South East groundwater monitoring status report and assessment of current trends - 2003 - 2004

DWLBC Report 2004/26

Government of South Australia

Department of Water, Land and Biodiversity Conservation

The Department of Water, Land and Biodiversity Conservation

South East groundwater monitoring status report and assessment of current trends 2003–2004

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Report DWLBC 2004/26

Government of South Australia

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Foreword

South Australia's natural resources are fundamental to the economic and social well-being of the State. One of the State's most precious natural resources, water is a basic requirement of all living organisms and is one of the essential elements ensuring biological diversity of life at all levels. In pristine or undeveloped situations, the condition of water resources reflects the equilibrium between, rainfall, vegetation and other physical parameters. Development of these resources changes the natural balance and may cause 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 the resource to continue to meet the needs of users and the environment. Understanding the cause and effect relationship between the various stresses imposed on the natural resources is paramount to developing effective management strategies. Reports of investigations into the availability and quality of water supplies throughout the State aim to build upon the existing knowledge base enabling the community to make informed decisions concerning the future management of the natural resources thus ensuring conservation of biological diversity.

Bryan Harris
Director, Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation

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FIGURES

1. INTRODUCTION

The South Australian Government, through the Department of Water, Land and Biodiversity Conservation (DWLBC) is responsible for the management of the State's groundwater resources. As a part of its role, the DWLBC monitors and maintains an extensive state-wide groundwater monitoring network.

Groundwater monitoring has been undertaken in parts of the South East of South Australia for more than 30 years. The two main parameters used to measure the condition of the groundwater resources are water levels and salinity. Over time, a history of the condition of the aquifers has been established from this baseline information, enabling longer term and short-term changes to be identified and correlated with either natural (e.g. climatic) or man-induced changes (e.g. irrigation, development, and vegetation clearance).

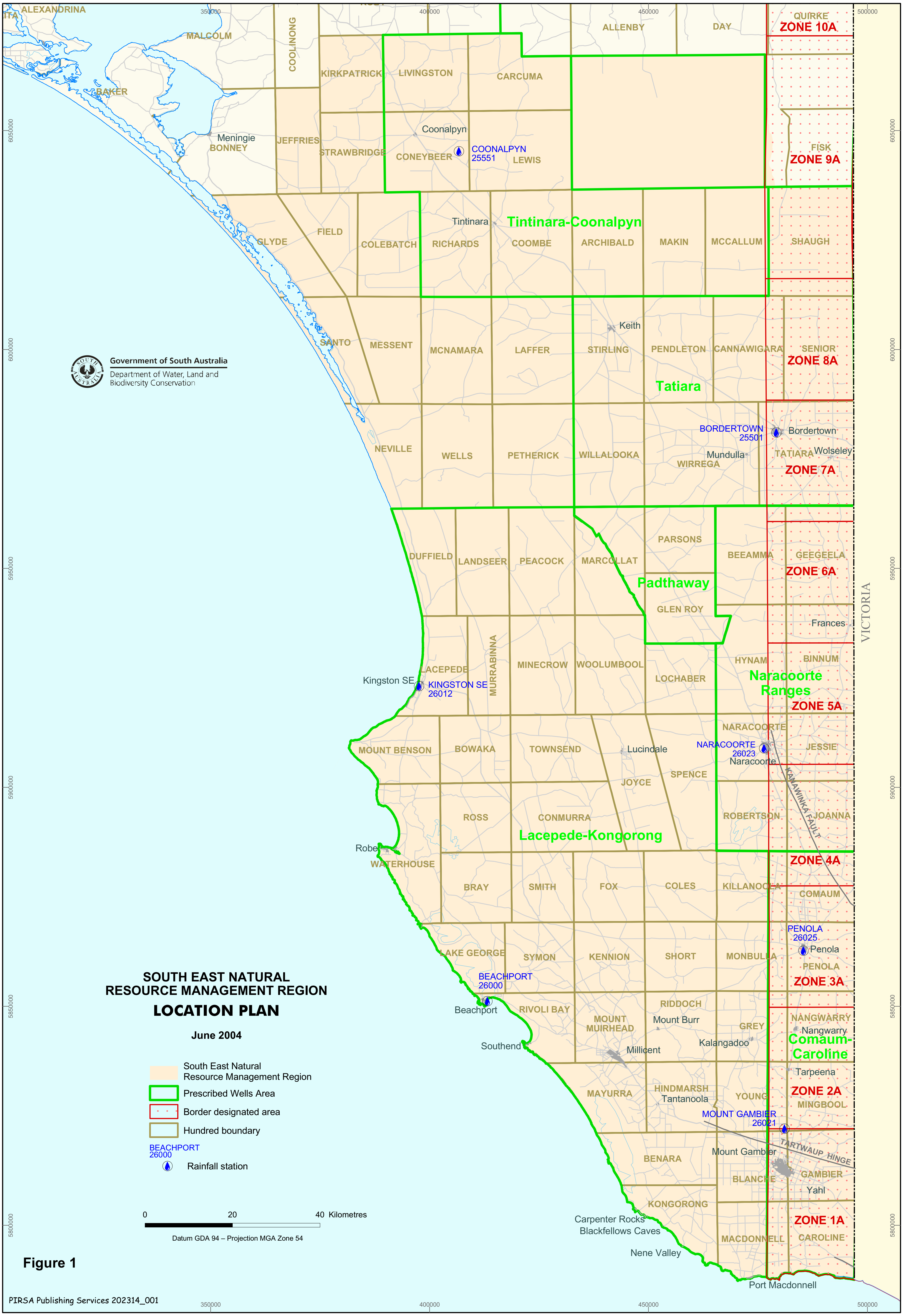
This report is compiled for the South East Catchment Water Management Board (SECWMB) and discusses data collected up to March 2004 for the South East Region. The information compiled was obtained from observation wells throughout the area to provide a focus on the trends observed in current monitoring data in relation to groundwater levels and groundwater quality for the unconfined and confined aquifer.

The South East Catchment area comprises five Prescribed Wells Areas (PWA), which cover an area of ~20 000 km^2. These groundwater management areas are referred to as the Padthaway, Tatiara, Comaum–Caroline, Naracoorte Ranges and Lacepede-Kongorong Prescribed Wells Areas. More recently a sixth management area identified as the Tintinara–Coonalpyn PWA has been included (Fig. 1).

Groundwater monitoring is undertaken in all prescribed wells areas and observation wells are grouped in networks bearing the same name as the PWA, albeit abbreviated (refer App. 1). The locations of water level and salinity observation wells are displayed in Figures 2 and 3.

Groundwater monitoring is also carried out in the north west portion of the South East and whilst it is within SECWMB boundary, it is not within a prescribed wells area. This monitoring area is referred to as the USE Region network and incorporates much of the *Upper South East Dryland Salinity and Flood Management Project* area.

A complete description of the regional hydrogeology and climate has been published in the South East Catchment Water Management Board groundwater monitoring status report 2002 (Rammers *et al.,* 2002).

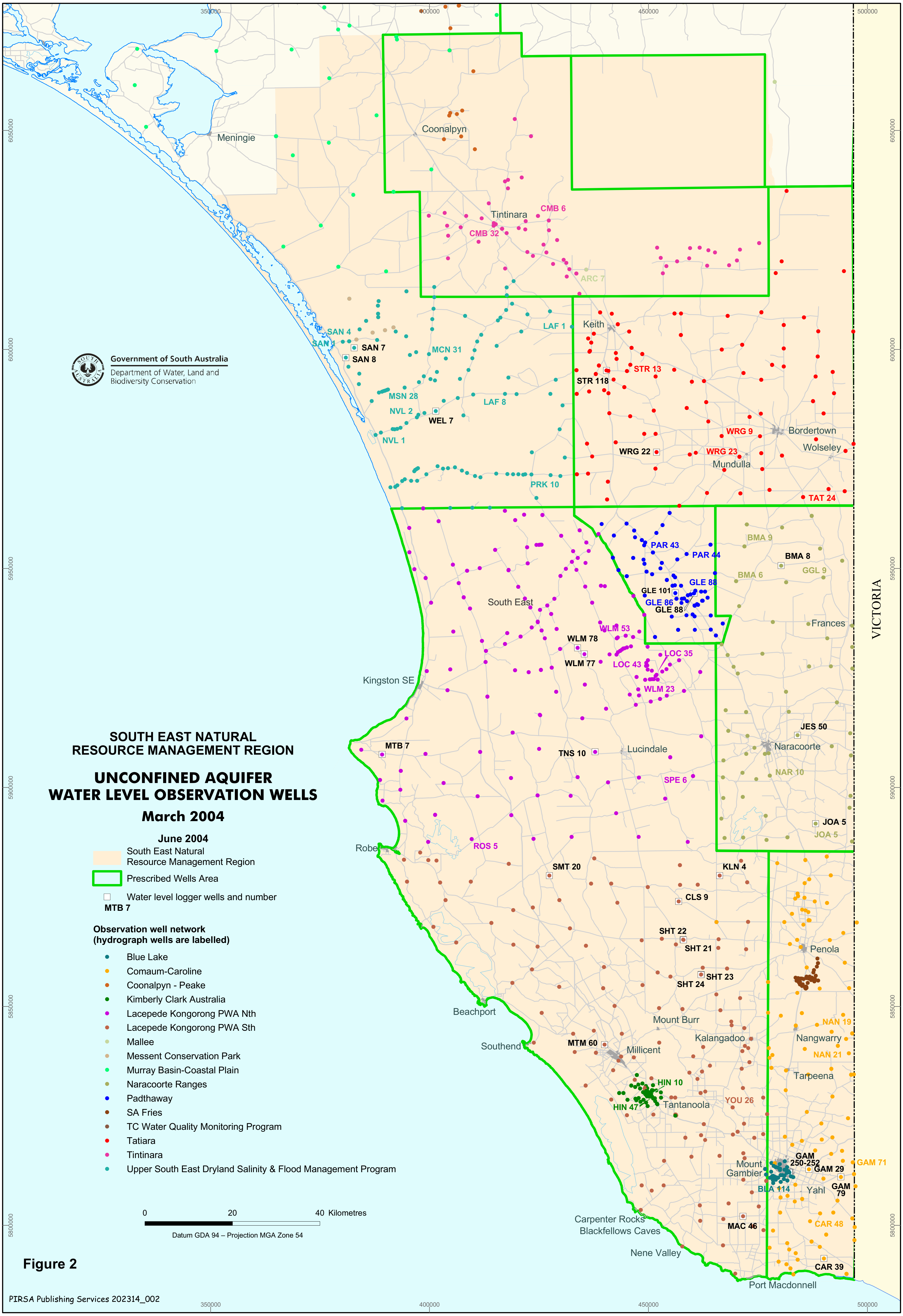


SOUTH EAST NATURAL RESOURCE MANAGEMENT REGION

LOCATION PLAN

June 2004

Figure 1


SOUTH EAST NATURAL
RESOURCE MANAGEMENT REGION
UNCONFINED AQUIFER
WATER LEVEL OBSERVATION WELLS
March 2004
June 2004
South East Natural
Resource Management Region
Prescribed Wells Area
Water level logger wells and number
MTB 7
Observation well network
(hydrograph wells are labelled)
Blue Lake
Comaum-Caroline
Coonalpyn - Peake
Kimberly Clark Australia
Lacepede Kongorong PWA Nth
Lacepede Kongorong PWA Sth
Mallee
Messent Conservation Park
Murray Basin-Coastal Plain
Naracoorte Ranges
Padthaway
SA Fries
TC Water Quality Monitoring Program
Tatiara
Tintinara
Upper South East Dryland Salinity & Flood Management Program
0
20
40 Kilometres
Datum GDA 94 – Projection MGA Zone 54
Government of South Australia
Department of Water, Land and
Biodiversity Conservation
VICTORIA
Meningie
Coonalpyn
Tintinara
Keith
Bordertown
Wolseley
Mundulla
South East
Frances
Kingston SE
Naracoorte
Lucindale
Robe
Penola
Beachport
Southend
Mount Burr
Kalangadoo
Millicent
Nangwarry
Tarpeena
Tantanoola
Mount
Gambier
Yahl
Carpenter Rocks
Blackfellows Caves
Nene Valley
Port Macdonnell
CMB 6
CMB 32
ARC 7
SAN 4
SAN 1
SAN 7
SAN 8
MCN 31
LAF 1
LAF 8
MSN 28
NVL 2
NVL 1
WEL 7
PRK 10
STR 13
STR 118
WRG 9
WRG 22
WRG 23
TAT 24
PAR 43
PAR 44
BMA 9
BMA 8
BMA 6
GGL 9
GLE 101
GLE 88
GLE 86
WLM 53
WLM 78
WLM 77
LOC 35
LOC 43
WLM 23
JES 50
MTB 7
TNS 10
SPE 6
NAR 10
JOA 5
ROS 5
SMT 20
KLN 4
CLS 9
SHT 22
SHT 21
SHT 23
SHT 24
NAN 19
NAN 21
MTM 60
HIN 10
HIN 47
YOU 26
GAM 250-252
GAM 29
GAM 71
GAM 79
BLA 114
MAC 46
CAR 48
CAR 39
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PIRSA Publishing Services 202314_002
Figure 2

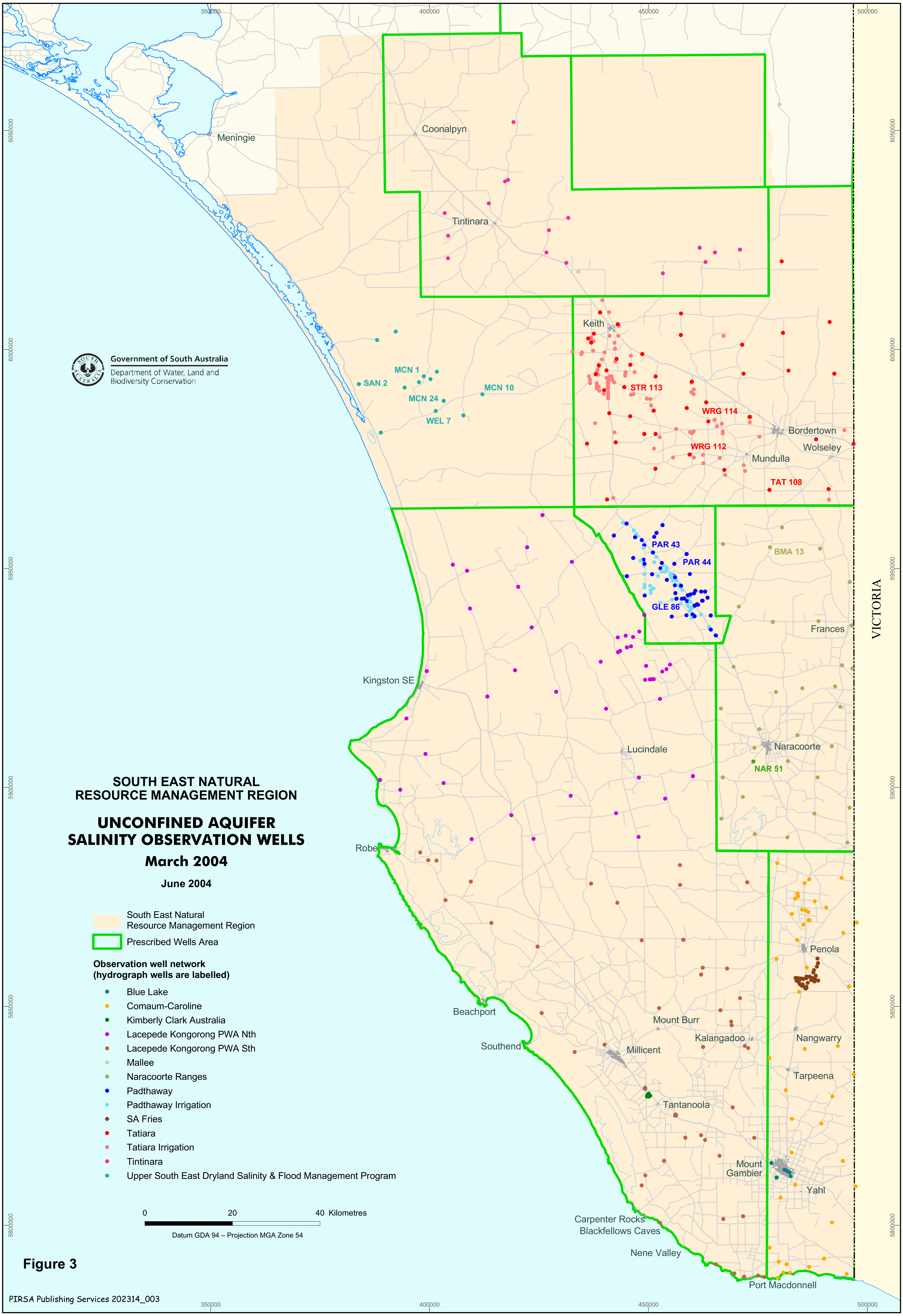

Figure 3

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2. DATA STORAGE

All groundwater data is stored in a database called *SAGeodata* and is shared between DWLBC and the Department of Primary Industries and Resources SA (PIRSA).

The entry, maintenance and viewing of data is undertaken via DWLBC's software program called *Obswell*. The web version of the program can be accessed via the Department's website **http://www.dwlbc.sa.gov.au/** where users can search for observation well data or drillhole data via map search facility. Users can view water level and salinity data and graphs and can perform bulk downloads of data to be used in spreadsheets or reports.

3. WATER LEVEL LOGGERS

40 continuous water level loggers are installed or due to be installed in the observation wells listed on the table in Appendix 2 and a description and purpose is provided. There are 30 loggers installed in the unconfined aquifer and 10 in the confined aquifer and the locations of loggers are shown on Figure 2 and Figure 26 respectively.

21 loggers were installed in August/September 2004 and therefore have minimal data. Two of the confined aquifer loggers are installed on artesian wells (BOW 22 and CNM 80) are coupled to telemetry (CDMA modem) and provide real time data. This data will assist in determining the most appropriate time to monitor other artesian wells immediately before and after the irrigation season to capture the maximum potentiometric head difference.

Generally, loggers are programmed to record readings every 12 hours and this data is maintained on Excel spreadsheets. Given the volume of data, it is intended that only one reading per week will be entered into the database *(SAGeodata)* for viewing through the *Obswell* interface program.

4. UNCONFINED AQUIFER – REGIONAL ASSESSMENT

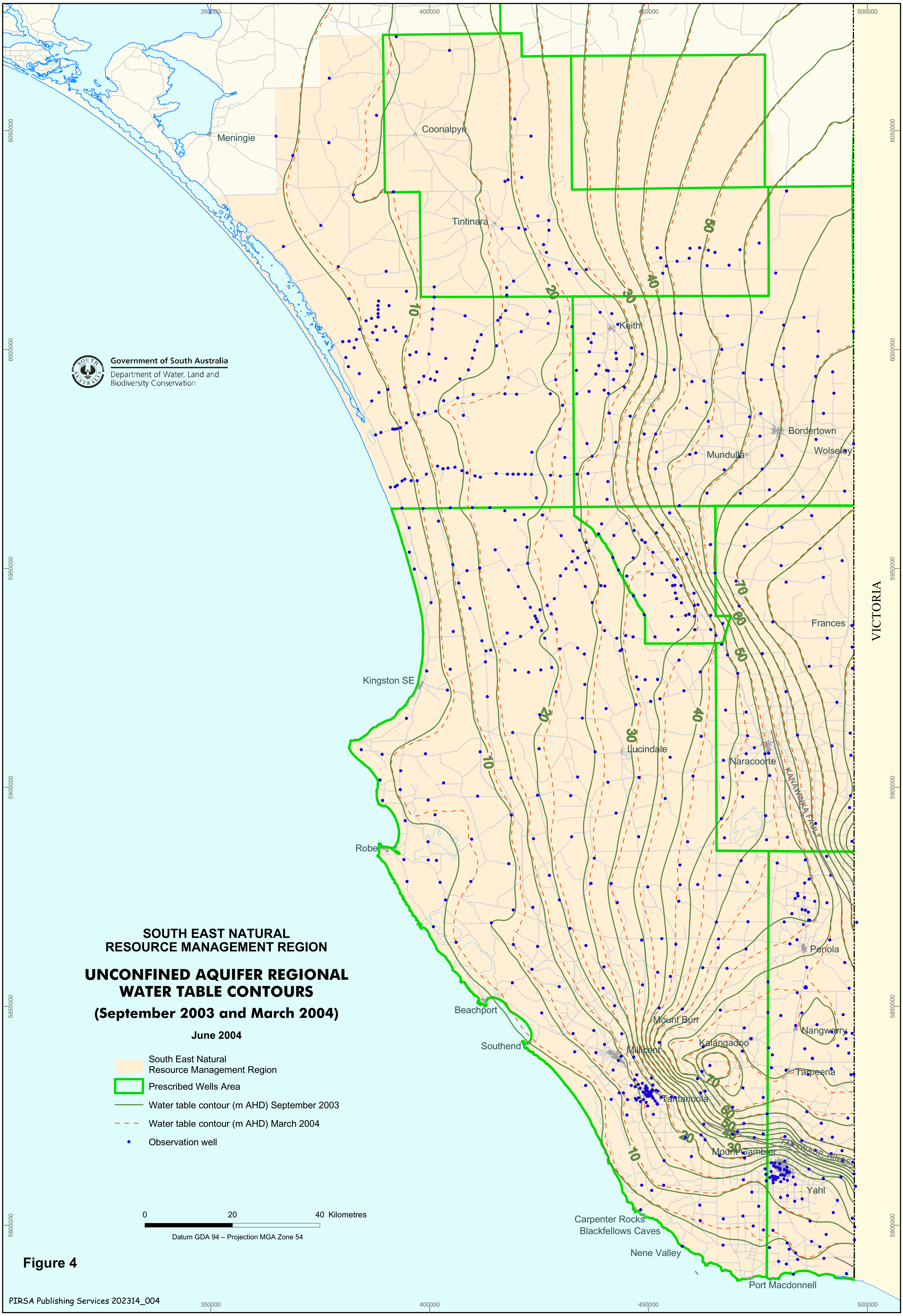
Water Level Assessment

Water table contours for the unconfined aquifer are presented for September 2003 and March 2004 (Fig. 4). The contours indicate the elevation of the groundwater table above the Australian Height Datum (AHD), as well as the gradient and groundwater flow direction. The September 2003 water level elevation represents groundwater at maximum recovery after winter rainfall recharge period, whilst the March 2004 water level elevation represents the lowest groundwater levels, at the end of summer and towards the end of the irrigation season. A comparison of the water table surfaces for September 2003 and March 2004 enables an assessment to be made of seasonal fluctuations and the impacts of groundwater extraction through the irrigation season.

