storage thus obtained is 72 million cubic metres.

2.2.2 Water quality

Fig. 2.2.2 is a plot of specific conductance. Values increase quite markedly towards the south western edge of the area. This is possibly due to the proximity of the granitic outcrop where low permeabilities and a high proportion of salts from the weathered overburden result in poor quality recharge waters from the west and south west. Away from this south western edge of the aquifer specific conductance varies from 1420 to 2000 microseimens per centimetre. Although complete water analyses for all bores are not available at the time of writing, these values of specific conductance equate to a TDS concentration of 1000 to 1500 mgL\(^{-1}\). A complete water analysis for Bore RN 13523 is listed in Table 2.2.2.

High concentrations of nitrate are common in groundwater throughout the Ti Tree Basin and range from 94 mgL\(^{-1}\) in the north west (Bore RN 12158) to 166 mgL\(^{-1}\) in the south east (Bore RN 2793) of the area. Without treatment groundwater in this area is unsuitable for human consumption due to an excessive concentration of nitrate. The suitability of the water for agricultural use would need to be assessed in conjunction with soil characteristics (by officers of the Department of Primary Production) as the quality of this water appears marginal for agricultural use.

2.2.3 Recharge

Insufficient data exists to contour the potentiometric surface. However from values of standing water levels obtained during this investigation, and from the regional Ti Tree Basin investigation (Reference 2) it is hypothesised that groundwater flow is north to north easterly in this region. One component of recharge has already been identified in section 2.2.2 as poor quality water entering from the west and south west. No data is available to identify the quantity of recharge from this source.

Direct recharge to the aquifers within the Waite formation is by percolation through the sands of the overlying upper unit of the Alcoota Beds. Assuming an infiltration coefficient of 0.02 and adopting an annual average rainfall of 250 millimetres, direct recharge is calculated to be 5000 cubic metres annually per square kilometre of surface area.
# TABLE 2.2.2 WATER QUALITY BORE RN 13523

<table>
<thead>
<tr>
<th>Parameter</th>
<th>RN 13523</th>
<th>Maximum Levels ++</th>
<th>Desirable Current Criteria</th>
<th>Long Term Objectives</th>
</tr>
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<tr>
<td>pH</td>
<td>7.6</td>
<td>6.5 - 9.2</td>
<td></td>
<td>7.0 - 8.5</td>
</tr>
<tr>
<td>Specific Conductance</td>
<td>2390</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>1410</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium, Na</td>
<td>269</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Potassium, K</td>
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<tr>
<td>Calcium, Ca</td>
<td>127</td>
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<tr>
<td>Magnesium, Mg</td>
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<tr>
<td>Total Hardness (as Ca CO₃)</td>
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<tr>
<td>Total Alkalinity (as Ca CO₃)</td>
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<td>Iron (total) Fe</td>
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<td>Silica, SiO₂</td>
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<td>Chloride, Cl</td>
<td>450</td>
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<td></td>
<td>200</td>
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<tr>
<td>Sulphate, SO₄</td>
<td>230</td>
<td>400</td>
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<td>200</td>
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<td>Nitrate, NO₃</td>
<td>84</td>
<td>45</td>
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<td>45</td>
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<tr>
<td>Bicarbonate; HCO₃</td>
<td>253</td>
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<td></td>
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<td>Carbonate, CO₃</td>
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<td></td>
<td></td>
<td></td>
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<td>Fluoride, F</td>
<td>0.7</td>
<td>1.5</td>
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<td>1.5</td>
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<td>Na Cl (calc. from chloride)</td>
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Note: All values in milligrams per litre (mgL⁻¹)

* microseimens per centimetre at 25°C
** by evaporation at 180°C
++ based on Department of Health et al (Reference 5)
LEGEND

- 3460 Water bore with value of Specific Conductance
Recharge from other sources such as through the Waite Formation from the south east is recognised but not calculated.
3. FUTURE WORK

3.1 Further drilling
Depending on the suitability of the water for agricultural needs, and thus the demand for water, any future bores should be drilled north of Bore RN 13523. This bore (RN 13523) can be used as a production bore, whilst an additional bore drilled alongside RN 13465, correctly constructed with screens and 200 mm casing, would enable a total supply of about 40 Ls to be withdrawn.

Further production and monitoring bores may be drilled as necessary in this northern area. Negotiations should take place with the management of Aileron pastoral lease to acquire an excision area with its northern boundary at least five kilometres north of the proposed area.

For optimum efficiency any production bores should be constructed with 200 mm diameter casing and screened opposite the major aquifers. On present day costs, a bore so drilled to 80 metres would cost about $15 000. In addition a monitoring bore, lined with 50 mm water pipe should be drilled near each production bore. Cost of this type of bore is not expected to exceed $5000.

3.2 Monitoring
Monitoring of both water quality and water levels is necessary if production bores are established in this area. A water management programme would need to be established for the area once the anticipated demand is known. From the monitoring results the minimum spacing between production bores can be determined to allow optimum siting of future bores.
4. CONCLUSIONS

4.1 Drilling south of the Majorca Bore on Aileron pastoral lease has defined aquifers of moderate transmissivity within the Waite Formation at depths of between 57 and 84 metres. These aquifers occur in the north eastern portion of the defined area of interest (refer Figure 1.1).

4.2 There are no major aquifers present within the defined area of interest except those noted within 4.1.

4.3 Bores capable of yielding upwards of 20 litres per second from pumping depths no greater than 60 metres can be constructed in this aquifer.

4.4 Water quality is not as good as desired, being excessive in nitrate concentration for domestic purposes, and possibly marginal for agriculture.
5. RECOMMENDATIONS

5.1 An excision area with its northern boundary at least five kilometres north of the defined area of interest be negotiated with the management of Aileron pastoral lease. This will incorporate the sites of proposed future production bores.

5.2 The Department of Primary Production be consulted regarding the suitability of this quality of water found in this investigation and the soil type of the proposed area for agricultural use.

5.3 The recommended long term pumping rate of Bore RN 13523, constructed during this investigation, is 15 litres per second from a pump setting of 56 metres.

5.4 Due to an excessive nitrate concentration, groundwater from Bore RN 13523 must be treated if used for domestic purposes.

5.5 Depending on water demand, future production bores, screened opposite the major aquifer, should be constructed north of RN 13523. Each production bore should be accompanied by a monitoring bore. The total cost of each production bore - monitoring bore pair is estimated to be $20,000.
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   WATER RESOURCES COUNCIL

   Quality for Drinking Water in Australia