Department for Water Resources

DWR

DOSAA

Improvement in groundwater supplies at the communities of Kalka, Amata, Mimili and Kenmore Park, Anangu Pitjantjatjara Lands, South Australia

DWR 2001/014

David Clarke and Sandy Dodds

Improvement in groundwater supplies at the communities of Kalka, Amata, Mimili and Kenmore Park, Anangu Pitjantjatjara Lands, South Australia

David Clarke and A.R. (Sandy) Dodds

Groundwater Assessment
Resource Assessment Division

September 2001

Report DWR 2001/014

Department for Water Resources

DOSAA

Government of South Australia

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Cover photo —Kenmore Park, northern South Australia. (Courtesy of Department of State Aboriginal Affairs; PIRSA photo 048364).

FOREWORD

South Australia's water resources are fundamental to the economic and social wellbeing of the State. Water resources are an integral part of our natural resources. In pristine or undeveloped situations, the condition of water resources reflects the equilibrium between rainfall, vegetation and other physical parameters. Development of surface and groundwater resources changes the natural balance and causes degradation. If degradation is small, and the resource retains its utility, the community may assess these changes as being acceptable. However, significant stress will impact on the ability of a resource to continue to meet the needs of users and the environment. Degradation may also be very gradual and take some years to become apparent, imparting a false sense of security.

Management of water resources requires a sound understanding of key factors such as physical extent (quantity), quality, availability, and constraints to development. The role of the Resource Assessment Division of the Department for Water Resources is to maintain an effective knowledge base on the State's water resources, including environmental and other factors likely to influence sustainable use and development, and to provide timely and relevant management advice.

Bryan Harris
Director, Resource Assessment Division
Department for Water Resources

ABBREVIATIONS

General

AHD	Australian height datum
SWL	standing water level

Measurement

Units of measurement used in this volume are those of the International System of Units (SI) as well as units outside the SI which have been authorised for use within Australia's metric system.

ha	hectares (area; 10^4 m^2)
h	hour (time interval; 3.6 x 10^3 s)
min	minute (time interval; 60 s)
s	second (time interval)

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Department for Water Resources

Report DWR 2001/014

Improvement in groundwater supplies at the communities of Kalka, Amata, Mimili and Kenmore Park, Anangu Pitjantjatjara Lands, South Australia

David Clarke and A.R. (Sandy) Dodds

ABSTRACT

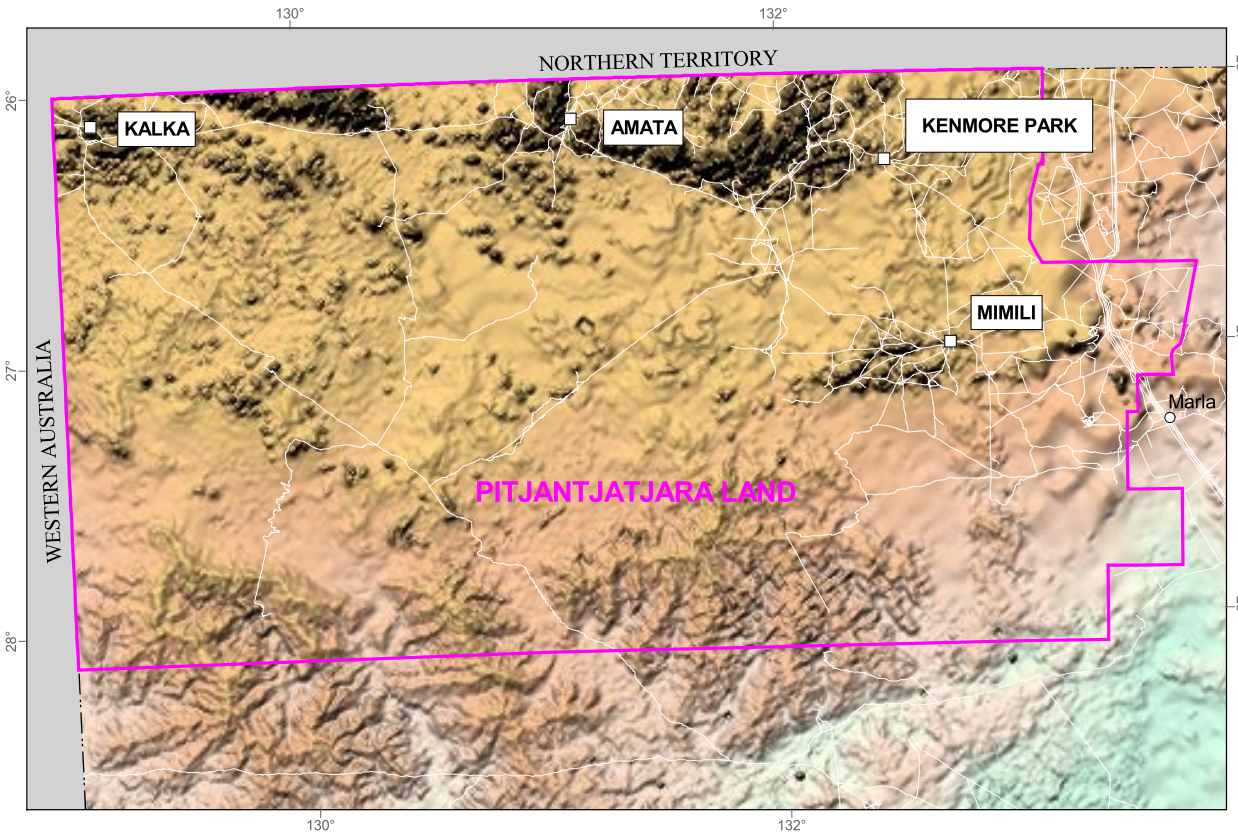
The community water supplies at Kalka, Mimili and Kenmore Park are insufficient for emergencies, while the wells at Amata are in poor condition. In this program, drilling of three wells at Kalka has doubled the available water supply and spread it over three wells, compared to the one original well. At Mimili two additional wells were drilled without success, and the supply problem remains uncertain. Three wells drilled at Kenmore Park likewise failed to find additional supplies, but a re-evaluation of the existing three production wells indicates that one well which was little used is capable of alleviating the water shortage, but should be monitored regarding its use and water levels. At Amata, one well was fully rehabilitated and a second replaced with a new, and more productive, well. The third producing well could only be flushed out, so the casing is still in poor condition.

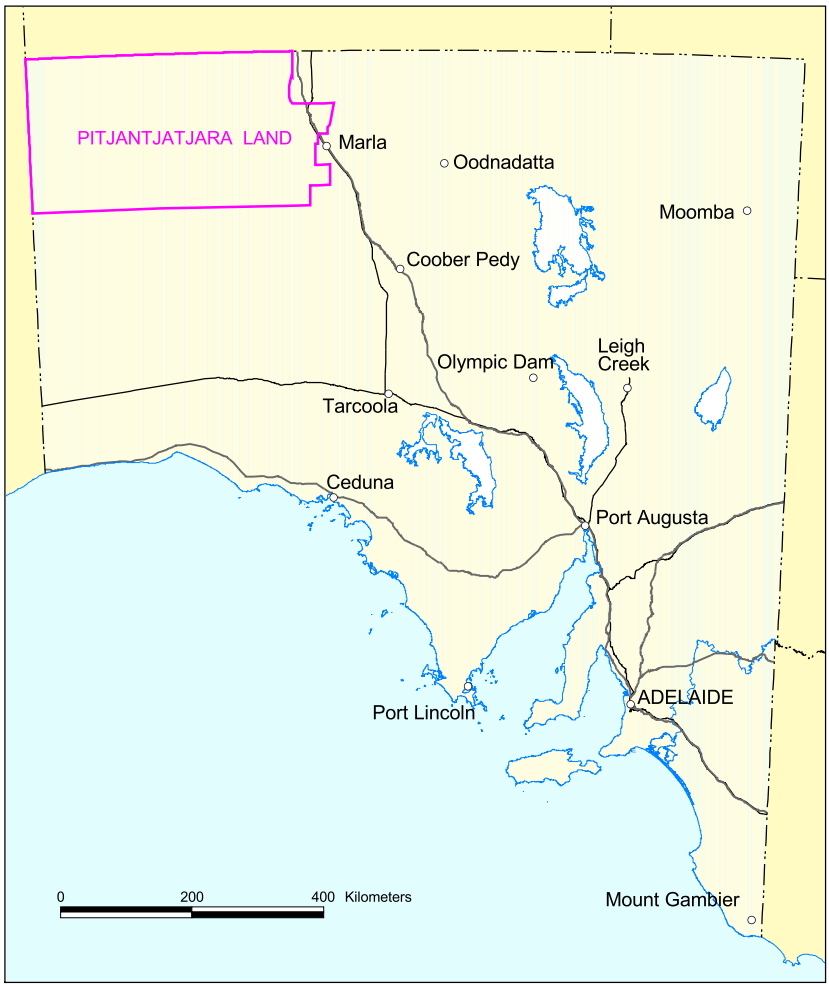
The water supplies at all communities, except Mimili, are now regarded as satisfactory for current levels of demand. Further water search is recommended at Mimili, and six provisional sites have been selected in the areas of the existing water supplies. The third supply well at Amata would benefit from either rehabilitation or replacement, but this is not regarded as urgent.

