Tatiara groundwater monitoring review

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by

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PRIMARY INDUSTRIES AND RESOURCES SOUTH AUSTRALIA

REPORT BOOK 2000/00035

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TATIARA GROUNDWATER MONITORING REVIEW

George MacKenzie

Groundwater monitoring commenced in 1975 to provide the basis for assessment of water level and salinity trends thereby providing the necessary information for the development of appropriate management strategies to ensure the sustainability of the groundwater resources throughout the Tatiara Prescribed Wells Area.

The depth to groundwater varies from 1 metre in the western portion of the area to 65 metres near the State border with seasonal fluctuations from 0.2 to 2 metres. Salinities range from approximately 8500 mg/L decreasing in an easterly direction to 1000 mg/L.

In some areas, it is evident that large groundwater withdrawals for irrigation are contributing to a long term decline in groundwater levels of up to 14 centimetres per year.

Increases in salinity ranging from less than 5 to 200 mg/L per year are attributed to continuous leaching of salts from the unsaturated zone into the water table by either recycling of irrigation water or increased vertical recharge fluxes.

The clearance of native vegetation and the loss of high water use pastures (during the 1970s) is causing groundwater levels to rise up to 10 centimetres per year in some areas.

BACKGROUND

The Tatiara Prescribed Wells Area was proclaimed in 1984 and its area was further extended in 1986 following the interstate agreement to manage groundwater resources along the SA-VIC border. The area is divided into 7 management sub-areas (Fig. 1) including all of Zone 8A and portions of Zone 7A and 9A within the Groundwater Border Agreement Act 1985.

Groundwater monitoring commenced in 1975 and provides the basis for assessment of water level and salinity trends due to the impact of groundwater extraction for irrigation and other purposes, and the impact of changing land uses such as native vegetation clearance. Observed data are also used to evaluate aquifer recharge rates.

The database provides the necessary information for the development of appropriate management strategies to ensure the sustainability of the groundwater resources throughout the region.

This report presents a review of groundwater level and salinity monitoring data for the Tatiara Prescribed Wells Area.

GROUNDWATER MONITORING

GROUNDWATER LEVELS

Monitoring of groundwater levels has been undertaken at various time intervals in both private and Government observation wells throughout the region. About 120 wells are currently monitored biannually and of these, approximately 40 are being monitored quarterly. The locations of the current water level observation wells are shown on Figure 2 along with the depth to water (March 1999) for each well.

Figure 4 shows the regional water table contours for March 1999 and in comparison with September 1998 contours (prior to irrigation season), mainly show an easterly migration of the 22 and 25 metre contour lines as a result of depression of the water table by the end of the irrigation season. The contours also show that groundwater flows in a general west to north-west direction.

Figure 5 displays the areas influenced by various groundwater level trends as at March 1999 and highlights the areas effected by groundwater level decline and the areas effected by rising groundwater levels, particularly in the Stirling sub-area and the southern portion of the Wirrega sub-area respectively.

Average annual groundwater level trends for each Hundred are presented in the table below and all available data is presented in Appendix 1.

Table 1 *Average annual groundwater level trends for each hundred*

Hundred	Trend (centimetres/year)	Hundred	Trend (centimetres/year)
Cannawigara	Rising by 1.7	Stirling	Declining by 6.8
Pendleton	Rising by 2.5	Tatiara	Rising by 0.7
Senior	Rising by 2.0	Willalooka	Declining by 3.1
Shaugh	Rising by 2.6	Wirrega	Rising by 2.4

GROUNDWATER SALINITY

To provide data for interpretation of salinity trends and their distribution, 37 Government observation wells are currently monitored biannually. Five of these wells are also within the Border Groundwater Agreement zones and are also sampled quarterly along with 6 private wells. Additionally, 112 privately owned wells are sampled at random throughout the irrigation season, with all but 6 of these being large yielding irrigation wells. The location of the current salinity observation wells are shown on Figure 3 along with the salinity (March 1999) for each well.

The monitoring data from each observation well have been used to assess groundwater salinity trends and distribution throughout the region. Figure 6 displays the regional salinity distribution at the end of the 1998/99 irrigation season, and for areas where observation well density is poor, the most recent salinity data were obtained from the Departmental database.

The distribution of individual well trends are displayed on Figure 7 including a contour of those areas where the trend exceeds 50 mg/L per year. All salinity data is presented in Appendix 2.

Using the salinity records for each well, a linear regression analysis of the data was applied to determine the annual salinity trend and a summary of trends for each Hundred is presented in the table below.

Table 2 *Average annual groundwater salinity trends for each hundred*

SALINITY TRENDS					
	INCREASE		NO CHANGE	DECREASE	
HUNDRED	No. of Wells	Trend (mg/L)	No. of Wells	No. of Wells	Trend (mg/L)
Cannawigara	2	+ 17	2		
Pendleton	10	+ 41			
Senior	2	+ 9	1		
Stirling	62	+ 65	3	3	- 22
Tatiara	3	+ 8	5		
Shaugh			1		
Willalooka	5	+ 25		2	- 15
Wirrega	17	+ 14	9	3	- 7

GROUNDWATER LEVEL AND SALINITY MONITORING RESULTS

The groundwater level and salinity monitoring results for each management sub-area are presented below and the major impacts observed are discussed and supported by a selection of graphs.

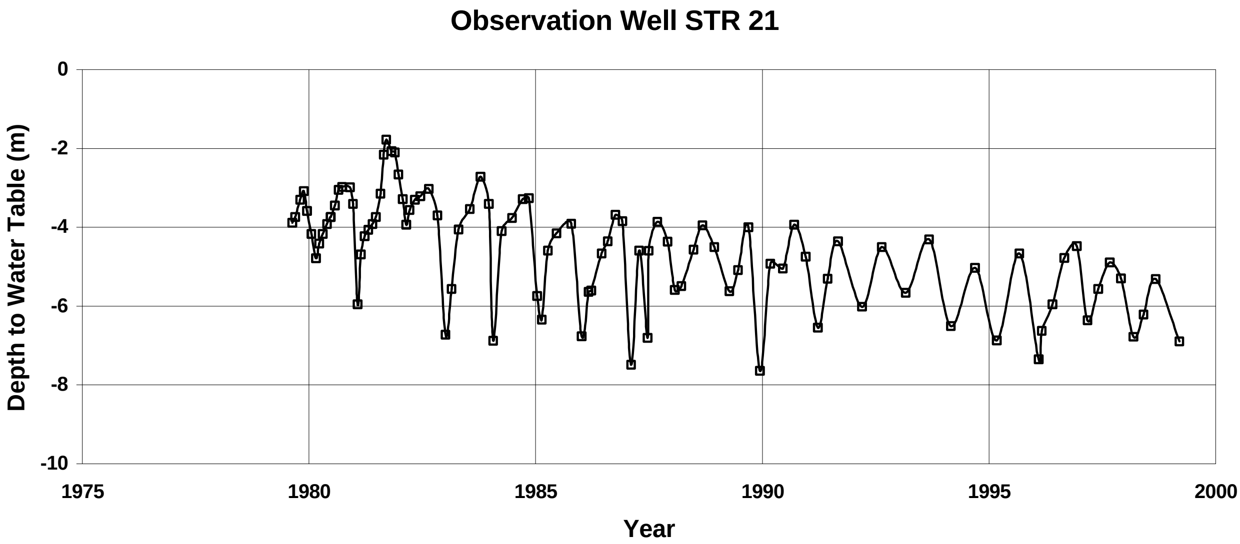
STIRLING SUB-AREA

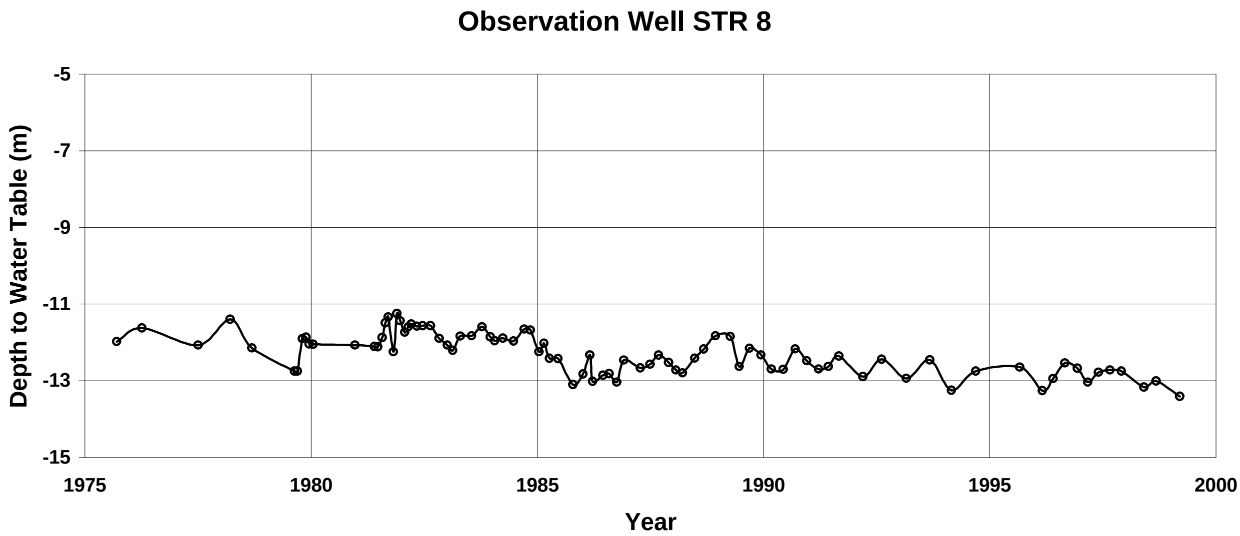
Large groundwater withdrawals within the sub-area have had a noticeable impact on both groundwater levels and salinity trends. Approximately 4200 hectares is currently utilised for flood irrigation of lucerne for seed and hay, and the high density of irrigation activity is clearly shown on Figure 8.

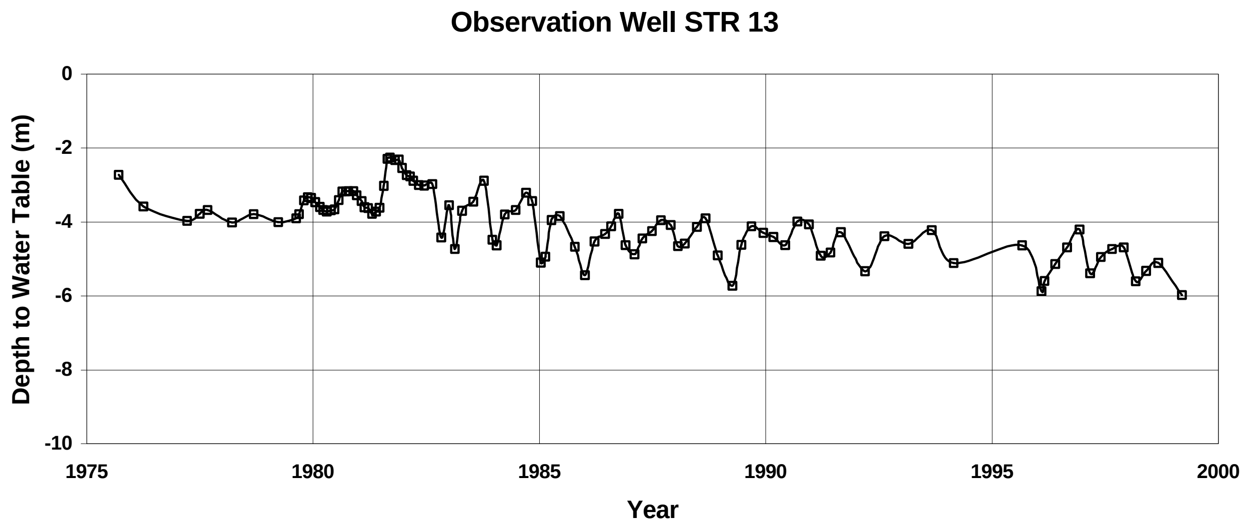
Water levels

Seasonal fluctuations up to 2 metres are evident where the depth to the water table is generally 3 to 6 metres (refer graph STR21 below) due to a combination of response to rainfall recharge and large groundwater withdrawals, particularly in the Mt Monster region where flood irrigation is most intense. In the more elevated areas north of the Dukes Highway, the depth to water increases up to 20 metres and the seasonal fluctuation ranges from 0.2 to 0.5 metres and the hydrograph below for STR8 shows this smaller seasonal fluctuation. In the areas away from the main irrigation area where the water table is generally less than 5 metres the seasonal fluctuation averages about 1 metre and reflects rapid response to rainfall recharge.

Since the early 1980s, an annual decline in groundwater levels of up to 14 centimetres per year is evident over most of the sub-area and is attributed to the large groundwater withdrawals exceeding rainfall recharge and lateral groundwater recharge. The hydrographs for observation wells STR21, 8 and 13 clearly illustrates this long term decline and Figure 5 shows the area of impact and the magnitude of this decline.


Observation Well STR 21
0
-2
-4
-6
-8
-10
Depth to Water Table (m)
1975
1980
1985
1990
1995
2000
Year


Observation Well STR 8
-5
-7
-9
-11
-13
-15
Depth to Water Table (m)
1975
1980
1985
1990
1995
2000
Year


Observation Well STR 13
0
-2
-4
-6
-8
-10
Depth to Water Table (m)
1975
1980
1985
1990
1995
2000
Year

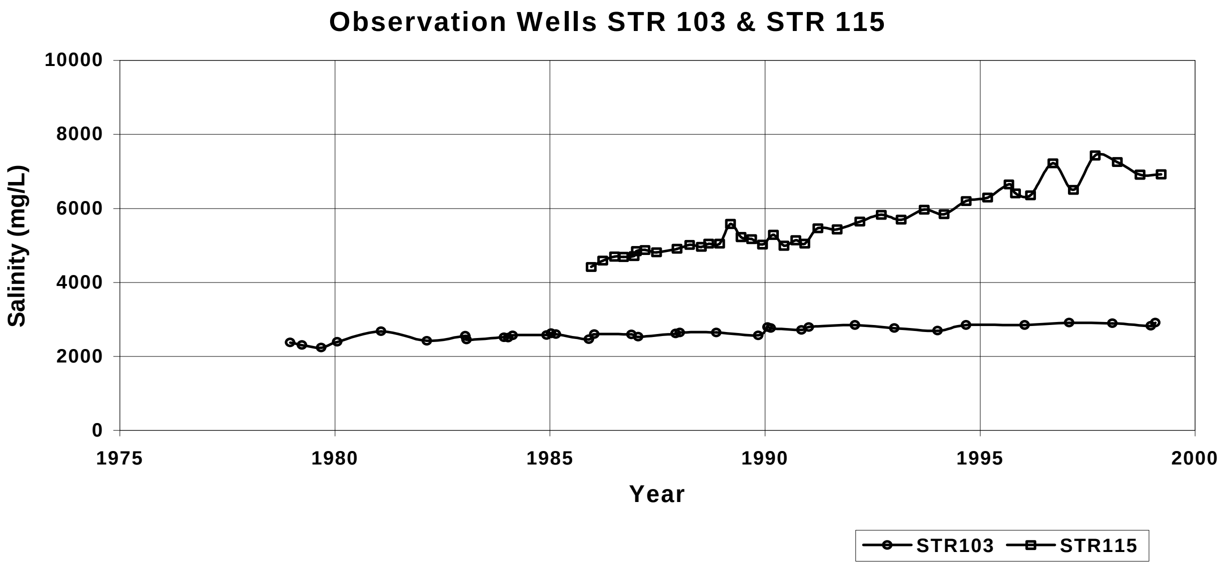
Within the densely irrigated area around Mt Monster, a cone of depression in the water table surface varying from 1 to 1.8 metres is evident toward the end of the irrigation seasons. Although it is not possible to contour a closed depression due to the spatial distribution of observation wells, the easterly migration of the 22 and 25 metre contour lines (Fig. 4) indicates a local lowering of the water table.

