BAROOTA PWRA

GROUNDWATER STATUS REPORT

2009-10

DEPARTMENT FOR WATER

Government of South Australia
Department for Water

SUMMARY 2009 - 10

The Baroota groundwater resource lies on the western side of the Flinders Ranges in the Mid-North of South Australia, approximately 25 km north of Port Pirie. It is a local scale resource for which surface water and groundwater have been prescribed under South Australia's *Natural Resources Management Act 2004*. Groundwater extractions are limited under a Notice of Prohibition, pending development and approval of a Water Allocation Plan that will provide for sustainable management of the resource.

Groundwater extractions in the Baroota Prescribed Water Resources Area (PWRA) occur from clay and gravel sediments, which can be up to 100 m thick, deposited as outwash from the Flinders Ranges. This aquifer is recharged by streamflow in the Baroota Creek downstream of the Baroota Reservoir, particularly in very wet years when the Baroota Reservoir overflows.

Metered extractions were 961 ML in 2009-10, the lowest recorded since metering commenced in the 2002-03 season. Since 2002, the average use has been about 1,500 ML/year. Grape vines received the greatest irrigation volume, 347 ML, followed by potatoes with 275 ML. Groundwater extractions are augmented by reticulated water from the Whyalla pipeline.

Groundwater levels have declined by up to 10 m across the area since 2002, and have reached their lowest levels recorded in over 30 years. It appears that this trend will continue in the next decade. Baroota Reservoir has contributed leakage to the groundwater system, but due to lower inflows into the reservoir, the contribution to the aquifer has been reduced. This has been caused by lower than usual rainfall and runoff since 2002. Extractions are thought to have only a minor impact on groundwater level trends. These groundwater level reductions can be accommodated by the aquifer system over the coming decade.

Despite the sustained fall in groundwater levels, a strong flow gradient from the ranges to the coast is still being maintained and there are no widespread increases in groundwater salinity levels. Under present conditions, it is unlikely that flow reversal from the west will occur that would cause rapid increases in salinity in the aquifer system.

Regular monitoring of observation wells will enable an adaptive management approach for the groundwater resource. Planned sampling of irrigation wells will improve the existing groundwater salinity monitoring network.

ASSESSMENT OF STATUS

The Baroota PWRA has been assigned a status of yellow "Adverse trends indicating low risk to the resource in the medium term" based on current trends. This status is supported by;

- Gradual decline in water levels over the last 30 years that appears as if it will continue for some years, but which is marginally significant in a comparatively thick aquifer that can accommodate these level reductions. These declines are not expected to affect access to the resource by groundwater users over the next 10 – 20 years.
- Apparently stable salinity levels, and maintenance of groundwater gradients toward the coast that are expected to prevent flow reversal of saline groundwater from the west.

Given the aquifer thickness of up to 100 m and the slow rate of groundwater movement within the aquifer, it is considered that the observed groundwater level and salinity trends are unlikely to lead to a change in capacity to serve the current consumptive uses of the groundwater resource in the medium term.

STATUS

No adverse trends, indicating a stable or improving situation

Trends are either stable (no significant change), or improving (i.e. decreasing salinity or rising water levels).

Adverse trends indicating low risk to the resource in the medium term

Observed adverse trends are gradual and if continued, will not lead to a change in the current beneficial uses of the groundwater resource for at least 15 years. Beneficial uses may be drinking water, irrigation or stock watering.

Adverse trends indicating high risk to the resource eventuating in the short to medium term

Observed adverse trends are significant and if continued, will lead to a change in the current beneficial uses of the groundwater resource in about 10 years.

Degradation of the resource compromising present use within the short term

Trends indicate degradation of the resource is occurring, or will occur within 5 years. Degradation will result in a change in the beneficial use (i.e. no longer suitable for drinking or irrigation purposes) and may take the form of increasing groundwater salinities, or a fall in the groundwater levels such that extractions from the aquifer may not be possible.

BACKGROUND

The Baroota groundwater resource lies on the western side of the Flinders Ranges in the Mid-North of South Australia, approximately 25 km north of Port Pirie. It is a local scale resource for which surface water and groundwater have been prescribed under South Australia's *Natural Resources Management Act 2004*. Groundwater extractions are limited under a Notice of Prohibition, pending development and approval of a Water Allocation Plan that will provide for sustainable management of the resource.

HYDROGEOLOGY

The Baroota PWRA incorporates the catchment of Baroota Creek in the Flinders Ranges and overlies sediments of the Pirie Basin on the plains. The Pirie Basin contains a considerable thickness of alluvial and fluvial Quaternary clays and gravels deposited as outwash from the Flinders Ranges. These units are underlain by Tertiary sediments which directly overlie the Neo-Proterozoic basement. In the Baroota area, groundwater extractions for irrigation are obtained solely from permeable gravel beds within the Quaternary sediments whose thickness extends to approximately 100 m (Fig. 1).