Localised water table contours for the unconfined aquifer were produced for the Tatiara and Padthaway Prescribed Wells Areas. The difference in hydraulic heads for the two time periods reflect the groundwater use in these areas and is discussed further in the following sections of this report.

Regional water table difference 1975–2003

The regional water table difference was contoured utilising September 1975 and 2003 water level data. Figure 5 displays the difference in hydraulic head and indicates the change in water table elevation since 1975. Differences are mostly driven by climatic variations and changes in land use (irrigation and development) and correlate well with the recent (10 year) regional trends (Fig. 6).



SOUTH EAST NATURAL
RESOURCE MANAGEMENT REGION
UNCONFINED AQUIFER REGIONAL
WATER TABLE CONTOURS
(September 2003 and March 2004)
June 2004
South East Natural Resource Management Region
Prescribed Wells Area
Water table contour (m AHD) September 2003
Water table contour (m AHD) March 2004
Observation well
0
20
40 Kilometres
Datum GDA 94 – Projection MGA Zone 54
Government of South Australia
Department of Water, Land and Biodiversity Conservation
Meningie
Coonalpyn
Tintinara
Keith
Bordertown
Mundulla
Wolseley
Frances
Kingston SE
Lucindale
Naracoorte
KANAWINKA FAULT
Robe
Penola
Beachport
Southend
Mount Burr
Kalangadoo
Millicent
Nangwarry
Tarpeena
Tantanoola
Mount Gambier
Yahl
Carpenter Rocks
Blackfellows Caves
Nene Valley
Port Macdonnell
VICTORIA
10
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5800000
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Figure 4

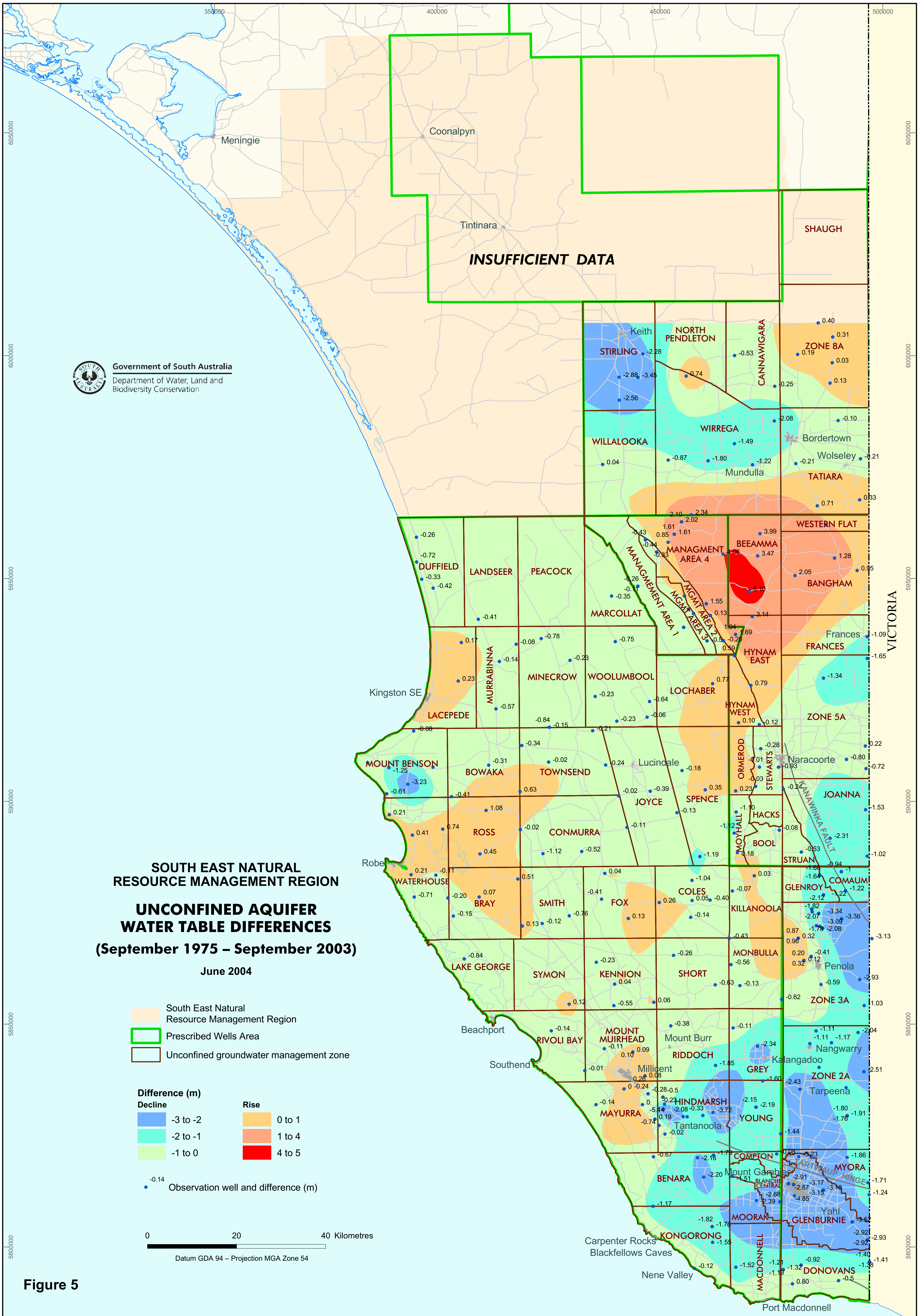

Figure 5

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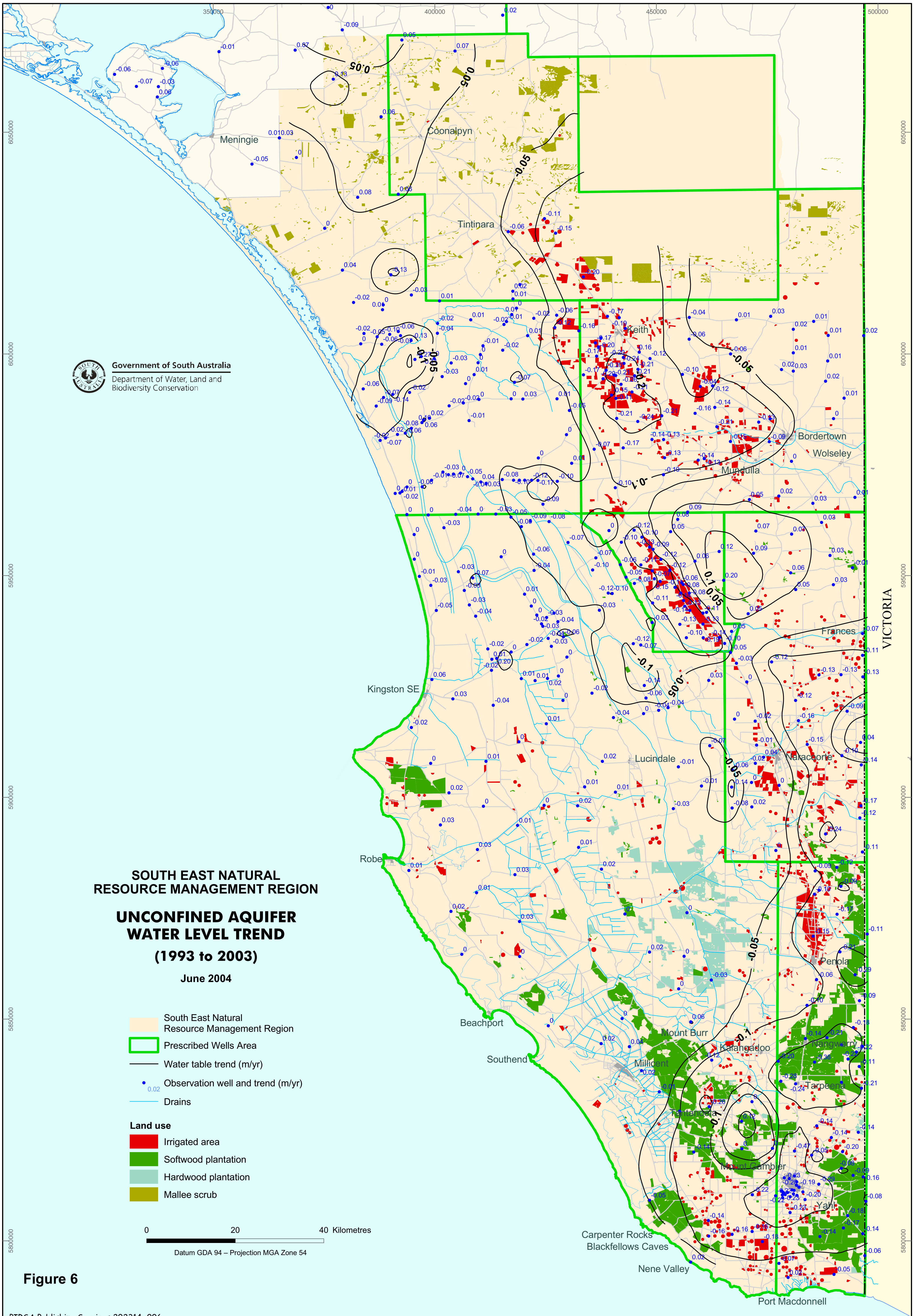

Figure 6

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Ten Year Regional water table trends (1993–2003)

Figure 6 displays water table trends over the preceding 10 years. The rate of groundwater level change (m/yr) was calculated using linear regression for each current observation well and contoured to indicate regions of rising and declining water levels. The main mechanisms governing changes in groundwater levels throughout the region are outlined below.

- A decline in water level due to below average rainfall since 1993 and subsequent reduction in recharge which has been observed in observation wells across most of the region (eg. Fig. 7).
- High volumes of groundwater extraction around the Blue Lake area and in areas of intense irrigation, particularly the Stirling management area in the Tatiara PWA.
- Declines in water table caused by reduced recharge within areas of plantations forrests.
- Rises in the water table associated with the clearing of native vegetation, notably in the northern portion of the Naracoorte Ranges PWA, around the elevated range areas east of the Riddoch Highway and in the Hundred of Senior.
- Relatively stable water levels throughout the Lacepede Kongorong PWA which is attributed in part to the drainage systems removing excess surface water and potential aquifer recharge during winter and spring periods.
- In the vicinity of wetlands in Upper SE region, water level trends are responsive to increased recharge to the aquifer and subsequent groundwater mounding

Figures 5 and 6 will be discussed further in the following sections of the report. Further assessment of groundwater trends are provided in the following sections for each of the Prescribed Wells Areas.

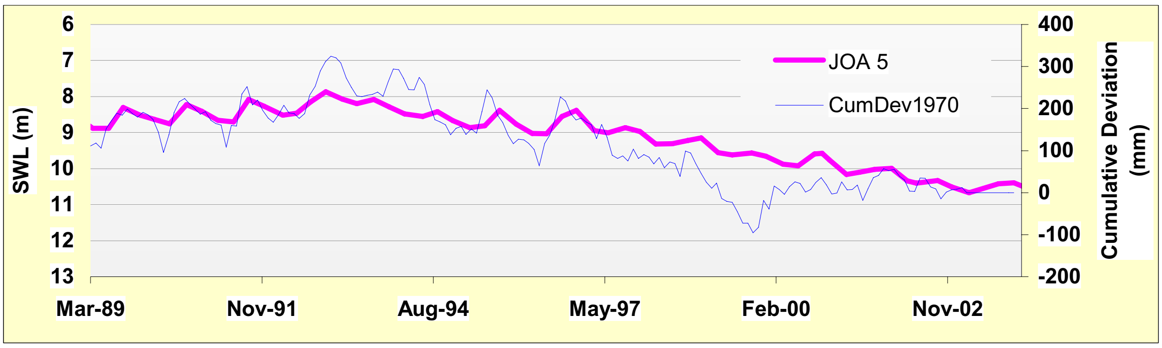

Figure 7. Unconfined aquifer hydrograph compared to cumulative deviation of monthly rainfall from Gauging Station 26079. A positive slope on the cumulative deviation line identifies periods of above average rainfall, while a negative slope identifies periods of below average rainfall.

Salinity Assessment

Salinity trends were also determined by linear regression for each observation well, using the entire length of record. Figure 8 shows the regional distribution of salinity trends (mg/L/yr) for the unconfined aquifer. In general, groundwater salinity increases from <500 mg/L in the south to greater than 4000 mg/L in the north, reflecting the reduction in annual rainfall and therefore recharge to the north (Rammers *et al*., 2002).

From Figure 8 it can be observed that:

- Salinity trends are generally greater in areas of high groundwater salinity.
- Increasing salinity trends are evident in areas that are intensely irrigated, particularly the Padthaway, Keith, Coonawarra and Naracoorte regions
- In the upper South East region (Naracoorte-Bordertown) increasing salinity trends are evident due to the mobilisation of soil accumulated salts resulting from increased recharge rates associated with native vegetation clearance.
- No discernible long term salinity trends are evident in other parts of the South East.

Further assessment of groundwater salinity is provided in the following sections for each of the Prescribed Wells Areas.

COMAUM-CAROLINE PRESCRIBED WELLS AREA

The Comaum-Caroline Prescribed Wells Area was proclaimed in 1986 and covers an area of approximately 1900 km^2. The PWA generally consists of low lying coastal plain that gently rises from the coast in the south to 70 m above sea level in the north of the area. In the north eastern portion of the PWA the Kanawinika fault separates the coastal plain from the elevated southern Naracoorte Ranges which rise 30 to 40 m above the elevation of the plain.

Unconfined and confined aquifers are both present in the PWA. The main water resource is the unconfined aquifer which predominantly consists of the Gambier Limestone formation. Land use in the PWA is mainly open pastures and forestry plantations (pinus radiata). Major underground water use includes irrigated pasture for dairying and other grazing in the southern portion of the PWA, viticulture (Coonawarra area) and potato growing (Kelly and Laslett, 2003).

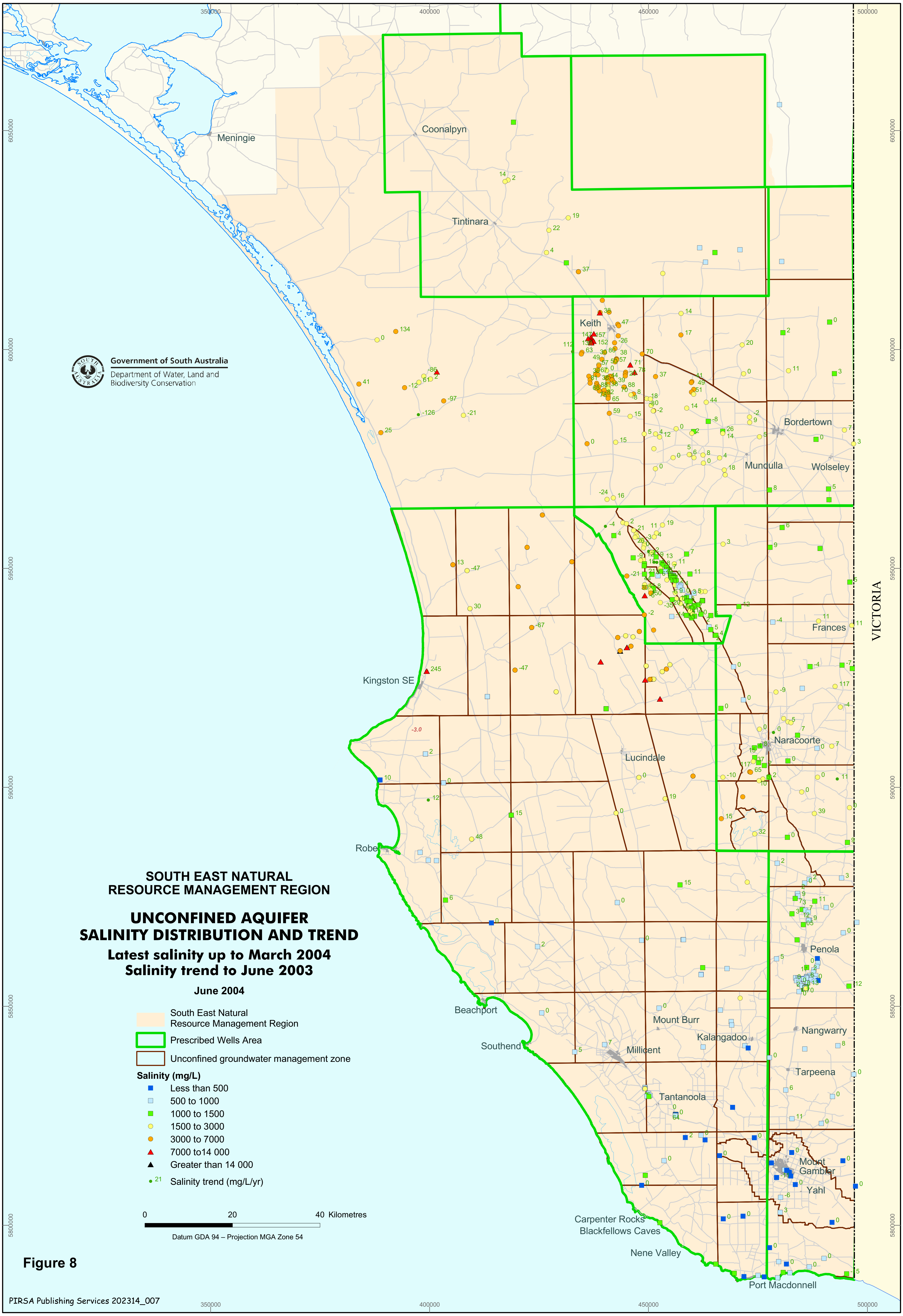

Figure 8

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Networks

The water level observation network in the Comaum Caroline PWA has been monitored for more than 30 years. There are currently 108 water level and 48 salinity monitoring wells which monitor the unconfined aquifer. Four observation well networks monitor the PWA and the locations of the current water level and salinity monitoring wells within these networks are shown on Figures 2 and 3. Observation wells are reasonably evenly distributed over the Comaum Caroline network PWA and monitor existing pine plantations, blue gum developments and intensely irrigated areas. The highest concentration of wells is centred around Mount Gambier city and are part of the water level and salinity monitoring network for the Blue Lake. Two other sub-networks include the Safries and Nangwarry networks. Safries was set up to monitor groundwater use and effluent disposal around a potato processing factory and the Nangwarry network monitors groundwater recharge and forestry impacts.

Water Level Trends

For the period 1993 to 2003 declining water levels are evident throughout most of the area (Fig. 6). This is consistent with below average rainfall and increased extraction over the same period.

In the northern portion of the Glenburnie management area, the decline is more long term and is reflective of the historical forestry in the area. Water level trends from hydrographs are shown spatially on Figure 6. Declining water levels in and around established plantations provide further evidence of their effect on reducing recharge to the unconfined aquifer. The greatest declines (-0.10 m to -0.36 m/yr) in water table over the preceding 10 years are seen in observation wells within the Hundred of Nangwarry (Zone 2A), Myora and Glenburnie management areas. The hydrographs displayed in Figure 9 from observation wells NAN 21, GAM 71 and CAR 48 illustrate this decline. Observation well NAN 19 in Zone 2A shows a 4.5 m rise in the watertable following the 1983 bushfire, and observation well YOU 26 shows a 3.0m rise since 1988 following the logging of the surrounding pine plantation (Fig. 9). These rises in groundwater level probably reflect an increase in rainfall recharge after those events.

The majority of observation wells within of the Blue Lake monitoring network indicate a steady decline in groundwater level since monitoring began in 1972. For the period 1993 to 2000 observation wells indicate a 2 to 2.3 m (~0.20 m/yr) drop in water table. Since the year 2000, water levels have generally remained stable. The hydrograph from observation well BLA 114 is a good representation of the overall trend in the area (Fig. 9). Long term rainfall trends help explain the changes in the water level observed in the Blue Lake network. Below average rainfall since 1993, continued potential forestry impacts and increased groundwater extraction within the area has contributed to the decline in groundwater level.

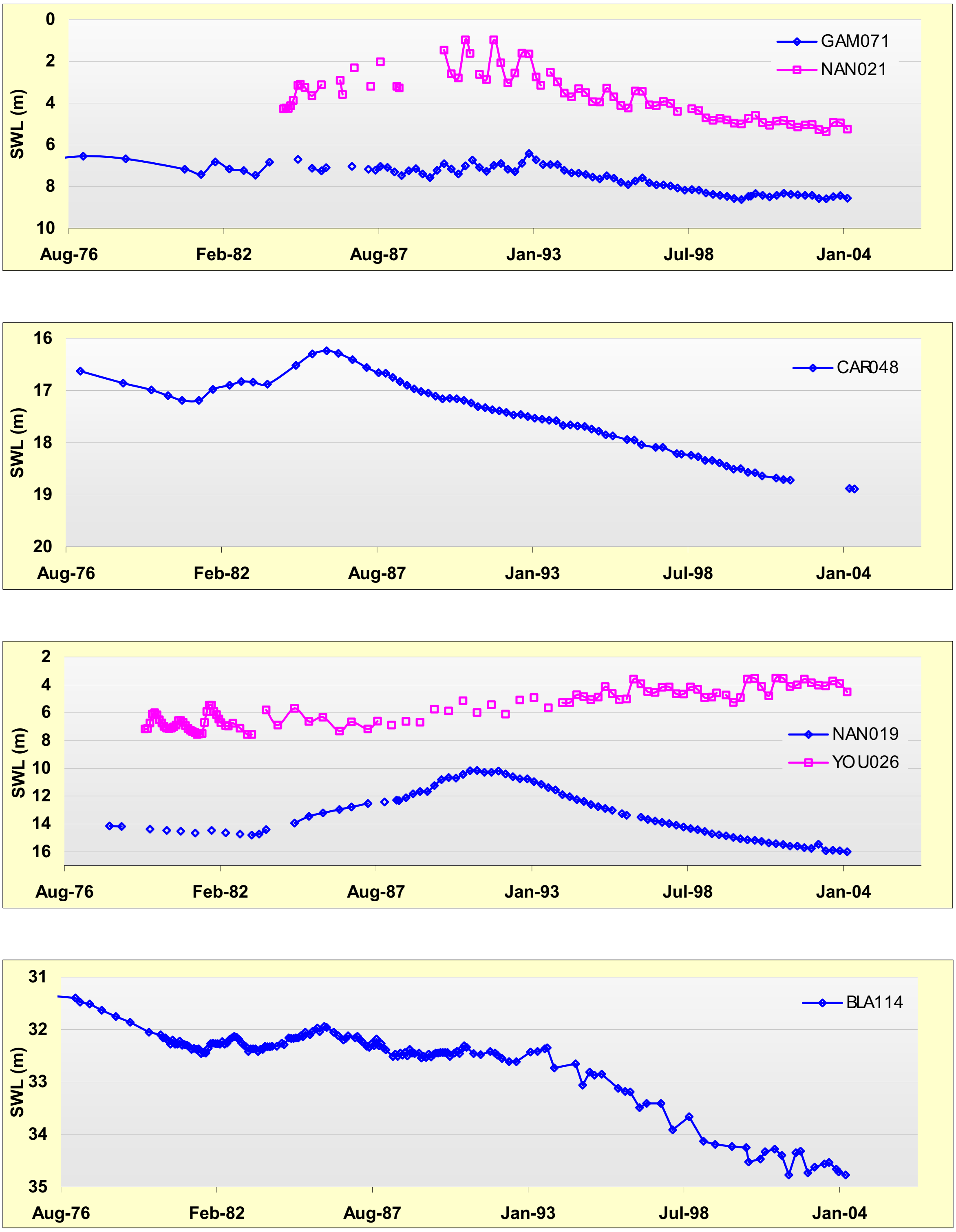


Figure 9. Hydrographs for the unconfined aquifer – Comaum-Caroline PWA

Salinity Trend

Long term salinity trends and latest salinity are displayed in Figure 8. Trends were calculated for each of the observation wells, with the majority containing salinity records dating back to 1986. The majority of the wells indicate that groundwater salinity has remained generally unchanged over the longer term. With the exception of a few, increases in groundwater salinity are generally less than 10 mg/L/yr.