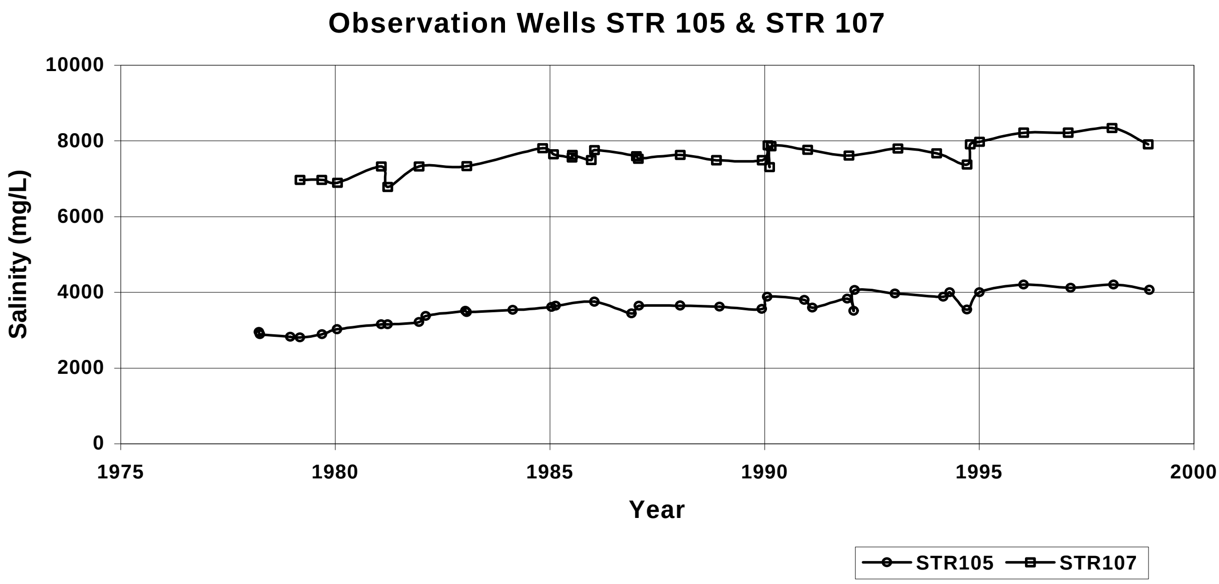
Salinity

Approximately 90% of observation wells show a salinity increase ranging from less than 5 to 200 mg/L per year, with an average increase of 65 mg/L per year. Figure 7 shows the distribution of wells where the annual salinity trend exceeds 50 mg/L.

It is evident that areas of higher salinity groundwater show a greater annual salinity increase due to the large salt load leaching from the unsaturated zone into the water table by recycling of irrigation water.

The graphs below for observation wells STR 103, 115, 105 and 107 represent the range of salinity trends over the last 22 years.



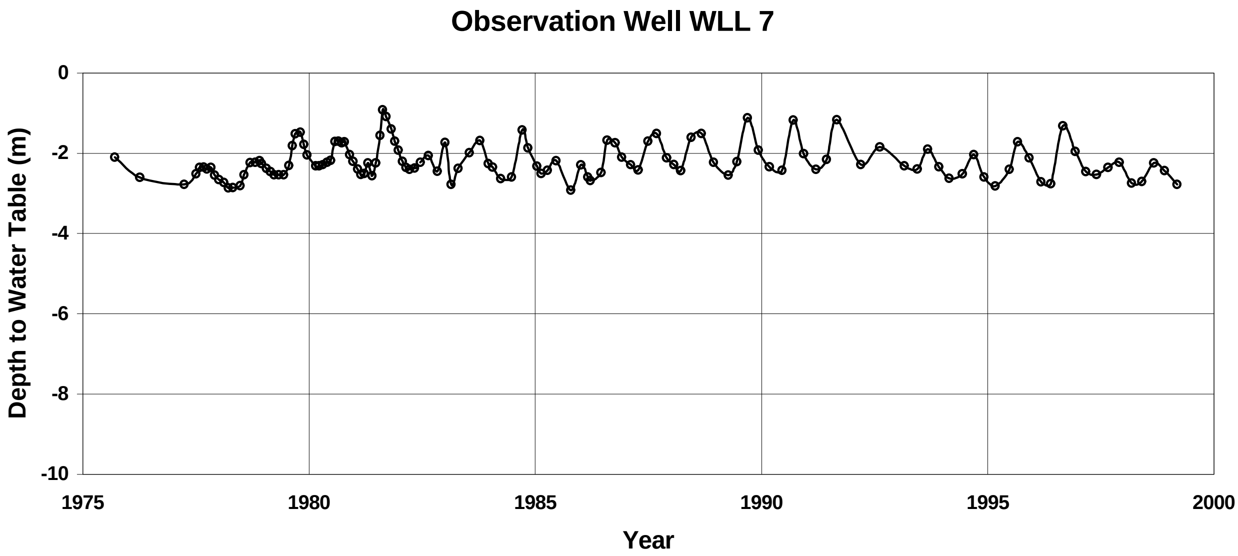


WILLALOOKA SUB-AREA

Scattered flood and centre pivot irrigation exists within this sub-area with the largest water allocations being west of the Riddoch Highway.

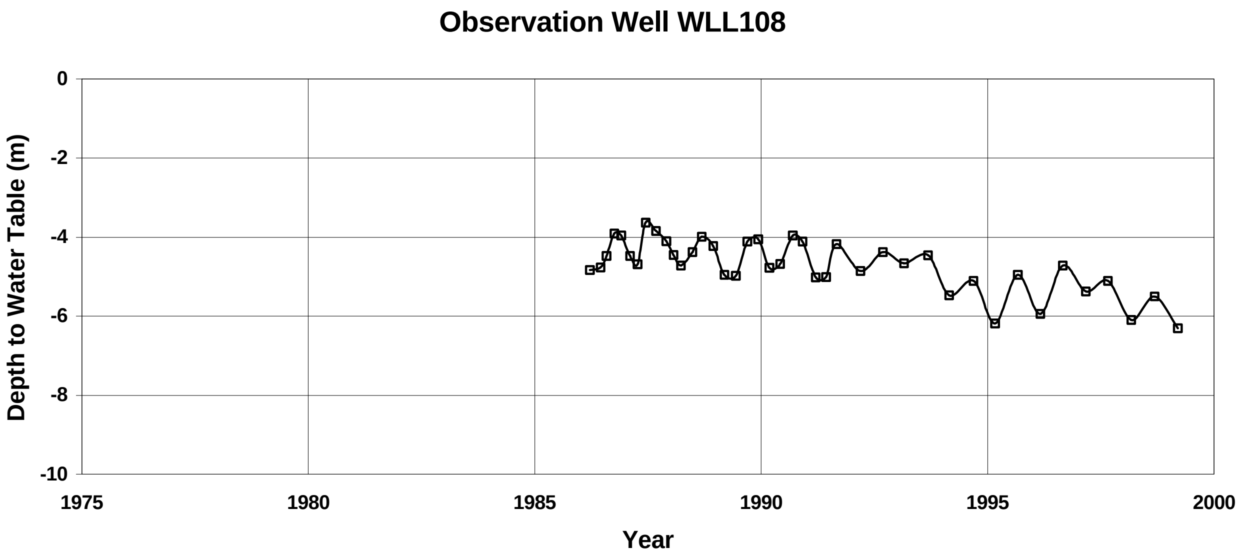
Water levels

Seasonal fluctuations of 1 to 2 metres are evident where the depth to the water table is generally less than 4 metres and the annual trend is reasonably static in areas away from irrigation activity, as illustrated by the hydrograph below for WLL007.



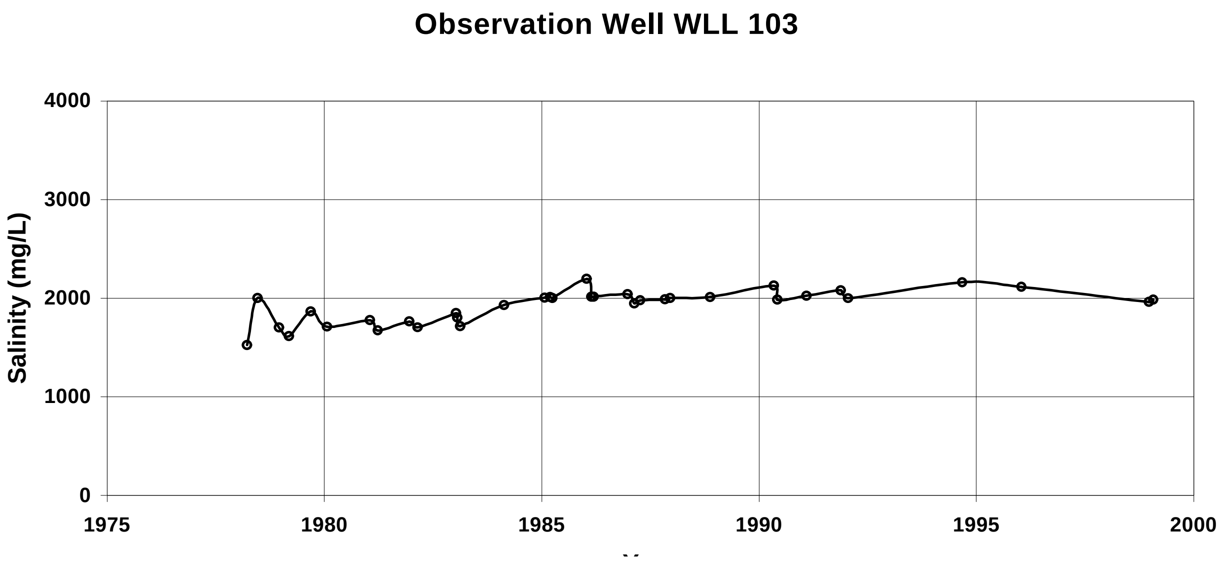
In the more elevated areas where the depth to water increases, the magnitude of seasonal fluctuation is less.

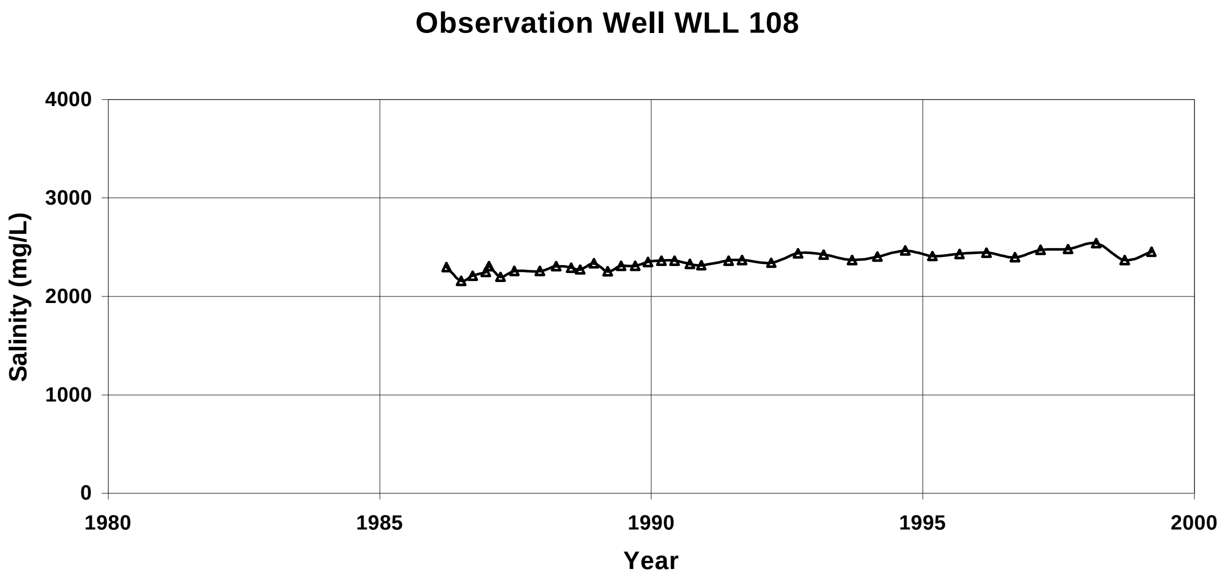
An annual decline in groundwater levels of up to 12 centimetres per year is evident over the northern part of the sub-area. This decline is directly attributed to large groundwater withdrawals for irrigation purposes both locally and the extended impact of the Stirling sub-area and to a lesser degree, the reduced rainfall recharge over recent years. The hydrograph below for observation well WLL108 illustrates this decline.



Salinity

Salinity ranges from 1900 mg/L to greater than 3000 mg/L, increasing in a north westerly direction and most irrigation wells show an increasing salinity trend with an average of 25 mg/L per year and the graphs for observation wells WLL103 and 108 illustrate this trend.





During the drilling of observation wells in the north eastern portion of the sub-area, highly saline groundwater (up to 17 000 mg/L) was encountered in a perched aquifer overlying the main aquifer which is separated from better quality groundwater by a clay layer at approximately 3 metres. After cementing the upper part of the drillholes, the salinity decreased to less than 3000 mg/L in some wells.