These gravel beds are frequently discontinuous and are not laterally extensive. Consequently, mapping discrete aquifers is virtually impossible. Some wells extract from more than one aquifer through multiple screened intervals.

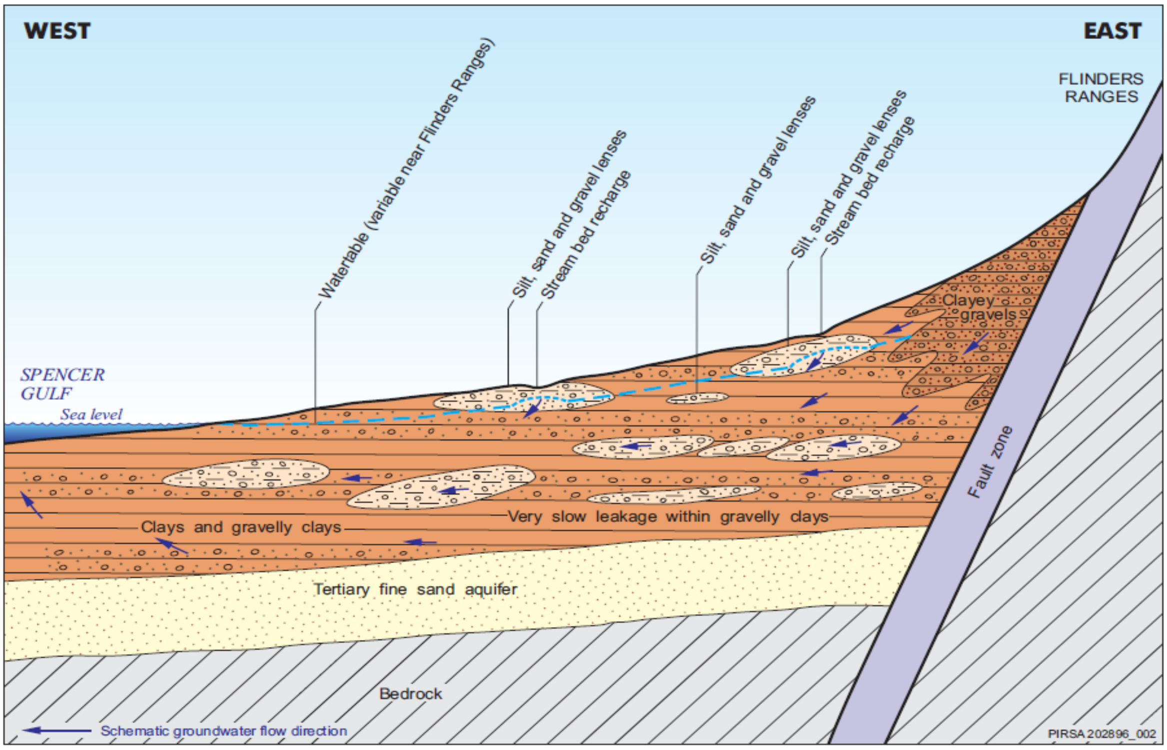

Figure 1. Schematic cross-section of the Baroota PWRA

Regional scale flow within the Pirie Basin is in a westerly direction from the fractured rock aquifers of the Flinders Ranges in the east, through the Quaternary and Tertiary sediments, to the coast in the west where discharge occurs. Because of the generally low permeability of the basin sediments and very slow rate of groundwater movement, salinity changes progressively from about 1500 mg/L near the ranges, to over 5000 mg/L downgradient to the west.

Significant local recharge of the aquifer occurs at locations where streams flow out of the ranges onto the plains (such as Baroota Creek). The permeable sand and gravel beds deposited by streams over geological time enhance the recharge process, which has formed significant areas of low salinity useable groundwater.

For further information, see the following report:

http://www.waterconnect.sa.gov.au/BusinessUnits/InformationUnit/Technical%20Publications/dwlbc_technote_2009_27.pdf

GROUNDWATER FLOW AND SALINITY

The regional groundwater flow direction and salinity distribution in the Baroota PWRA is presented in Figure 2. Groundwater flow is from the ranges in the east to the coast in the west. Figure 2 indicates the reasonably large area of low salinity groundwater which supports irrigation, also shown are the location of irrigation wells (in red), and the area where the chloride:calcium ratio is below 7, indicating probable long term recharge by surface water from the Baroota Creek.