TATIARA PRESCRIBED WELLS AREA

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. It covers an area of 3500 km^2 and is divided topographically into two discrete landforms, a low lying coastal plain to the west and the uplifted highlands of the Pinnaroo Block to the east. A scarp referred to as the Marmom Jabuk Fault to the north of the PWA and the Kanawinka Fault to the south separates the two terrains. The major irrigated crop in the Tatiara PWA area is lucerne seed. Other irrigated crops includes irrigated pasture, grape vines, pasture seed (mostly clovers), potatoes and oil seeds (Kelly and Laslett, 2003).

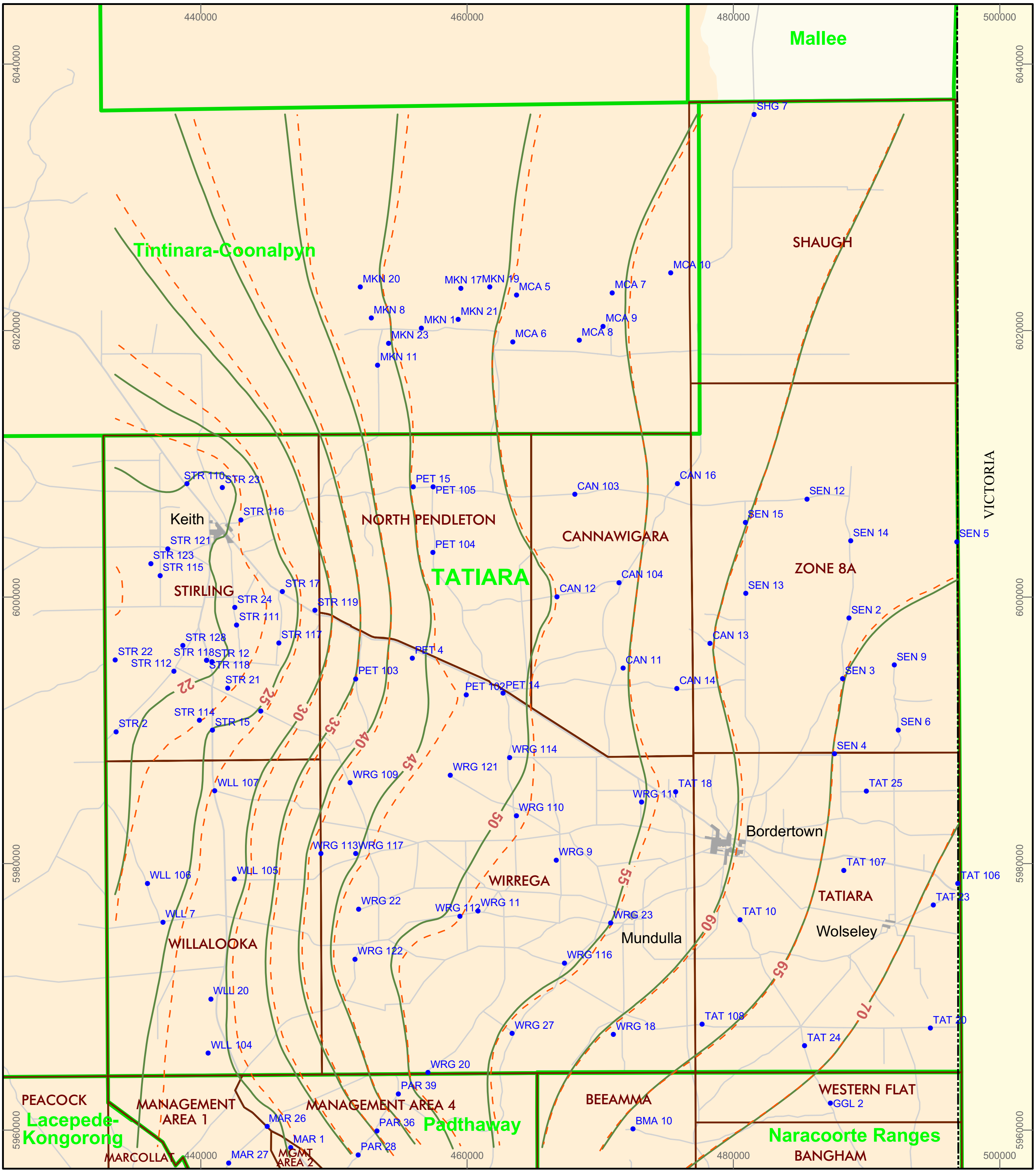
Networks

Groundwater level and salinity 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 the impact of changing land uses such as native vegetation clearance.

The locations of the current water level and salinity monitoring wells are shown on Figures 2 and 3. The majority of the wells are concentrated in the areas of highest risk, namely the intensely irrigated area of the Hundred of Stirling. 92 water level wells are monitored biannually and of these 43 are being monitored quarterly. Of the salinity monitoring wells, 32 Government wells are monitored biannually, 11 Government and private wells are monitored quarterly and an additional 101 privately owned irrigation wells which are monitored at random times throughout the irrigation season. These private irrigation wells make up the Tatiara Irrigation network (TAT-IRR).

Groundwater Flow

A detailed water table contour for the unconfined aquifer within the Tatiara PWA is shown in Figure 10 and illustrates that the direction of flow is generally from east to west. The changes in hydraulic gradient as reflected in the spacings of the contours represents changes in hydraulic conductivity and thickness of the aquifer. The gradient becomes steeper near the eastern boundary of the Hundreds of Stirling and Willalooka. This steep gradient corresponds to a change in the aquifer lithology, with the tertiary limestone being the dominant unit east of the escarpment and the quaternary sediments being the main units west of the escarpment. The increased hydraulic gradient reflects a reduction in both the hydraulic conductivity and the thickness of the aquifer.



Government of South Australia
Department of Water, Land and Biodiversity Conservation

0 10 20 Kilometres

Datum GDA 94 – Projection MGA Zone 54

- South East Natural Resource Management Region
- Prescribed Wells Area
- Unconfined groundwater management zone
- Reduced standing water level (m/AHD) - March 2004
- Reduced standing water level (m/AHD) - September 2003
- CAN 14 • Water level observation bores and number

TATIARA PRESCRIBED WELLS AREA

UNCONFINED AQUIFER WATER TABLE CONTOURS

(September 2003 and March 2004)

June 2004

Figure 10

PIRSA Publishing Services 202314_013

Water table contours are presented for September 2003 and March 2004 (Fig. 10). A comparison of the water table surfaces for these periods enables an assessment to be made of the impacts of groundwater extraction through the irrigation season. Importantly, from this figure it can be observed that the eastward migration of the 22 m contour at March 2004 is a result of high groundwater extraction within the Hundred of Stirling throughout the irrigation season.

Water Level Trends

Figure 6 indicates that water levels in the north-western portion of the PWA, particularly the Hundred of Stirling, are declining at a rate of -0.20 to -0.25 m/yr over the preceding 10 years. This is further supported by Figure 5 (water table difference 1975–2003) which indicates a decline in water table of 2 to 3 m. Factors contributing to this decline in groundwater level are intense irrigation with large groundwater extractions exceeding vertical recharge compounded by below average rainfall. The hydrograph from observation well STR 13 clearly indicates a steady decline in water level over the entire record (Fig. 11). The change in slope from 1993 is the combined effect of irrigation and below average rainfall throughout this period.

Similar declines are noticed in the hundred of Willalooka (-0.10 to -0.24 m/yr) and in the northern part of Wirrega (-0.13 to -0.21 m/yr) for the same period. It is presumed that this declined is an expansion of the cone of depression emanating from the hundred of Stirling, combined with localised impacts.

Over the long term, water levels within the Hundred of Wirrega have remained static up until 1993 where they have declined due to reduced recharge caused by below average rainfall or unseasonal rainfall (rainfall during summer when evaporation is high). The hydrograph from WRG 23 illustrates this trend (Fig. 11).

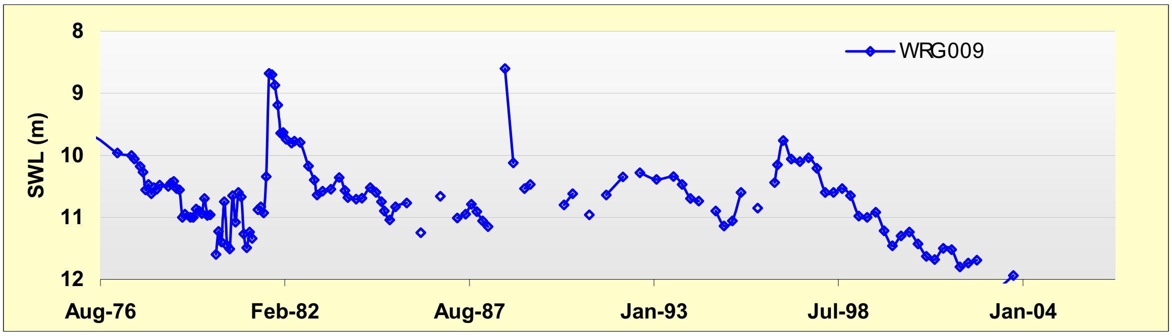
The peaks in the water level in hydrograph WRG 9 are a result of direct recharge (localised recharge) to the water table via surface water discharge into numerous runaway holes (Fig. 11).

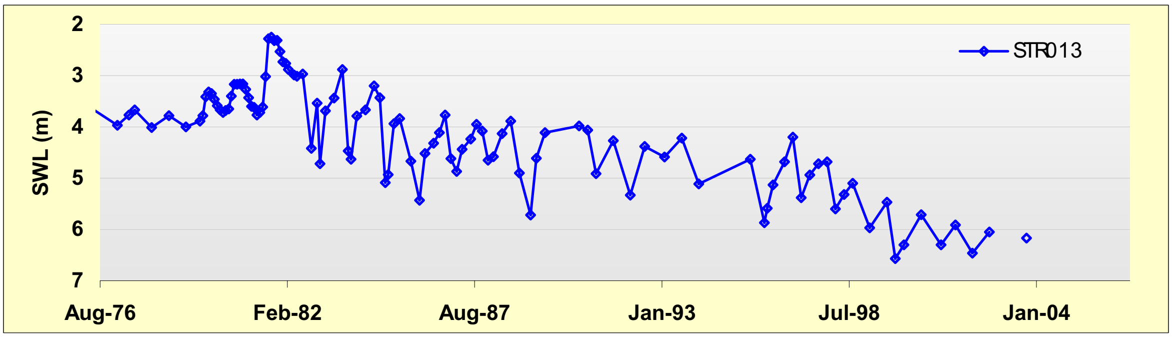
Towards the east of the PWA, hydrographs are indicating a slight rise in the water table level. This is associated with increased recharge through the clearance of native vegetation by early European settlers, and is clearly illustrated by the hydrograph from observation well TAT 24 (Fig. 11).

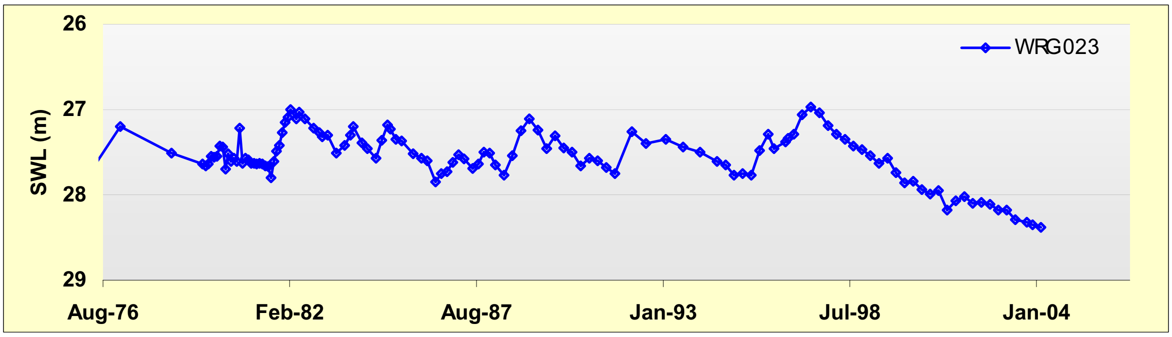
Salinity Trends

The salinity distribution for the Tatiara PWA is shown on Figure 12. Generally the salinity ranges from ~1000 mg/L in the east to > 8500 mg/L in the north west portion of the Stirling irrigation area.

Figure 12 also shows the distribution of wells and their annual salinity trend. The higher trends in groundwater salinity are associated with areas of high groundwater salinity and areas where irrigation exceeds vertical recharge, notably the Stirling irrigation area.







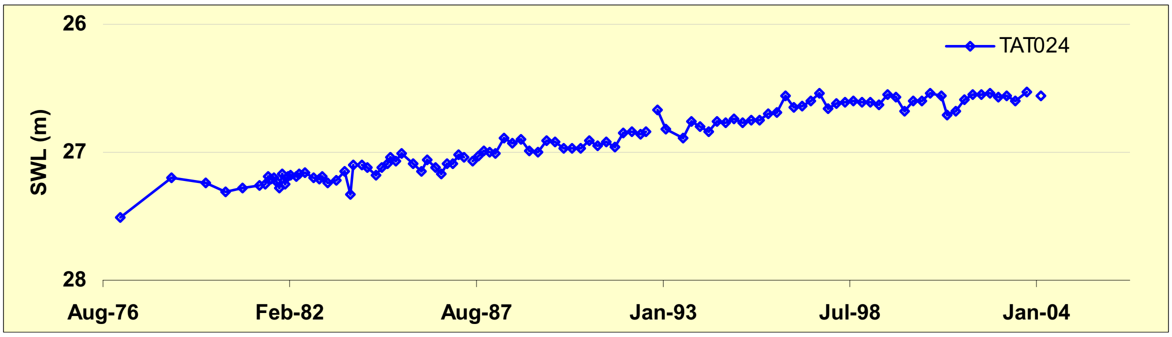
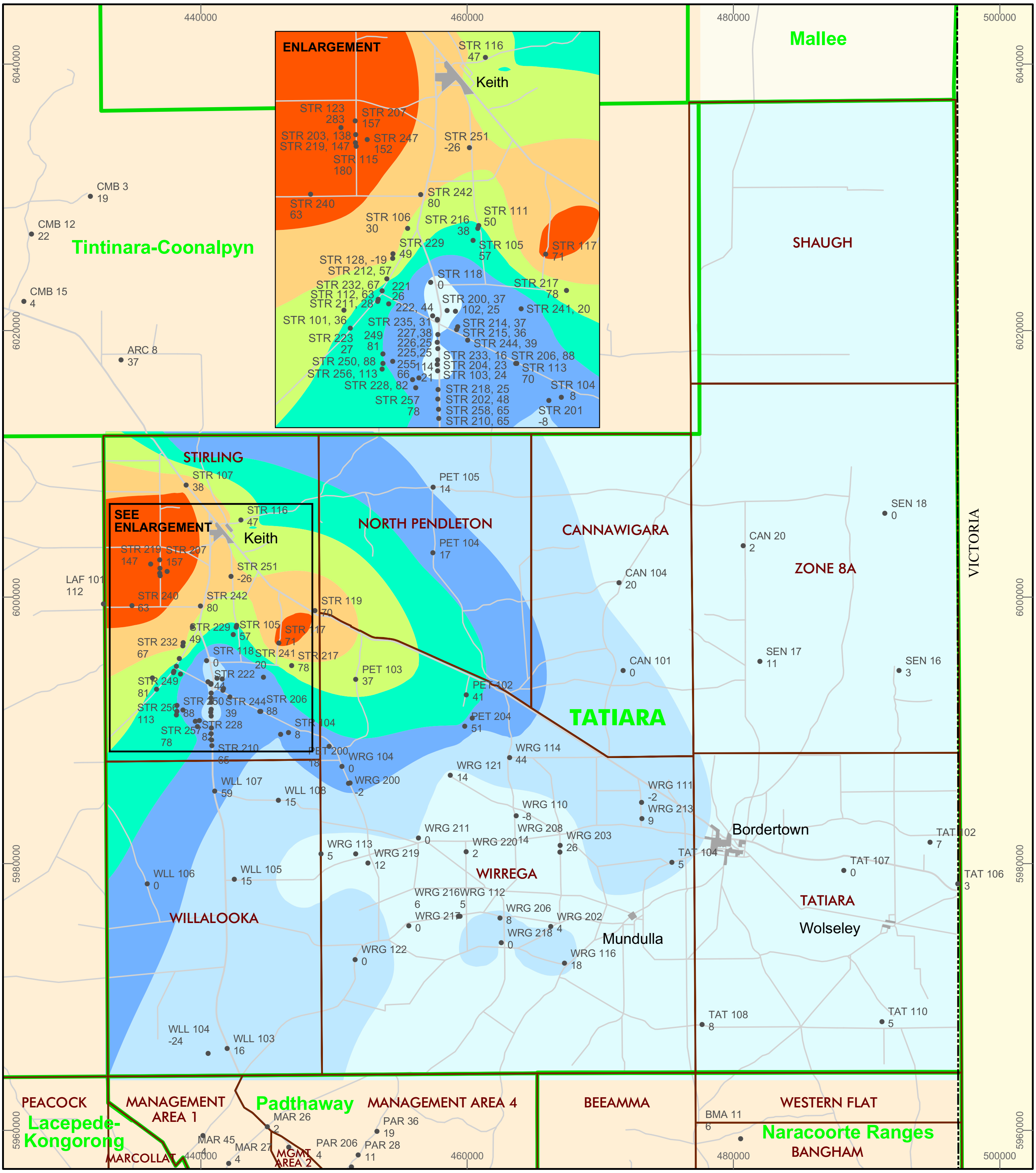


Figure 11. Hydrographs from the unconfined aquifer – Tatiara PWA



Government of South Australia
Department of Water, Land and Biodiversity Conservation

0 10 20 Kilometres

Datum GDA 94 – Projection MGA Zone 54

South East Catchment Water Management Board Area
Prescribed Wells Area
Unconfined groundwater management zone
WRG 116 18 • Salinity trend (mg/L/yr)

Salinity (mg/L)

- 1000 to 2000
- 2000 to 3000
- 3000 to 4000
- 4000 to 5000
- 5000 to 6000
- 6000 to 7000
- Greater than 7000

TATIARA PRESCRIBED WELLS AREA

UNCONFINED AQUIFER SALINITY AND TRENDS

Latest salinity to March 2004
Salinity trend to June 2003
June 2004

Figure 12

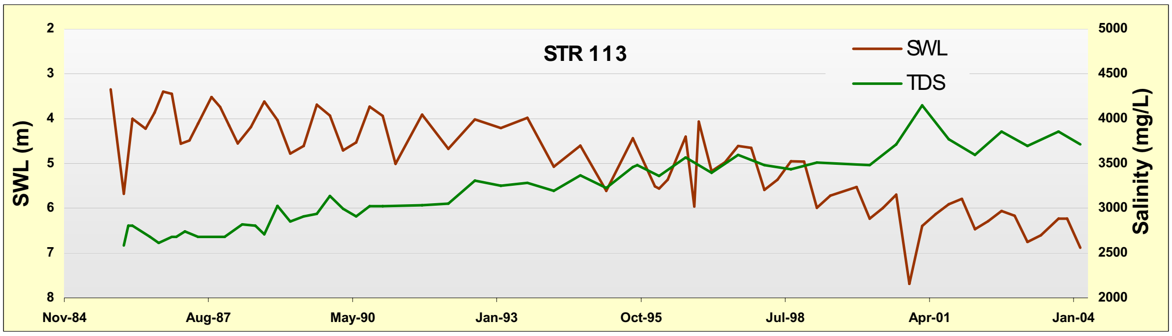
PIRSA Publishing Services 202314_014

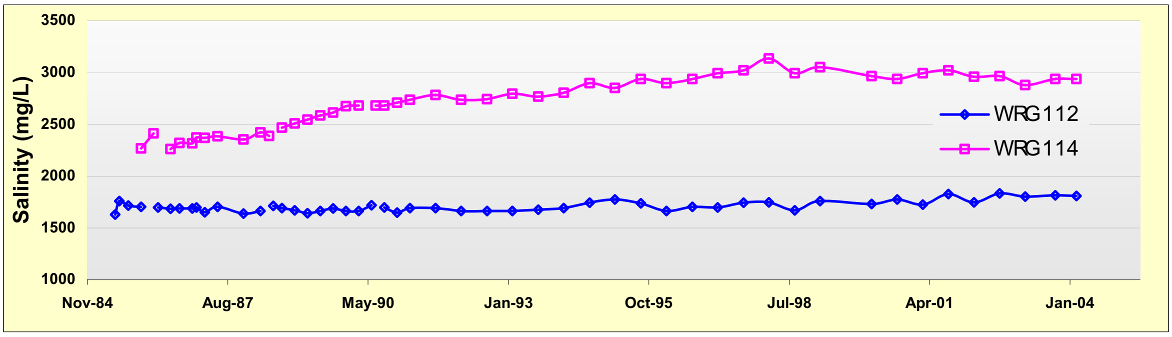
It is evident that areas of higher groundwater salinity show a greater annual salinity increase due to the large salt load leaching from the unsaturated zone into the water table by the recycling of irrigation water. In parts of the Stirling irrigation area, where the salinity of the groundwater exceeds 7000 mg/L, the salinity is increasing at a rate of 50 to >100 mg/L/yr (Fig. 12) for the majority of observation wells.