INTRODUCTION

In November 2000, at the request of the Department of State Aboriginal Affairs (DOSAA), the Department for Water Resources (DWR) submitted a quotation for the improvement of water supplies at three communities, Kalka, Mimili and Kenmore Park, in the Anangu Pitjantjatjara Lands, South Australia (Fig. 1). The quotation was accepted in December 2000 and an office study was commenced immediately to determine the most favourable procedure for each community. A report on the office study was submitted to DOSAA in February 2001 and the recommended course of action approved.

Permission for field studies at each community and quotations for well drilling and pump testing were sought by Clarke in February and an initial field trip to the sites was undertaken in March by Clarke and Dodds. Drill sites at Mimili and Kenmore Park were selected, but further progress to Kalka was precluded by heavy rains in the area. Clarke carried out a second field trip to Kalka in April.





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Projection - Equidistant Conic

Department for Water Resources

Anangu Pitjantjatjara Land Communities

LOCALITY MAP

Figure I

PIRSA Publishing Sevices AV:201057_005

At this time a further quotation for the rehabilitation of wells at Amata was sought and accepted by DOSAA and incorporated in the same program.

Drilling permits were acquired in April 2001, and anthropological clearance of the drill sites achieved between April 30 and May 5, 2001. Well drilling and rehabilitation at all four communities was carried out between 4–14 May and pump testing of successful wells carried out in the last two weeks of May 2001.

Details of the wells are contained in Appendix 1, while analysis of water samples for the successful wells are contained in Appendix 2.

A preliminary report and a quotation for further work to complete the objectives were submitted on 28 June 2001.

KALKA

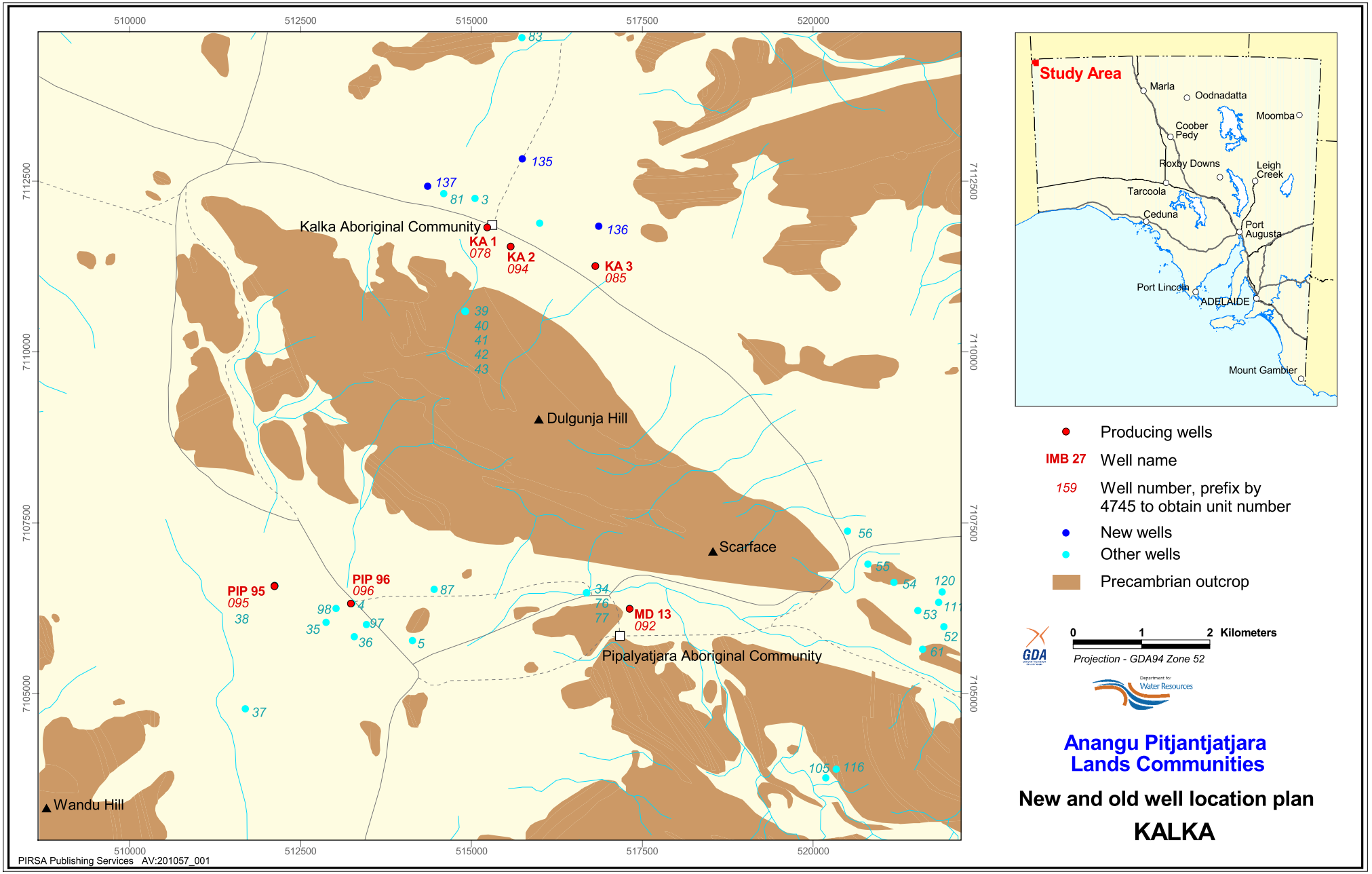
Before this program, Kalka was adequately served by three wells, KA-1, KA-2 and KA-3. However, as 67% of the water came from KA-3 and the other two wells were incapable of supplying additional water, the community would have been in difficulty had the supply in this well failed.

All three existing wells (Fig. 2) are located in a wide east-trending valley that flanks the community to the north. Several ephemeral creeks flow into this valley, but there is no creek line along the valley or leaving it, nor are there any extensive evaporative pans, suggesting that the incoming water is absorbed into the sub-surface. The wells have shown no sign of recharge or dewatering of the aquifer. However, the maximum monthly rainfall since monitoring began has been 88 mm, which is probably not enough to cause recharge.

Three drill sites were selected and drilled in the valley (Fig. 2), aimed at deeper parts of the valley and preferably near inflowing creek systems. Two of these were successful, producing conservative long-term yields of 0.63 and 7.1 L/s of good quality water. All the water comes from weathered gneissic gravel, sometimes transported, under 20 m or so of finer Quaternary sediments. Basement is gneiss. The third well produced only a seepage of water, despite intersecting weathered and highly fractured gneiss from 27 to 43.5 m, a depth at which the water table should have been intersected. It appears that the aquifer at this point is not connected to a recharge supply of groundwater. This indicates a lack of lateral connectivity of aquifers in this area and, indeed, the existence of total barriers to groundwater movement.