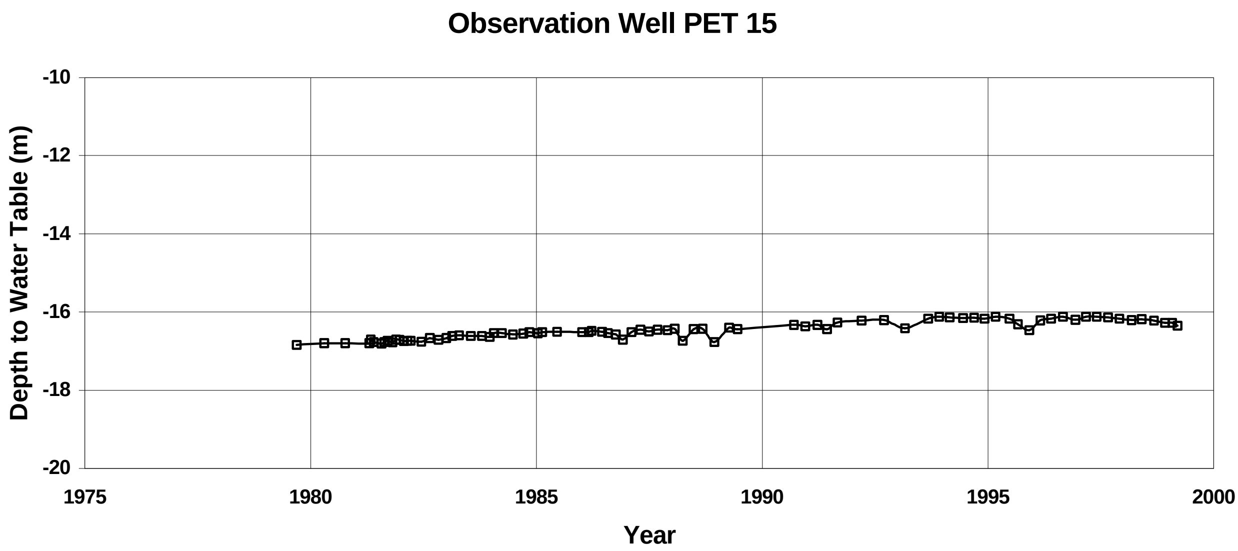
CANNAWIGARA AND NORTH PENDLETON SUB-AREAS

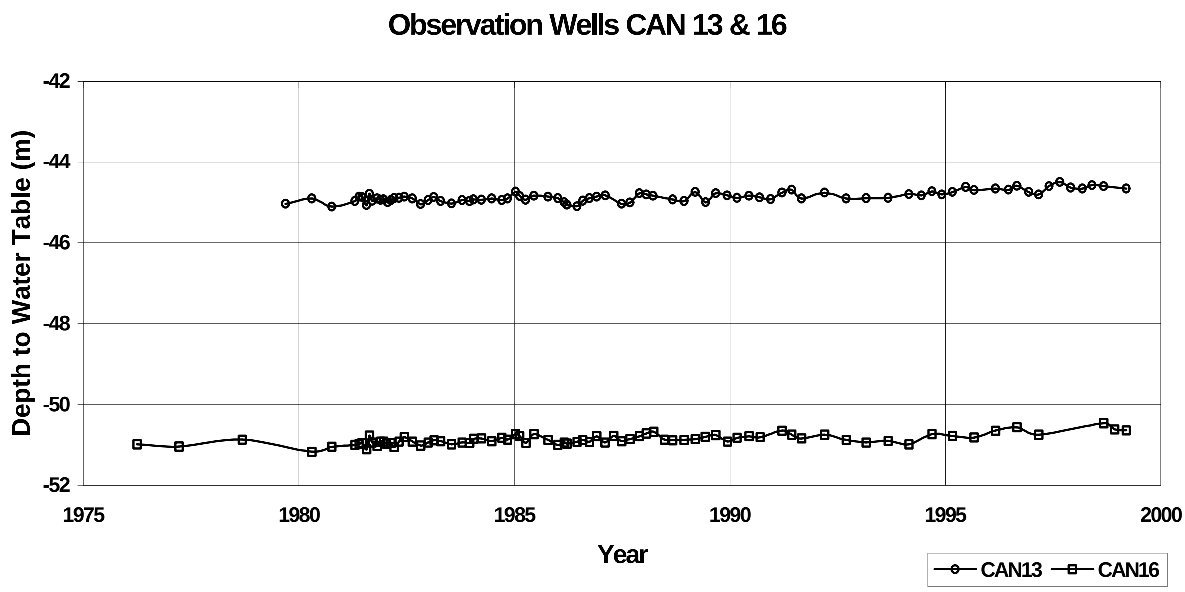
Scattered flood and centre pivot irrigation exists within these sub-areas with the most intense area being immediately north of Wirrega railway siding. The increase in water use for irrigation of lucerne and more recently olive plantations in these sub-areas may have an impact on the groundwater resources in the future.

Water levels

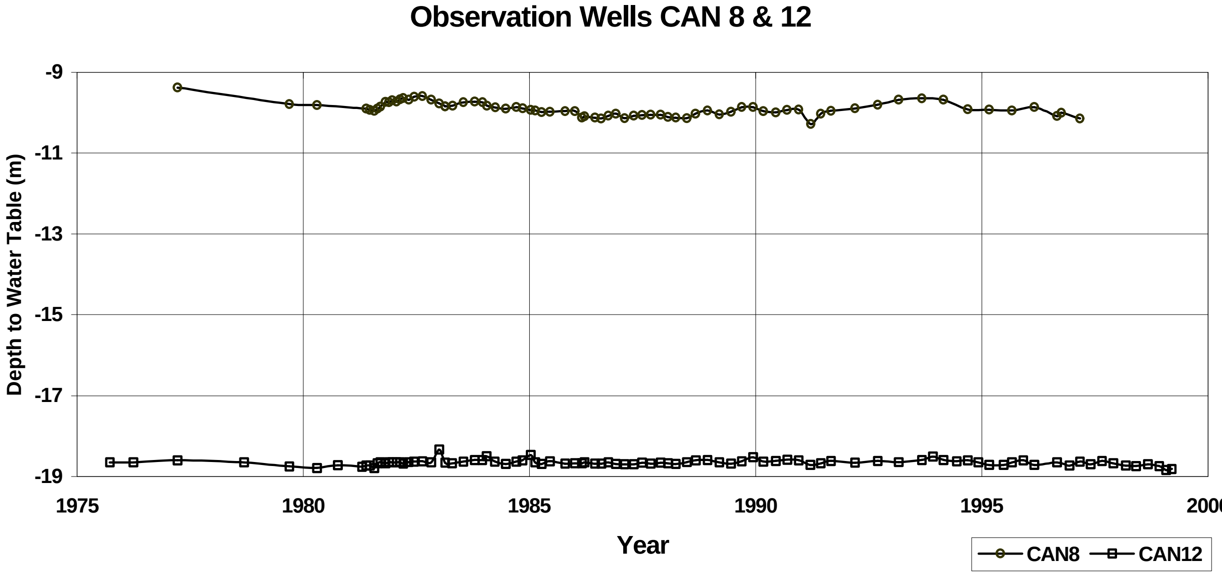
The depth to water ranges from 10 to 50 metres generally increasing in a north easterly direction with seasonal fluctuations normally being less than 0.5 metre.

The water table is rising over most of this region at an average of 2 centimetres per year which is considered to be a result of increased recharge due to the clearance of natural vegetation. The graphs for observation wells PET 15 and CAN 13 and 16 illustrate this rise.





Some landowners in proximity to the irrigation areas immediately north of Wirrega railway siding, have expressed concern that groundwater levels appear to be declining, however, no noticeable decline has been observed at this stage. The graph below for observation wells CAN 8 and 12 are representative of the water level trends in the surrounding area.

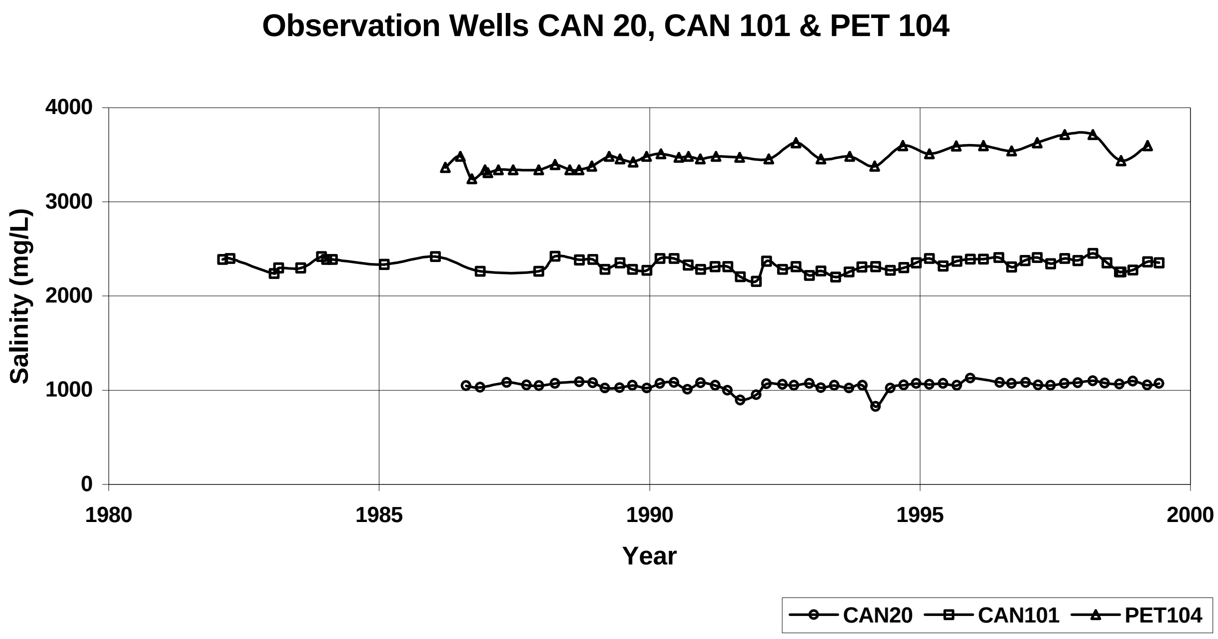


Salinity

In the south western portion of the Hundred of Pendleton, salinities exceed 5000 mg/L and increase in a westerly direction as shown on Figure 6. Throughout the remainder of the Hundred of Pendleton and western portion of the Hundred of Cannawigara, salinities range from 2000 to 5000 mg/L with increases of up to 45 mg/L per year, with the exception of the irrigated areas immediately south west of Wirrega railway siding where annual increases of up to 120 mg/L have been recorded.

In the eastern portion of Cannawigara where the salinity is generally less than 1500 mg/L, the annual increase is less than 10 mg/L.

The graph below for observation wells CAN 20, 101 and PET 104 indicates typical salinity trends which are representative for most of these sub areas over the last 15 to 20 years.



WIRREGA SUB-AREA

High utilisation of groundwater for irrigation purposes (approx. 2700 hectares) occurs throughout most of the area with the exception being the southern portion where limited use is due to the greater depth to water and the undulating range country being unsuitable for flood irrigation.

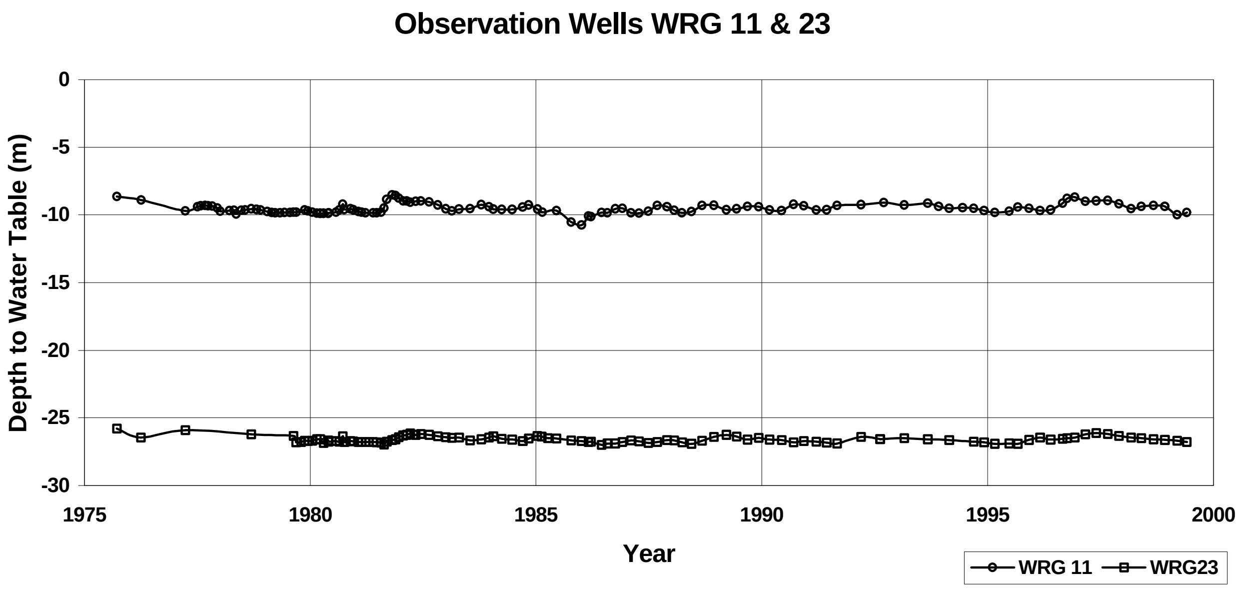
Irrigation of vineyards, potatoes, fodder crops for dairy cattle, vegetables, lucerne seed and hay using various water application methods including flood, centre pivot, lateral sprinkler and drip irrigation systems are all common throughout the sub-area.

The diversity of irrigation systems and crop types is mainly determined by soil type rather than availability of groundwater, although water quality does have some influence in local areas.