The following graph from observation well STR 113 (Fig. 13) helps explain the trend within Stirling irrigation area. Water level and salinity have been plotted together to illustrate the relationship of declining water level and the corresponding rise in salinity, caused from the extraction and recycling of irrigation water.

Within the Wirrega Management Area, salinities vary from 2000 mg/L to > 5000 mg/L in the north western portion of the Management Area (Fig. 12). In close proximity to numerous runaway holes in the north eastern 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 runoff. The majority of observation wells indicate a salinity increase of <5 to 15 mg/L/yr (WRG 112 Fig. 13) with some indicating a higher trend of 35 to 50 mg/L/yr (WRG 114 on Fig. 13) towards the northern portion of the Wirrega Management Area.

Within the Tatiara Management Area, salinity trends have remained relatively unchanged (<10 mg/L/yr). This is illustrated by observation well TAT 108 in figure 13 and is attributed to the minimal use of low salinity irrigation water, combined with the greater depth to the water table. A small number of observation wells in the Cannawigara Management Area and Zone 8A suggest that groundwater salinity has also remained stable in these areas.





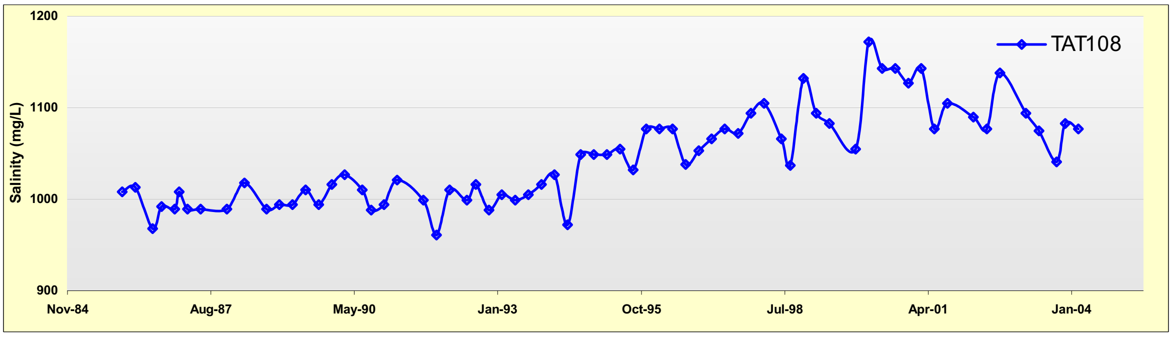


Figure 13. Salinity graphs form the unconfined aquifer – Tatiara PWA

PADTHAWAY PRESCRIBED WELLS AREA

The Padthaway PWA was proclaimed in 1976 following concern that increased irrigation activity may lower the water table. It covers an area of 700 km^2 and is divided by topography into a low lying inter-dunal flat to the west and a remnant dune ridge to the east that rises up to 60 m above the flat. The two terrains are separated by the Kanawinka fault, which runs through the middle of the PWA in a NW-SE direction.

On the inter-dunal flat, groundwater flows through two sub aquifers of the unconfined aquifer system: the Padthaway Formation sub aquifer which is present only on the flat and the underlying Bridgewater formation sub aquifer. In the ranges to the east, the Bridgewater formation sub aquifer is the main source of groundwater. The principal irrigated industry in the Padthaway PWA is viticulture. There are also substantial areas of irrigated pasture, hay and seed production, cereals and canola (Kelly and Laslett, 2003).

Networks

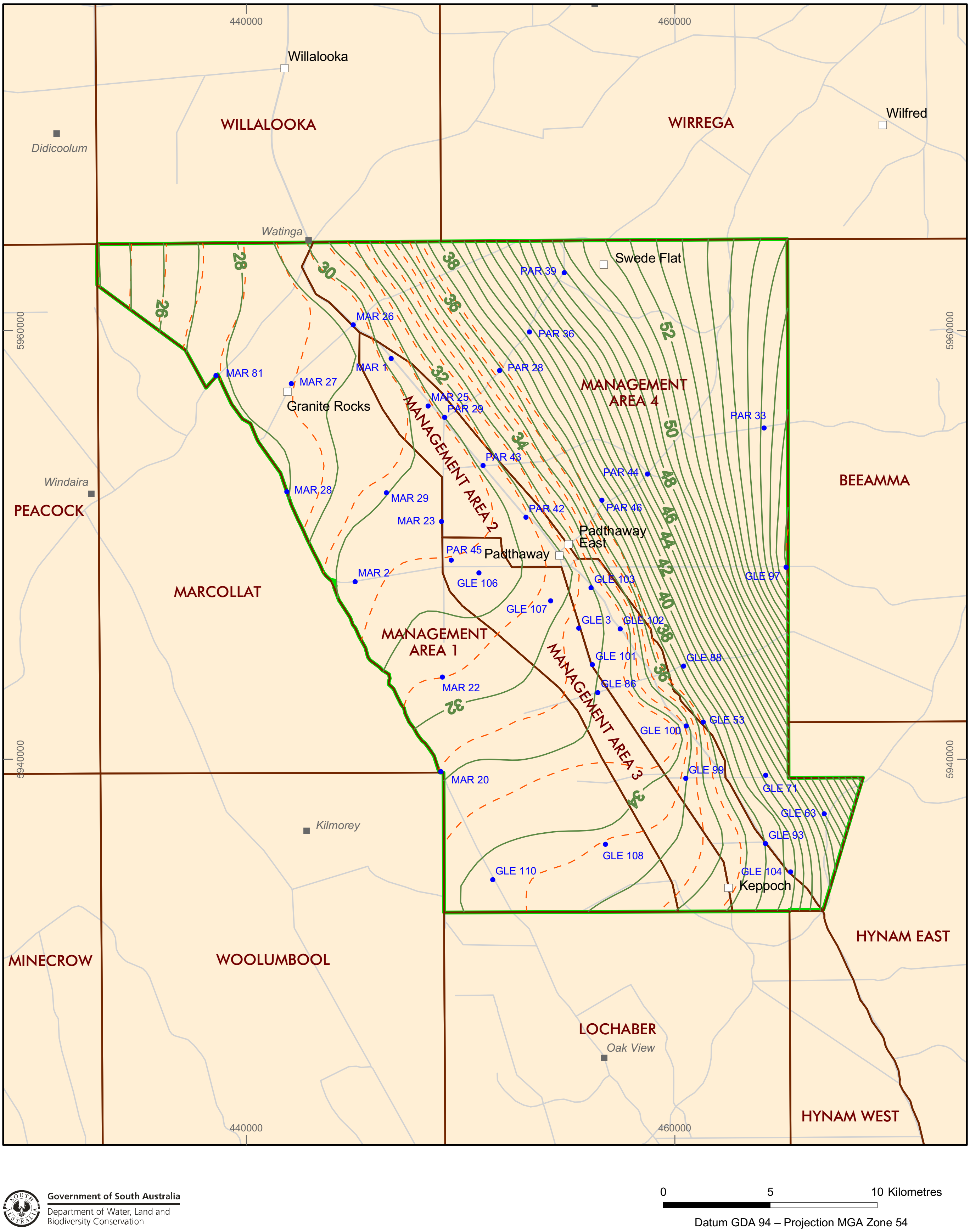
Groundwater level monitoring has been undertaken in the Padthaway PWA since 1970 and salinity monitoring commenced in 1978. The Padthaway network (PADTH) is monitored on a quarterly basis and contains 67 water level and 54 salinity observation wells. In addition, the Padthaway Irrigation network (PAD-IRR) which consists of 62 privately owned irrigation which are monitored for salinity on a random basis throughout the irrigation season. The locations of the wells in the current water level and salinity monitoring networks are shown on Figures 2 and 3 respectively.

Groundwater Flow

A detailed water table contour for the unconfined aquifer is presented in Figure 14. Groundwater flow is generally in south south-westerly direction east of the Kanawinka Fault. On the inter-dunal flat the flow direction changes to a north-westerly direction consistent with the slope of the ground surface. The hydraulic gradient is relatively steep up gradient of the Kanawinka fault. This steepening reflects the lower hydraulic conductivity in the Bridgewater formation (or could be caused through a change in flow dynamics related to the fault; Cobb *et al.*, 2000). Hydraulic gradients are much lower on the flat, reflecting the high transmissivity of the Padthaway Formation.

Water Level Trends

The distribution of water level trends over the preceding 10 years (Fig. 6) indicates a general rise in water table level throughout Management Area 4 of about 0.05 to 0.10 m/yr. This is supported by Figure 5 (water table difference 1975–2003) which indicates a rise in water table of 1 to 2 m. The following representative hydrographs from observation wells GLE 88 and PAR 44 (Fig. 15) indicate a higher rising trend beginning in the 1980s. The rise is due to an increase in vertical recharge to the water table following the clearing of native vegetation.



Government of South Australia
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PADTHAWAY PRESCRIBED WELLS AREA

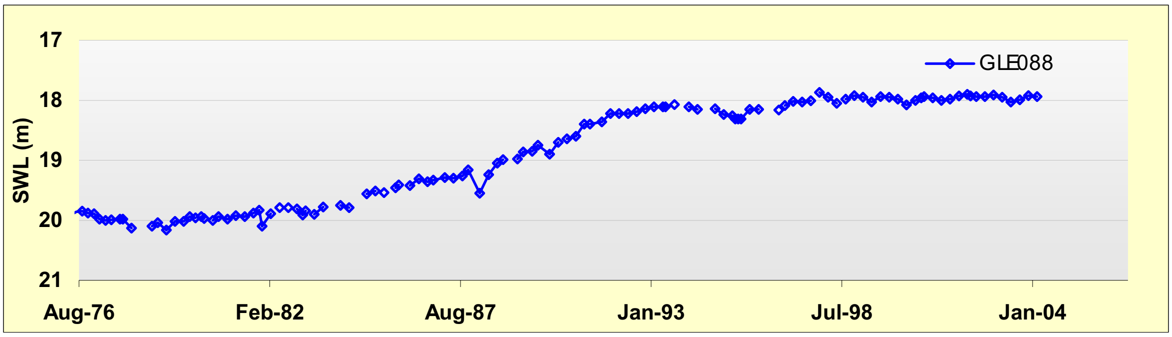
UNCONFINED AQUIFER WATER TABLE CONTOURS

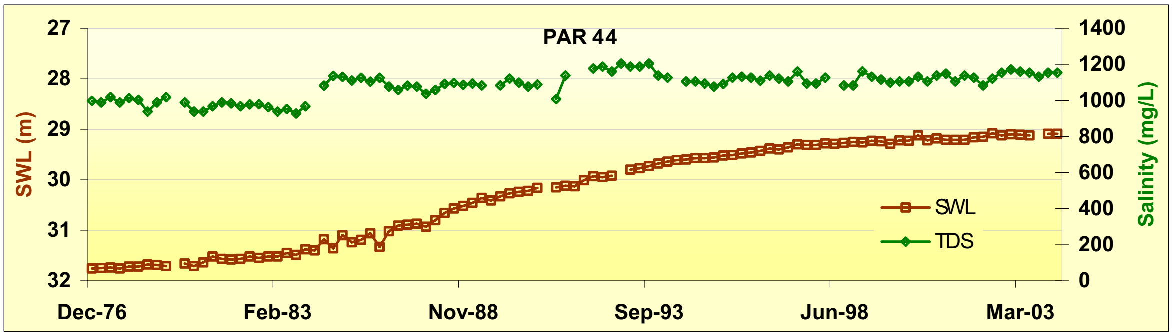
(September 2003 and March 2004)

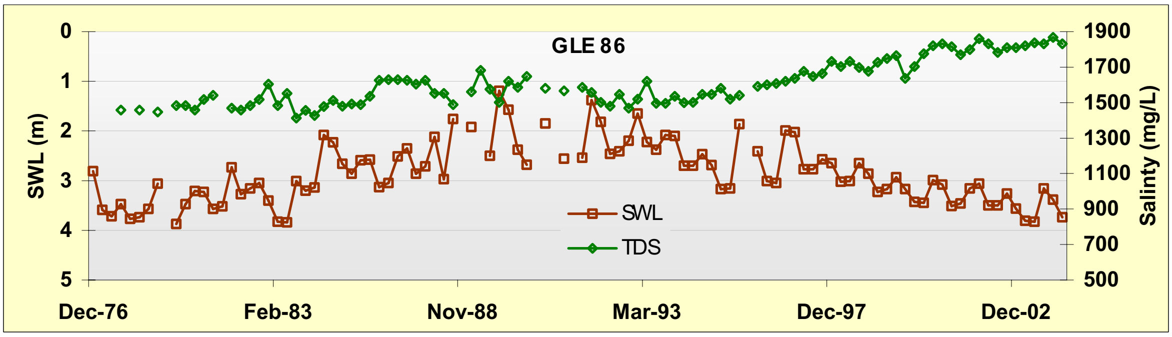
June 2004

Figure 14

PIRSA Publishing Services 202314_015







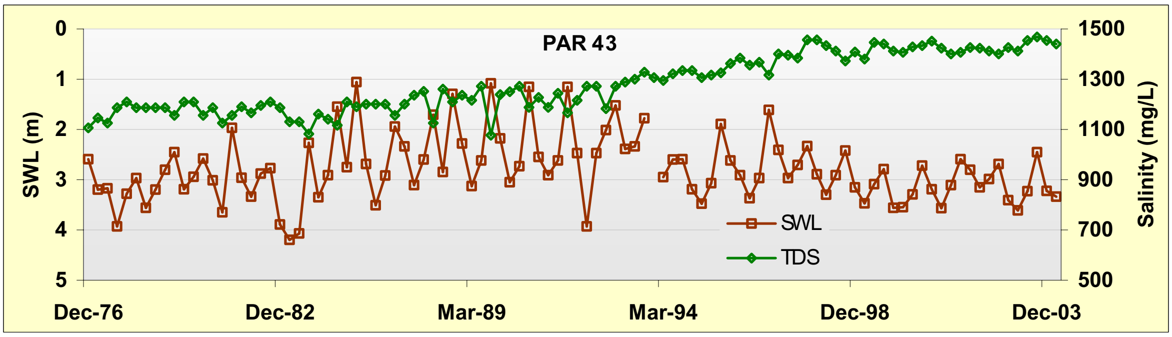


Figure 15. Hydrographs and salinity graphs for the unconfined aquifer – Padthaway PWA

In the other Management Areas (1, 2 and 3) observation wells generally respond to rainfall trends and have indicated a slight decreasing trend (-0.07 to -0.10 m/yr). This trend is attributed to below average rainfall experienced throughout this period as recognised elsewhere in the South East region. The hydrographs from GLE 86 and PAR 43 help explain the trends in Management Areas 1, 2 and 3 (Fig. 15).

Salinity trends

The rise in groundwater salinity observed throughout Management Area 4, is associated with the steady increase in groundwater level. Generally, groundwater salinity throughout Management Area 4 is increasing at a rate of 7 to 20 mg/L/yr (Fig. 16). This is due to the mobilisation of historic salt loads within the unsaturated zone caused by the higher rates of groundwater recharge and dissolution of salts as the water table rises. This can be observed in observation well PAR 44 which shows this rise in water table and corresponding rise in groundwater salinity (Fig. 15).

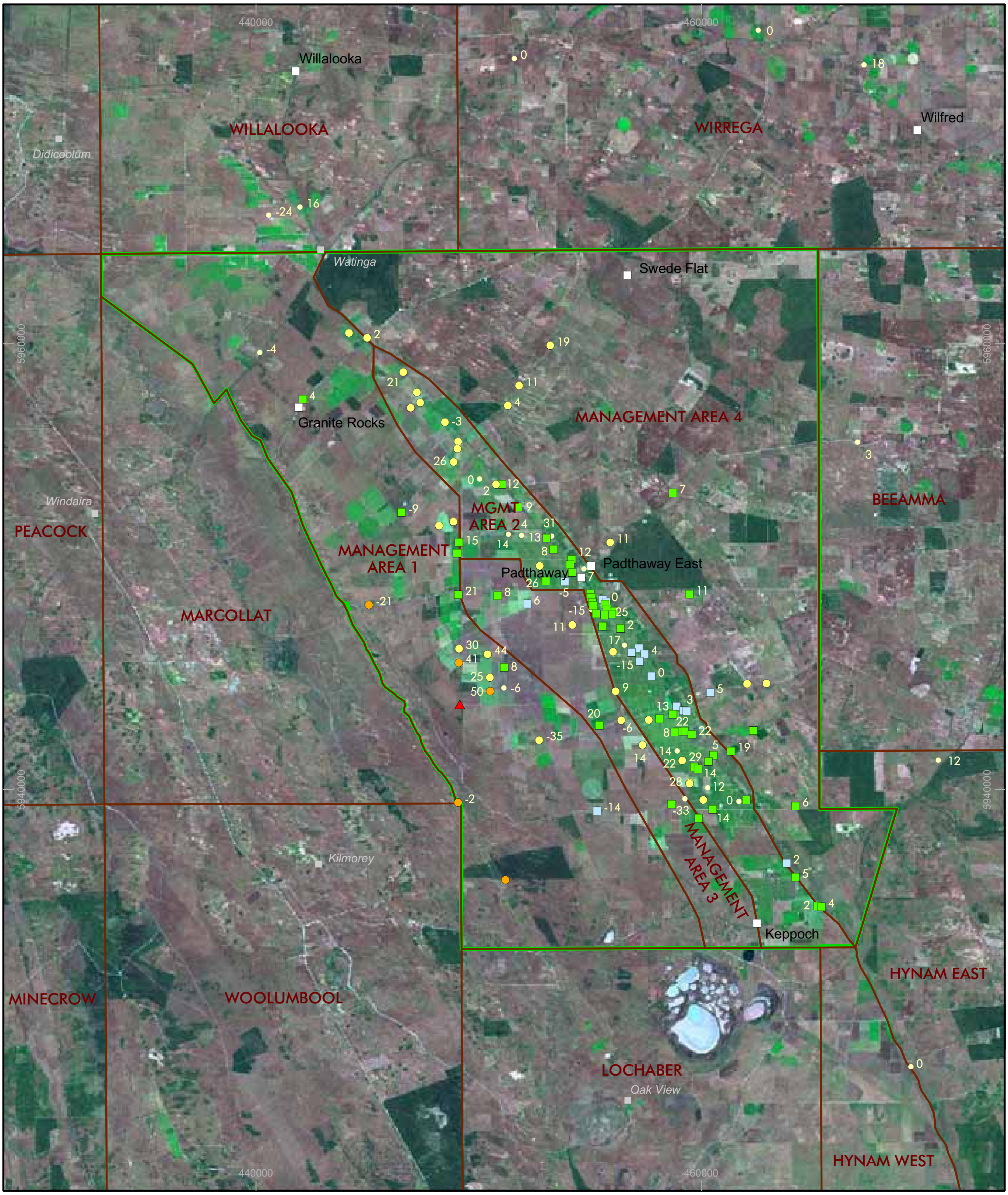
In Management Areas 2 and 3, the groundwater salinity is rising at a rate of 10 to 20 mg/L/yr (Fig. 16). The significant rising trend is attributed to two basic mechanisms, the recycling of irrigation water and the movement of salt fluxes down gradient from the ranges in the east (Management Area 4). The salinity graphs for GLE 86 and PAR 43 (Fig. 15) reflect these processes.

The mechanisms described above which are contributing to groundwater salinity increases are currently being investigated as part of the National Action Plan Padthaway Salt Accession Project.

LACEPEDE KONGORONG PRESCRIBED WELLS AREA

The Lacepede-Kongorong PWA was prescribed in 1997. It is the largest PWA in the South East, covering an area of approximately 9000 km^2. The northern and central portion of the PWA is characterised by sub-parallel northwest trending stranded beach-dune ranges separated by flat lagoonal/lacustrine plains. These ranges coalesce to the south forming the more uniformly undulating area west of Mount Gambier.

The regional unconfined and confined aquifers are both present and utilised in the PWA. Land use in the PWA is primarily grazing, cropping and pine forest plantation. Other major uses of groundwater include irrigation of pastures, grape vines, fruit orchards, potatoes and dairying (Kelly and Laslett, 2003).



Government of South Australia
Department of Water, Land and Biodiversity Conservation

0 5 10 Kilometres

Datum GDA 94 – Projection MGA Zone 54

Salinity (mg/L)

- Less than 500
- 500 to 1000
- 1000 to 1500
- 1500 to 3000
- 3000 to 7000
- 7000 to14 000
- Greater than 14 000
- Salinity trend (mg/L/yr)

Padthaway Prescribed Wells Area

Unconfined groundwater management zone

Imagery provided by ImageMapSA

PADTHAWAY PRESCRIBED WELLS AREA

UNCONFINED AQUIFER LATEST SALINITY AND TREND

(Salinity trend to September 2003)

June 2004

Figure 16

PIRSA Publishing Services 202314_016

Networks

There are currently 315 water-level monitoring wells in the unconfined aquifer measured quarterly and 112 salinity monitoring wells (Figs 2 and 3). The existing monitoring networks were reviewed in 2003 and were altered to align within the Lacepede Kongorong Prescribed Wells Area. The former Blackford, Conmurra and Millicent networks were merged into two networks named Lacepede Kongorong North and Lacepede Kongorong South. The KCA network consists of 53 water level and 7 salinity observation wells and remains a separate network to monitor intense groundwater use from the unconfined aquifer in the vicinity of paper and pulp mills operated by Kimberly Clark Australia (KCA).