AMATA

The community has a satisfactory water supply from three wells, A-15, A-17 and A-26, (Fig. 3) any two of these wells could supply the normal requirements of the community. However, the casing and screens in all three wells were highly corroded and partially blocked, with a build up of sediment at the foot of the well. After initially considering redrilling all three wells, it was eventually decided that rehabilitation would be attempted.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512500
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7110000
7107500
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Kalka Aboriginal Community
KA 1
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KA 2
094
KA 3
085
MD 13
092
PIP 95
095
PIP 96
096
Pipalyatjara Aboriginal Community
▲Dulgunja Hill
▲Scarface
▲Wandu Hill
83
135
137
81
3
136
39
40
41
42
43
87
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77
4
98
35
97
36
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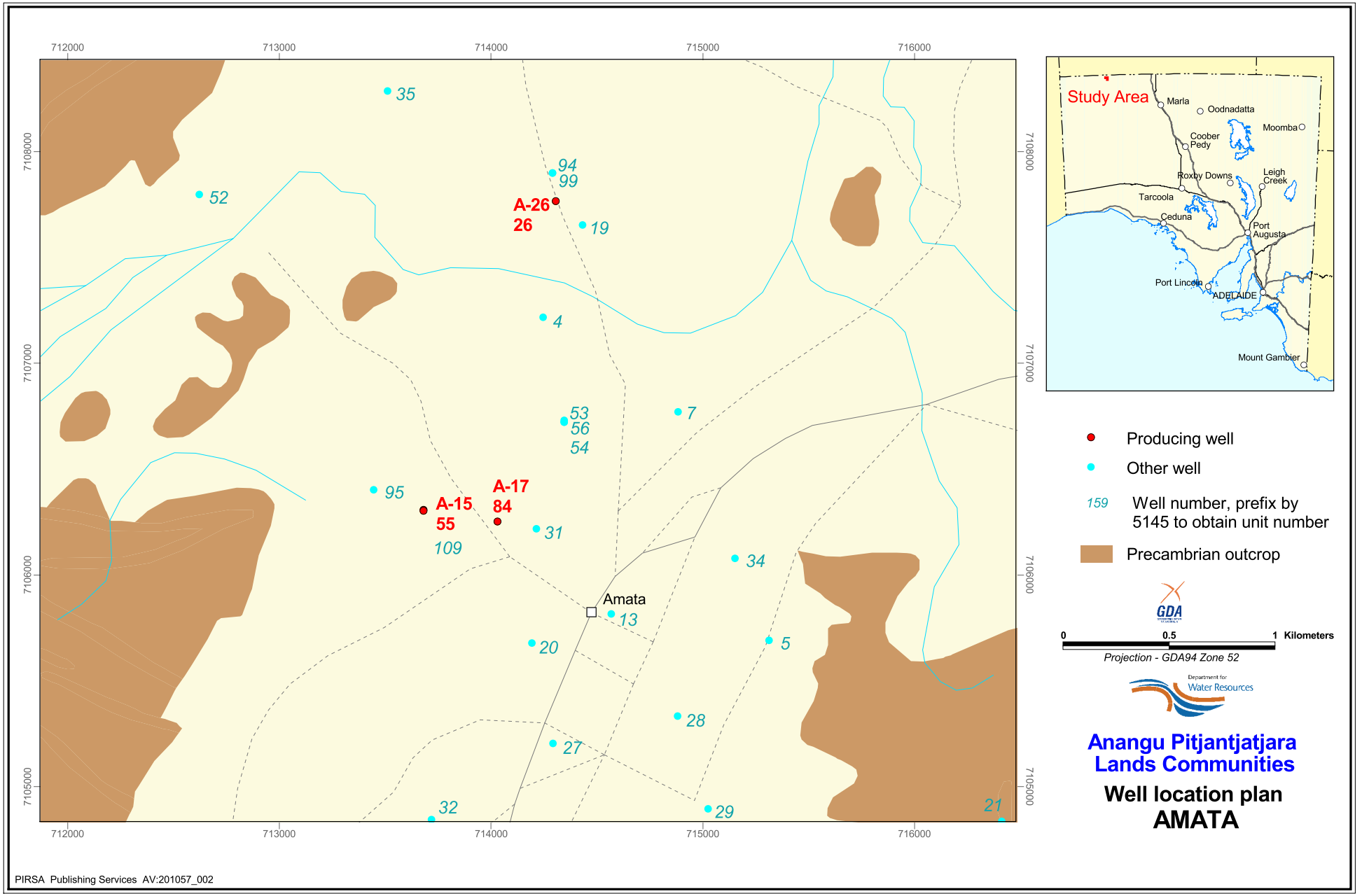
38
37
56
55
54
120
53
52
61
105
116
PIRSA Publishing Services AV:201057_001
Study Area
Marla
Oodnadatta
Moomba
Coober Pedy
Roxby Downs
Leigh Creek
Tarcoola
Ceduna
Port Augusta
Port Lincoln
ADELAIDE
Mount Gambier
Producing wells
IMB 27 Well name
159 Well number, prefix by 4745 to obtain unit number
New wells
Other wells
Precambrian outcrop
0 1 2 Kilometers
Projection - GDA94 Zone 52
GDA
Department for Water Resources
Anangu Pitjantjatjara Lands Communities
New and old well location plan
KALKA

Figure 2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7107000
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35
52
94
99
A-26
26
19
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56
54
7
95
A-15
55
109
A-17
84
31
34
Amata
13
20
5
28
27
32
29
21
Study Area
Marla
Oodnadatta
Moomba
Coober Pedy
Roxby Downs
Leigh Creek
Tarcoola
Ceduna
Port Augusta
Port Lincoln
ADELAIDE
Mount Gambier
Producing well
Other well
159
Well number, prefix by 5145 to obtain unit number
Precambrian outcrop
GDA
0
0.5
1 Kilometers
Projection - GDA94 Zone 52
Department for Water Resources
Anangu Pitjantjatjara Lands Communities
Well location plan
AMATA
PIRSA Publishing Services AV:201057_002

Figure 3

Attempts to rehabilitate A-15 resulted in the screen being destroyed and the well being abandoned. A new well was drilled a few metres away, the position was selected on the basis of convenience for movement of the infrastructure. The resulting well has a long-term yield of 5.1 L/s, considerably more than the original well. The water comes from a fractured gneiss aquifer.

Well A-17 was fully flushed and rehabilitated with new PVC casing. Well A-26 could not be rehabilitated, since there was immovable infrastructure positioned over the well, preventing access by the drilling rig. It was therefore only flushed out, and the casing remains fragile.

MIMILI

The community has an adequate water supply coming equally from two wells, M-1 and M-3 (Fig. 4), either of which could supply the community's needs in the short term. Neither well shows signs of dewatering or recharge, however rainfall has not been heavy at any time since monitoring began, so there has been no source of recharge water. A third well is considered desirable to ensure the community water supply.

Three well sites were selected, two in the general area of the existing wells and one further north and closer to the hills. The last was selected on the basis of the extrapolation into the valley of a fault indicated by linear structures in the hills that, on inspection, proved to be associated with mylonite. Unfortunately, the anthropological team rejected this site.

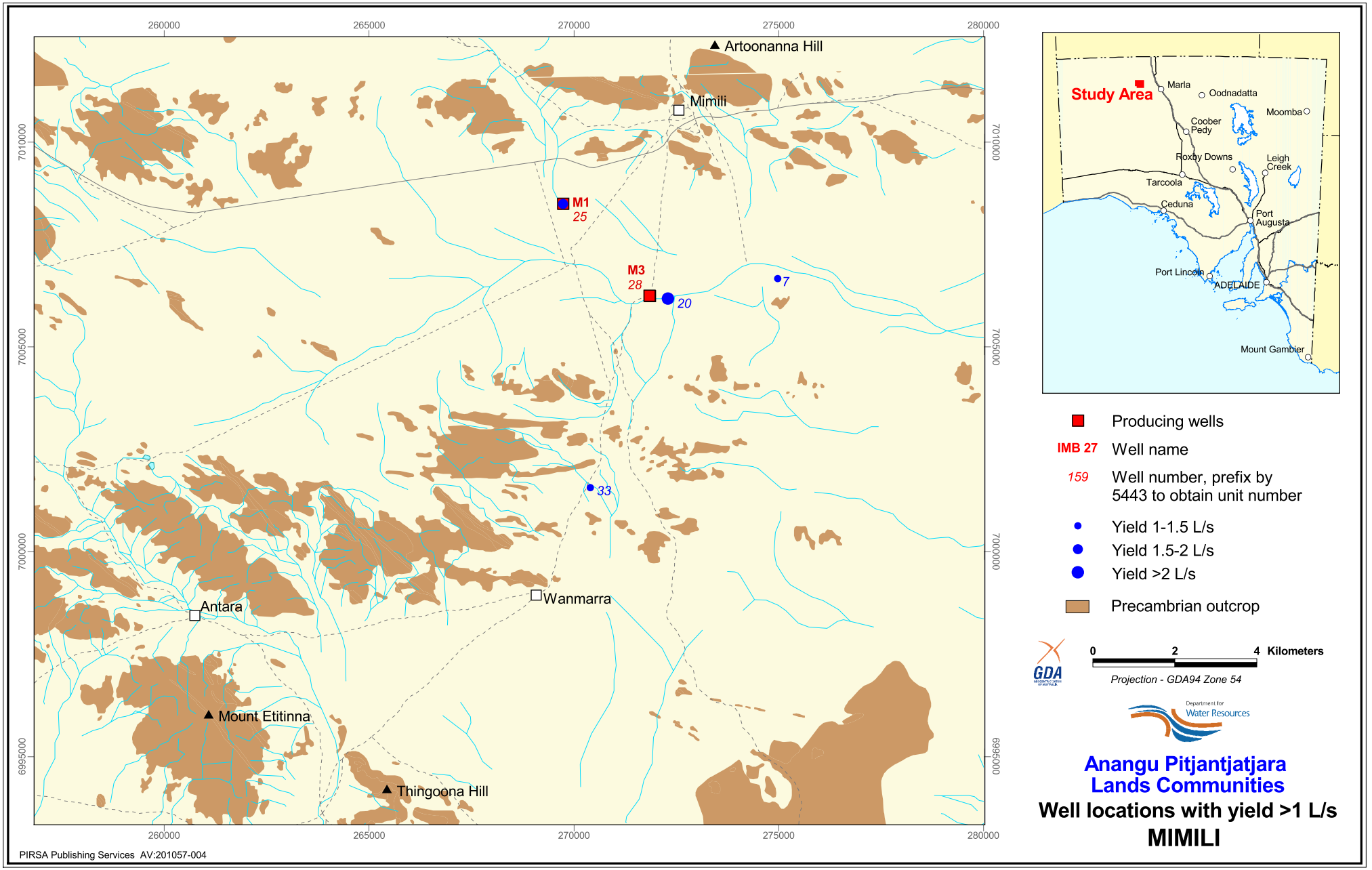
The other two sites, chosen on the basis of surface features, were drilled without success. One yielded saline water (over 2000 mg/L) and was abandoned at 25 m, while the other yielded only a seepage of water (Fig. 4).

Away from outcrop ridges there are few indicators to guide the search for supplies of fresh water. In the absence of other indications, the areas near proven water supplies appear best, so long as the chosen sites are not close enough for wells to interfere with each other's supply.

KENMORE PARK

Three wells supply water to this community: KP-6, KP-7 and KP-94B (sometimes referred to as KP-98 after the well unit number, 5345-98) (Fig. 5). The first two have been regularly pumped and monitored and, while not providing generous supplies, have sufficed to serve the community. KP-94B was little used before last year, 2000. While it was previously assumed that this was due to an unreliable supply, the real reason was that the pump had to be manually turned on and off at the well site, some 4 km from the community. Increased use in the last year, and a more detailed study of the well's testing and performance, indicate that the well can supply at least 1 L/s in the long term, and could be a major contributor to the community's water supply.