Water Levels

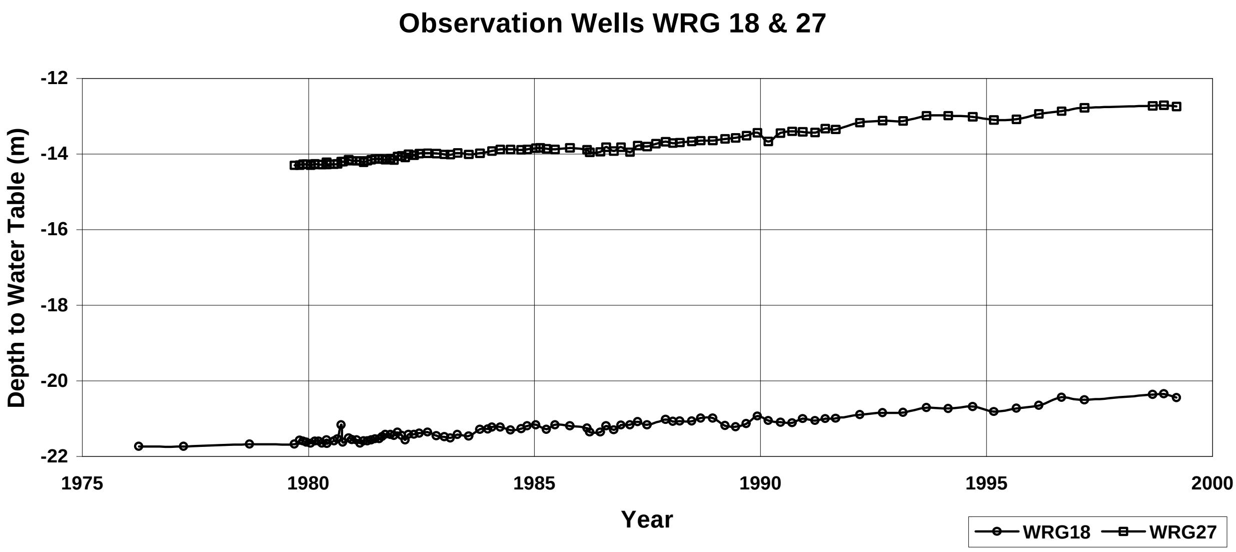
The depth to water varies from 3 metres at the western end of Cannawigara Road to a depth of 25 metres near Bordertown which is attributed to the greater topographic elevations.

Water levels trends are generally static throughout the central portion even though there is a high density of irrigation (refer to Fig. 8). Seasonal fluctuations in this area are about 0.5 metre as the hydrographs for WRG011 and WRG023 demonstrate.

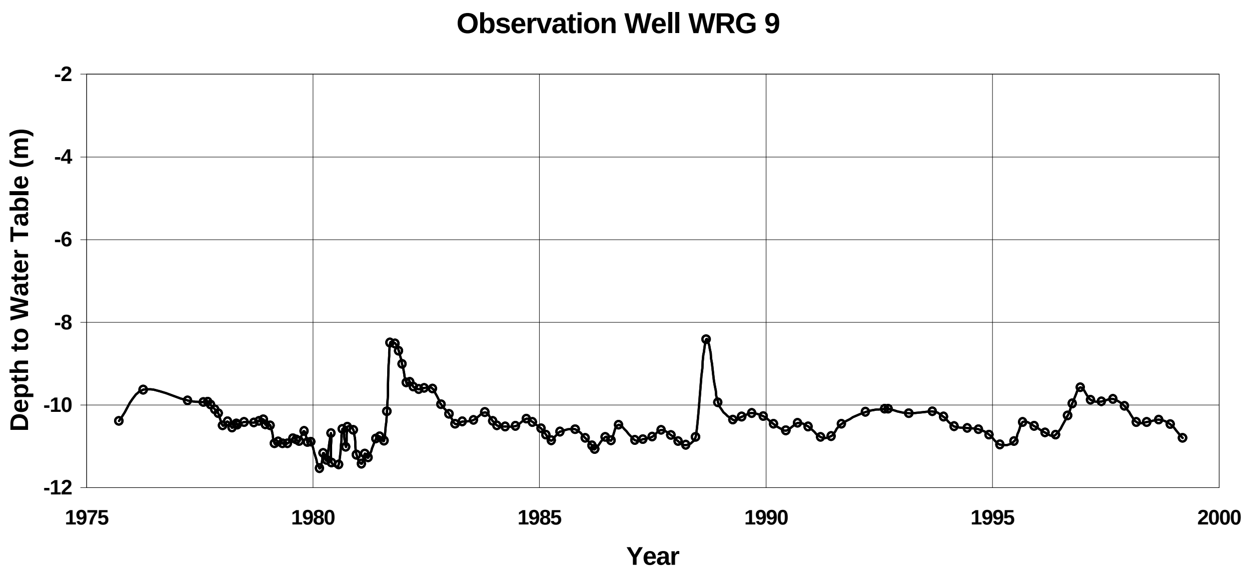


An annual decline in groundwater levels of up to 5 centimetres per year is evident in the north west part of the sub-area (refer Fig. 5). This decline is directly attributed to large groundwater withdrawals for irrigation purposes both locally and from the extended impact of the Stirling sub-area.

A long term rise in water levels of greater than 5 centimetres per year has been observed in the southern portion of the region. The area of influence is the northern end of the Padthaway Range system which extends in a southerly direction, where similar trends are being observed. This is considered to be a result of increased recharge due to the clearance of natural vegetation and the loss of high water use perennial pastures in the late 1970s. The hydrographs below for observation wells WRG18 and WRG27 clearly show this long term rise.



Some abnormal fluctuations have been observed as result of direct recharge to the water table via surface water discharge into numerous runaway holes mainly in the north eastern portion of the sub-area. The hydrograph below for observation well WRG009 illustrates the impact of localised point recharge on groundwater levels, particularly during 1981 and 1988.

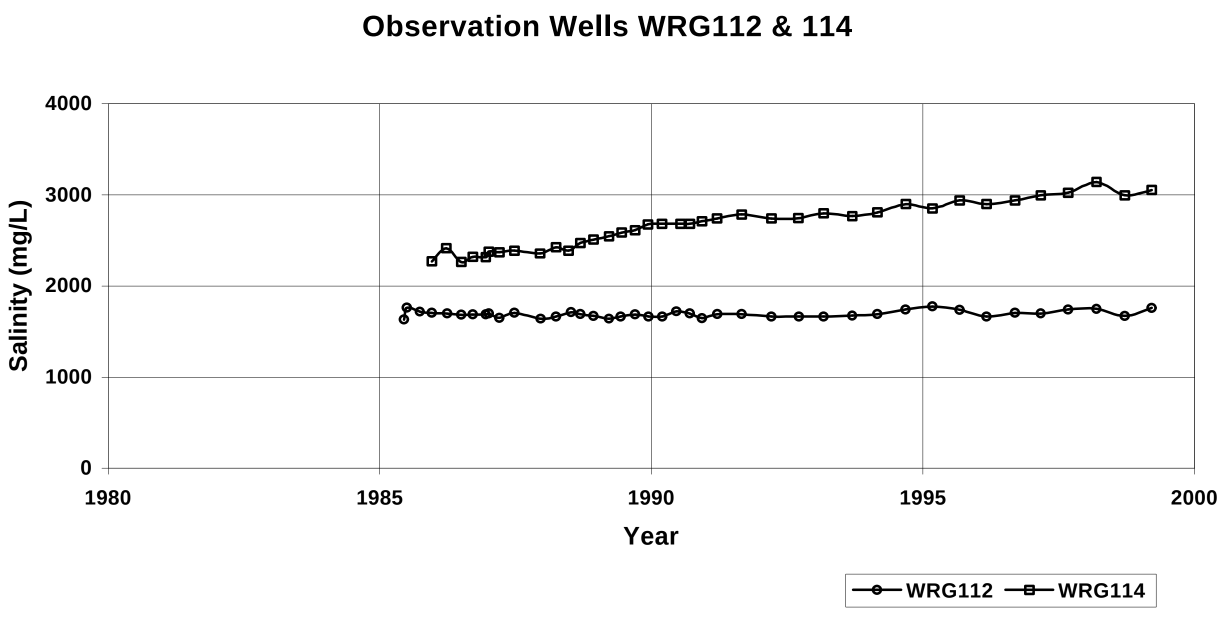


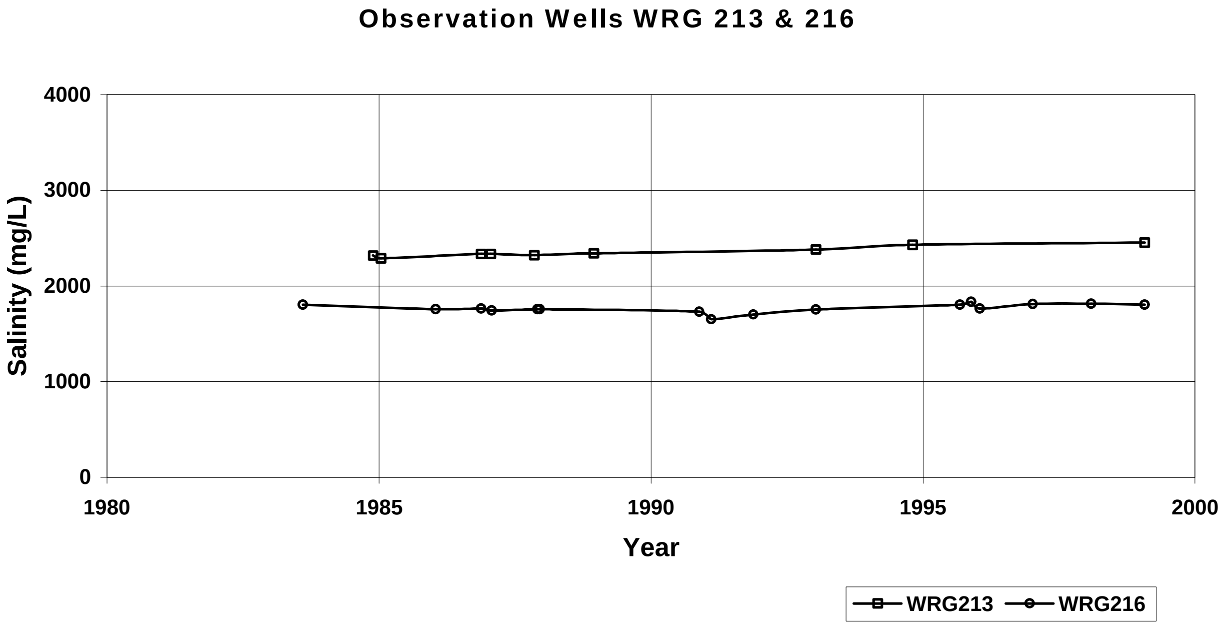
Salinity

Salinities vary from 2000 to greater than 5000 mg/L in the north western portion (refer Fig. 6) of the sub-area and over the remainder of the area salinities are generally 1200 to 2000 mg/L.

In close proximity to the numerous runaway holes (eg. Poocher Swamp) in the north east portion of the Wirrega sub-area, salinities can be as low as 350 mg/L as a result of direct recharge to the water table from rainfall run-off. Seasonal salinity changes in these areas have not been monitored.

About 60 % of the observation wells throughout the sub-area indicate a salinity increase averaging 14 mg/L per year and the remainder show no significant change or a slight decrease. Graphs for observation wells WRG 112, 114, 213 and 216 represent these trends.





ZONE 8A AND PART ZONE 9A SUB-AREAS

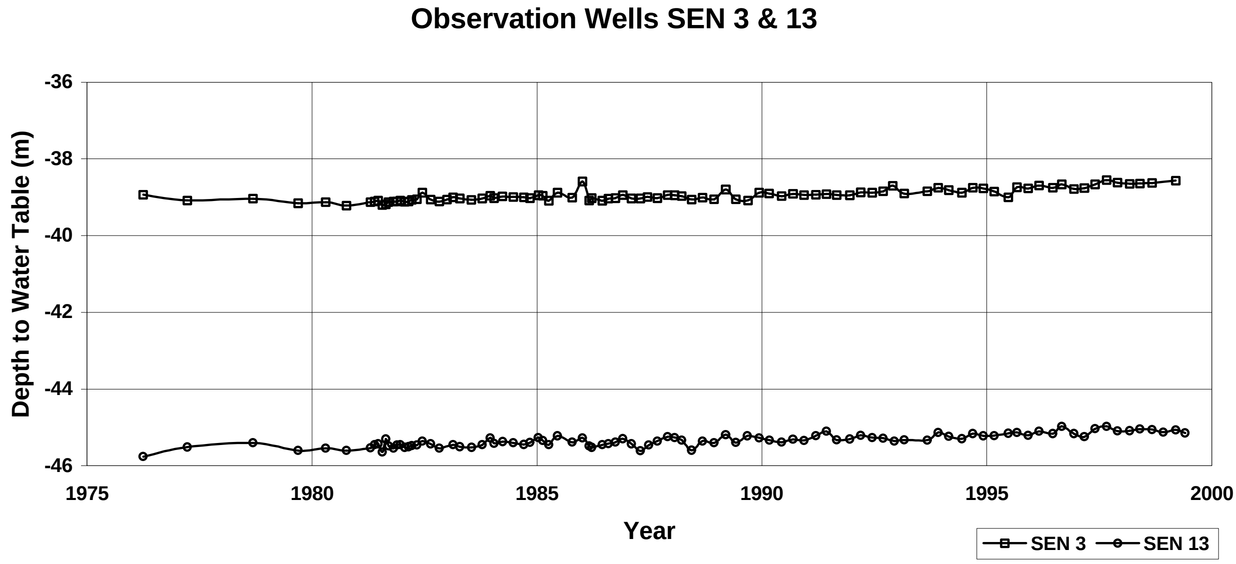
Currently there is very little use of groundwater for irrigation purposes in these sub-areas even though low salinity groundwater is available. This is attributed to the depth to groundwater and the subsequent high cost of withdrawal, combined with the soil types being mainly suited to centre pivot or drip irrigation systems.

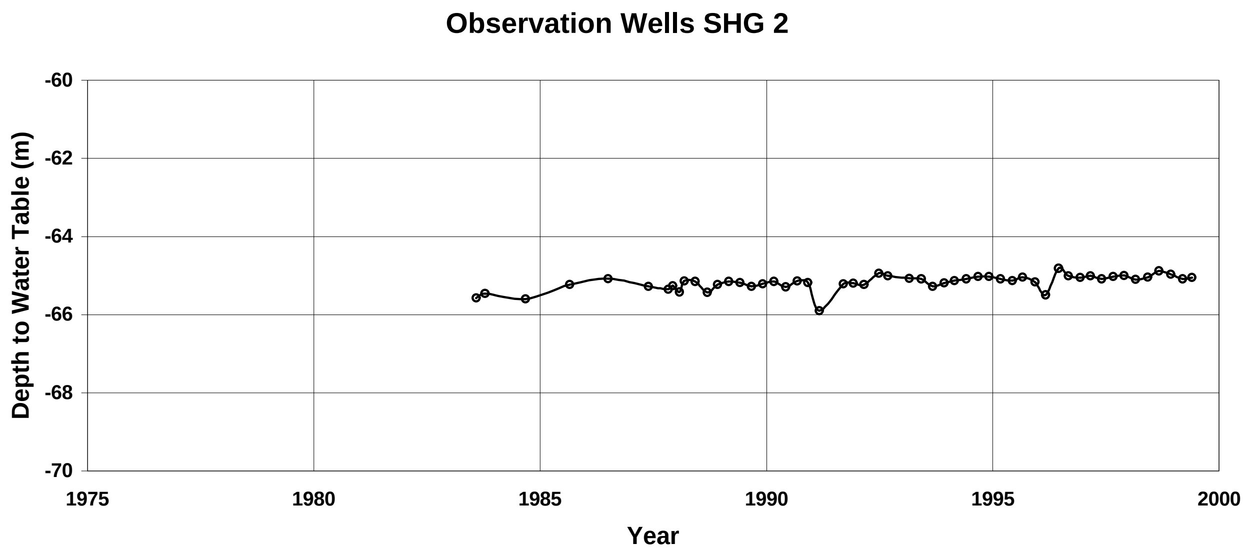
Increased water use for irrigation of potatoes and olives in the last two years may have some influence on the groundwater resources in the future.