Water Level Trends

The majority of observation wells throughout the PWA show negligible change in water table. Those which indicate a decline in trend lie within an acceptable amount of <0.10 m/yr for the period 1993 to 2003. This decline would be largely due to the below average rainfall experienced throughout this period.

Large decreasing trends are evident in observation wells from KCA network. These were not included in the 10 year trend map on Figure 6 and are displayed in the following hydrographs from observation wells HIN 10 and 47 (Fig. 17). The distinct lowering of groundwater levels near Millicent (Snuggery) observed in the above hydrographs are associated with the large groundwater extraction (~15 000 ML/y) for a paper mill, which has resulted in a localised cone of drawdown (*Rammers et al., 2002*).

Observation wells in the north east of the PWA, have indicated a decreasing trend in water level since 1996 at a rate of -0.10 to -0.15 m/yr. Representative hydrographs shown in Figure 17 (LOC 35, LOC 43, WLM 53) indicate a drop in water table elevation of about 1 m and have levelled out in recent years. This is largely related to the construction of Fairview drain.

Figure 6 indicates relatively stable long-term water levels, particularly in the area south of Lucindale towards Millicent, which is attributed in part to the long established drainage system, which removes excess surface water during the winter–spring period (ROS 5 and SPE 6 Fig. 17) and prevents maximum rise in groundwater table level.

Salinity Trends

Whilst the number of suitable monitoring wells is small, most of those with a long enough record show no overall trend in salinity (Fig. 8). Increasing trends in salinity are seen in observation wells ROS 5 (48 mg/L/yr), CNM 6 & 7 (15 mg/L/yr) and LAN 1 (30 mg/L/yr).

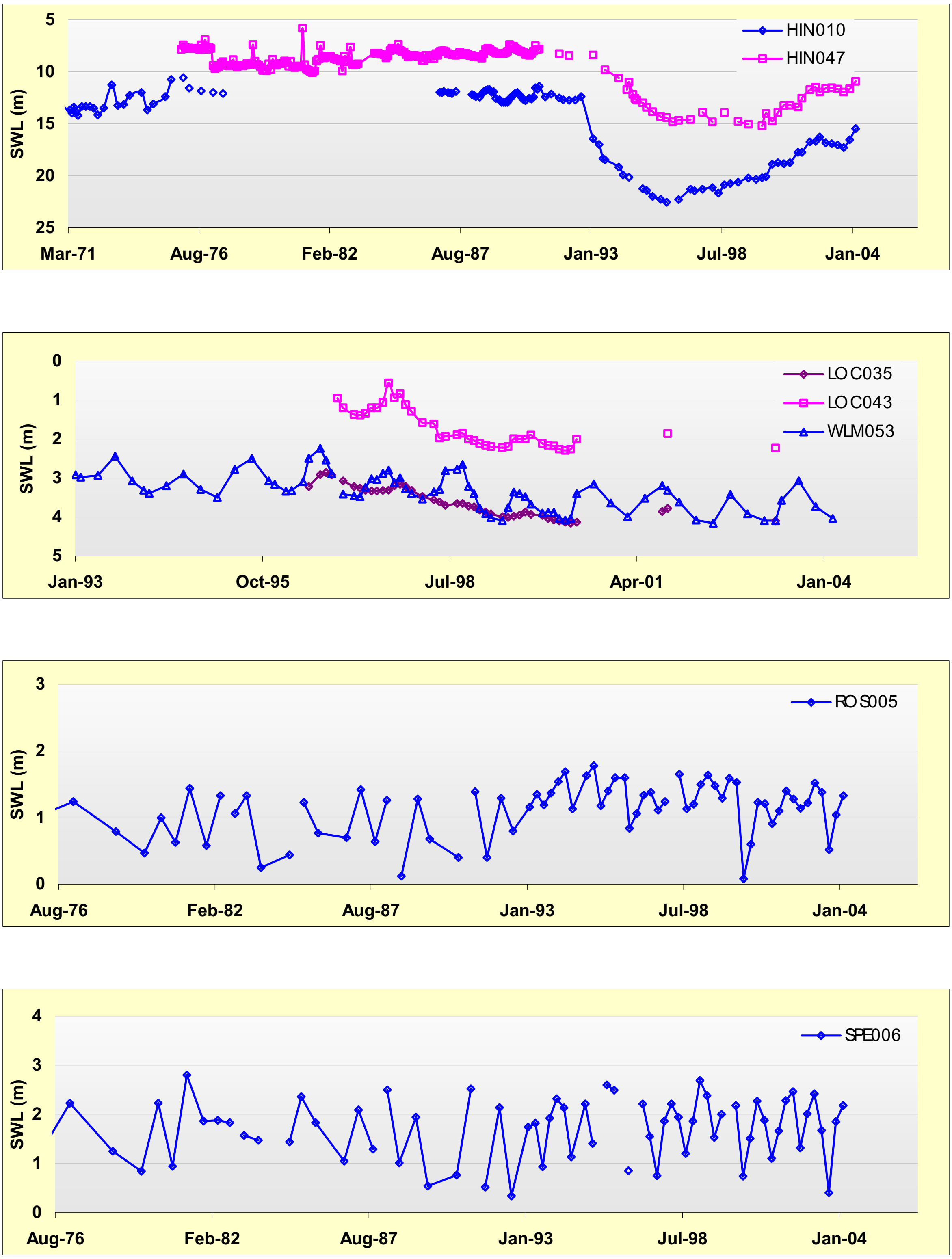


Figure 17. Hydrographs for the unconfined aquifer – Lacepede Kongorong PWA

NARACOORTE RANGES PRESCRIBED WELLS AREA

The Naracoorte Ranges PWA was proclaimed in 1986 and the boundary was expanded in 1993 to include the Naracoorte Plains (Hundreds of Naracoorte and Robertson). The PWA covers a area of approximately 2400 km^2. The PWA can be divided by topography into a low-lying interdunal flat located in the south-western portion of the PWA and an elevated highlands area in the north-east. The two terrains are separated by the NW-SE Kanawinka Fault.

The unconfined and confined aquifers are both present in the Naracoorte Ranges PWA. The main water resource is the regionally unconfined aquifer contained within Gambier Limestone formation in the Naracoorte highlands. Beneath the inter-dunal flat groundwater flow is generally through the Padthaway and Bridgewater Formations. Sheep and cattle grazing and dry land cropping are the main land uses in this PWA. Other major uses of groundwater include irrigation of pastures, hay and seed production, viticulture and potatoes (Kelly and Laslett, 2003).

Networks

In the Naracoorte Ranges PWA there are currently 57 observation wells in the water level monitoring network. There are two salinity monitoring networks in the PWA, a Government operated network (31 wells) and a private irrigation network (23 wells). The locations of the wells in the current water level and salinity monitoring networks are shown on Figures 2 and 3.

Water Level Trends

With the exception of the Hundred of Beeamma and Geegeela in the north of the PWA, groundwater levels from hydrographs generally show a decline over the previous 10 years. This is consistent with a period of below average rainfall and increased groundwater extraction that has occurred since 1993. The same trend is evident a large number of observation wells across the region.

Observation wells within the hundreds of Beeamma and Geegeela indicate a steady rise of about >0.10 m/yr in groundwater level since monitoring began in 1972. This is due to native vegetation clearance and the loss of lucerne crops in the mid 1970s, which has resulted in increased recharge rates to the aquifer. Over the previous 10 years, the rate of increase in ground water level has stabilized to 0.03 to 0.06 m/yr (Fig. 6). This change in trend is demonstrated in hydrographs from observation wells BMA 6, BMA 9 and GLE 9 (Fig. 18) and is largely due to the below average rainfall since 1993. Figure 5 shows the difference in water level 1975–2003 and indicates a 2 to 5 m rise in the Hundred of Beeamma and 1 to 2 m rise in the Hundred of Geegeela.

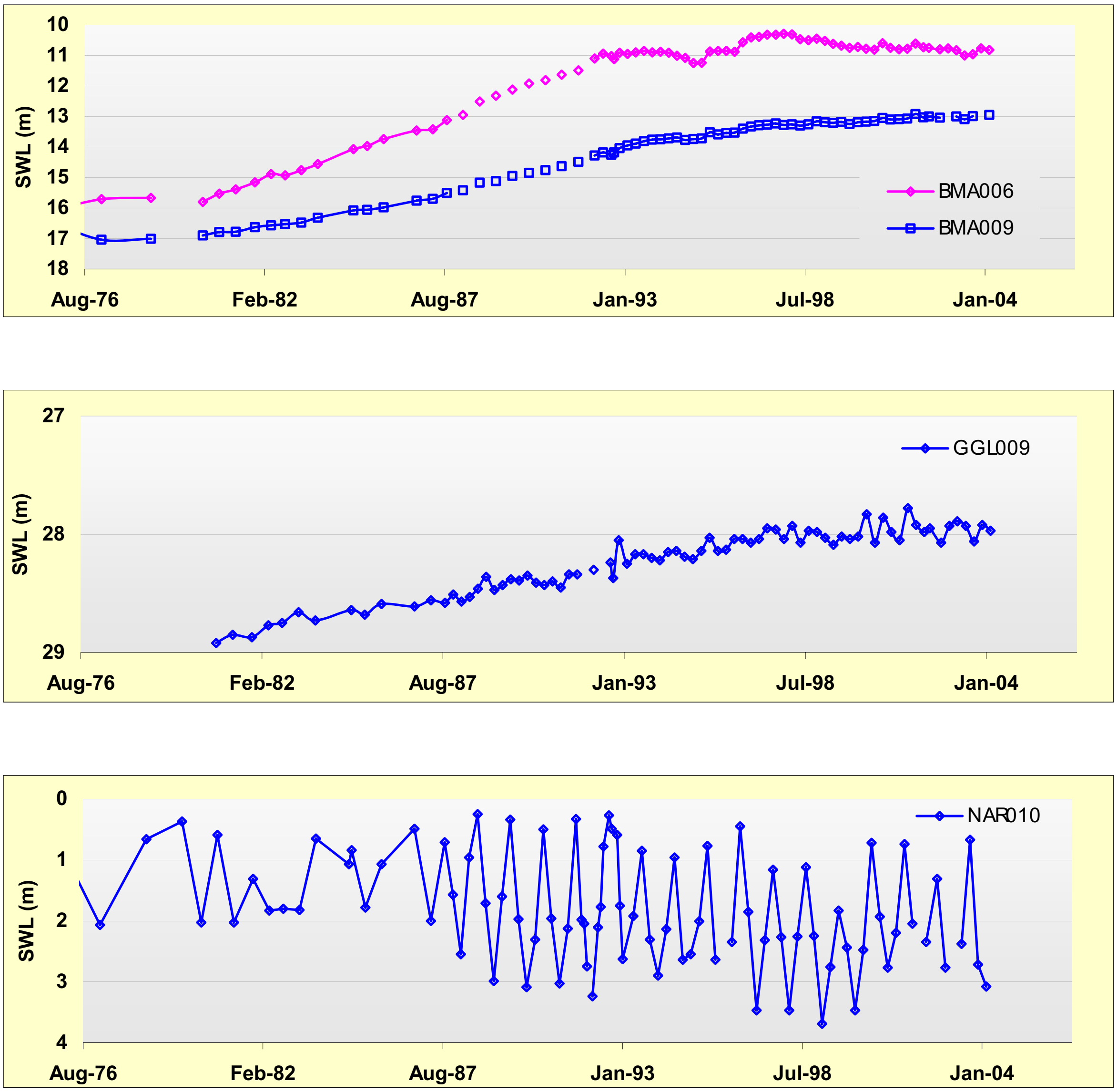


Figure 18. Hydrographs for the unconfined aquifer – Naracoorte Ranges PWA

Salinity Trends

Figure 8 displays the long term groundwater salinity trends. A number of observation wells are showing an increase in groundwater salinity above the acceptable limit (10 mg/L/yr).

In the Hundreds of Beeamma, Geegeela and Binnum, small increases in groundwater salinity (3 to 11 mg/L/yr) are observed and is attributed to higher rates of recharge mobilizing salt stored in the unsaturated zone as a result of land clearance and dissolution of salts as the water table rises. The salinity graph from observation well BMA 13 in Figure 19 illustrates this increase.

In the Hundred of Naracoorte and in the southern portion of the Hundred of Binnum, the increase in groundwater salinity is associated with areas of irrigation (recycling of irrigation

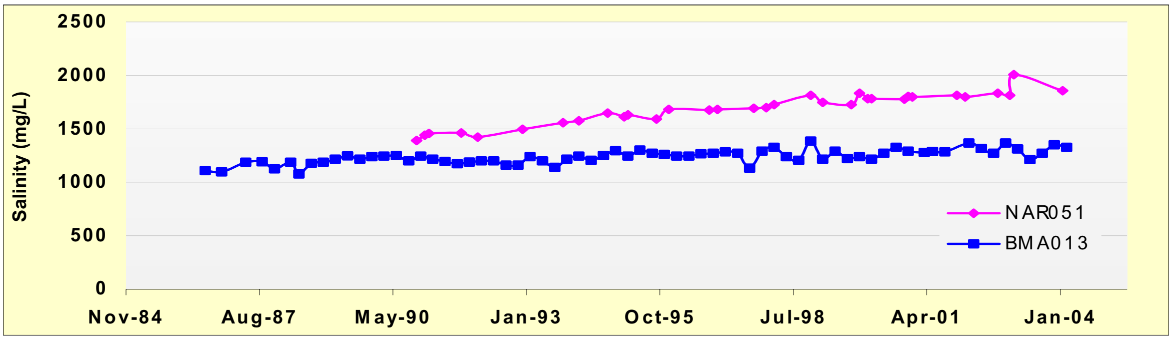


Figure 19. Salinity graph of observation wells BMA 13 and NAR 51

water as described previously). The biggest increases in groundwater salinity are noticed within the dense irrigation areas around BIN 39 (117 mg/L/yr since 1995), NAR 53 (65 mg/L/yr) and NAR 51 (37 mg/L/yr) as shown on Fig 8.

Further study to differentiate between increases in groundwater salinity caused by land clearance and that of high density irrigation is needed.

In the south west portion of the PWA, increases in salinity trend for ROB 4 (15 mg/L/yr) and ROB13 (32 mg/L/yr) are likely to be influenced by evaporation from Bool Lagoon and inflows of high salinity from the Mosquito Creek system.

TINTINARA – COONALPYN PRESCRIBED WELLS AREA

The Tintinara - Coonalpyn Prescribed Wells Area (TCPWA) covers an area of 3423 km^2 (Fig. 1). The TCPWA can be divided into two discrete land forms, the low-lying Coastal Plain to the west and the highlands of the Mallee to the north and east. Separating the two terrains is the extension of the Marmon Jabuk scarp.

Unconfined and confined aquifers are both present in the TCPWA. A more detailed description of the hydro stratigraphy can be found in Barnett 2002. The main water resource is the unconfined aquifer. Pasture and Lucerne dominate the irrigation activity from the unconfined aquifer.

Networks

The water level monitoring network in the TCPWA has been in operation for more than 17 years. The network has recently been upgraded and expanded to monitor the increase in irrigation development. There are currently 27 wells monitored for water level and these wells are measured approximately quarterly (March, June, September and December) or at appropriate times to monitor the beginning and end of the irrigation season. The locations of the current water level monitoring wells for the unconfined aquifer that have been entered into Obswell are shown on Figure 2.

There are currently six observation wells monitoring salinity in the TCPWA. Most of these were selected to monitor the salinity impacts of land clearing beneath the Mallee Highlands. Sampling is undertaken every six months. The location of wells in the salinity monitoring network for the unconfined aquifer are shown on Figure 3.

In 2000, a program to sample all private irrigation wells on an annual basis began, initially on the Coastal Plain to determine any effects of groundwater recycling in the shallow unconfined aquifer. This should be continued.

Currently, all observation wells for both the unconfined and confined aquifer are in one network called Tintinara, however, it is planned to separate these wells into two specific networks in the near future.

Water level Trends

On the Coastal Plain, water levels in the unconfined aquifer have been rising up until 1993 in response to increased vertical recharge resulting from the clearance of native vegetation (Barnett 2002). Below average rainfall since 1993 has lead to a decline in water level of about 1 m over that time. The fall in water table has the beneficial effect of delaying the spread of dry land salinity in an easterly direction from the low lying areas to the west and south of Tintinara (Barnett 2002). The following hydrographs from observation wells ARC 7, CMB 6 and CMB 32 display these trends (Fig. 20).

Due to the greater depth to the water table in the Mallee Highlands, variations in annual rainfall are generally dampened and a continuous rise due to vegetation clearance is observed (Barnett 2002). The rising trend is continuing to the north of Tintinara (Hundred of Lewis) and also to the east (Hundreds of Makin, McCallum) in areas not influenced by irrigation (Barnett 2002).

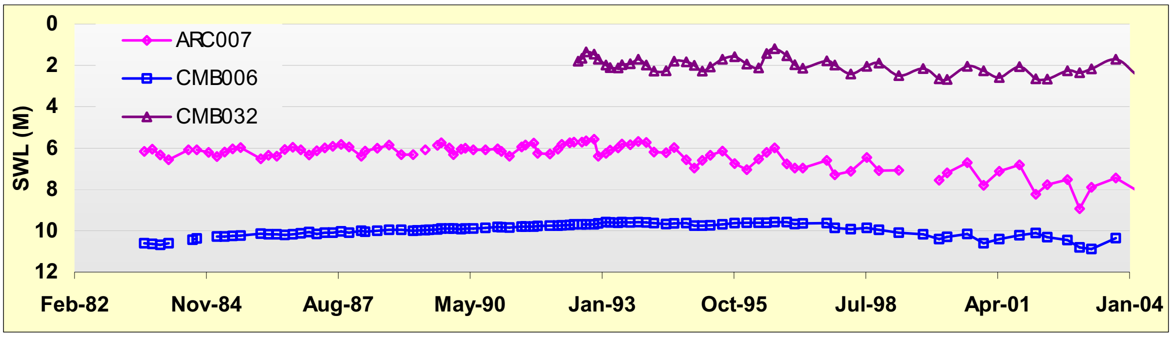


Figure 20. Hydrograph for the unconfined aquifer – Tintinara PWA

Salinity Trends

Insufficient data is available to assess trends after 2002. A discussion on salinity trends throughout the Tintinara PWA up to 2002 can be found in Barnett (2002).

UPPER SOUTH EAST REGION

Whilst not a Prescribed Wells Area, monitoring of water levels and salinity within the Upper South East region area has been undertaken since 1980. The monitoring area covers approximately 2450 km^2 (Fig. 1) and is characterised by stranded coastal dune ranges sub-parallel to the present coastline with inter-dunal corridors where numerous swamps and wetlands are common. The topography rises in the eastern portion extending into the Black Range and toward the Tatiara PWA.

The unconfined aquifer which underlies the area ranges from moderately saline to highly saline and is utilised primarily for stock water with some irrigation present within the Hundred of Laffer on the eastern margin. Where highly saline groundwater exists, stock and domestic water supplies are provided by reticulated supply from the Murray River.

The confined aquifer exists in the eastern portion of the area where some better quality water is utilised for stock supplies. Some small artesian flows have been observed during winter periods.

Many low lying areas have historically experienced prolonged inundation from excess surface water that naturally flows or has been diverted into the area from further south. Poor natural drainage, terminal wetlands and the shallow depth to the water table have all contributed the occurrence of dryland salinity on many of the interdunal flats.

A more detailed description of the groundwater occurrence can be found in MacKenzie & Stadter 1992.

A selection of observation wells were chosen in 1980 to fill a void in the existing regional networks that were established in the early 1970's and to observe water level and salinity trends. Additional wells were selected or drilled during the period 1990 to 1993 after it was recognised that the groundwater was mounding in vicinity of some wetlands and that the rising water table was causing water logging and increasing groundwater salinity. This information provided the background data for the USE Dryland Salinity and Flood Management Scheme that is currently being implemented to ameliorate surface water flood management and groundwater drainage.

Several traverses of observation wells were installed to examine the groundwater gradients and to provide background data prior to the installation of drains and an example groundwater cross-section is provided below. More recently, three traverses of observation wells were install to monitor the impact of drains on native vegetation.

Networks

The major monitoring network is called the USE Region and consists of 121 water level and 11 salinity observation wells in the unconfined aquifer, which are monitored on a 3 monthly basis. A sub network called Messent consists of 11 wells, which are within the Messent Conservation Park and are monitored for water levels by National Parks & Wildlife staff from Salt Creek on a monthly basis. There are 89 historic water level and 145 historic salinity observation wells in the region, many of which are in the vicinity of Jip Jip wetland and Cortina Lakes wetland complex.

A small group of 8 wells, two of which have continuous water level loggers installed, surround the Morella Basin in the north west corner of the region and monitor the potential impact of storage of water inflow from groundwater drains and natural surface water drainage.

There are no monitoring wells for the confined aquifer.

Water Level Trends

The depth to water varies according to topography and can rise above ground during winter along the low-lying watercourses. Observation wells LAF 8 and MCN 31 (Fig. 21) provide examples of this. Generally, the depths to the water table are approximately 1.5 to 5.0 metres below ground surface in most areas but can be up to 30 metres beneath the highest dune ranges.

Generally water levels across the region show a rising trend for the period 1980 to 1992 and a decline through to 2004 consistent with a period of below average rainfall. Observation well NVL 1 (Fig. 21) illustrates this trend. Seasonal fluctuations range from 1 to 1.5 metres where the water table is shallow and up to 0.5 metres where there is a greater depth to water table in the elevated or range areas.

A continuous decline is evident in the north eastern portion of the area and this is attributed to a response to groundwater extraction for irrigation of lucerne both locally and further east into the Hundred of Stirling (Tatiara PWA). The hydrograph for LAF 1 demonstrates this decline (Fig. 21).