On this basis, the water supply for Kenmore Park is reasonable, with two wells capable of supplying the normal needs of the community (based on past performance). The third well is of sufficient capacity to contribute to supply during times of high demand or to take over temporarily, should there be a problem with one of the two main wells.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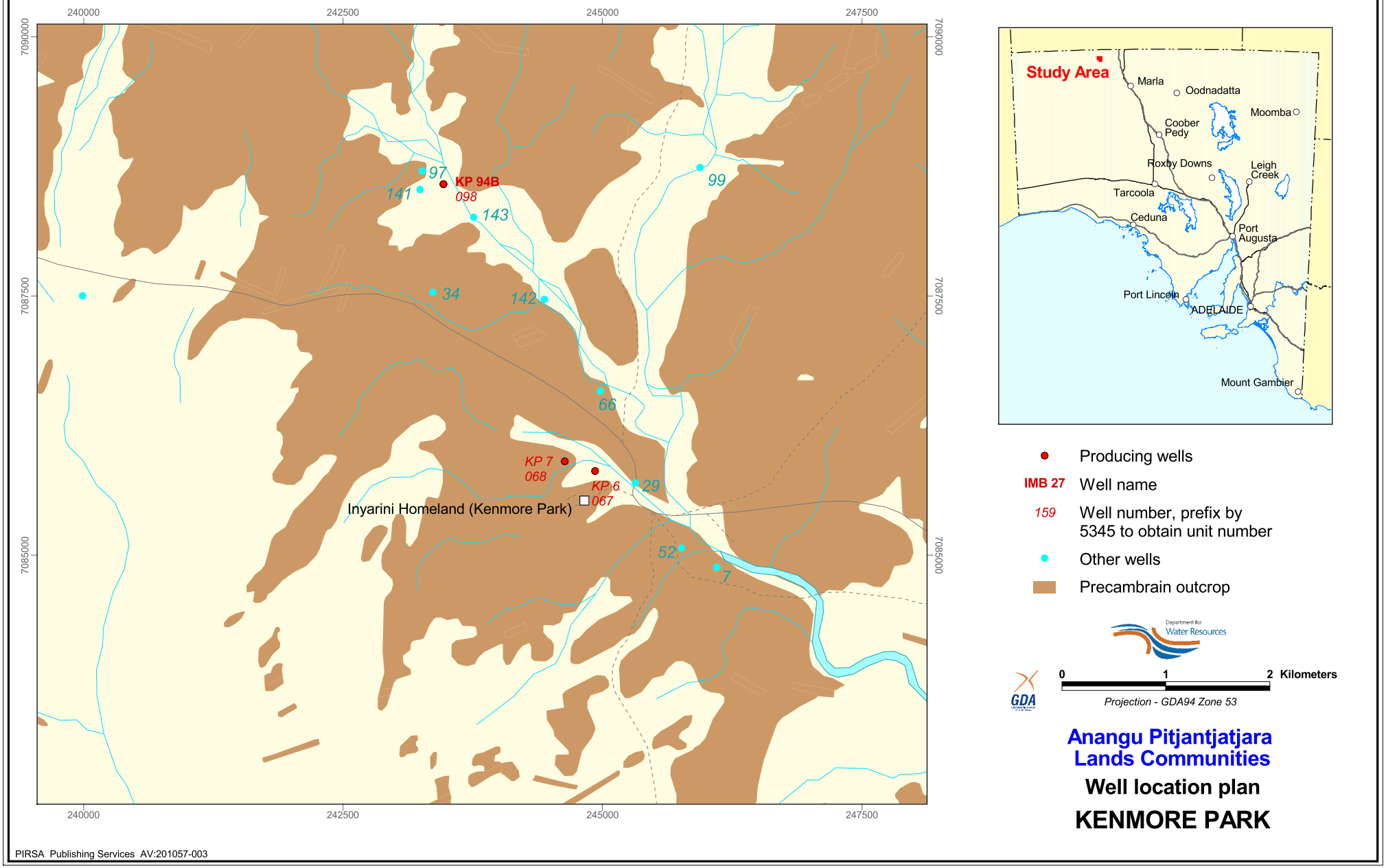
275000
280000
7010000
7005000
7000000
6995000
Artoonanna Hill
Mimili
M1
25
M3
28
20
7
33
Wanmarra
Antara
Mount Etitinna
Thingoona Hill
Study Area
Marla
Oodnadatta
Moomba
Coober Pedy
Roxby Downs
Leigh Creek
Tarcoola
Ceduna
Port Augusta
Port Lincoln
ADELAIDE
Mount Gambier
Producing wells
IMB 27
Well name
159
Well number, prefix by 5443 to obtain unit number
Yield 1-1.5 L/s
Yield 1.5-2 L/s
Yield >2 L/s
Precambrian outcrop
0
2
4
Kilometers
GDA
Projection - GDA94 Zone 54
Department for Water Resources
Anangu Pitjantjatjara Lands Communities
Well locations with yield >1 L/s
MIMILI
PIRSA Publishing Services AV:201057-004

Figure 4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7087500
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KP 94B
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143
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34
142
66
KP 7
068
KP 6
067
29
Inyarini Homeland (Kenmore Park)
52
7
Study Area
Marla
Oodnadatta
Moomba
Coober Pedy
Roxby Downs
Leigh Creek
Tarcoola
Ceduna
Port Augusta
Port Lincoln
ADELAIDE
Mount Gambier
Producing wells
IMB 27
Well name
159
Well number, prefix by 5345 to obtain unit number
Other wells
Precambrain outcrop
Department for Water Resources
GDA
0
1
2 Kilometers
Projection - GDA94 Zone 53
Anangu Pitjantjatjara Lands Communities
Well location plan
KENMORE PARK
PIRSA Publishing Services AV:201057-003

Figure 5

While consistent pumping and equipment problems resulted in unreliable data, it is clear that the water levels in both KP-6 and KP-7 have not shown any long-term decline, and DWR considers that the aquifer is not being dewatered. It is probable that occasional recharge is taking place.

The search for additional supplies in this area concentrated on the vicinity of KP-94B, where favourable structures are indicated by outcropping formations. Three wells were drilled, but produced only minor quantities of water. All the wells encountered gneiss at shallow levels and found little weathering or fracturing of the rock. One well was terminated at 12 m, since the water found was saline. The area along the main road west of Kenmore Park was also considered, despite high nitrate values recorded in some earlier wells. Well 5345-34 had reasonable quality water in unknown quantities, and was pump tested. The supply proved to be minor.

SUMMARY AND RECOMMENDATIONS

Kalka's water supply seems assured by the new well, but monitoring of its water level (on a six-monthly basis) would be advisable. Should the well be equipped, then the installation of monitoring equipment would provide valuable data, whether the well is being pumped or not. It would be interesting to find out more about the aquifer in this location, perhaps by application of geophysics to assess the dimensions of the channel, however, this can only be justified unless additional water supplies are required.

While some of the work at Amata was unsuccessful, the work has resulted in an increase in the water supply available though well 5145-137 and improved the condition of well 5145-84 (A-17). Unfortunately, the casing in well 5145-19 (A-26) could not be rehabilitated and flushing the well will be of limited value. The aquifer is performing very well, with major recharge over the past 18 months, indicating that the conclusion expressed by Dodds and Sampson (2000; RB2000/027) that only a drought of 20 years or more would be likely to cause a water shortage, is verified. Rehabilitation or replacement of well 5145-19 is desirable but not urgent.

The situation at Mimili is unchanged, with the community still dependant on two wells for its water supply. The difficulty in finding additional supplies has been reinforced, and the solution of concentrating further search efforts near existing wells is recommended. A minimum separation of 200 m is suggested to ensure that wells do not interfere with each other. Some use of geophysics could help in locating new wells more precisely, however this could only be justified if the crew and equipment were already in the area for other work. Six well sites have subsequently been selected for possible future drilling; three near each of the current town water supply (TWS) wells.

While no additional water supplies have been found for Kenmore Park (and the difficulties of finding such supplies highlighted), a reassessment of existing supplies has shown that the water supply may be sufficient unless there is an increase in demand. If the need for water increases, or if one of the wells shows signs of stress, the supply from 5345-98 (KP-94B) could be reassessed by more stringent pump testing and by monitoring its use and water levels. It is likely that this well can supply more than the 1 L/s currently recommended as the maximum yield.

APPENDIXES

1 INTERIM REPORT ON DRILLING RESULTS — AMATA, KALKA, KENMORE PARK AND MIMILI, D.K. CLARKE

Interim report on drilling results

Wednesday, 29 August 2001

David Clarke, Crystal Brook, Department for Water Resources

Amata, Kalka, Kenmore Park, Mimili

Introduction

Supplementary community supply water wells were required for Kalka, Kenmore Park and Mimili, and wells at Amata needed rehabilitation; all in the Anangu Pitjantjatjara Lands in the far northwest of South Australia.

Nine wells were drilled, one old well rehabilitated and another cleaned out, in May 2001. This work was done by Gorey and Cole Drillers of Alice Springs and was supervised by the Department for Water Resources for the Department of Aboriginal Affairs, South Australia (the driller was Barton Phillips).