Water levels

The seasonal fluctuations are generally less than 0.3 metre which is due to the greater depth to water table (up to 65 metres) and the subsequent lower recharge rates.

The water table is rising over most of this region with some wells showing an annual rise of 2.5 centimetres per year which is considered to be a result of increased recharge due to the clearance of natural vegetation. The hydrographs for SEN 3 and 13 and SHG 2 illustrate this long term rise.

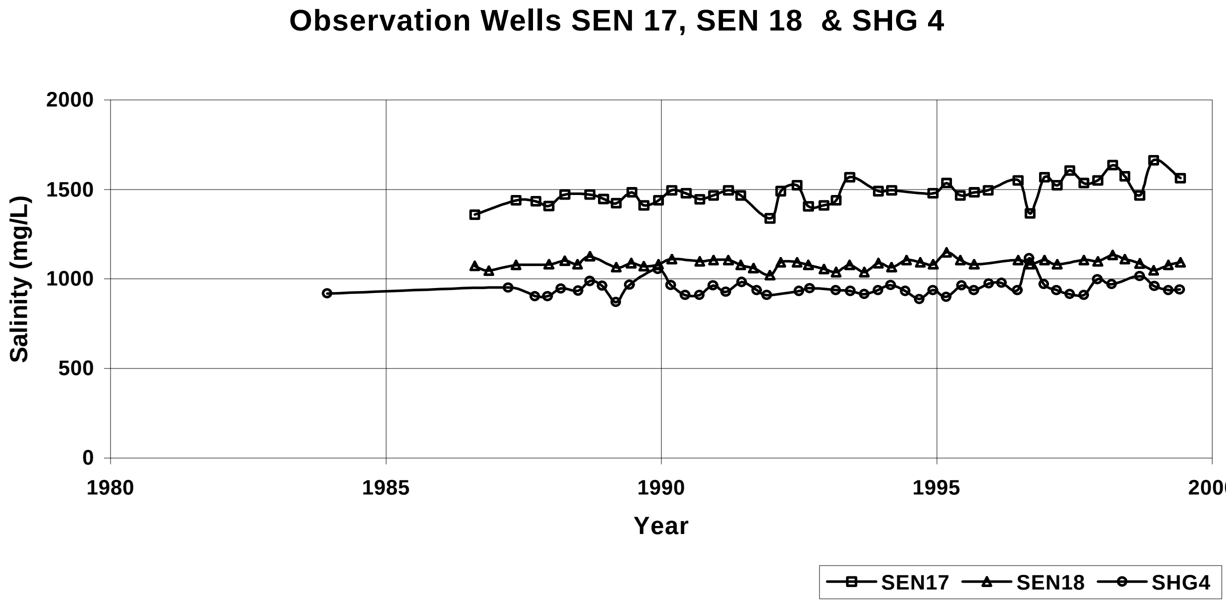




Salinity

The salinity ranges from 900 to 1500 mg/L throughout these sub-areas and decreases in a northerly direction.

Salinity trends from the limited number of observation wells in these sub-areas, vary from no significant change up to an increase of 12 mg/L per year. The graph below for observation wells SEN 17, 18 and SHG 4 indicates the ranges of salinity and trends being observed.

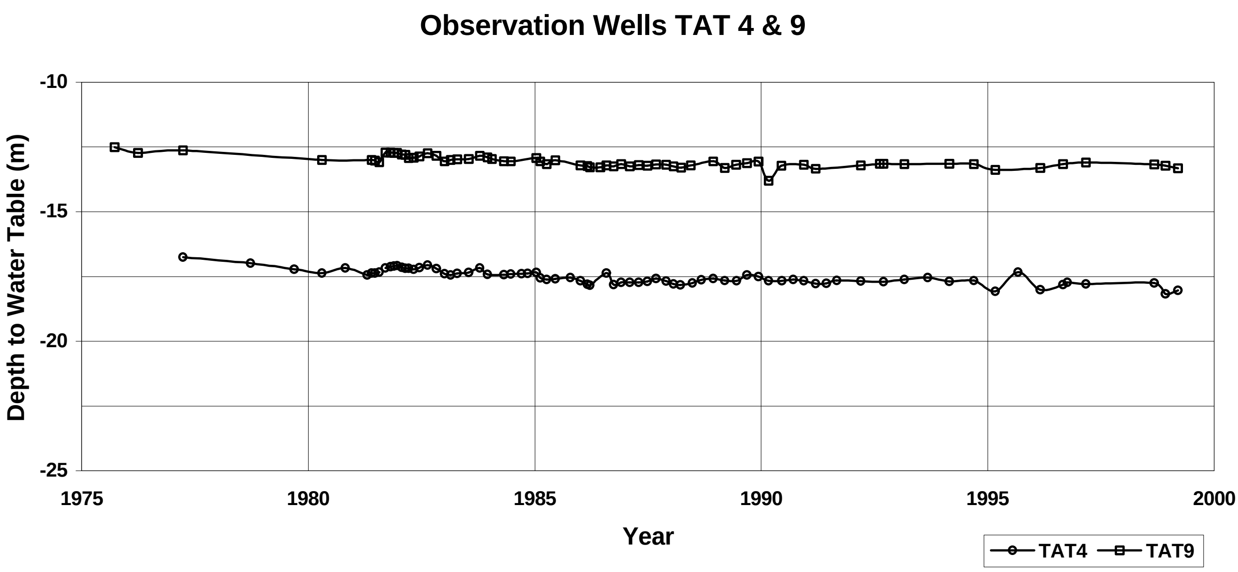


PART ZONE 7A SUB-AREA

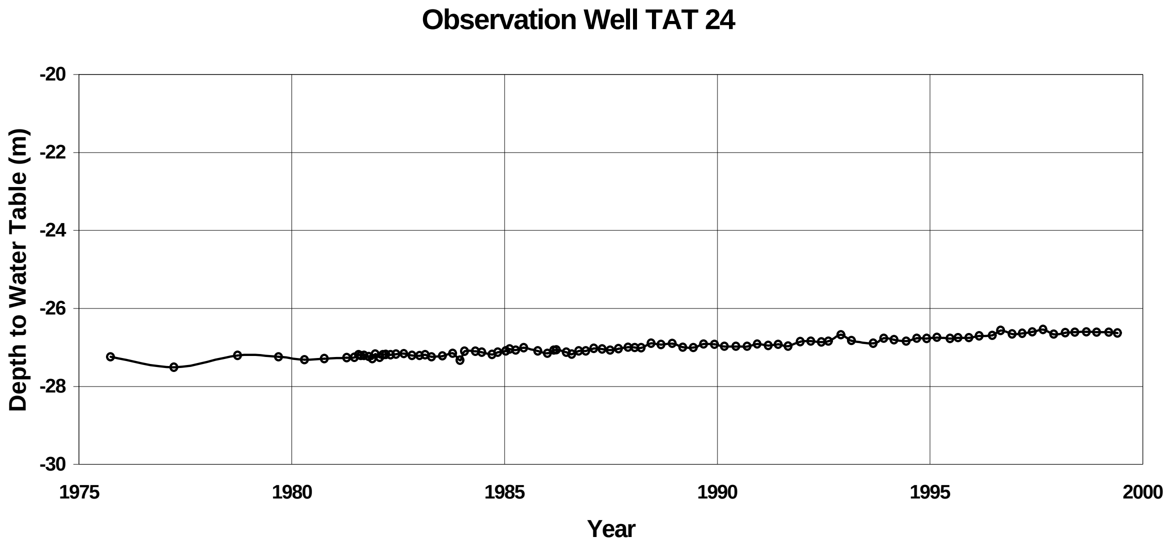
The main area of groundwater use extends along the western boundary of the sub-area. Good quality water (less than 1200 mg/L) is available over much of the eastern portion but is under utilised. This is attributed to the depth to water and the subsequent high cost of withdrawal combined with the soil types being mainly suited to centre pivot applications.

Water levels

A small decline in water levels is evident in the Pigeon Flat area (south west of Bordertown) and the reason for this has not been identified. The hydrographs below for TAT004 and TAT009 show this long term decline.

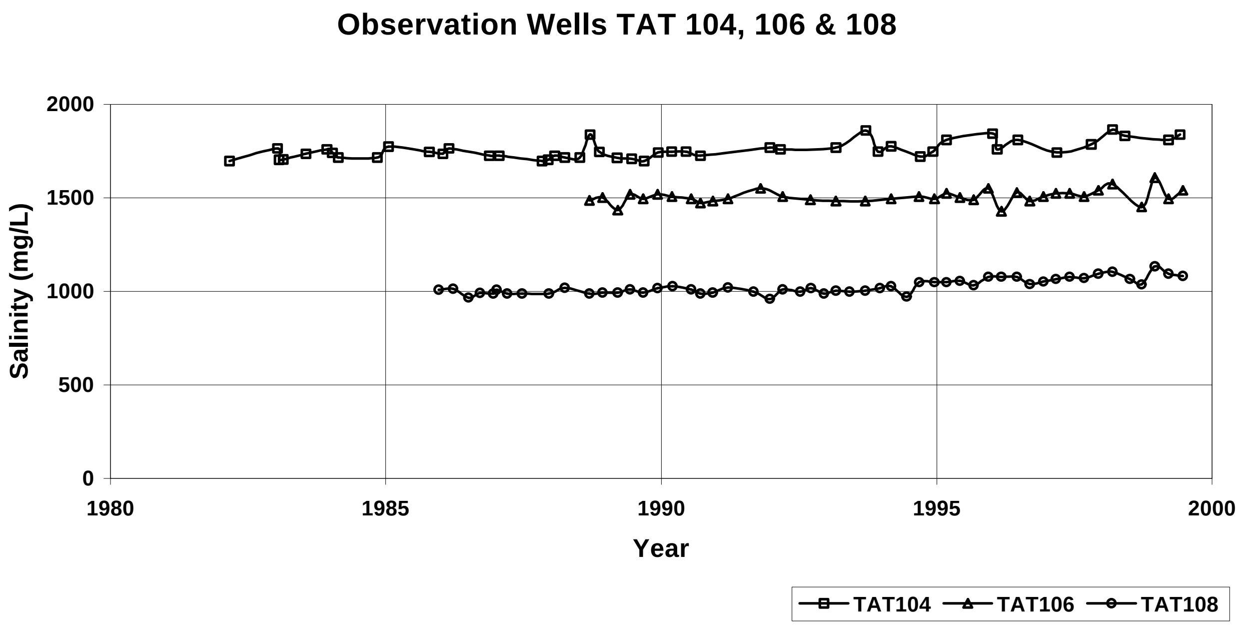


A long term rise in water levels ranging from 1 to 4 centimetres per year has been observed over much of the remainder of the sub-area. This is considered to be a result of increased recharge due to the clearance of natural vegetation and the hydrograph for TAT024 shows this effect.



Salinity

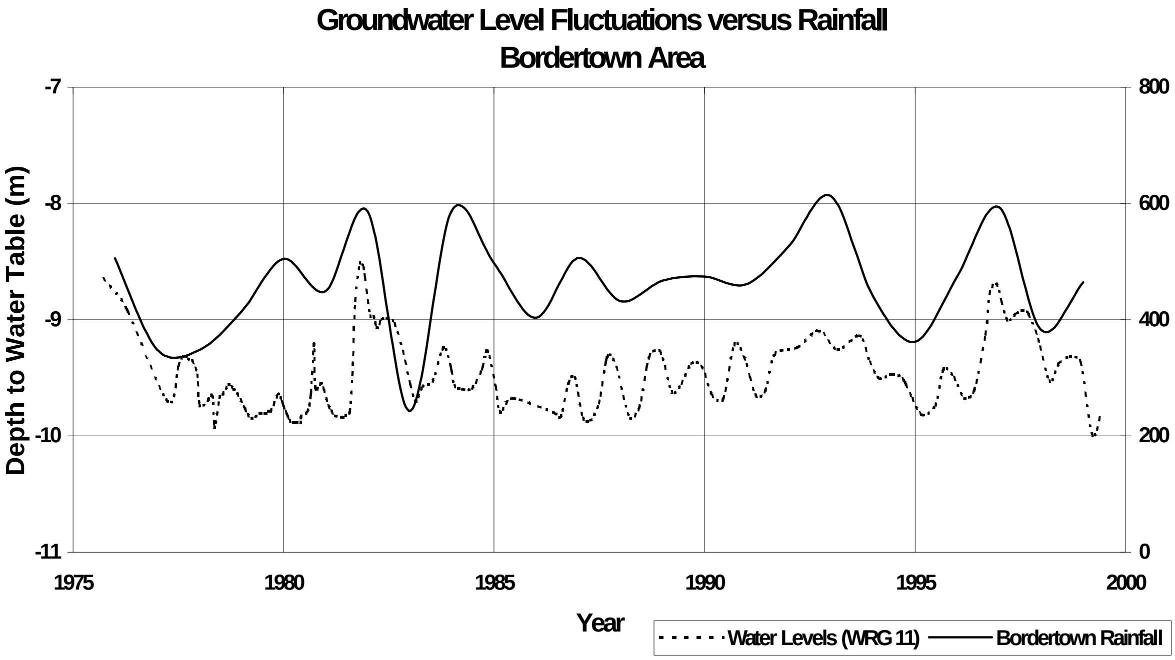
No significant changes in water quality have been observed. This is attributed to the minimal use of low salinity irrigation water combined with the greater depth to the water table and the salinity graphs for TAT104, 106 and 108 illustrate the regional trend.