Salinity Trends

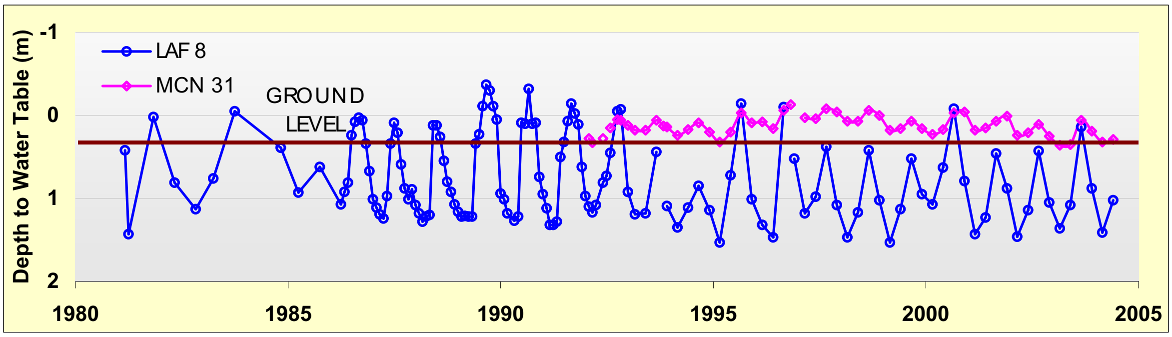
The average salinity of the 11 monitoring wells is 3850 mg/L, however the salinity varies dependent on the proximity to the coast, low lying salt effected areas and wetlands. The depth of the well is also significant as salinity stratification is evident within the unconfined aquifer.

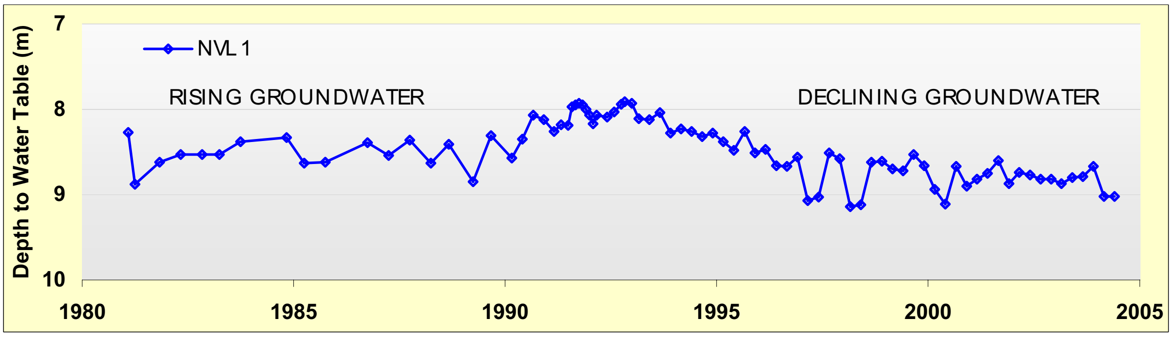
The small number of monitoring wells reflects the low dependency on groundwater for stock and domestic purposes due to the high salinity in most areas.

The variations in salinity trends are displayed for wells MCN 1 and SAN 2 (Fig. 22).

It is observed that there is a corresponding decline in salinity where there is a declining water level and this is illustrated on graph for observation well MCN 24. (Fig. 22) In some cases this can be attributed to declining groundwater mounds in the vicinity of wetlands.

Some small swamps in the vicinity of wetlands have been identified as exposed groundwater as a result of mounding of the water table and the highest salinity recorded at one of these sites was 142 000 mg/L at the end of the summer evaporation period.





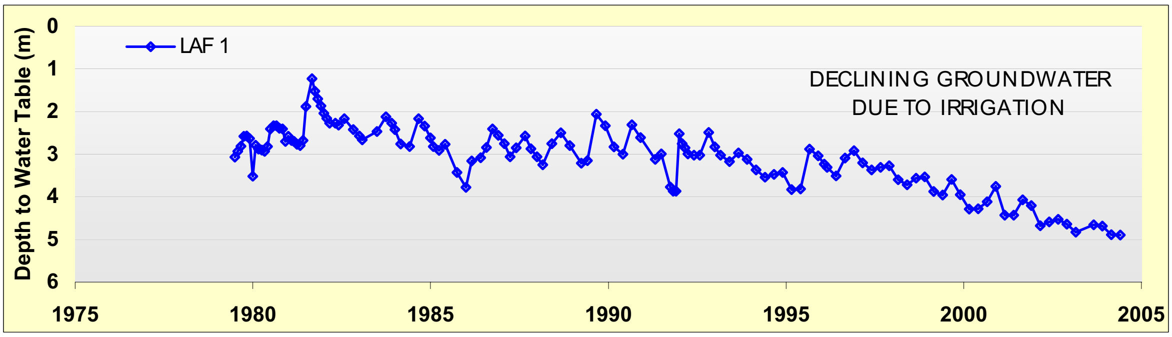
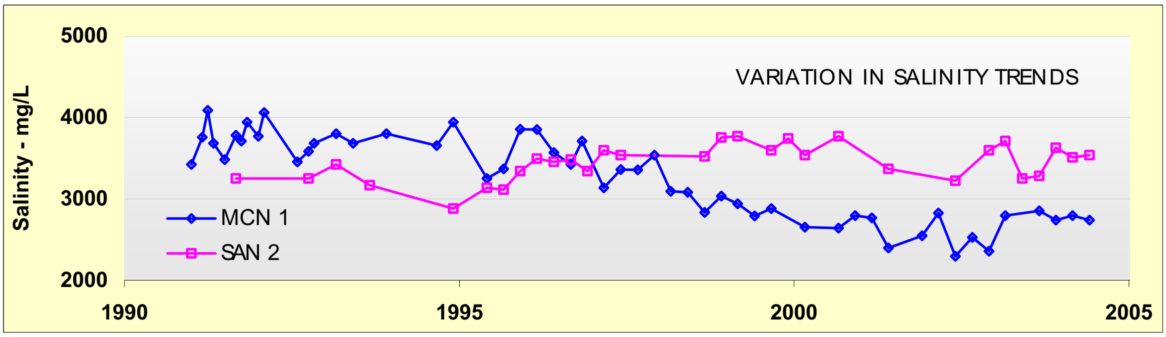
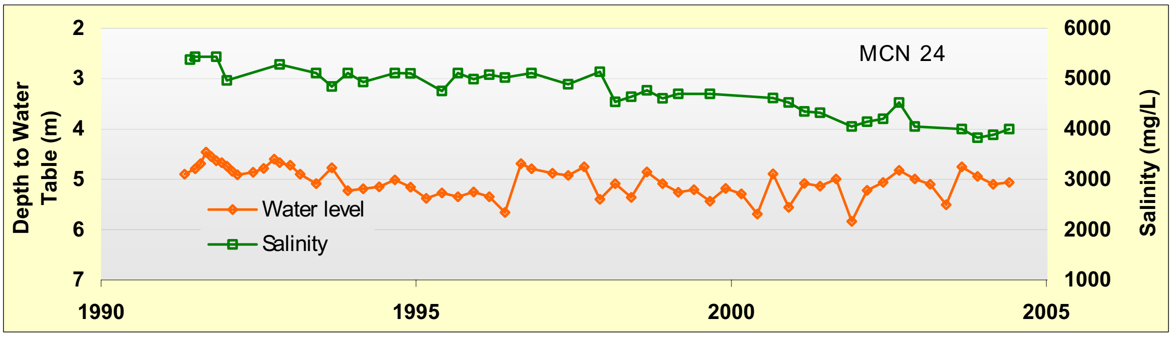
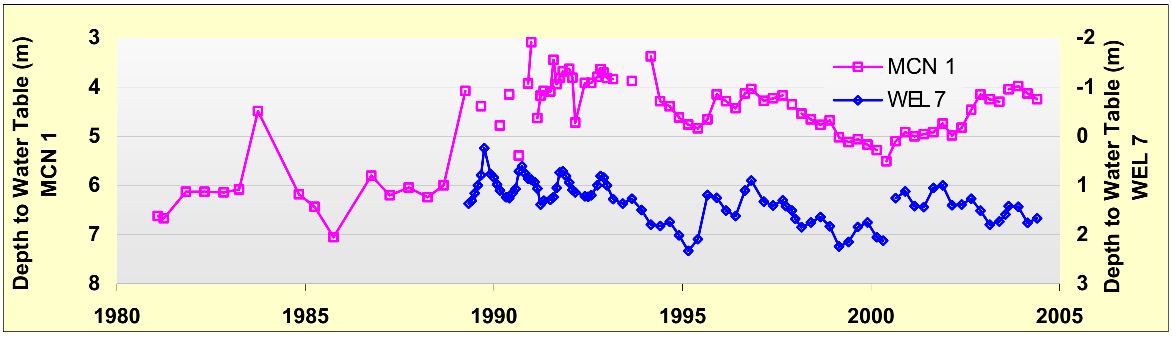


Figure 21. Hydrographs from the unconfined aquifer – Upper South East Dryland Salinity and Flood Management Program







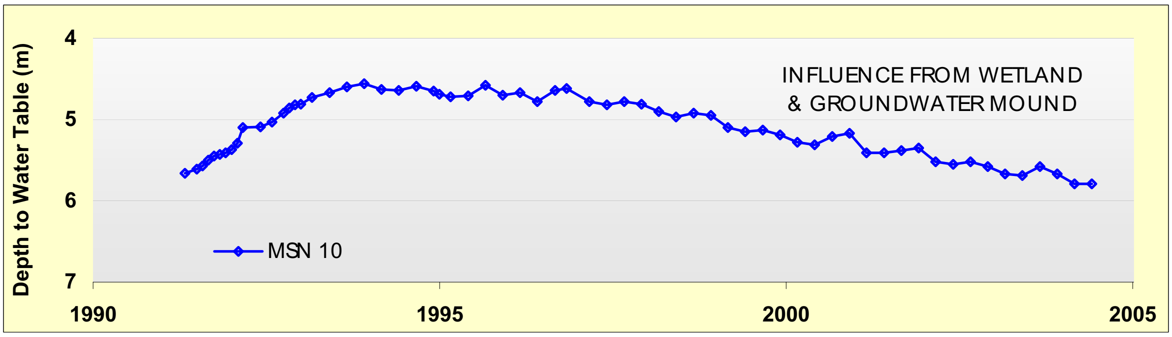


Figure 22. Salinity graphs for the unconfined aquifer – Upper South East Dryland Salinity and Flood Management Program

Wetlands

In some areas water level trends are responsive to increased recharge and groundwater mounding in the vicinity of wetlands. Consequently, water levels can be either rising or declining and may show either a prolonged or delayed response to pondage of water in wetlands. Graphs for MCN 1 and WEL 7 (Fig. 22) show response to wetland storage whilst MSN 10 (Fig. 22) shows a rise from groundwater mounding and then a continuous decline as mounding regresses. The areas where the water table is showing a decline from mounding is illustrated on Fig. 6.

Hydrographs for SAN 1 and SAN 4 (Fig. 23) which are located on the northern end of Morella Basin show an obvious rise in water level due to storage of water from the USE groundwater drainage scheme since the year 2000. Observation well NVL 2 (Fig. 23) which is located on the western side of Cortina Lakes, shows a slight rising trend which is attributed to groundwater mounding around the lakes.

A noticeable change in groundwater flow direction is evident on the eastern side of the Cortina Lakes wetland. It is considered that the presence of a groundwater mound is contributing to the change in flow direction by creating a barrier to the general westward movement of groundwater. This is indicated by the westerly migration of the 15 metre water table elevation contour shown on Fig. 4.

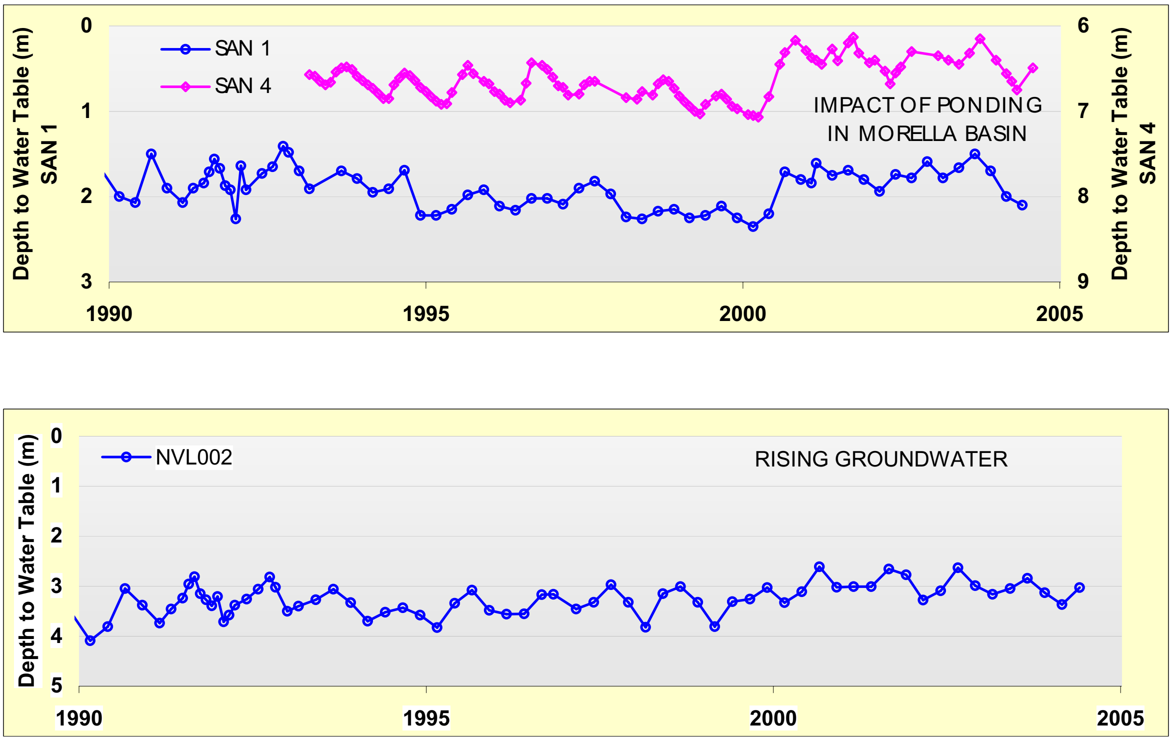
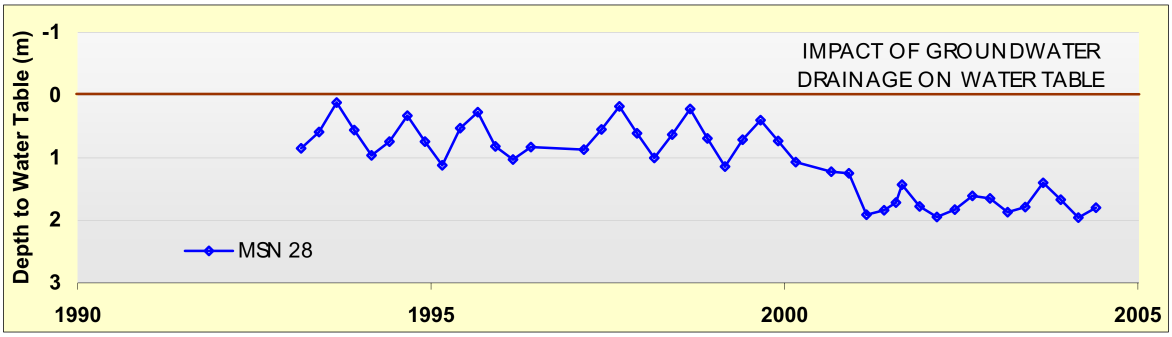


Figure 23. Hydrographs for the unconfined aquifer located on the northern end of Morella Basin

Drainage

The groundwater drains which have been constructed as part of the USE Dryland Salinity and Flood Management Scheme indicate that the drawdown or lowering of the water table is typically 1 to 2 metres (dependent on depth of drain) immediately adjacent to these drains with the gradient ascending in the order of 1 to 4 kms away from drains. The hydrographs for MSN 28 and PRK 10 (Fig. 24) illustrate the impact of drainage on the water table.



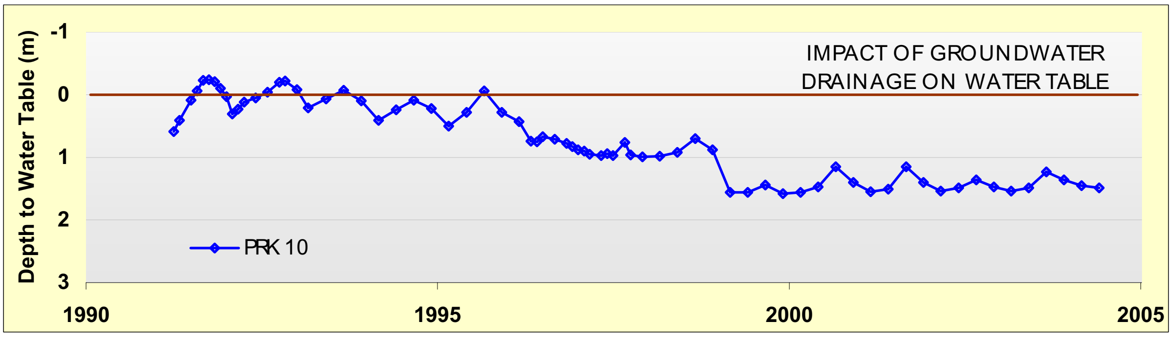


Figure 24. Hydrographs for the unconfined aquifer – impact of drainage on the water table

A cross-section of the water table is shown in Figure 25 and illustrates the influence of a groundwater drain that has been constructed on the east side of the Tilley Swamp watercourse. Notably the summer water table is maintained at about 2 metres below ground thereby preventing waterlogging and reducing the dryland salinity process.

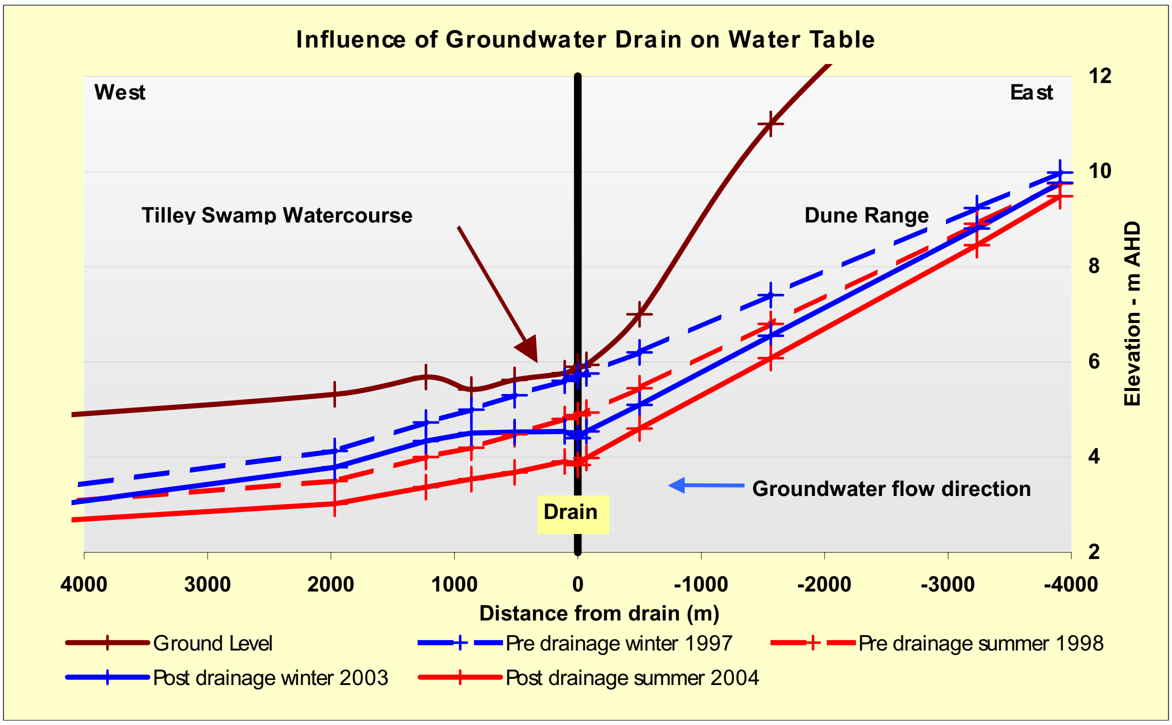


Figure 25. Influence of a groundwater drain on the water table

5. CONFINED AQUIFER – REGIONAL ASSESSMENT

For management purposes, the confined aquifer is treated regionally as one aquifer, but it is in reality, a complex multi-aquifer groundwater system. Lack of data means there is little real understanding on the hydraulic interconnection between these subaquifers. The confined aquifer does not have the same lateral extent as the unconfined aquifer as it is very thin or absent in much of the northern margins of the South East. For example, there is generally no confined aquifer in the Padthaway PWA.

SOUTH EAST CONFINED AQUIFER

There is currently one network called SE-CONF which monitors the South East Confined Aquifer with 110 wells monitoring water levels and 46 monitoring salinity. Most of the current water level monitoring wells are concentrated around and south east of Kingston SE, either side of the Princess Highway (Fig. 26). This reflects both the high level of groundwater use and the artesian nature of the aquifer in this area. Whilst the remaining spread of monitoring wells is significantly less dense, it is considered adequate for the current level of development for this aquifer. There are very few confined aquifer monitoring wells in the northern portion of the South East as the Dilwyn Formation confined aquifer is generally thin or absent.

Figure 27 shows the current salinity monitoring network. Although there are few observation wells monitoring salinity in the confined aquifer, the network is considered sufficient as there has been no real change in salinity since monitoring began.