Of the new wells, three were successful (two at Kalka, one at Amata), the others failing either to obtain sufficient supply (one at Kalka, two at Kenmore Park, one at Mimili) or intersecting water that was too saline (one at Kenmore Park, one at Mimili).

Geology

Gneiss (a medium-grey metamorphic rock, often locally referred to as granite) is the most common rock type in the AP Lands from Kenmore Park to the Western Australia border. Dolerite (a very dark-grey, medium-grained intrusive igneous rock) is often found as dykes (bodies that are long and narrow in plan and extend to substantial depths) passing through the gneiss. Some occurrences of ‘dolerite’ are fine grained and are then perhaps more properly called basalt (although they still seem to be intrusive in placement). Some adamallite and granite is present in the Everard Ranges; their hydraulic properties are very similar to gneiss.

Gneiss or dolerite also is widespread beneath very shallow alluvial cover, but there are areas where the alluvium or saprolite extends to ten metres or more over the bedrock; Amata, Kalka, and the community well-field area at Mimili are such areas.

The gneiss is very close to the surface in the vicinity of Kenmore Park.

Both the gneiss and dolerite lack primary porosity; they yield water to a well only where they are weathered and/or fractured.

Alluvium (characterised by rounding of the particles) to any more than superficial depth is rare, but was encountered as deep as 43 m in well Kalka 2001 C.

Well siting

Sites for the wells were chosen after examination of satellite images and areal photographs and over-flying the sites in a light plane. Factors considered included:

- Records from existing wells: stratigraphy, depth to basement, depth to the water table, typical yield, salinity
- Rock type, mineralogy, and disposition of outcrop
- Tectonic factors: faults, joints, lineaments
- Drainage patterns and relative elevations
- Presence and distribution (as far as the very limited evidence permitted) of alluvium/sediment/saprolite.

The use of geophysical methods as an aid in site selection was considered, but rejected on the grounds that the results would be unlikely to economically justify the cost.

MINERALOGICAL FACTORS

Epidote

The glassy green calcium silicate mineral epidote had previously been found to be fairly abundant in an exceptionally high yielding well in the Young's Well area northeast of Pukatja (well Unit No. 5345-120). As this mineral is formed under hydrothermal conditions it seemed to be a possible indicator for higher than normal yields.

Well Kenmore Park 2001 A was drilled at a site where epidote float (scattered surface stones) was common; but this well was practically dry.

Epidote was abundant in some parts of Well Amata 2001 A, which was an exceptionally high-yielding well by AP Lands standards. However, some epidote was found in several wells drilled for Pitjantjatjara Projects (Watinuma 2001 A and Umuwa Sunfarm 2001 E) and having limited yield.

Whether epidote is an indicator of higher than average yields in the AP Lands remains inconclusive.

Talc

Talc, a very soft hydrous magnesium silicate, was common within fractures in the gneiss in an exceptionally high-yielding well drilled at Umuwa in May 2001, and a moderate amount of talc was noticed in well Amata 2001 A.

Well Mimili 2001 A penetrated some 20 m of massive talc; in this form talc is not prospective.

It is possible that talc within fractures in gneiss, granite, or dolerite might be associated with higher than usual well yields. However, since talc is too easily eroded to be seen in undisturbed outcrop it is difficult to see that this will be of practical use.

Well data tables

Well numbers and locations (coordinates are WGS84)

Well name	Permit No.	Unit No.	Easting	Northing	Zone
Amata 2001 A	55338	5145-109	713680	7106307	52
Kalka 2001 A	55335	4745-135	515737	7112823	52
Kalka 2001 B	55336	4745-136	516857	7111837	52
Kalka 2001 C	55337	4745-137	514353	7112419	52
Kenmore 2001 A	55339	5345-141	243240	7088524	53
Kenmore 2001B	55340	5345-142	244439	7087465	53
Kenmore 2001 C	55341	5345-143	243759	7088256	53
Mimili 2001 A	55342	5443-53	269969	7007513	53
Mimili 2001 B	55343	5443-54	271423	7005942	53

WELL COMPLETION

All wells used 6 m of cement grouted 220 mm (outside diameter) steel surface casing.

Main casing:

- in productive wells, was class 9, 155 mm (outside diameter) PVC
- where used in non-productive wells, was 50 mm PVC.

Well name	Status	Head	Total depth (m)	Slots from (m)	Slots to (m)	Airlifted yield (L/s)
Amata 2001 A	Productive	Open for pump	55	31 43	37 49	8?
Kalka 2001 A	Observation	50 mm screw plug	43.5	37.5	43.5	0.0002
Kalka 2001 B	Productive	Steel plate	43.5	31.5	37.5	1.05
Kalka 2001 C	Productive	Steel plate	55.5	37.5	49.5?	8?
Kenmore 2001 A	Observation	50 mm screw plug	25	open hole	–	Trickle
Kenmore 2001 B	Observation	Steel plate	12	open hole	–	0.1
Kenmore 2001 C	Observation	50 mm screw plug	31	open hole	–	0.2
Mimili 2001 A	Observation	50 mm screw plug	49.5	43.5	49.5	0.03
Mimili 2001 B	Observation	50 mm screw plug	25.5	19.5	25.5	0.6

Water cuts and salinities (Also see cumulative water cut graphs)

Well name	Water cut — depth (m)	Water cut — yield (L/s)	Salinity (where/how tested)
Amata 2001 A	24	1	
	37	4	
	43-49	3 (total 8)	1200 ECU (Field test)
Kalka 2001 A	?	0.0002	Insufficient yield to test
Kalka 2001 B	33	1	900 ECU, 500 mg/L (DfWR, Glenside)
Kalka 2001 C	38	0.2	
	43	0.7	
	45	3	
	49	2	
	52	2 (total 8)	900 ECU, 500 mg/L (DfWR, Glenside)
Kenmore 2001 A	9	trickle	
Kenmore 2001 B	7	0.05	13 800 ECU (Field test)
	10?	0.05 (total 0.1?)	
Kenmore 2001 C	25	0.1	
	26-31	0.1 (total 0.2)	1300 ECU (Field test)
Mimili 2001 A	40-43	0.02	
	44-49.5	0.01 (total 0.03?)	Insufficient yield to test
Mimili 2001 B	17	0.25	
	19-25.5	0.35 (total 0.6)	3320 ECU (Field test)

Standing water levels (relative to ground level)

Well name	Standing water level (m)	Date measured
Amata 2001 A	10.17	11/5/01, after drilling
	9.75	17/5/01, before well test
Kalka 2001 A	?	Insufficient yield to measure
Kalka 2001 B	19.97	19/5/01, before well test
Kalka 2001 C	27.22	4/5/01, ½ hr after drilling
	27.28	20/5/01, before well test
Kenmore 2001 A	11.68?	13/5/01, 20hrs after drilling
Kenmore 2001 B	7.98	13/5/01, 18hrs after drilling
Kenmore 2001 C	9.44	13/5/01, 14hrs after drilling
Mimili 2001 A	18.98	14/5/01, 15hrs after drilling
Mimili 2001 B	12.29	14/5/01, ½ hr after drilling

Well construction

All wells used 220 mm outside diameter steel surface casing, in most cases 6 m.

Below the level of the surface casing, all wells were drilled with a 200 mm diameter bit.

All production wells used slotted class 9 PVC 155 mm outside diameter casing in which the slots were longitudinal, 2 mm wide, and in three rows along the casing; the spacing between the slots being approximately the same as the lengths of the slots.

Those observation wells that were cased used 50 mm PVC casing.

Well discharge tests

Recommended maximum discharge rates have been calculated using a safety margin appropriate to each well. In the long term probably the greatest threat to the viability of the suggested discharge rates is the possible dewatering of the aquifers by natural groundwater flow. Early results from regional groundwater monitoring is showing that the water table can decline by as much as a metre per year even where there is no artificial discharge (pumping). In the very long term (10 to 50 years) this will be balanced by recharge of the aquifer due to rainfall.

In the notes below the well equation has the form:
$s = AQ + BQ \log(t) + CQ^D$ (for isotropic aquifers)
where:
‘s’ is drawdown of the water level in the well
A, B, C and D are coefficients evaluated for each well
Q is the discharge (pumping) rate
‘t’ is the duration of discharge from the well.
Units are metres and days.

AMATA

Well Amata 2001 A

A excellent fit between the drawdowns recorded and the type curve was given by an isotropic well equation with the coefficients: A=0.015, B=0.0027 (Transmissivity, T=68), C=1.79e-5, D=2.

The available drawdown in this well (the distance that the water level can draw down before reaching the aquifer) is a very good 23 m.

Recommended maximum discharge rates

Duration of discharge	Rate (kL/d)	Rate (L/s)	Safety margin (%)
1 day	590	6.9	25%
20 days	510	5.9	30%
1 year	440	5.1	35%

KALKA

Well Kalka 2001 B

A very good fit between the drawdowns recorded and the type curve was given by an isotropic well equation with the coefficients: A=0.053, B=0.0059 (T=31), C=6.45e-4, D=2.

The available drawdown in this well is 13 m, rather less than the other new wells. Therefore this well is a little more susceptible to natural declines in the water table; consequently the safety margins in the recommended rates have been increased.