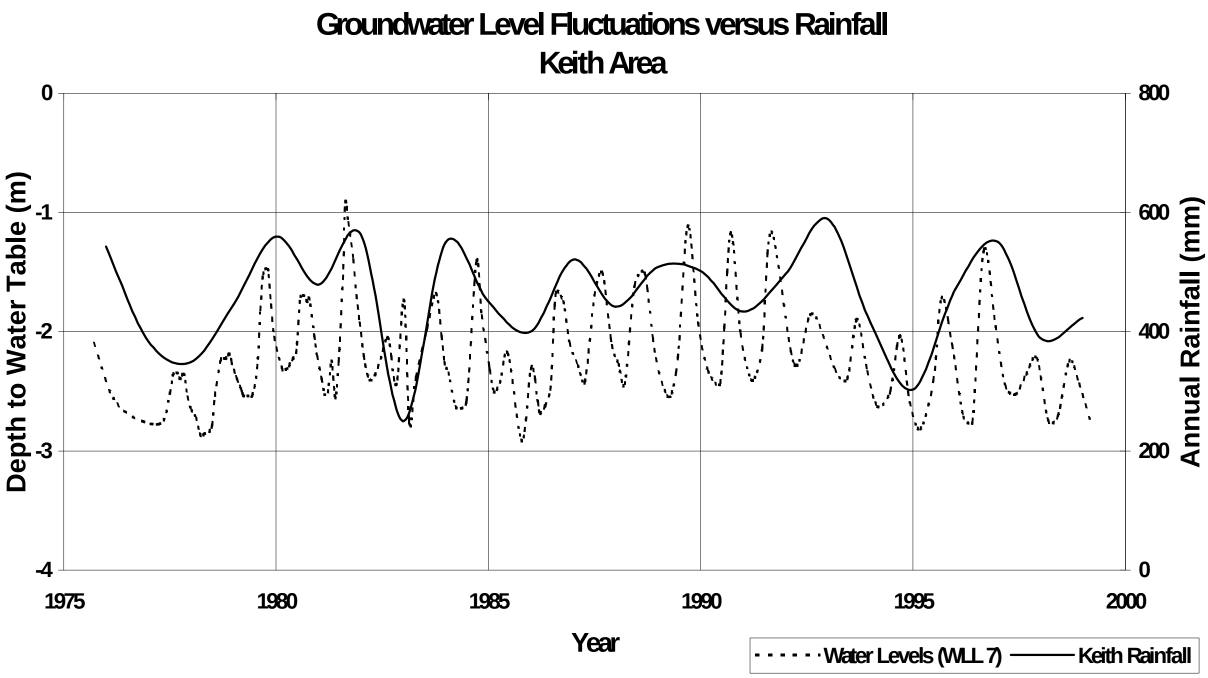


RAINFALL RECHARGE

Seasonal fluctuations, of varying magnitude, in response to rainfall recharge are observed in all water level monitoring wells. Some hydrographs show a noticeable decline in water levels over the last 7 years of up to 12 centimetres per year which is attributed to below average rainfall and the subsequent reduced recharge which is being observed over much of the South East region.

The graphs below show the relationship between rainfall recharge and water level fluctuations. In areas where there is little or no influence by either natural vegetation clearance or groundwater withdrawal for irrigation, the fluctuations in water levels show a similar trend to seasonal rainfall patterns and this is more noticeable where the depth to water is less than 10 metres.





CONCLUSIONS

The major impact on the groundwater resources of the Tatiara Prescribed Wells Area is the increase in salinity which is being observed in several areas particularly where there is a high density of irrigation. It is also concluded that:

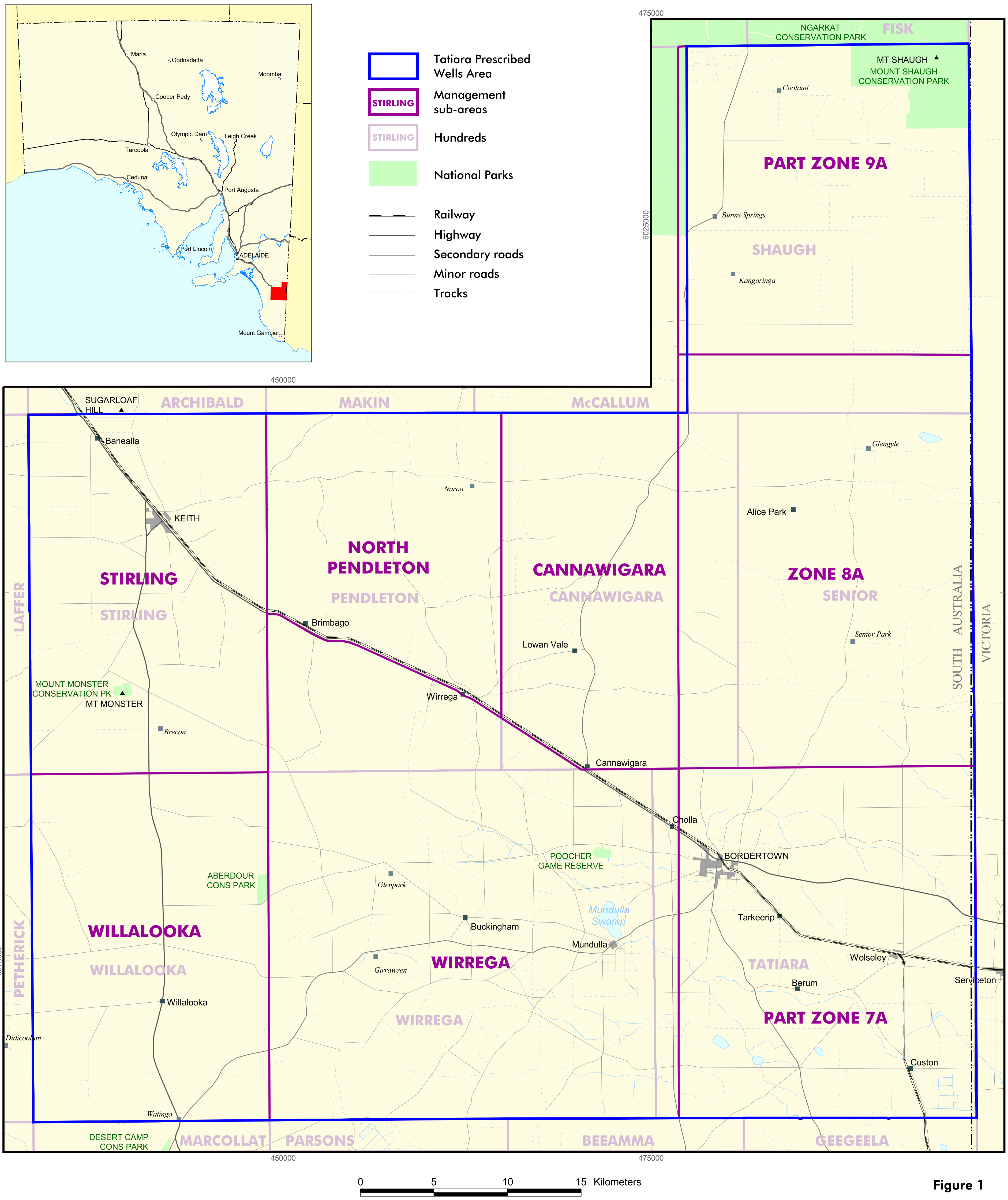
- large groundwater withdrawals in the Stirling sub-area are having a significant impact where a long term decline in water levels and an increase in salinity is being observed.
- rising water levels, due mainly to the clearance of native vegetation, are of concern as it is considered that rising water levels are contributing to increases in groundwater salinity.

RECOMMENDATIONS

It is recommended that monitoring of both groundwater levels and salinity continue at the current frequency and at least three more continuous water level recorders be installed to enable more accurate assessment of:

- the anticipated increase in water use in the vicinity of the expanding vineyard areas near Mundulla.
- fluctuations in water levels in proximity to runaway holes where surface water recharge is occurring.
- background water levels that are not influenced by the groundwater withdrawals in vicinity of the Stirling irrigation area.

Figures



Map Projection - AMG Zone 54

Figure 1

TATIARA PRESCRIBED WELLS AREA

LOCATION PLAN INCLUDING MANAGEMENT SUB-AREAS

PRIMARY INDUSTRIES AND RESOURCES SA

Government of South Australia

AV3: 200164-001

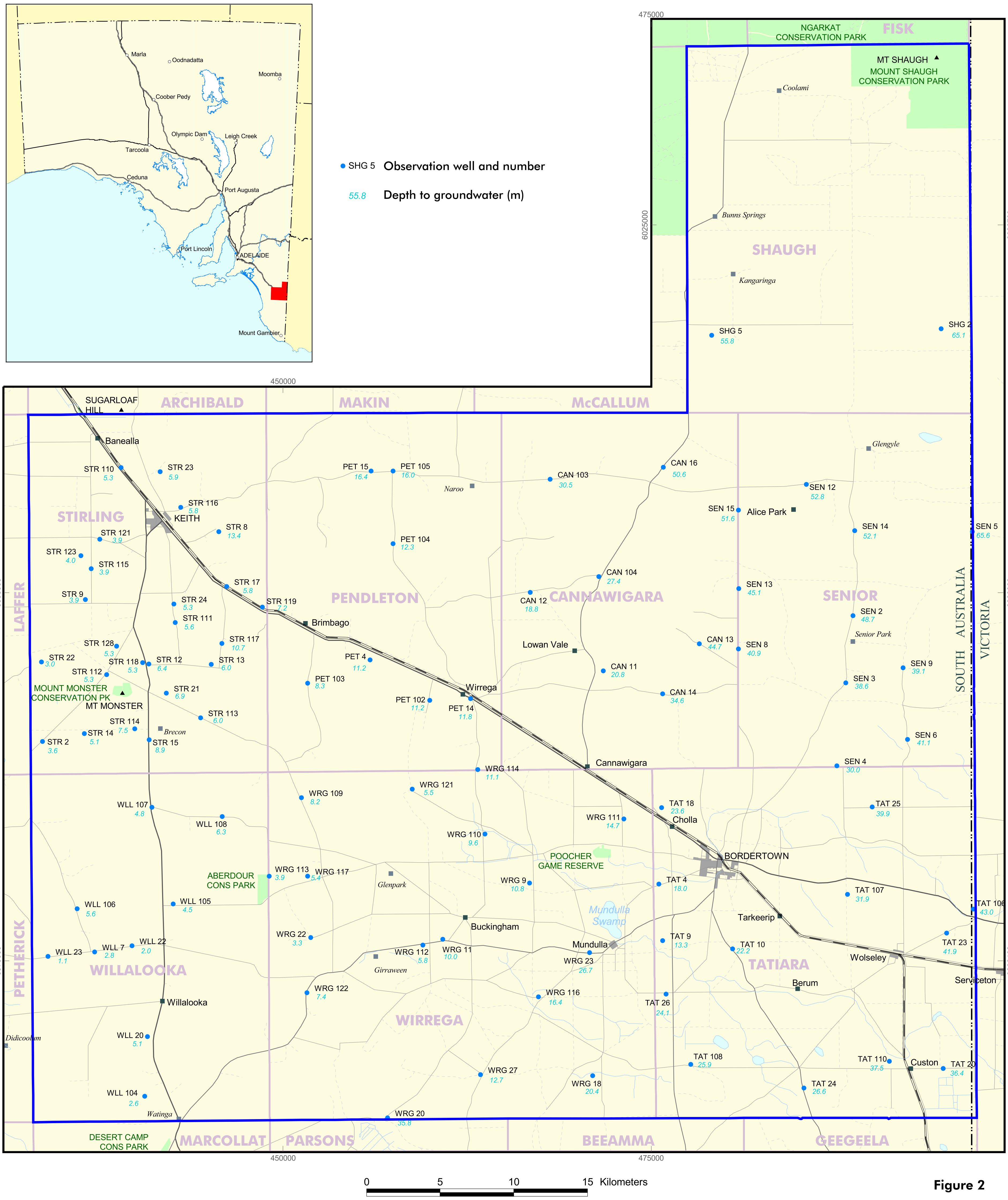


Figure 2

Map Projection - AMG Zone 54

TATIARA PRESCRIBED WELLS AREA

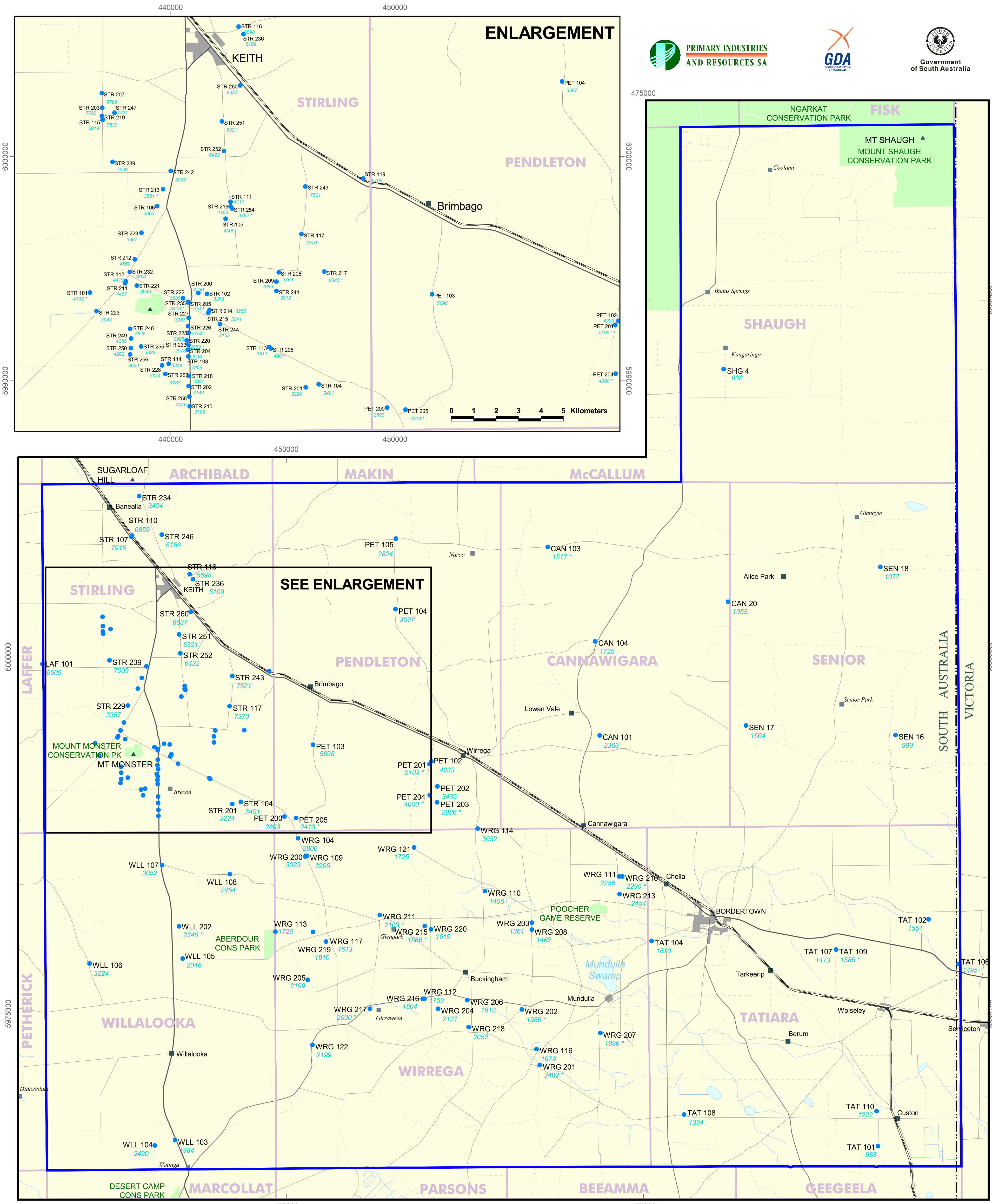
LOCATION OF WATER LEVEL OBSERVATION WELLS AND DEPTH TO GROUNDWATER MARCH 1999

PRIMARY INDUSTRIES AND RESOURCES SA

GDA

Government of South Australia

AV3: 200164-002



0 5 10 15 Kilometers

Map Projection - AMG Zone 54

• SHG 4 Observation well number

938 Salinity (mg/L)

* Indicates where salinity has been calculated using linear regression from previous data