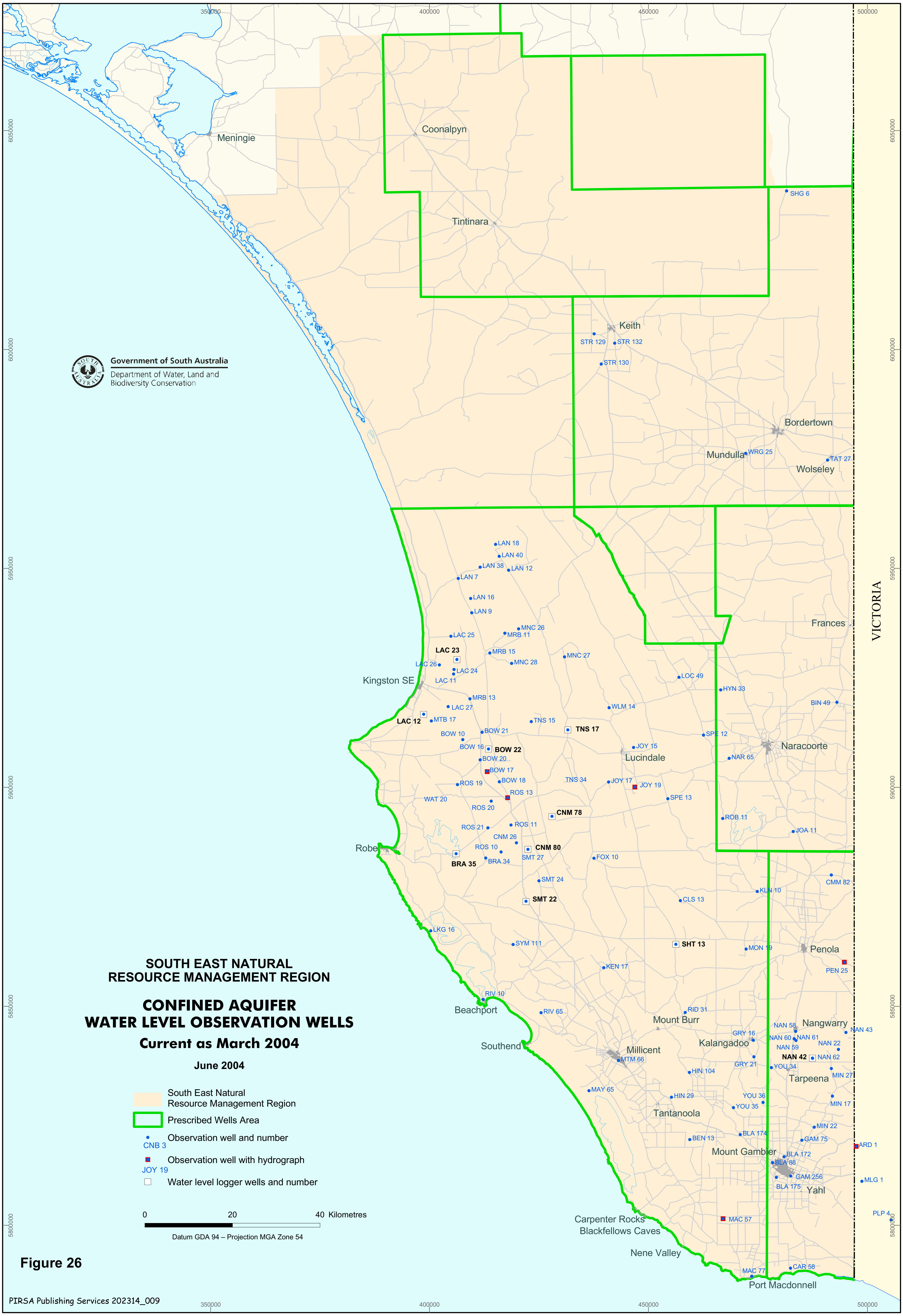
Since the confined aquifer well abandonment program began in 2001, 24 observation wells have been backfilled and are no longer in the network with a further 7 to be abandoned in November 2004. 5 newly constructed replacement wells have been added to the network and other confined wells will be incorporated where existing observation wells are lost as the abandonment program progresses.

There are currently 25 confined aquifer monitoring wells which are part of the network that monitors confined aquifer water levels in the Designated Border Zone. Salinity monitoring is carried out on 8 of these wells every 5 years as part of the Border Agreement Act.

Monitoring Methodology

Currently, the potentiometric head is measured from all wells within the network using a pressure gauge or tube (for artesian wells) and a water level sensor (for non flowing wells).

In October 2004, 9 observation wells (Fig. 26) within the SE-CONF network will be equipped with pressure transducers and will continuously record head pressure readings. Two of these wells (BOW 22 and CNM 80) will be equipped with telemetry (CDMA modems) providing real time data to desktop computers. The continuous log of data from these wells will be utilised to evaluate a precise time to manually monitor absolute high



SOUTH EAST NATURAL RESOURCE MANAGEMENT REGION

CONFINED AQUIFER WATER LEVEL OBSERVATION WELLS

Current as March 2004

June 2004

Figure 26

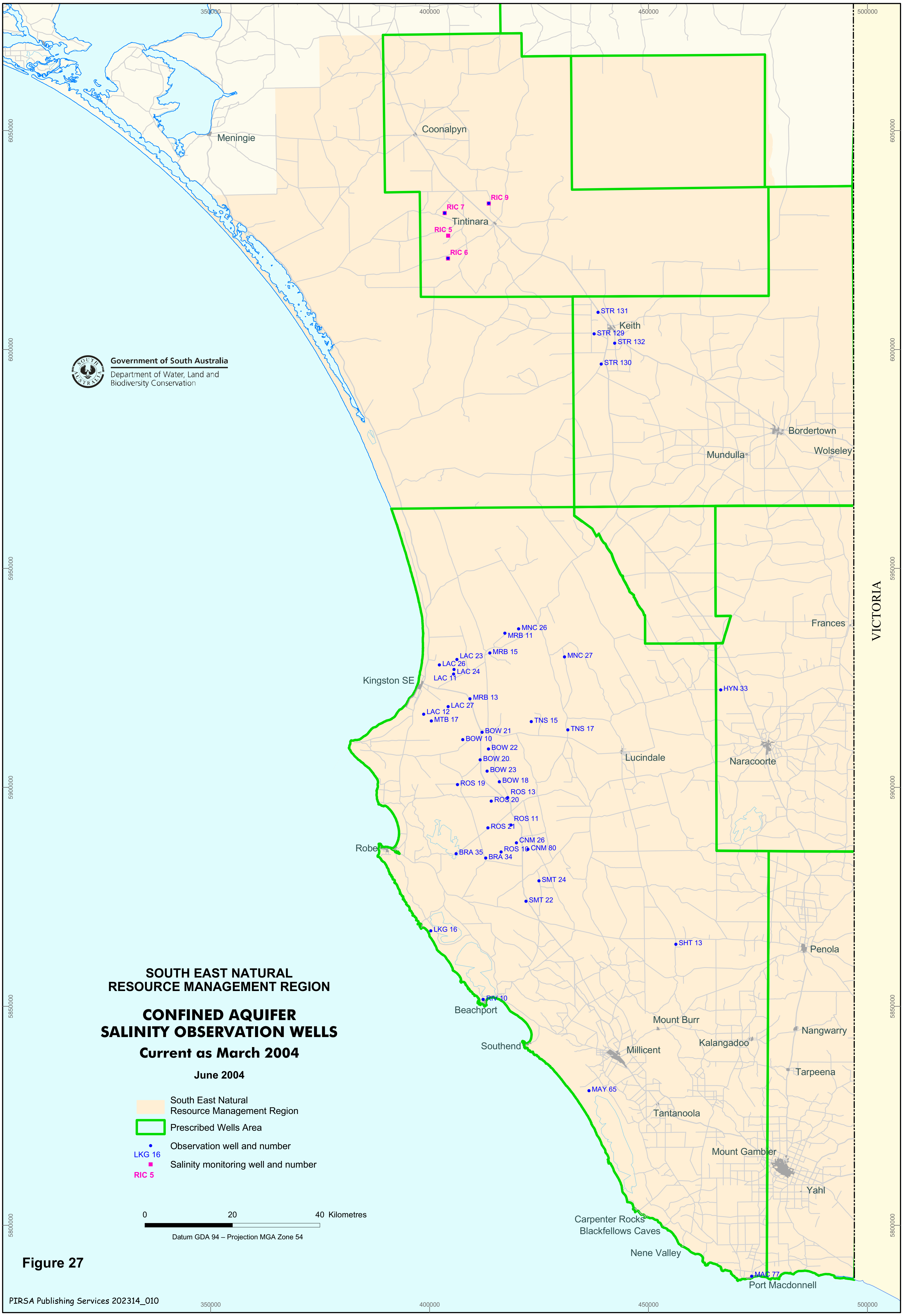


Figure 27

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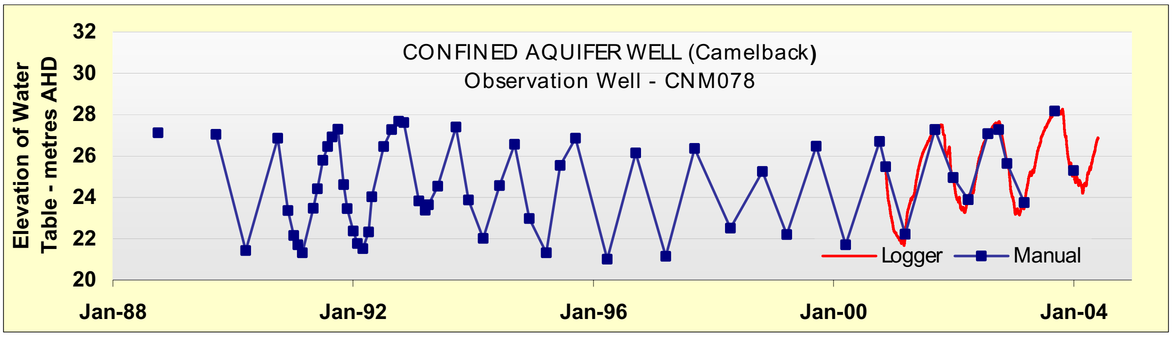
and low water level / pressure readings from the other observation wells. The hydrograph below (Fig. 28) compares the manual data and logged data from observation well CNM 78.



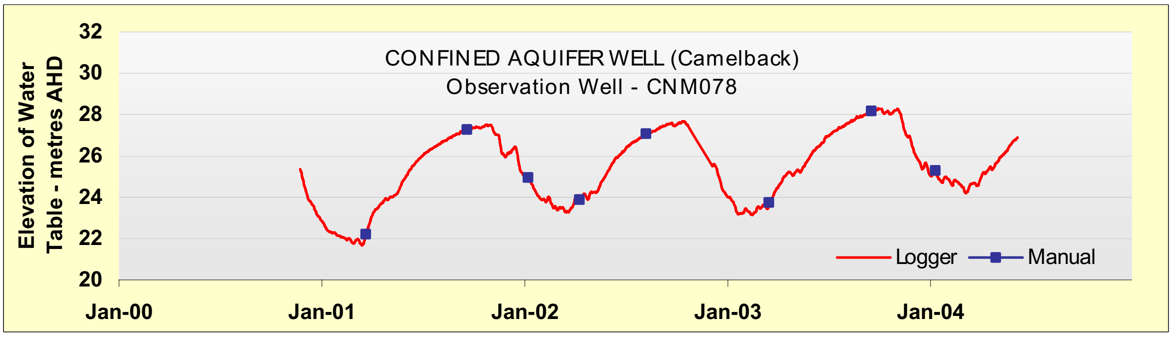


Figure 28. Hydrograph for the confined aquifer of observation well CNM 78.

Water Level Assessment

A potentiometric surface is provided for the confined aquifer utilising the September 2003 reduced standing water level (RSWL) values (Fig. 29). They represent groundwater at maximum recovery levels prior to the commencement of pumping and indicate the likely direction of groundwater flow and gradient. Flow direction is similar to the unconfined aquifer, being southerly in the region to the south of the Nangwarry - Tarpeena high, whereas above this region flow is more in a westerly direction.

The change in potentiometric head over the period September - October 2003 to March 2004 (Fig. 30) illustrates a noticeable seasonal decline in head inland from Kingston to Beachport (either side of Princess Highway) associated with the irrigation groundwater use in this area. The heads in the confined aquifer generally show a seasonal fluctuation of up to 8 m annually as a result of these groundwater withdrawals. In the Tintinara–Coonalpyn region there is also notable fluctuation in groundwater levels which is also caused by pumping; this is further discussed in Barnett (2002).

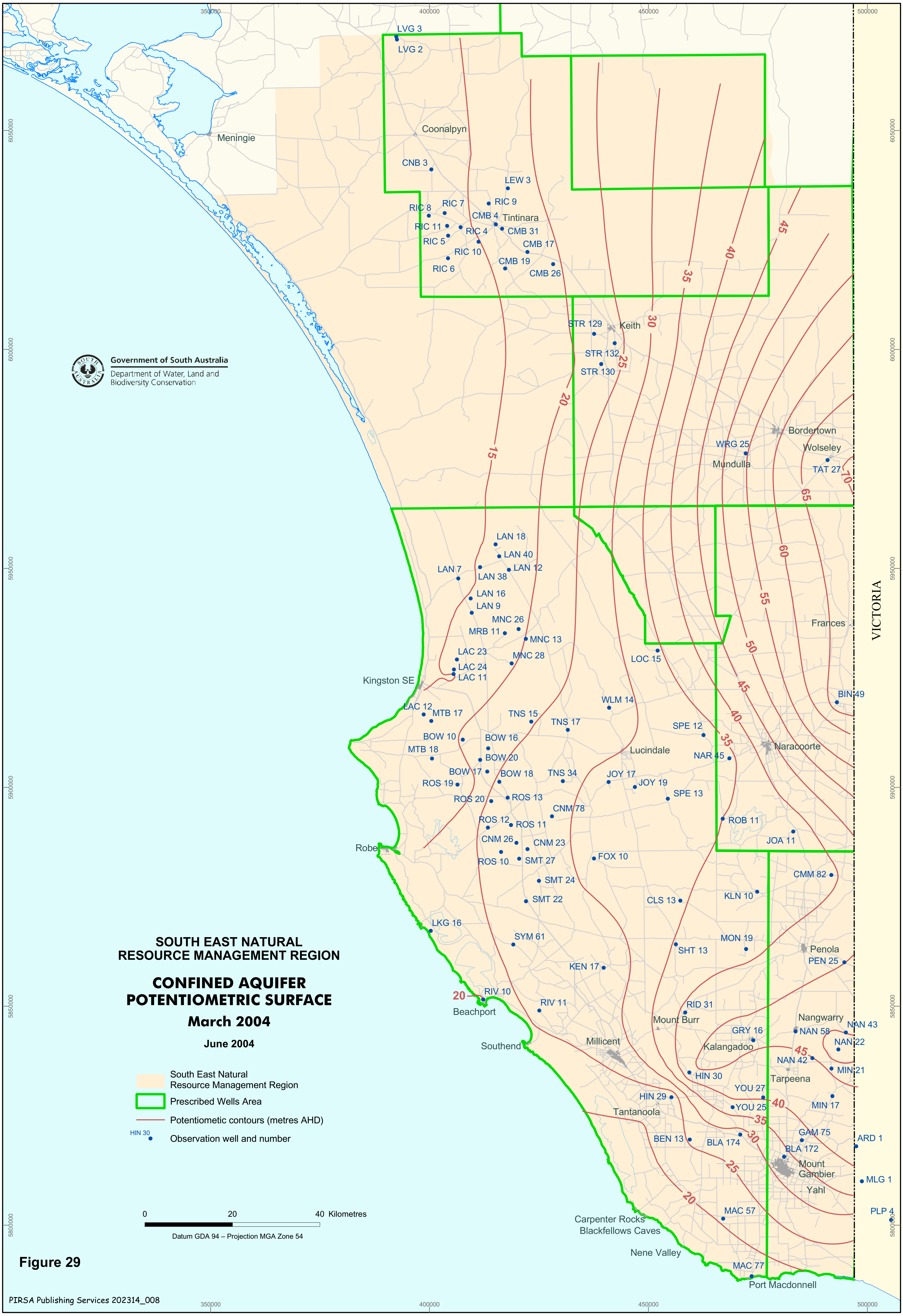

SOUTH EAST NATURAL
RESOURCE MANAGEMENT REGION
CONFINED AQUIFER
POTENTIOMETRIC SURFACE
March 2004
June 2004
South East Natural
Resource Management Region
Prescribed Wells Area
Potentiometic contours (metres AHD)
HIN 30
Observation well and number
0
20
40 Kilometres
Datum GDA 94 – Projection MGA Zone 54
Government of South Australia
Department of Water, Land and
Biodiversity Conservation
VICTORIA
Meningie
Coonalpyn
Tintinara
Keith
Bordertown
Wolseley
Mundulla
Frances
Kingston SE
Lucindale
Naracoorte
Robe
Penola
Beachport
Southend
Millicent
Mount Burr
Nangwarry
Kalangadoo
Tarpeena
Tantanoola
Mount
Gambier
Yahl
Carpenter Rocks
Blackfellows Caves
Nene Valley
Port Macdonnell
LVG 3
LVG 2
CNB 3
LEW 3
RIC 7
RIC 9
RIC 8
CMB 4
RIC 11
RIC 4
CMB 31
RIC 5
CMB 17
RIC 10
CMB 19
RIC 6
CMB 26
STR 129
STR 132
STR 130
WRG 25
TAT 27
LAN 18
LAN 40
LAN 7
LAN 12
LAN 38
LAN 16
LAN 9
MNC 26
MRB 11
MNC 13
LAC 23
MNC 28
LAC 24
LAC 11
LOC 15
BIN 49
WLM 14
LAC 12
MTB 17
TNS 15
TNS 17
SPE 12
BOW 10
BOW 16
MTB 18
BOW 20
NAR 45
BOW 17
BOW 18
TNS 34
JOY 17
ROS 19
JOY 19
SPE 13
ROS 20
ROS 13
CNM 78
ROS 12
ROS 11
ROB 11
CNM 26
CNM 23
JOA 11
ROS 10
SMT 27
FOX 10
SMT 24
CMM 82
SMT 22
CLS 13
KLN 10
LKG 16
SYM 61
SHT 13
MON 19
PEN 25
KEN 17
RIV 10
RIV 11
RID 31
NAN 43
NAN 58
GRY 16
NAN 22
NAN 42
MIN 21
HIN 30
YOU 27
HIN 29
YOU 25
MIN 17
GAM 75
BEN 13
BLA 174
ARD 1
BLA 172
MLG 1
MAC 57
PLP 4
MAC 77
15
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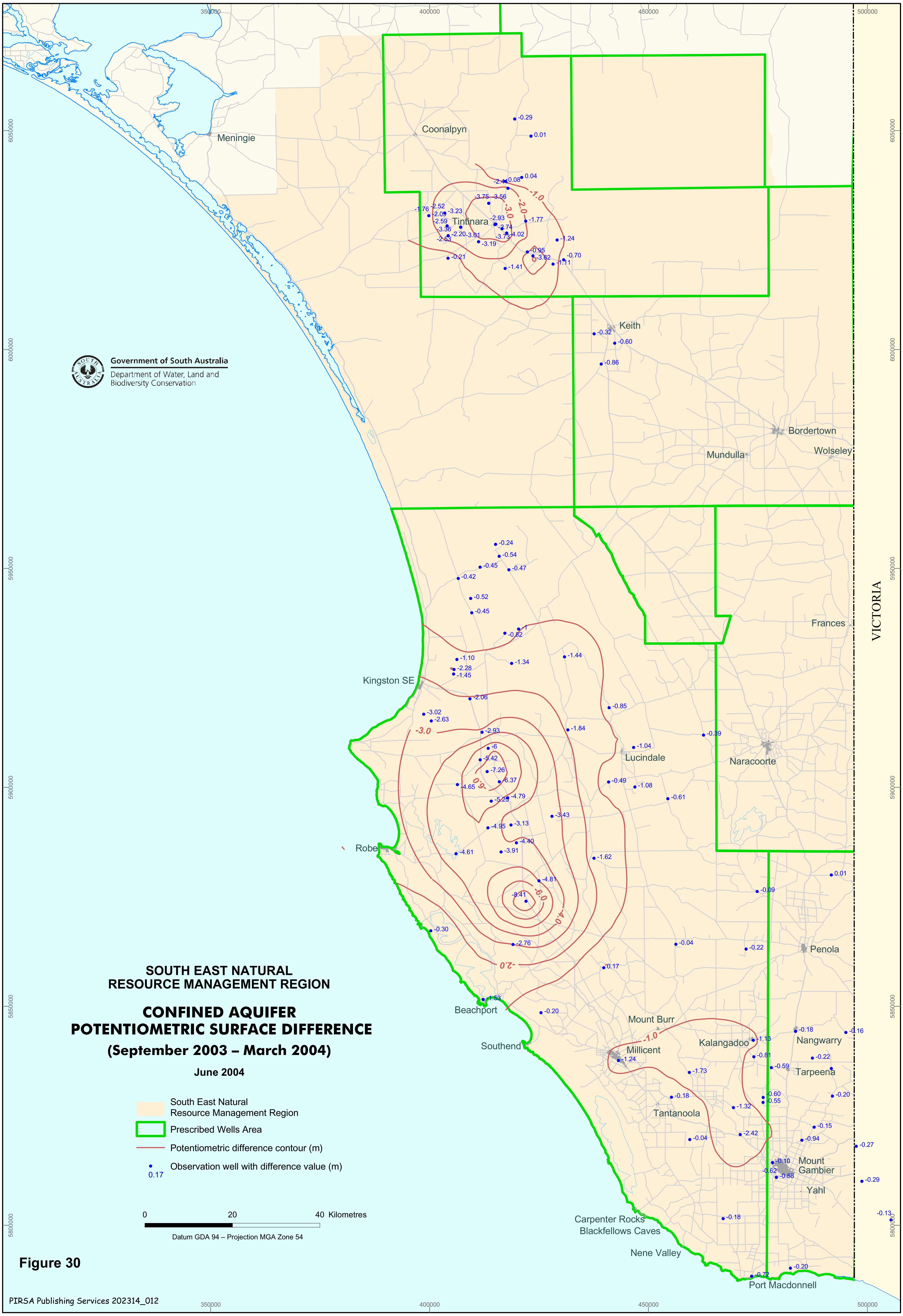
Figure 29



SOUTH EAST NATURAL RESOURCE MANAGEMENT REGION

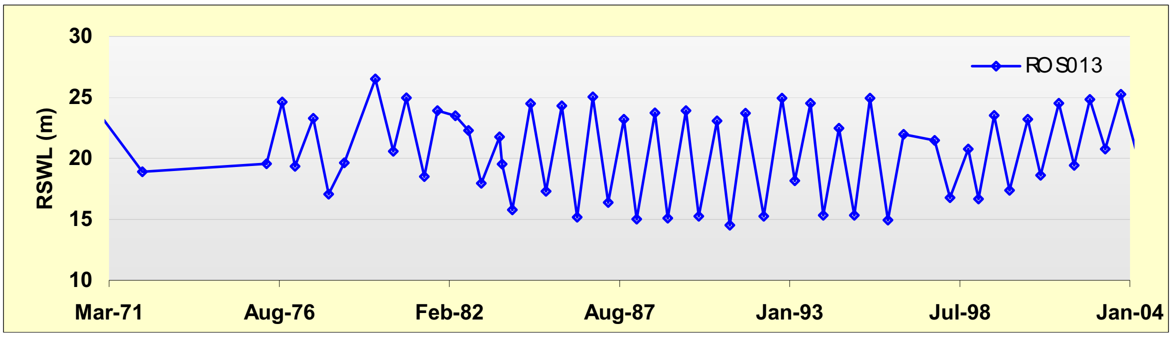
CONFINED AQUIFER POTENTIOMETRIC SURFACE DIFFERENCE (September 2003 – March 2004)

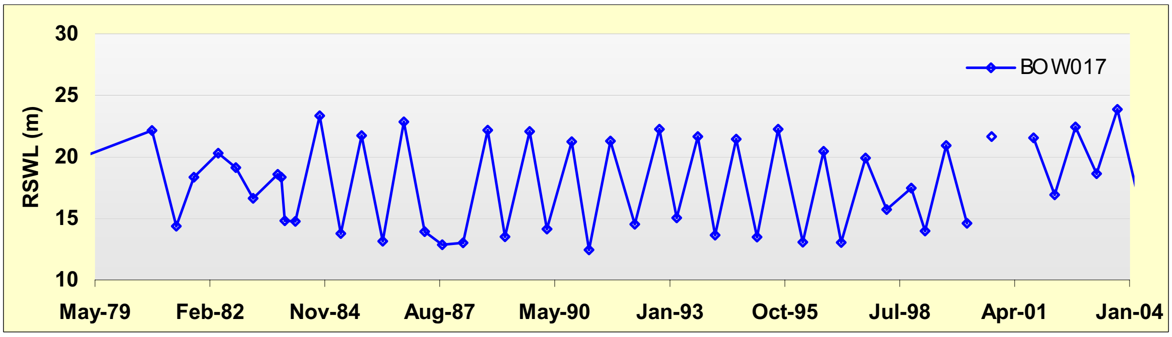
June 2004

Figure 30

Water Level trends

The hydrographs for confined aquifer observation wells in the central artesian area (inland of Kingston to Beachport) show significant fluctuations between seasons due to the high levels of irrigation use as discussed previously. The overall trends are mainly stable showing that intensive extraction in this part of the region has not greatly stressed the resource (Fig. 31 for observation wells ROS 13, BOW 17 and JOY 19). In recent years a rise in head is noticed throughout this area. It is unclear if the rise is due to the South East Confined Aquifer Well Rehabilitation Scheme, increased hydrostatic pressure from the unconfined aquifer, an increase in irrigation efficiency or a combination of all factors.