Recommended maximum discharge rates

Duration of discharge	Rate (kL/d)	Rate (L/s)	Safety margin (%)
1 day	69	0.80	35%
20 days	62	0.72	40%
1 year	54	0.63	45%

Well Kalka 2001 C

A fair fit between the drawdowns recorded and the type curve was given by an isotropic well equation with the coefficients: A=0.0078, B=0.00086 (T=210), C=7.56e-6, D=2. (The second of three discharge stages did not fit well with these coefficients, and the recovery showed evidence of air entrapped in the aquifer.)

The available drawdown in this well is 18 m. The safety margin for the 1 year recommended rate has been increased to reflect the poorer fit between the recorded data and the theoretical model.

Recommended maximum discharge rates

Duration of discharge	Rate (kL/d)	Rate (L/s)	Safety margin (%)
1 day	830	9.6	25%
20 days	740	8.5	30%
1 year	610	7.1	40%

KENMORE PARK

Well KP-94B (Unit No. 5345-98)

On re-examination of the test data from well KP–94B it seems that it may be capable of a considerably greater yield than the previous recommendation; perhaps as high as 1.8 L/s continuously for a year. However, before substantially increasing the pumping rate the well should be discharge tested at a rate considerably higher than the test of 1994. That test, at 1.7 L/s, achieved a maximum drawdown of about 10 m while the major water cut was about 17 m below SWL. Ideally the well should be tested with a pump capable of at least 2.5 L/s. Much of the previous test was taken in dewatering several upper aquifers; the ideal test would achieve a period of relatively

stable drawdown around 12–17 m and might require pumping for 48 or even 72 hours.

Well Unit No. 5345-34

This well was discharge tested by DfWR during this project. The calculated maximum yield is too small for including the well into the community supply to be considered.

The derived well equation was for an isotropic aquifer with coefficients: A=0.56, B=0.10 (T=1.8), C=0, D=2. (Coefficient C has been taken as zero because it could not be evaluated from the test results; coefficient A has been adjusted accordingly.)

Projected maximum discharge rates (no safety margin has been used)

Duration of discharge	Rate (kL/day)	Rate (L/s)
1 day	12	0.14
20 days	10	0.11
1 year	8	0.09

Well rehabilitation at Amata

The three existing community supply wells were constructed many years previously with steel casing. This was known to be in poor condition and it was intended to clean out, acid dose (to remove any calcic encrustations), line the wells with 100 mm PVC casing and grout between the old steel and new PVC casings.

WELL A17

On 9 May 2001 the well was cleaned out and acid dosed. On 10 May it was jetted and air lifted. It was noticed that air and water were coming up outside of the casing although the air was being injected inside the casing and above the screen. This probably indicated that there were holes rusted through the steel casing.

PVC casing was run to the top of the screen. It was decided that grouting all the way from surface to the top of the screen would involve too much risk of grout getting into the aquifer part of the well, so the well was grouted only from surface to 6 m. Packers were placed at 6 m and just above the screen (in case any grout got past the top packer).

The well was air lifted again until the water became acceptably clear. Finally, the pump was replaced in the well and run for a short time.

WELL A15

An attempt was made to clean out the well on 10 May 2001. The drill became stuck at about 38 m before reaching the bottom of the hole. It was found that the drill string could not be removed from the hole without taking the casing out at the same time. The casing and screens were removed from the well.

There were four screens in the well, each 0.66 m long. There was a 0.87 m sump below the bottom screen. From the bottom, the lengths of casing between the screens were: 0.85, 0.93, 1.94 m respectively. The total length of casing and screens in the hole was found to be 37.85 m.

A replacement well was drilled nearby; see elsewhere in this report.

WELL A26

The proximity of overhead power lines and the power box to the well made cleaning out and recasing this well impracticable. On 11 May 2001 the pump was removed and the well was flushed out with compressed air (using 50 mm poly pipe and the rig compressor). The poly pipe was run in to a depth of approximately 38.0 m and the depth of the hole was measured after the cleaning operation at 36.9 m.

The pump was placed back in the well and run for a short time.

COMMENT

Rehabilitating old wells is always a risky operation; many drillers refuse to do it at all. It is probable that few drillers could have produced a better outcome than that achieved.

Well Logs

AMATA

Amata 2001 A

From (m)	To (m)	Rock	Description
0	7	Calcrete	
7	19	Clayey silt	Yellow-brown to olive-brown. Containing some epidote
19	25	Clayey silt	With minor sand and grit. The sand is weathered gneiss, black mineral, and epidote
25	31	Gneiss	Highly weathered, with abundant clayey silt, moderate epidote, some talc
31	37	Gneiss	Highly weathered gneiss followed by highly fractured gneiss. Very abundant epidote, some talc
37	43	Gneiss	Highly weathered, little epidote and talc
43	50	Gneiss	Fresh. Abundant epidote in places
50	53	“Dolerite”	Very dark grey medium grained igneous rock
53	55	Gneiss	Fresh, with epidote

KALKA

Kalka 2001 A

From	To (m)	Rock	Description
0	9	Silty sand	With fine gneiss gravel. The sand is red. The gravel shows abundant weathering staining.
9	12	Gneiss	Very highly weathered, with some gabro; calcareous. Alluvial/residual (judging by composition), no rounding.
12	19	Gneiss	As above, but with significant clay.
19	27	Feldspar–quartz	Highly weathered; calcareous (indicated by effervescence with acid), little clay. The quartz is subrounded. Quick drilling.
27	31	Gneiss	Weathered. Yellowish brown. No limestone.
31	37	Gneiss	Weathered, highly fractured.
37	43.5	Gneiss	Weathered, fractured

Drilling was terminated at 43.5 m. The water table in this area would be about 23 m; it was reasoned that if no water was cut in 20 m of fractured gneiss, going deeper would be unlikely to cut water. Estimated total yield 0.2 mL/s. (based on the water level in the well rising 5.19 m in the subsequent nine days).

Kalka 2001 B

From	To (m)	Rock	Description
0	6	Silty sand	Red, little limestone
6	12	Silty sand	Calcareous, clayey
12	15	Gravelly silt	Calcareous, the gravel is gneiss
15	18	Clay	Light grey. No limestone
18	25	Gritty clay	Brown
25	31	Gravel and clay	The gravel is weathered gneiss
31	37	Gneiss	Weathered, with some clay
37	43.5	Gneiss	Weathered

Kalka 2001 C

From	To (m)	Rock	Description
0	6	Silty sand	With gneiss and basic gravel
6	13	Silty sand	Weakly indurated, red, little limestone. Some gravel is well rounded. The gravel is mainly gneiss.
13	16	Clayey gravel	The clay appears to be kaolin. Minor reaction to HCl.
16	19	Silty gravel	Gneiss gravel, with silt and sand
19	22	Gravel	Mainly gneiss, some dolerite. Some pieces are well rounded. Minor limestone. Weakly indurated
22	28	Silty sand	Red. Most particles are gneiss fragments; some quartz; many are subrounded.
28	31	Sandy gravel	Many pieces subrounded; gneiss and quartz, silty.
31	40	Gravel	Gneiss; angular to subrounded. (Drilling was very quick from 28 m to app. 34 m)
40	43	Sand and gravel	The gravel is gneiss, dolerite, some chert. Some gravel is coarse and well rounded.
43	45	Gravel and sand	(Much harder drilling at about 45 m)
45	49	Gneiss	Weathered
49	55.5	Gneiss	Weathered

KENMORE PARK

Kenmore Park 2001 A

From	To (m)	Rock	Description
0	7	Gneiss	Slightly weathered, abundant epidote in places, some limestone
7	9	Gneiss	Fresh, minor epidote. Fractured and weathered around 9 m, more epidote
9	25	Gneiss	Fresh, minor epidote spread throughout. Very slow drilling

Drilling terminated because the unweathered, unfractured gneiss looked quite unpromising.

Kenmore Park 2001 B

From	To (m)	Rock	Description
0	3	Gneiss	Weathered, with limestone (reaction to HCl)
3	12	Gneiss	Weathered

Drilling terminated because of saline water (field test 13 800ECU)

Kenmore Park 2001 C

From	To (m)	Rock	Description
0	7	Gneiss	Highly weathered, with limestone (reaction to HCl)
7	10	Gneiss	Weathered in places
10	19	Gneiss	A few indications of weathering
19	31	Gneiss	Mainly fresh, a few signs of weathering. Small water cut at 20 m, 0.1 L/s. Quite a bit of epidote at 25 m.

MIMILI

Mimili 2001 A

From	To (m)	Rock	Description
0	7	Calcrete and sand	With silt
7	10	?Granite	Very highly weathered
10	13	Talc	Clean, white
13	16	Talc	Possibly with silt
16	25	Talc	Clean, white (damp from 19 m)
25	31	Talc	?Gritty, ?clayey. Very light grey
31	36	Clay	Possibly with talc
36	38	Granite/gneiss	Weathered; with quartzite.
38	43	Granite/gneiss	Little weathering. (Small water cut 40–43 m, ?0.02 L/s)
43	49.5	Gneiss	Some weathering apparent in places. The drill indicated a fractured area around 44 m. (Total WC ?0.03 L/s)

Drilling abandoned because of lack of water cuts, even in the apparently promising fractured area at 44 m.