Figure 3

TATIARA PRESCRIBED WELLS AREA

LOCATION OF SALINITY OBSERVATION WELLS AND SALINITY MARCH 1999

AV3: 200164-003

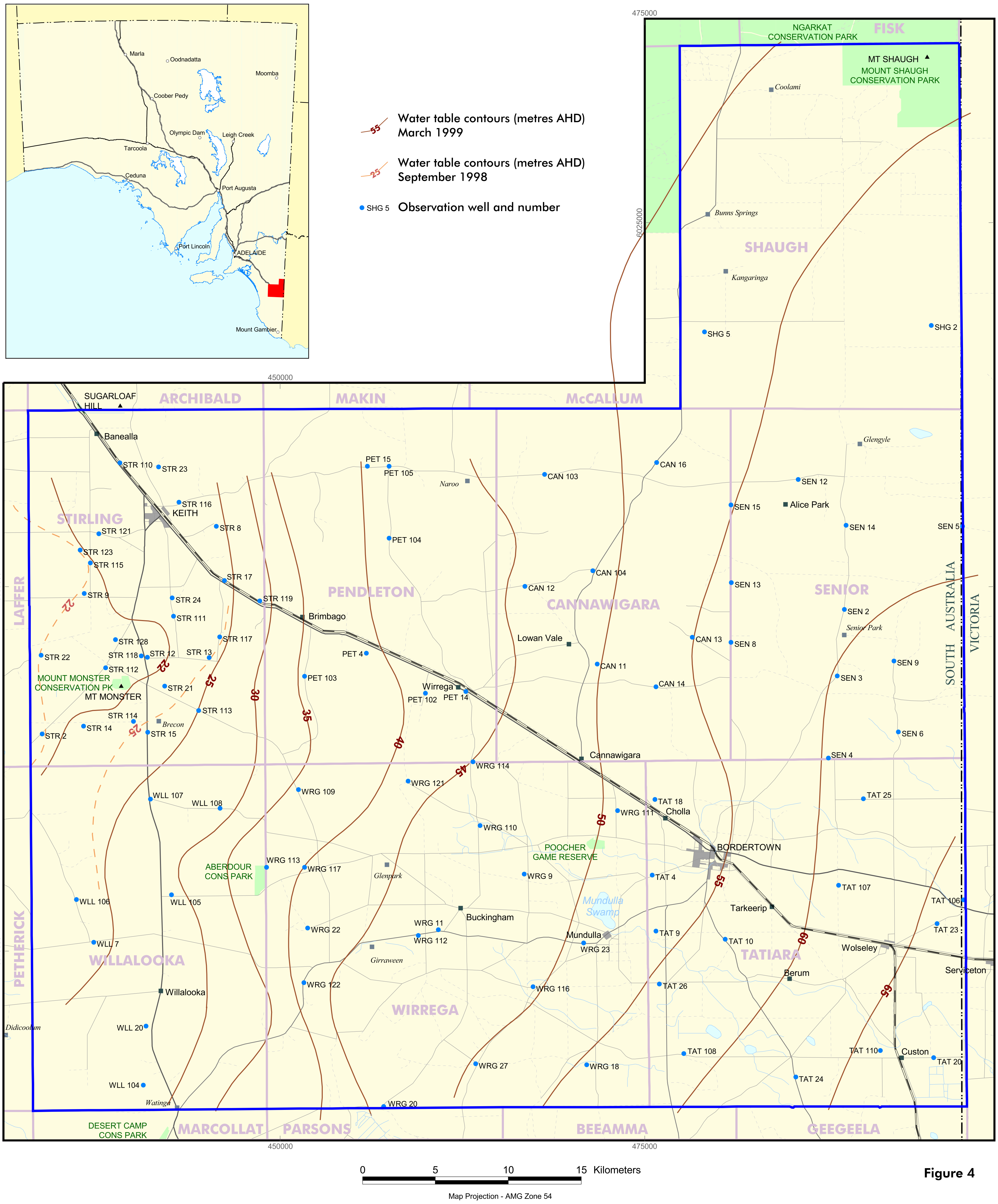


Figure 4

TATIARA PRESCRIBED WELLS AREA

WATER TABLE CONTOURS MARCH 1999

PRIMARY INDUSTRIES AND RESOURCES SA

GDA

Government of South Australia

AV3: 200164-004

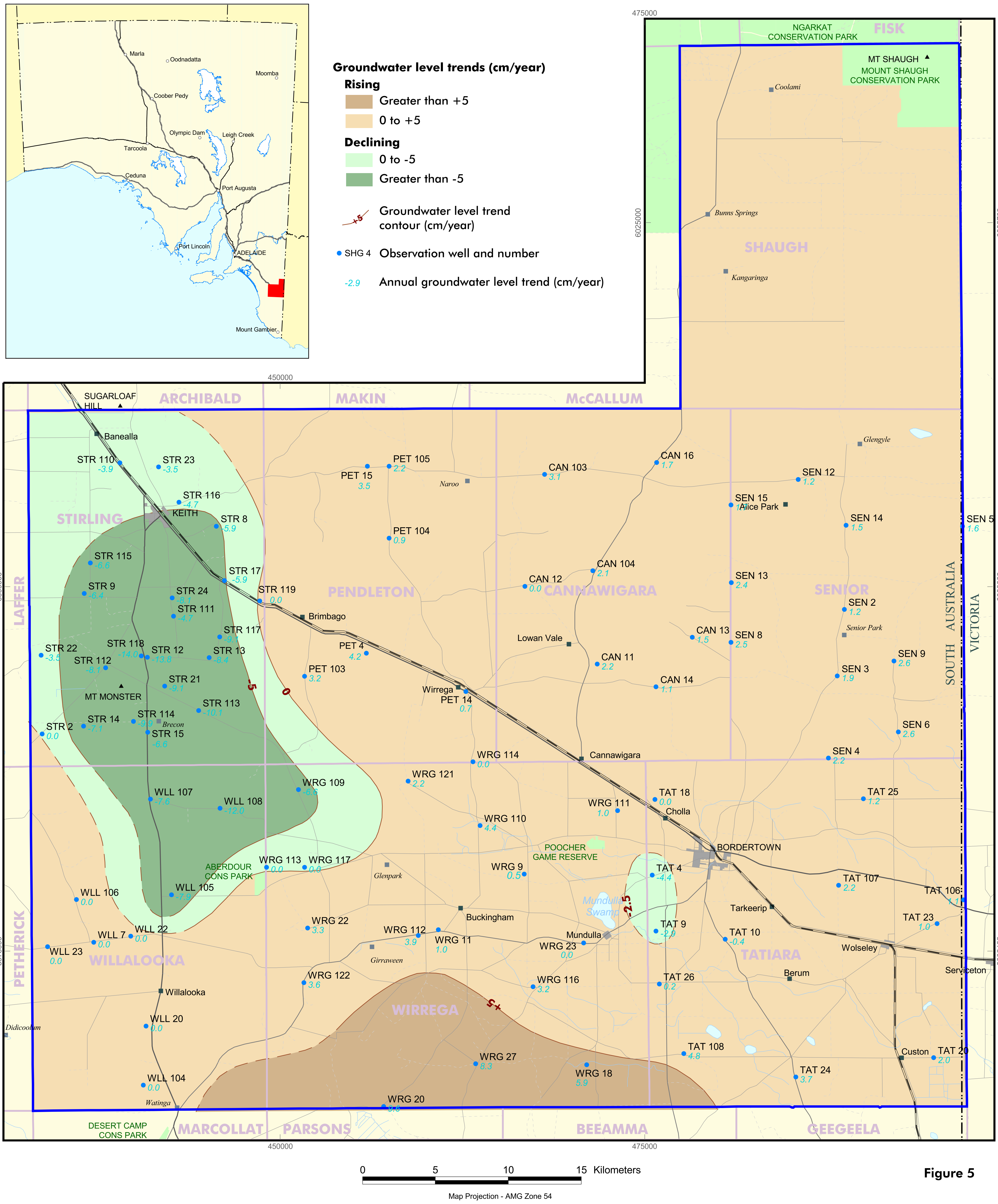


Figure 5

TATIARA PRESCRIBED WELLS AREA

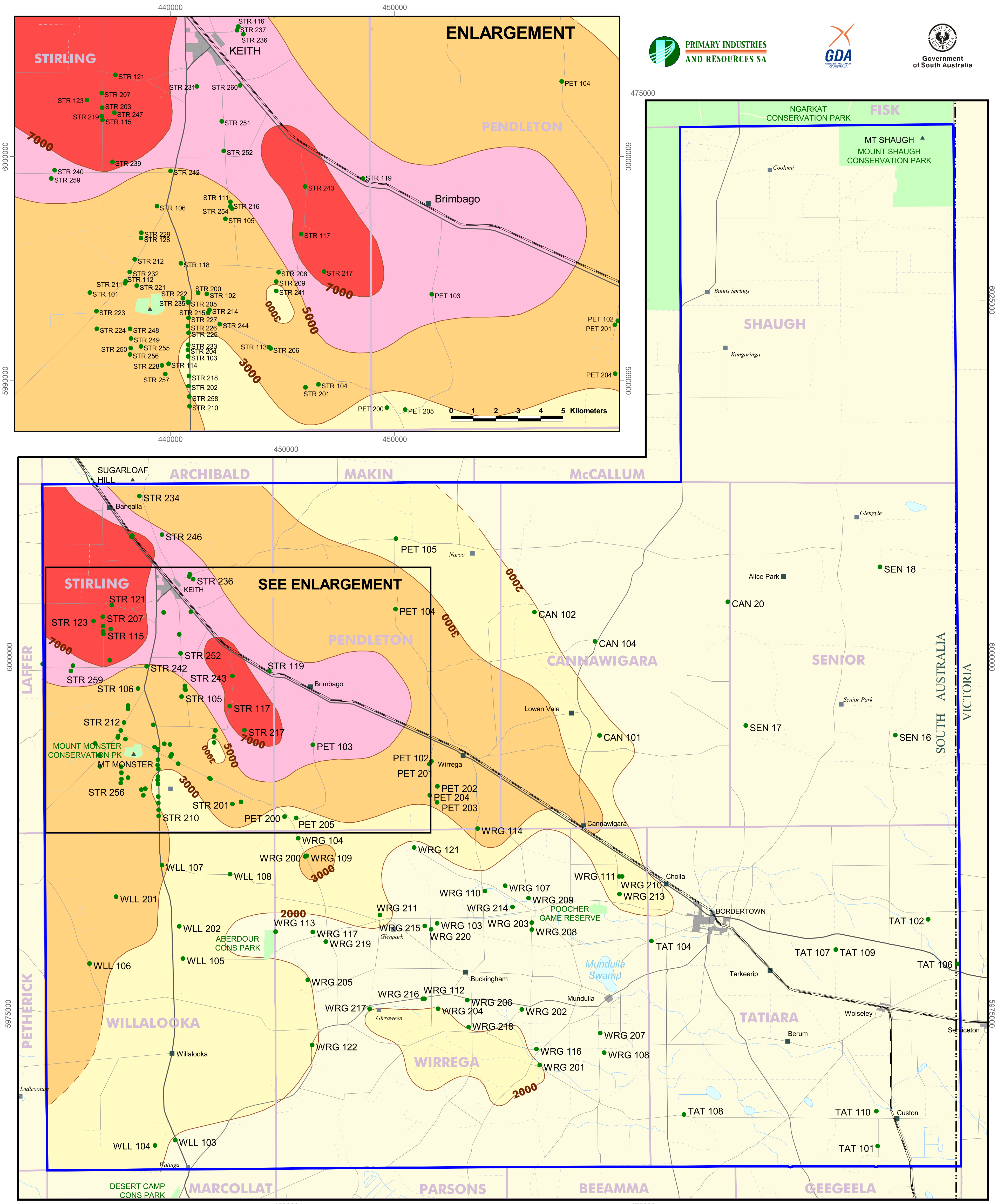
ANNUAL GROUNDWATER TRENDS AT END OF 1998-1999 IRRIGATION SEASON

PRIMARY INDUSTRIES AND RESOURCES SA

GDA

Government of South Australia

AV3: 200164-005



Salinity distribution (mg/L)

- Less than 2000
- 2000 to 3000
- 3000 to 5000
- 5000 to 7000
- Greater than 7000

3000 Salinity contour in mg/L

SEN 16 Observation well number

NOTE: Areas where observation well density is poor, most recent salinity data was obtained from Departmental data base