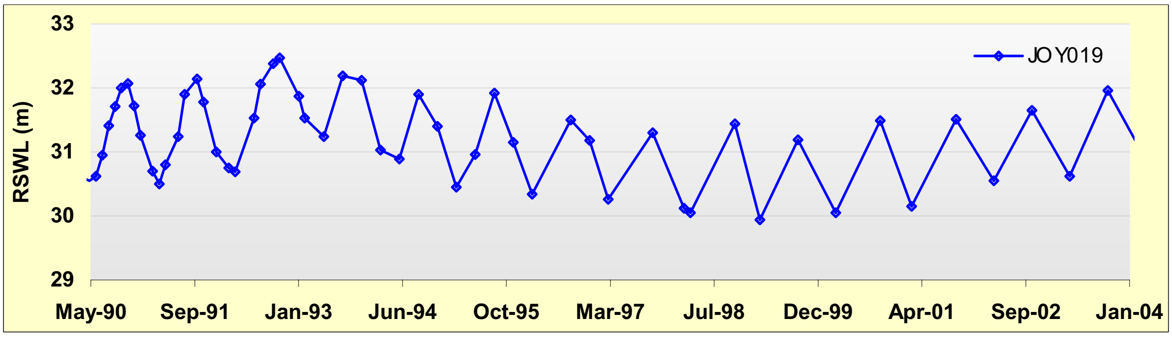
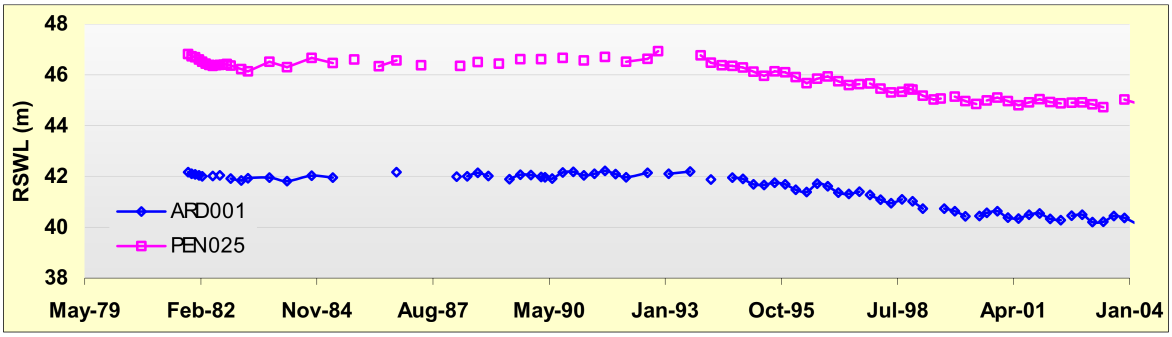


Figure 31. Confined aquifer hydrographs

Away from the Kingston - Beachport area, water levels tend to be relatively stable until 1993, after which declining trends are evident as illustrated in Figure 32 for observation wells ARD 1, PEN 25 and MAC 57. This downward trend is believed to be a result of the below average rainfall over the last nine years. The decline in water levels in the confined aquifer is attributed to a decrease in overburden pressure associated with the decrease in recharge rates over the same period in the unconfined aquifer (Brown et al., 2001).



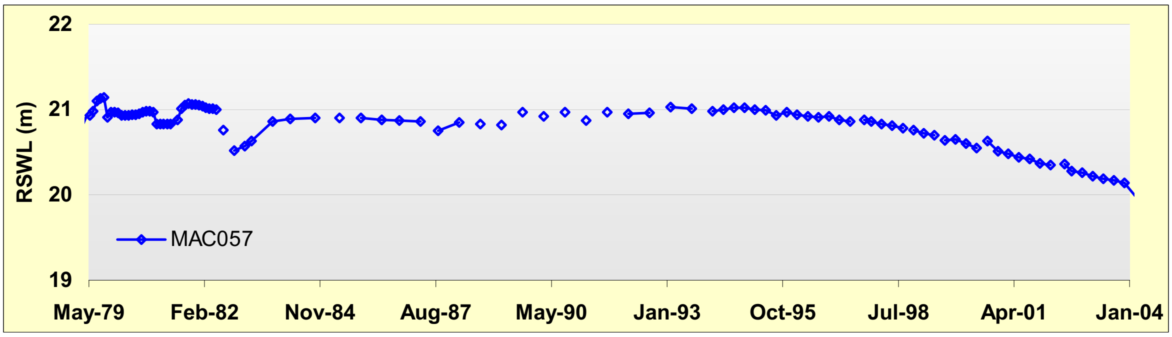
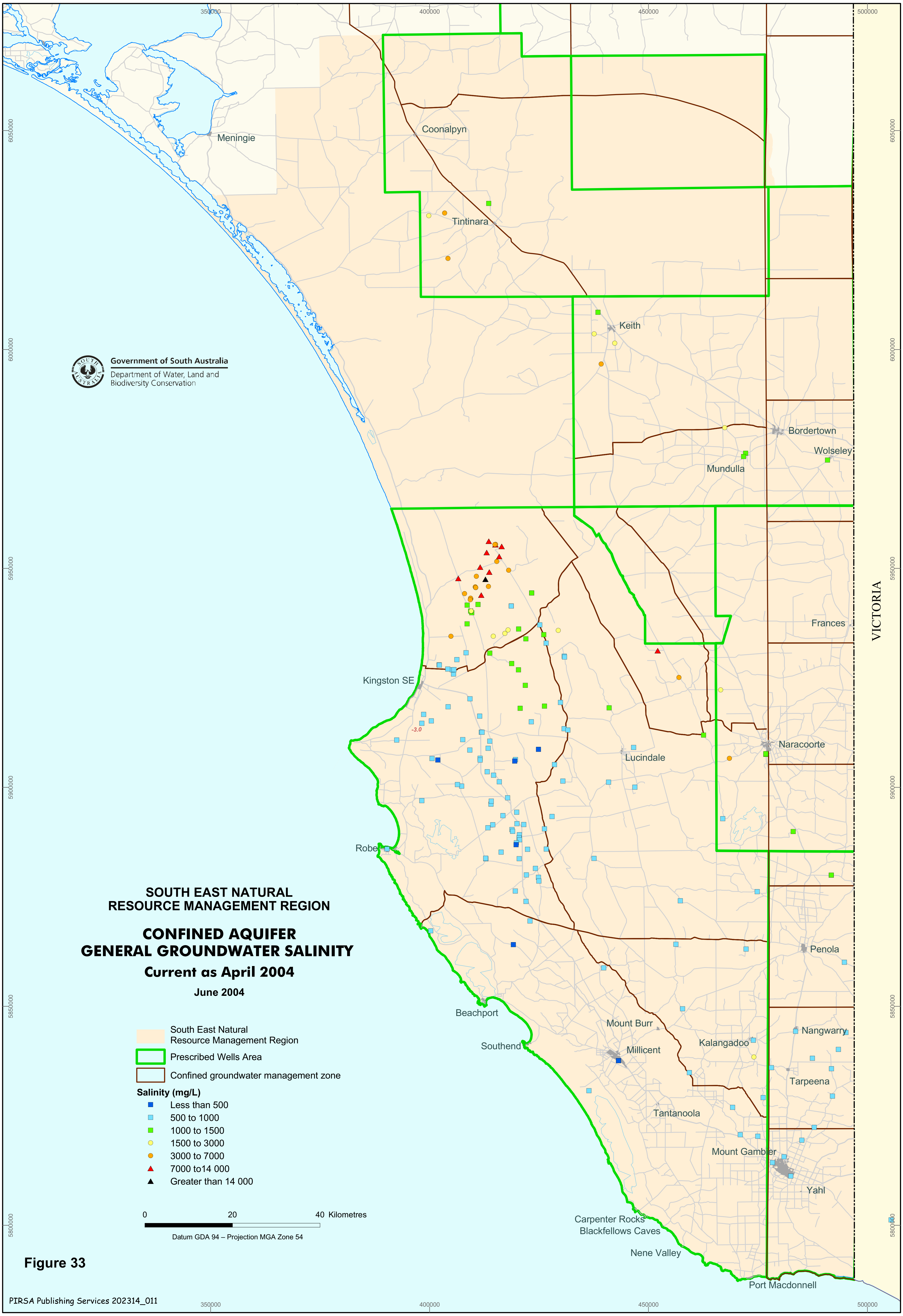


Figure 32. Confined aquifer hydrographs

Salinity Trends

Groundwater salinity in the Confined Aquifer is quite uniform and less than 1000 mg/L over the southern area of the South East (Fig. 33). In the upper parts of the South East, the Confined Aquifer's salinity increases rapidly as the aquifer thins and groundwater circulation becomes restricted near the Padthaway ridge. Salinity monitoring has revealed no discernible salinity trend.



SOUTH EAST NATURAL RESOURCE MANAGEMENT REGION

CONFINED AQUIFER GENERAL GROUNDWATER SALINITY

Current as April 2004

June 2004

Figure 33

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TINTINARA – COONALPYN CONFINED AQUIFER

There are currently 13 water level observation wells monitoring the confined aquifer in the Coastal Plain region of the TCPWA, two of which are equipped with data loggers for continuous readings. There are also 15 observation wells located in the Hundreds of Lewis and Carcuma to monitor drawdowns due to the irrigation extractions for olive plantations (three have data loggers). The locations of these wells are shown in Figure 26. The only monitoring well in the Mallee Highlands to the east of Tintinara is SHG 6, which lies just outside the eastern boundary of the TCPWA.

The confined aquifer network can be expanded when necessary to monitor new areas of irrigation. There are eight monitoring wells (Fig. 27) currently used to monitor groundwater salinity in the confined aquifer, mostly to the west of Tintinara, where they will provide early warning for any increases in salinity due to reversal of groundwater flow caused by drawdown if it occurs.

Currently, all observation wells for both the unconfined and confined aquifer are in one network called Tintinara, however, it is planned to separate these wells into two specific networks in the near future.

6. RECOMMENDATIONS

In order to improve the monitoring and assessment of the groundwater resources of the South East Catchment Water Management Board region, the following points are recommended:

- Increase the number of water level loggers throughout the entire South East which will assist with determining the most appropriate time to undertake manual readings, especially in areas of deep water tables to get a better understanding of rainfall recharge lag time.
- Increase the number of regional salinity observation wells as the high densities of salinity observation wells are predominately within intensely irrigated areas. The monitoring networks could be improved in the following areas:
    - Lacepede-Kongorong PWA
    - Southern portion of the Comaum-Caroline PWA
- Identify and evaluate increases in groundwater salinity associated with irrigation water recycling and the clearing of native vegetation.
- For all salinity observation wells, identify well construction details (particularly well depth, casing depth and pumping interval) to assess which unconfined aquifer formation or sub-unit is being monitored as salinity stratification is evident in some areas.
- Future monitoring reports to be undertaken every 5 years and assessment to be more localised based on PWA. The reports should be precede the review of each of the Water Allocation Plans.

6. SHORTENED FORMS - (TO BE JOINED)

Measurement

Name of unit	Symbol	Definition in terms of other metric units	
Gram	g		Mass
Kilometre	km	10^3 m	Length
Litre	L	10^{-3} m^3	Volume
Metre	m		Length
Metres per year	m/yr		
Milligram	mg	10^{-3} g	Mass
Milligrams per litre	mg/L		
Milligrams per litre per year	mg/L/yr		
Megalitre	ML	10^{-6} m^3	Volume
Megalitres per year	ML/y		
Millimetre	mm	10^{-3} m	Length

General

Shortened form	Description
AHD	Australian height datum
DWLBC	Department of Water, Land and Biodiversity Conservation
PWA	prescribed wells area
RSWL	reduced standing water level
SE	South East
SECWMB	South East Catchment Water Management Board
TDS	total dissolved solids
USE	Upper Sout East

7. REFERENCES

Barnett, S.R., 2002. Water resource assessment of the Tintinara–Coonalpyn Prescribed Wells Area. *South Australia. Department of Water, Land and Biodiversity Conservation. Report Book*, 2002/019.

Brown, K.G., Love, A.J. and Harrington, G.A., 2001. Vertical groundwater recharge to the Tertiary Confined Sand Aquifer, South East, South Australia. *South Australia. Department For Water Resources. Report DWR,* 2001/002.

Cobb, M. and Brown, K.G., 2000 Water Resource Assessment: Padthaway Prescribed Wells Area for the South East Catchment Water Management Board. *South Australia. Department for Water Resources. Report DWR*, 2000/00031.

Cobb, M. and Brown, K.G., 2000 Water Resource Assessment: Tatiara Prescribed Wells Area for the South East Catchment Water Management Board. *South Australia. Department for Water Resources. Report DWR*, 2000/00036.

Cobb, M. and Brown, K.G., 2000 Water Resource Assessment: Naracoorte Ranges Prescribed Wells Area for the South East Catchment Water Management Board. *South Australia. Department for Water Resources. Report DWR*, 2000/00042.

Cobb, M. and Brown, K.G., 2000 Water Resource Assessment: Comaum-Caroline Prescribed Wells Area for the South East Catchment Water Management Board. *South Australia. Department for Water Resources. Report DWR*, 2000/00043.

Cobb, M. and Brown, K.G., 2000 Water Resource Assessment: Lacepede-Kongorong Prescribed Wells Area for the South East Catchment Water Management Board. *South Australia. Department for Water Resources. Report DWR*, 2000/00049.

Kelly, R. and Laslett, D., 2003 Water Allocation and Use in the South East in 2002-2003. "Report to the South East Catchment Water Management Board SA." Report DWLBC.

MacKenzie, G., 2000 Tatiara groundwater monitoring review. *South Australia. Department for Water Resources. Report DWR*, 2000/00035.

MacKenzie, G. and Stadter, F., 1992. Groundwater Occurrence and the Impacts of Various Land Practices in the Upper South East of South Australia. *South Australia. Department of Mines and Energy. Report 92/58*.

Rammers, N. and Stadter, F., 2002. South East Prescribed Wells Areas groundwater monitoring status reports 2002. *South Australia. Department of Water, Land and Biodiversity Conservation. Report,* DWLBC 2002/10.

8. APPENDIX 1



OBSERVATION WELL NETWORK NAME DESCRIPTIONS

BLUELAKE	Blue Lake (within Comaum Caroline PWA)
COM-CAR	Comaum Caroline PWA
NCTE	Naracoorte Ranges PWA
NCTE-IRR	Naracoorte Ranges Irrigation Area (within Naracoorte Ranges PWA)
PADTH	Padthaway PWA
PAD-IRR	Padthaway Irrigation Area (within Padthaway PWA)
KCA	Kimberly Clark Australia (within Lacepede Kongorong PWA)
LACKON NTH	Lacepede Kongorong PWA (North)
LACKON STH	Lacepede Kongorong PWA (South)
SAFRIES	SA Fries (within Comaum Caroline PWA)
NANGWARY	Nangwarry Recharge (within Comaum Caroline PWA
TATIARA	Tatiara PWA
TAT-IRR	Tatiara Irrigation Area (within Tatiara PWA)
TINTINARA	Tintinara Coonalpyn PWA
USE REGION	Upper South East Dryland Salinity & Flood Management Project
MESSENT	Messent Conservation Park (within USE Region)

9. APPENDIX 2



DETAILS OF CONTINUOUS WATER LEVEL LOGGERS

UNCONFINED AQUIFER					
Obs. Well	**Hundred**	**PWA**	**Network**	**Data Period**	**Monitoring Purpose/Impact**
CAR 39	CAROLINE	Comaum-Caroline	COM-CAR	Nov 2000	Dairies & Irrigation
GAM 250	GAMBIER	Comaum-Caroline	BLUELAKE	Nov 2000	Hydro-stratification
GAM 251	GAMBIER	Comaum-Caroline	BLUELAKE	Aug 2004	Hydro-stratification
GAM 252	GAMBIER	Comaum-Caroline	BLUELAKE	Nov 2000	Hydro-stratification
GAM 29	GAMBIER	Comaum-Caroline	COM-CAR	Aug 2004	Seasonal recharge
GAM 79	GAMBIER	Comaum-Caroline	COM-CAR	Aug 2004	Seasonal recharge
CLS 9	COLES	Lacepede Kongorong	LACKON STH	Nov 2000	Bluegums
KLN 4	KILLANOOLA	Lacepede Kongorong	LACKON STH	Nov 2000	Bluegums background
MAC 46	MACDONNELL	Lacepede Kongorong	LACKON STH	Nov 2000	Dairies & Irrigation
MTB 7	MOUNT BENSON	Lacepede Kongorong	LACKON NTH	Feb 1998	Vineyards and pine forest
MTM 60	MOUNT MUIRHEAD	Lacepede Kongorong	LACKON STH	Aug 2004	Regional trend
SHT 21	SHORT	Lacepede Kongorong	LACKON STH	Aug 2002	Bluegums
SHT 22	SHORT	Lacepede Kongorong	LACKON STH	Aug 2002	Bluegums background
SHT 23	SHORT	Lacepede Kongorong	LACKON STH	Aug 2002	Bluegums background
SHT 24	SHORT	Lacepede Kongorong	LACKON STH	Aug 2002	Bluegums
Not allocated	SHORT	Lacepede Kongorong	LACKON STH	Sept 2004	Land use, recharge, drainage interaction
SMT 20	SMITH	Lacepede Kongorong	LACKON STH	Aug 2004	Regional trend
TNS 10	TOWNSEND	Lacepede Kongorong	LACKON NTH	Aug 2004	Regional trend
WLM 77	WOOLUMBOOL	Lacepede Kongorong	LACKON NTH	Nov 1997	Fairview Drain background
WLM 78	WOOLUMBOOL	Lacepede Kongorong	LACKON NTH	Nov 1997	Fairview Drain weir
BMA 8	BEEAMMA	Naracoorte Ranges	NCTE	Aug 2004	Rising water level in elevated range

UNCONFINED AQUIFER					
JES 50	JESSIE	Naracoorte Ranges	NCTE	Nov 1997	Vineyards and abattoir
JOA 5	JOANNA	Naracoorte Ranges	NCTE	Aug 2004	Regional trend
GLE 101	GLEN ROY	Padthaway	PADTH	Aug 2004	Irrigation on Padthaway flat
GLE 88	GLEN ROY	Padthaway	PADTH	Aug 2004	Elevated range east of Padthaway
STR 118	STIRLING	Tatiara	TATIARA	Nov 1997	Stirling irrigation area
WRG 22	WIRREGA	Tatiara	TATIARA	Aug 2004	Wirrega west irrigation area
SAN 7	SANTO		USE REGION	Nov 2000	Morella Basin pondage (east side)
SAN 8	SANTO		USE REGION	Nov 2000	Morella Basin pondage (west side)
WEL 7	WELLS		USE REGION	Nov 1997	Cortina Lakes wetland complex

CONFINED AQUIFER					
Obs. Well	**Hundred**	**PWA**	**Network**	**Data Period**	**Monitoring Purpose/Impact**
NAN 42	NANGWARRY	Comaum-Caroline	SE-CONF	Aug 2004 >	Regional trend
BOW 22	BOWAKA	Lacepede Kongorong	SE-CONF	Aug 2004 >	Centre of seasonal drawdown (Telemetry site)
BRA 35	BRAY	Lacepede Kongorong	SE-CONF	Aug 2004 >	West control of seasonal drawdown
CNM 78	CONMURRA	Lacepede Kongorong	SE-CONF	Nov 2000 >	East control of seasonal drawdown
CNM 80	CONMURRA	Lacepede Kongorong	SE-CONF	Aug 2004 >	Centre of seasonal drawdown (Telemetry site)
LAC 12	LACEPEDE	Lacepede Kongorong	SE-CONF	Aug 2004 >	West control of seasonal drawdown
LAC 23	LACEPEDE	Lacepede Kongorong	SE-CONF	Aug 2004 >	North control of seasonal drawdown
SHT 13	SHORT	Lacepede Kongorong	SE-CONF	Aug 2004 >	Regional trend
SMT 22	SMITH	Lacepede Kongorong	SE-CONF	Aug 2004 >	South control of seasonal drawdown
TNS 17	TOWNSEND	Lacepede Kongorong	SE-CONF	Aug 2004 >	East control of seasonal drawdown