Mimili 2001 B

From	To (m)	Rock	Description
0	7	Alluvium	Weathered gneiss sand and fine gravel. Many particles are rounded. Some limestone. Red
7	13	Alluvium	as above, but olive brown. (Damp from 8 m)
13	19	Gneiss	Highly weathered, little rounding. Olive brown. (Becoming harder drilling around 16 m). (Water cut about 17 m, 0.25 L/s app.)
19	25.5	Gneiss	Mainly fresh, weathering showing in places, epidote in places. Slow drilling.

Drilling abandoned because of relatively saline water (3560 ECU, checked with two conductivity meters).

2 ANALYSIS OF WATER SAMPLES FROM NEW WELLS AT KALKA AND AMATA

AUSTRALIAN WATER QUALITY CENTRE

ANALYTICAL REPORT

23-JUL-2001

5145-109
AMATA 2001 A

Report No : R036706
Account : 108874 DEPT FOR WATER RESOURCES - AWQC 187
Project : 1088740080 NORTH WEST PITLANDS - C170208
Job ID : 1075955 AMATA
Sample Point : 1191
Date Sampled : 18-MAY-2001 14:40

Analysis	Component name	Result	Unit
Other Tests			
[203-01]	Carbonate hardness as CACO3	316	mg/L
[204-01]	Noncarbonate hardness as CACO3	122	mg/L
[205-01]	Calcium hardness as CACO3	207	mg/L
[206-01]	Magnesium hardness as CACO3	231	mg/L
[208-01]	Total chlorides as NACL	305	mg/L
General Data			
[10-01]	pH	7.6	pH UNITS
[116-02]	Dissolved Organic Carbon	0.6	mg/L
[15-01]	Total dissolved solids (by EC)	680	mg/L
[158-05]	Total Organic Carbon	0.5	mg/L
[16-01]	Conductivity	1240	uS/cm
[160-01]	Suspended Solids	< 1	mg/L
[211-01]	Dissolved solids by calculation	696	mg/L
Physical Characteristics			
[18-01]	Turbidity	0.10	NTU
Cations			
[520-01]	Calcium	83.0	mg/L
[555-01]	Magnesium	56.1	mg/L
[580-01]	Potassium	1.3	mg/L
[600-01]	Sodium	99.8	mg/L
Anions			
[102-01]	Bicarbonate	386	mg/L
[104-02]	Chloride	185	mg/L
[105-01]	Fluoride	0.65	mg/L
[110-31]	Sulphate	81.4	mg/L
Nutrients			
[100-01]	Ammonia as N	<0.005	mg/L
[108-01]	Filt Reactive Phosphorus as P	0.007	mg/L
[109-01]	Phosphorus - Total as P	0.009	mg/L
[112-01]	TKN as Nitrogen	<0.05	mg/L
[161-01]	Nitrate + Nitrite as N	4.69	mg/L
Metals			
[510-61]	Arsenic - Total	<0.001	mg/L
[511-61]	Arsenic - Soluble	<0.001	mg/L
[515-01]	Boron	0.046	mg/L
[525-61]	Cadmium - Total	<0.0005	mg/L

NOTES
1. The last figure of the result value is a significant figure.
2. Samples are analysed as received.
3. The code shown in [ ] refers to the AWQC analysis code.
4. # - determination of this component not covered by NATA Accreditation.

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5145 109

Report No : R036706

Analysis	Component name	Result	Unit
[526-61]	Cadmium - Soluble	<0.0005	mg/L
[530-61]	Chromium - Total	<0.003	mg/L
[531-61]	Chromium - Soluble	<0.003	mg/L
[540-61]	Copper - Total	0.001	mg/L
[541-61]	Copper - Soluble	0.001	mg/L
[545-01]	Iron - Total	<0.030	mg/L
[546-01]	Iron - Soluble	<0.030	mg/L
[550-61]	Lead - Total	<0.0005	mg/L
[551-61]	Lead - Soluble	<0.0005	mg/L
[560-61]	Manganese - Total	<0.0005	mg/L
[561-61]	Manganese - Soluble	<0.0005	mg/L
[565-61]	Mercury - Total	<0.0005	mg/L
[566-61]	Mercury - Soluble	<0.0005	mg/L
[575-61]	Nickel - Total	0.0006	mg/L
[576-61]	Nickel - Soluble	<0.0005	mg/L
[605-61]	Zinc - Total	0.004	mg/L
[606-61]	Zinc - Soluble	0.004	mg/L
Derived Data			
[101-01]	Alkalinity as calcium carbonate	316	mg/L
[200-01]	Langelier Index	0.46	-
[201-01]	Sodium adsorption ratio	2.08	-
[202-01]	Total hardness as CaCO3	438	mg/L
[207-01]	Free carbon dioxide	15	mg/L
[209-01]	sodium / total cations ratio	33.1	%
[210-01]	Ion balance	-1.79	%
Pesticides			
[700-01]	Aldrin	<0.05	ug/L
[700-01]	Chlorthal-Dimethyl (Dacthal)	<0.05	ug/L
[700-01]	Dieldrin	<0.05	ug/L
[700-01]	Endosulfan 1	<0.05	ug/L
[700-01]	Endosulfan 2	<0.05	ug/L
[700-01]	Chlorothalonil	<0.05	ug/L
[700-01]	Chlorpyrifos	<0.05	ug/L
[700-01]	4,4-DDD (TDE)	<0.05	ug/L
[700-01]	4,4-DDE	<0.05	ug/L
[700-01]	4,4-DDT	<0.05	ug/L
[800-01]	Simazine	<0.5	ug/L
[700-01]	Endosulfan Sulphate	<0.05	ug/L
[800-01]	Atrazine	<0.5	ug/L
[700-01]	Lindane	<0.05	ug/L
[800-01]	Azinphos-Methyl	<0.5	ug/L
[700-01]	Heptachlor	<0.05	ug/L
[800-01]	Diazinon	<0.5	ug/L
[700-01]	Heptachlor Epoxide	<0.05	ug/L

5145 109

Report No : R036706

Analysis	Component name	Result	Unit
[800-01]	Fenitrothion	<0.5	ug/L
[700-01]	Trifluralin	<0.10	ug/L
[800-01]	Hexazinone	<0.5	ug/L
[700-01]	Chlordane-a	<0.05	ug/L
[800-01]	Malathion	<0.5	ug/L
[700-01]	Chlordane-g	<0.05	ug/L
[800-01]	Parathion	<0.5	ug/L
[700-01]	Endrin	<0.05	ug/L
[800-01]	Parathion-Methyl	<0.3	ug/L
[700-01]	Methoxychlor	<0.05	ug/L
[800-01]	Prometryne	<0.5	ug/L
[700-01]	Vinclozolin	<0.05	ug/L

Comments:

Job :1075955 Analysis :158-05
DOC>TOC but within experimental error

5145 109

AUSTRALIAN WATER QUALITY CENTRE

4745-136
KALKA 2001 B

ANALYTICAL REPORT

23-JUL-2001

Report No : R036706
Account : 108874 DEPT FOR WATER RESOURCES - AWQC 187
Project : 1088740080 NORTH WEST PITLANDS - C170208
Job ID : 1075956 KALKA B
Sample Point : 1191
Date Sampled : 20-MAY-2001 14:00

Analysis	Component name	Result	Unit
Other Tests			
[203-01]	Carbonate hardness as CACO3	302	mg/L
[204-01]	Noncarbonate hardness as CACO3	51	mg/L
[205-01]	Calcium hardness as CACO3	124	mg/L
[206-01]	Magnesium hardness as CACO3	229	mg/L
[208-01]	Total chlorides as NACL	125	mg/L
General Data			
[10-01]	pH	7.8	pH UNITS
[116-02]	Dissolved Organic Carbon	<0.3	mg/L
[15-01]	Total dissolved solids (by EC)	490	mg/L
[158-05]	Total Organic Carbon	0.3	mg/L
[16-01]	Conductivity	889	uS/cm
[160-01]	Suspended Solids	< 1	mg/L
[211-01]	Dissolved solids by calculation	459	mg/L
Physical Characteristics			
[18-01]	Turbidity	0.20	NTU
Cations			
[520-01]	Calcium	49.6	mg/L
[555-01]	Magnesium	55.7	mg/L
[580-01]	Potassium	2.1	mg/L
[600-01]	Sodium	57.5	mg/L
Anions			
[102-01]	Bicarbonate	369	mg/L
[104-02]	Chloride	76.0	mg/L
[105-01]	Fluoride	0.72	mg/L
[110-31]	Sulphate	36.5	mg/L
Nutrients			
[100-01]	Ammonia as N	0.005	mg/L
[108-01]	Filt Reactive Phosphorus as P	0.008	mg/L
[109-01]	Phosphorus - Total as P	0.009	mg/L
[112-01]	TKN as Nitrogen	<0.05	mg/L
[161-01]	Nitrate + Nitrite as N	9.47	mg/L
Metals			
[510-61]	Arsenic - Total	<0.001	mg/L
[511-61]	Arsenic - Soluble	<0.001	mg/L
[515-01]	Boron	<0.040	mg/L
[525-61]	Cadmium - Total	<0.0005	mg/L

NOTES
1. The last figure of the result value is a significant figure.
2. Samples are analysed as received.
3. The code shown in [ ] refers to the AWQC analysis code.
4. # - determination of this component not covered by NATA Accreditation.