0 5 10 15 Kilometers

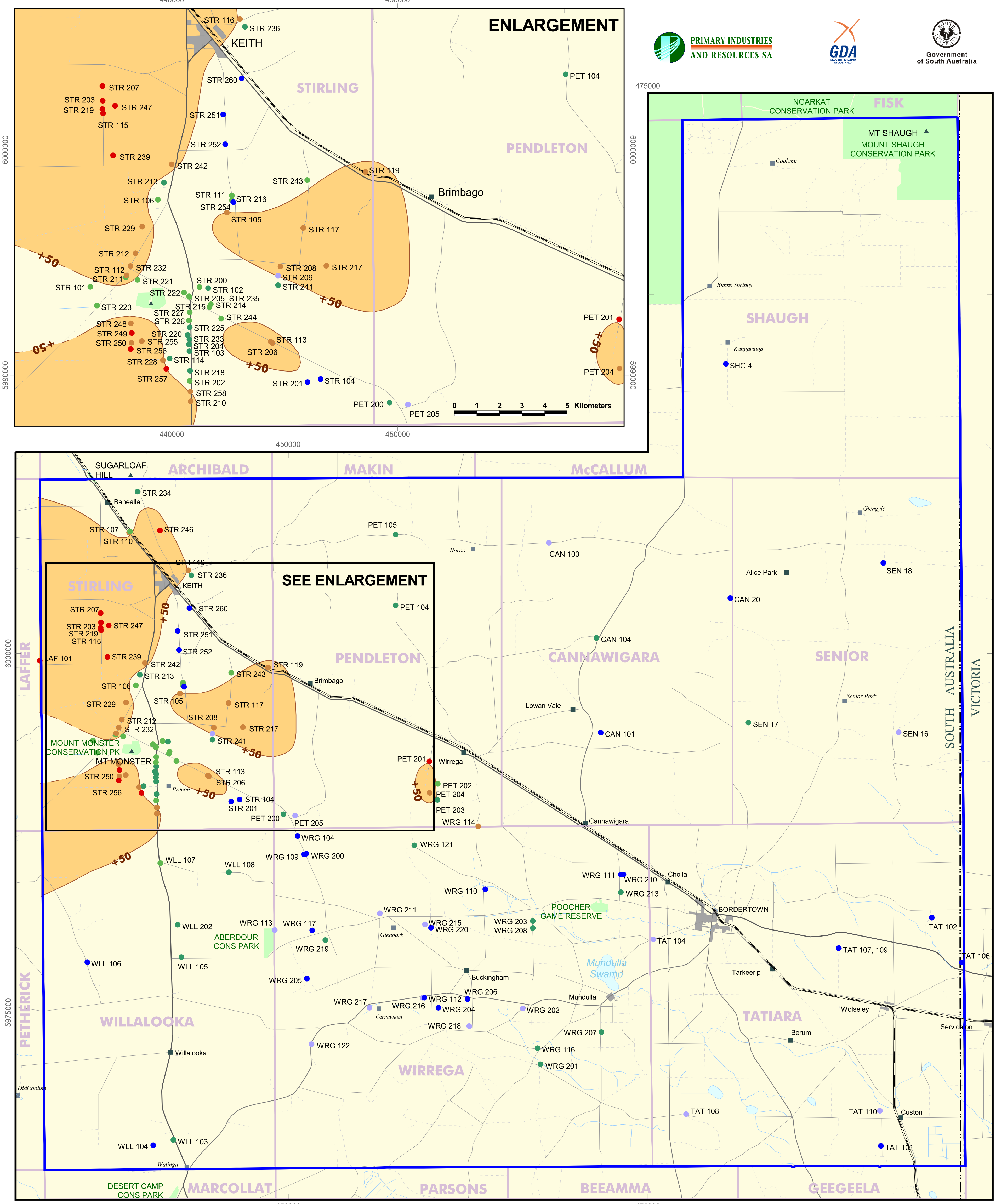
Map Projection - AMG Zone 54

Figure 6

TATIARA PRESCRIBED WELLS AREA

SALINITY DISTRIBUTION AT END OF 1998-1999 IRRIGATION SEASON

AV3: 200164-006



Annual salinity trends (mg/L)

Decreasing

- -50 to 0

Increasing

- 0 to 10
- 10 to 30
- 30 to 50
- 50 to 100
- Greater than 100

+50 Annual salinity trend contour - mg/L (calculated from linear regression of all available data at end of 1998-1999 irrigation season)

Salinity increase greater than 50 mg/L per year

SHG 4 Observation well number

0 5 10 15 Kilometers

Map Projection - AMG Zone 54

Figure 7

TATIARA PRESCRIBED WELLS AREA

SALINITY TRENDS AT END OF 1998-1999 IRRIGATION SEASON

AV3: 200164-007

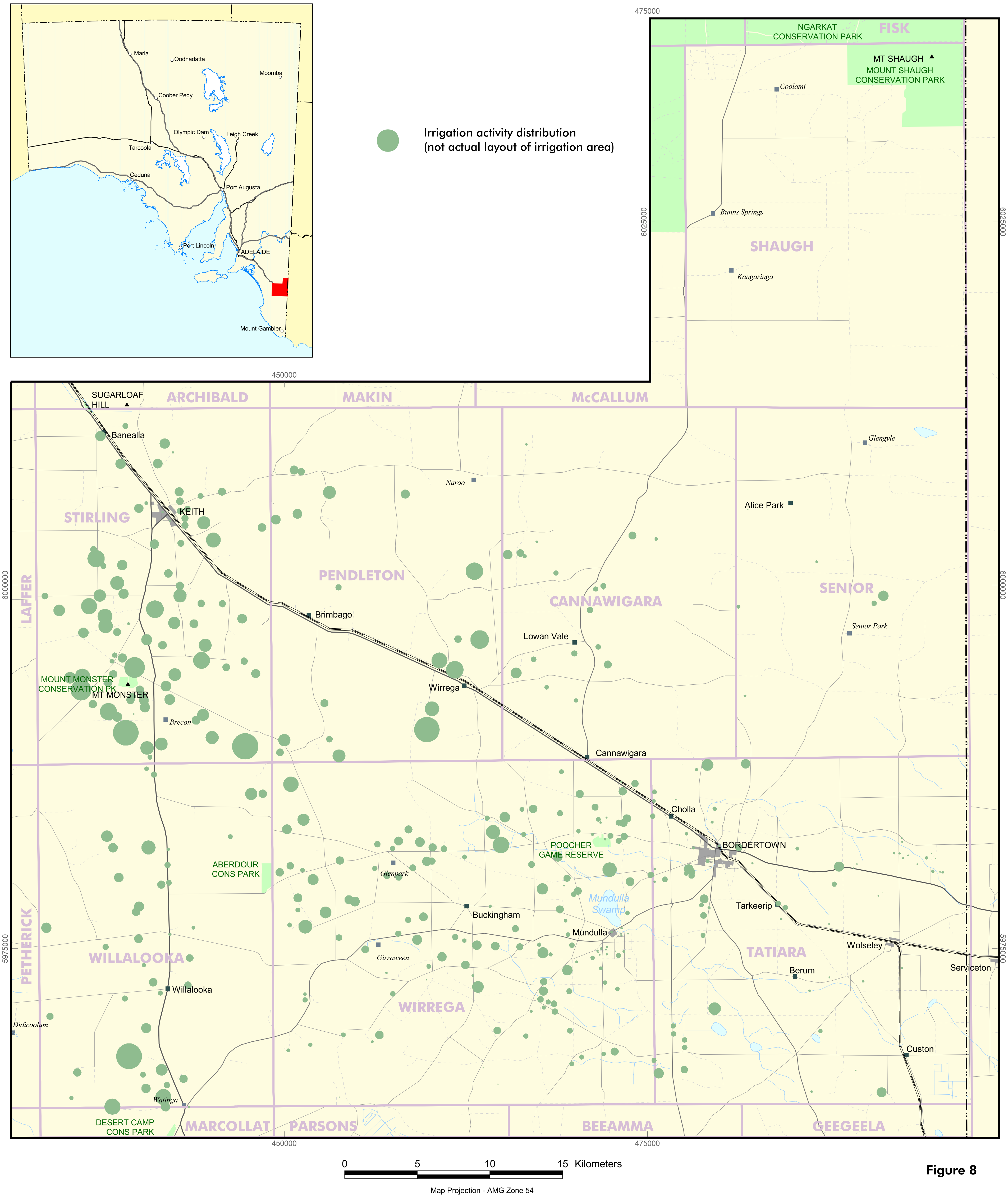


Figure 8

TATIARA PRESCRIBED WELLS AREA

IRRIGATION ACTIVITY DISTRIBUTION FOR 1998-1999 IRRIGATION SEASON

PRIMARY INDUSTRIES AND RESOURCES SA

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Appendix 1

Depth to groundwater and water level trend at

end of 1998/99 irrigation season

Hundred	Obs No.	Depth to Water March 1999 (m)	Water Level Trend (cm/yr)	Hundred	Obs No.	Depth to Water March 1999 (m)	Water Level Trend (cm/yr)
Cannawigara	11	20.8	2.2	**Tatiara**	4	18.0	-4.4
	12	18.8	0		9	13.3	-2.9
	13	44.7	1.5		10	22.2	0
	14	34.6	1.1		18	23.6	0
	16	50.6	1.7		20	36.3	2
	103	30.5	3.1		23	41.8	1
	104	27.4	2.1		24	26.6	3.7
Laffer	1	3.9	-5.4		25	39.9	1.2
Pendleton	4	11.2	4.2		26	24.1	0
	14	11.8	0.7		106	43.0	1.1
	15	16.4	3.5		107	31.9	0
	103	8.3	3.2		108	25.9	4.8
	104	12.3	0.9	**Willalooka**	7	2.8	0
	105	16.0	2.2		20	5.1	0
Senior	2	48.7	1.2		22	2.0	0
	3	38.6	1.9		23	1.1	0
	4	29.9	2.2		104	2.6	0
	5	65.6	1.6		105	4.5	-7.9
	6	41.1	2.6		106	5.6	0
	8	40.9	1.7		107	4.8	-7.6
	9	39.1	2.6		108	6.3	-12
	12	52.8	1.2	**Wirrega**	9	10.8	0.5
	13	45.1	2.4		11	10.0	1
	14	52.1	1.5		18	20.4	5.9
	15	51.6	1.7		20	35.8	9.6
Shaugh	2	65.1	2.7		22	3.3	3.3
	5	55.8	2.5		23	26.7	0
Stirling	2	3.6	0		27	12.7	8.3
	8	13.4	-5.9		109	8.2	-6.6
	9	3.9	-6.4		110	9.6	4.4
	12	6.4	-13.8		111	14.7	1
	13	6.0	-8.4		112	5.8	3.9
	14	5.1	-7.1		113	3.9	0
	15	8.9	-6.6		114	11.1	0
	17	5.8	-5.9		116	16.4	3.2
	21	6.9	-9.1		117	5.4	0
	22	3.0	-3.5		121	5.5	2.2
	23	5.9	-3.5		122	7.4	3.6
	24	5.3	-8.1				
	110	5.3	-3.9				
	111	5.5	-4.7				
	112	5.3	-8.1				
	113	6.0	-10.1				
	114	7.5	-9.9				
	115	3.9	-6.6				
	116	5.8	-4.7				
	117	10.7	-9.1				
	118	5.3	-14				
	119	7.2	0				

Appendix 2

Salinity trends and data for hundred of Stirling

STR Obs No.	Annual Trend (mg/L/yr	TDS (mg/L)	STR Obs No.	Annual Trend (mg/L/yr	TDS (mg/L)
101	36	4193 *	**218**	22	2921
102	25	3269	**219**	172	7533
103	27	2909	**220**	24	2952 *
104	NC	3401	**221**	41	3943
105	59	4065	**222**	41	3585
106	38	3660	**223**	31	3943
107	53	7915	**225**	24	2995
110	35	6859	**226**	31	3252
111	46	4117	**227**	40	3367
112	58	4419	**228**	92	3914
113	73	3511	**229**	77	3367
114	25	3338	**232**	67	4863
115	202	6919	**233**	17	2978
116	59	5698	**234**	15	3424
117	99	7370	**235**	35	3413 *
119	69	6709	**236**	19	5109
200	41	3730	**239**	144	7009
201	NC	3224	**241**	19	2812
202	48	3149	**242**	80	3833
203	159	7793	**243**	44	7521
204	28	2938	**244**	45	3155
205	40	3511	**246**	141	6166
206	93	4001	**247**	183	7431
207	187	8769	**248**	76	3828
208	75	3764	**249**	103	4285
209	10	2886	**250**	94	4262
210	54	3195	**251**	-37	6321
211	44	4407	**252**	-16	6422
212	59	4559	**254**	-13	3482 *
213	25	3551 *	**255**	76	3828
214	42	3252	**256**	116	4699
215	36	3241	**257**	132	4233
216	39	4163	**258**	69	3046
217	92	8345 *	**260**	NC	6637

Annual Trend is based on linear regression on all data
NC = Negligible Change
TDS is last recorded salinity reading taken during 1998-99 irrigation season
* indicates where salinity has been calculated using linear regression

Appendix 3

Salinity trends and data for all other hundreds

Hundred	Obs No	Annual Trend (mg/L/yr)	TDS (mg/L)	Hundred	Obs No	Annual Trend (mg/L/yr)	TDS (mg/L)
CANNAWIGARA	**20**	NC	1055	WIRREGA	**104**	NC	2806
	101	NC	2363		**109**	-10	2995
	103	10	1517 *		**110**	-7	1406
	104	24	1725		**111**	NC	2256
LAFFER	**101**	113	5609		**112**	NC	1759
PENDLETON	**102**	45	4233		**113**	5	1720
	103	41	5698		**114**	61	3052
	104	23	3597		**116**	18	1979
	105	16	2824		**117**	NC	1613
	200	22	2693		**121**	13	1725
	201	116	5103 *		**122**	4	2199
	202	49	3436		**200**	NC	3023
	203	14	2986 *		**201**	26	2482 *
	204	75	4000 *		**202**	8	1986 *
	205	5	2413 *		**203**	19	1361
SENIOR	**16**	5	999		**204**	NC	2131
	17	12	1664		**205**	NC	2199
	18	NC	1077		**206**	NC	1613
TATIARA	**101**	NC	988		**207**	16	1896 *
	102	NC	1551		**208**	12	1462
	104	6	1810		**210**	NC	2290 *
	106	NC	1495		**211**	8	2103 *
	107	NC	1473		**213**	11	2454
	108	8	1094		**215**	4	1586 *
	109	NC	1586 *		**216**	4	1804
	110	9	1222		**217**	3	2000 *
WILLALOOKA	**103**	20	1984		**218**	10	2052
	104	-23	2420		**219**	15	1810
	105	12	2046		**220**	-4	1619
	106	-6	3224	SHAUGH	**4**	NC	938
	107	42	3052				
	108	19	2454				
	202	30	2345 *				

Annual Trend is based on linear regression on all data
NC = Negligible Change
TDS is last recorded salinity reading taken during 1998-99 irrigation season
* indicates where salinity has been calculated using linear regression