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4745-136

Report No : R036706

Analysis	Component name	Result	Unit
[526-61]	Cadmium - Soluble	<0.0005	mg/L
[530-61]	Chromium - Total	<0.003	mg/L
[531-61]	Chromium - Soluble	<0.003	mg/L
[540-61]	Copper - Total	<0.001	mg/L
[541-61]	Copper - Soluble	<0.001	mg/L
[545-01]	Iron - Total	<0.030	mg/L
[546-01]	Iron - Soluble	<0.030	mg/L
[550-61]	Lead - Total	<0.0005	mg/L
[551-61]	Lead - Soluble	<0.0005	mg/L
[560-61]	Manganese - Total	<0.0005	mg/L
[561-61]	Manganese - Soluble	<0.0005	mg/L
[565-61]	Mercury - Total	<0.0005	mg/L
[566-61]	Mercury - Soluble	<0.0005	mg/L
[575-61]	Nickel - Total	<0.0005	mg/L
[576-61]	Nickel - Soluble	<0.0005	mg/L
[605-61]	Zinc - Total	<0.003	mg/L
[606-61]	Zinc - Soluble	<0.003	mg/L
Derived Data			
[101-01]	Alkalinity as calcium carbonate	302	mg/L
[200-01]	Langelier Index	0.43	-
[201-01]	Sodium adsorption ratio	1.33	-
[202-01]	Total hardness as CaCO3	353	mg/L
[207-01]	Free carbon dioxide	9	mg/L
[209-01]	sodium / total cations ratio	26.0	%
[210-01]	Ion balance	-0.29	%
Pesticides			
[700-01]	Aldrin	<0.05	ug/L
[700-01]	Chlorthal-Dimethyl (Dacthal)	<0.05	ug/L
[700-01]	Dieldrin	<0.05	ug/L
[700-01]	Endosulfan 1	<0.05	ug/L
[700-01]	Endosulfan 2	<0.05	ug/L
[700-01]	Chlorothalonil	<0.05	ug/L
[700-01]	Chlorpyrifos	<0.05	ug/L
[700-01]	4,4-DDD (TDE)	<0.05	ug/L
[700-01]	4,4-DDE	<0.05	ug/L
[700-01]	4,4-DDT	<0.05	ug/L
[800-01]	Simazine	<0.5	ug/L
[700-01]	Endosulfan Sulphate	<0.05	ug/L
[800-01]	Atrazine	<0.5	ug/L
[700-01]	Lindane	<0.05	ug/L
[800-01]	Azinphos-Methyl	<0.5	ug/L
[700-01]	Heptachlor	<0.05	ug/L
[800-01]	Diazinon	<0.5	ug/L
[700-01]	Heptachlor Epoxide	<0.05	ug/L

4745-136

23-JUL-2001

Report No : R036706

Analysis	Component name	Result	Unit
[800-01]	Fenitrothion	<0.5	ug/L
[700-01]	Trifluralin	<0.10	ug/L
[800-01]	Hexazinone	<0.5	ug/L
[700-01]	Chlordane-a	<0.05	ug/L
[800-01]	Malathion	<0.5	ug/L
[700-01]	Chlordane-g	<0.05	ug/L
[800-01]	Parathion	<0.5	ug/L
[700-01]	Endrin	<0.05	ug/L
[800-01]	Parathion-Methyl	<0.3	ug/L
[700-01]	Methoxychlor	<0.05	ug/L
[800-01]	Prometryne	<0.5	ug/L
[700-01]	Vinclozolin	<0.05	ug/L

4745-136

AUSTRALIAN WATER QUALITY CENTRE

ANALYTICAL REPORT

23-JUL-2001

KALKA 2001 C
4745-137

Report No : R036706
Account : 108874 DEPT FOR WATER RESOURCES - AWQC 187
Project : 1088740080 NORTH WEST PITLANDS - C170208
Job ID : 1075957 KALKA C
Sample Point : 1191
Date Sampled : 21-MAY-2001 18:20

Analysis	Component name	Result	Unit
Other Tests			
[203-01]	Carbonate hardness as CACO3	259	mg/L
[204-01]	Noncarbonate hardness as CACO3	72	mg/L
[205-01]	Calcium hardness as CACO3	99	mg/L
[206-01]	Magnesium hardness as CACO3	232	mg/L
[208-01]	Total chlorides as NACL	148	mg/L
General Data			
[10-01]	pH	8.0	pH UNITS
[116-02]	Dissolved Organic Carbon	<0.3	mg/L
[15-01]	Total dissolved solids (by EC)	480	mg/L
[158-05]	Total Organic Carbon	<0.3	mg/L
[16-01]	Conductivity	876	uS/cm
[160-01]	Suspended Solids	< 1	mg/L
[211-01]	Dissolved solids by calculation	449	mg/L
Physical Characteristics			
[18-01]	Turbidity	0.10	NTU
Cations			
[520-01]	Calcium	39.7	mg/L
[555-01]	Magnesium	56.3	mg/L
[580-01]	Potassium	2.2	mg/L
[600-01]	Sodium	61.9	mg/L
Anions			
[102-01]	Bicarbonate	316	mg/L
[104-02]	Chloride	90.0	mg/L
[105-01]	Fluoride	0.79	mg/L
[110-31]	Sulphate	43.6	mg/L
Nutrients			
[100-01]	Ammonia as N	0.006	mg/L
[108-01]	Filt Reactive Phosphorus as P	0.009	mg/L
[109-01]	Phosphorus - Total as P	0.011	mg/L
[112-01]	TKN as Nitrogen	<0.05	mg/L
[161-01]	Nitrate + Nitrite as N	8.35	mg/L
Metals			
[510-61]	Arsenic - Total	<0.001	mg/L
[511-61]	Arsenic - Soluble	<0.001	mg/L
[515-01]	Boron	0.043	mg/L
[525-61]	Cadmium - Total	<0.0005	mg/L

NOTES
1. The last figure of the result value is a significant figure.
2. Samples are analysed as received.
3. The code shown in [ ] refers to the AWQC analysis code.
4. # - determination of this component not covered by NATA Accreditation.

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A BUSINESS UNIT OF THE SOUTH AUSTRALIAN WATER CORPORATION

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Analysis	Component name	Result	Unit
[526-61]	Cadmium - Soluble	<0.0005	mg/L
[530-61]	Chromium - Total	0.005	mg/L
[531-61]	Chromium - Soluble	0.004	mg/L
[540-61]	Copper - Total	0.001	mg/L
[541-61]	Copper - Soluble	<0.001	mg/L
[545-01]	Iron - Total	<0.030	mg/L
[546-01]	Iron - Soluble	<0.030	mg/L
[550-61]	Lead - Total	<0.0005	mg/L
[551-61]	Lead - Soluble	<0.0005	mg/L
[560-61]	Manganese - Total	<0.0005	mg/L
[561-61]	Manganese - Soluble	<0.0005	mg/L
[565-61]	Mercury - Total	<0.0005	mg/L
[566-61]	Mercury - Soluble	<0.0005	mg/L
[575-61]	Nickel - Total	<0.0005	mg/L
[576-61]	Nickel - Soluble	<0.0005	mg/L
[605-61]	Zinc - Total	<0.003	mg/L
[606-61]	Zinc - Soluble	<0.003	mg/L
Derived Data			
[101-01]	Alkalinity as calcium carbonate	259	mg/L
[200-01]	Langelier Index	0.45	-
[201-01]	Sodium adsorption ratio	1.48	-
[202-01]	Total hardness as CaCO3	331	mg/L
[207-01]	Free carbon dioxide	5	mg/L
[209-01]	sodium / total cations ratio	28.8	%
[210-01]	Ion balance	0.50	%
Pesticides			
[700-01]	Aldrin	<0.05	ug/L
[700-01]	Chlorthal-Dimethyl (Dacthal)	<0.05	ug/L
[700-01]	Dieldrin	<0.05	ug/L
[700-01]	Endosulfan 1	<0.05	ug/L
[700-01]	Endosulfan 2	<0.05	ug/L
[700-01]	Chlorothalonil	<0.05	ug/L
[700-01]	Chlorpyrifos	<0.05	ug/L
[700-01]	4,4-DDD (TDE)	<0.05	ug/L
[700-01]	4,4-DDE	<0.05	ug/L
[700-01]	4,4-DDT	<0.05	ug/L
[800-01]	Simazine	<0.5	ug/L
[700-01]	Endosulfan Sulphate	<0.05	ug/L
[800-01]	Atrazine	<0.5	ug/L
[700-01]	Lindane	<0.05	ug/L
[800-01]	Azinphos-Methyl	<0.5	ug/L
[700-01]	Heptachlor	<0.05	ug/L
[800-01]	Diazinon	<0.5	ug/L
[700-01]	Heptachlor Epoxide	<0.05	ug/L

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Analysis	Component name	Result	Unit
[800-01]	Fenitrothion	<0.5	ug/L
[700-01]	Trifluralin	<0.10	ug/L
[800-01]	Hexazinone	<0.5	ug/L
[700-01]	Chlordane-a	<0.05	ug/L
[800-01]	Malathion	<0.5	ug/L
[700-01]	Chlordane-g	<0.05	ug/L
[800-01]	Parathion	<0.5	ug/L
[700-01]	Endrin	<0.05	ug/L
[800-01]	Parathion-Methyl	<0.3	ug/L
[700-01]	Methoxychlor	<0.05	ug/L
[800-01]	Prometryne	<0.5	ug/L
[700-01]	Vinclozolin	<0.05	ug/L

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