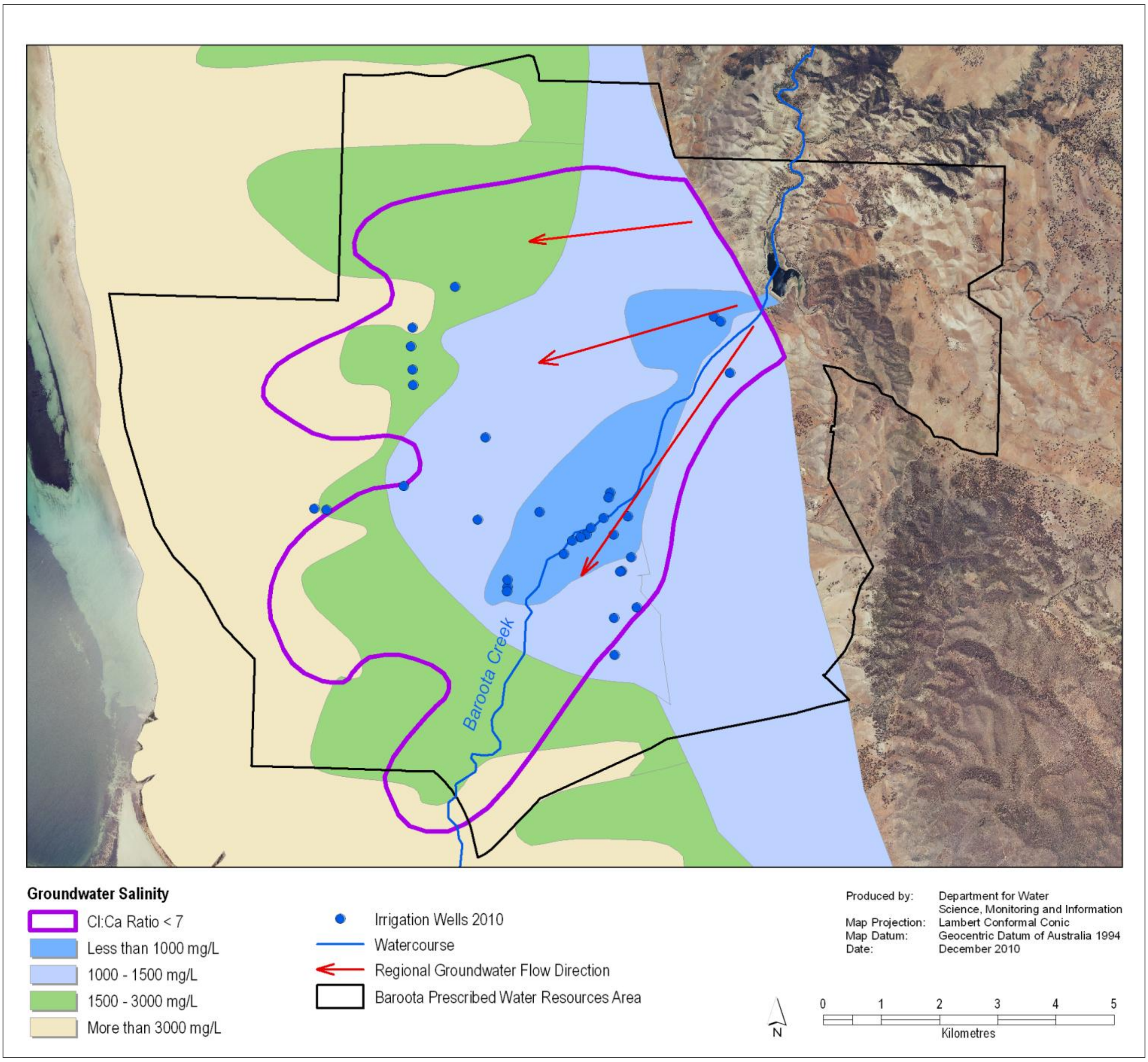

Figure 2. Salinity distribution and regional groundwater flow direction for the Quaternary aquifer in the Baroota PWRA

HYDROLOGY

Recharge to the alluvial and fluvial Quaternary clays and gravels is enhanced by underflow leakage from the Baroota Reservoir into the Baroota Creek. The reservoir was found to be leaky soon after completion in 1921, and after further investigation it was concluded that an average of 2 ML/day of seepage water was contributing to groundwater recharge. In addition to the underflow recharge provided by leakage, the reservoir would occasionally overflow providing short periods of intensive recharge via the gravelly and highly permeable bed of Baroota Creek.

Up until 1997, the reservoir was being used as a balancing storage for the reticulation of River Murray pipeline water, resulting in water levels being higher than those produced from the contributions from local catchment runoff. Since then, SA Water has removed the reservoir from the major water distribution network and as such water levels have been consistently lower than before 1997. The change in reservoir water level has diminished the volume of water available from underflow recharge, and the lower levels have reduced the potential for overflow intensive recharge. Together with a prolonged period of below average rainfall, these factors have brought about a fundamental change in the water balance of this resource.

GROUNDWATER DEPENDENT ECOSYSTEMS

Whilst groundwater dependent ecosystems (GDEs) have not been used in the assessment of the status of the resource, it is important to note the presence and ecological characteristics of the GDEs found in the Baroota PWRA. Water Allocation Plans must include an assessment of the water required by ecosystems, including water from both surface water and groundwater resources. Groundwater dependent ecosystems can be defined as ecosystems where groundwater provides all or part of the water quantity, chemistry or temperature either permanently, seasonally or intermittently. It is generally considered that shallow watertables, i.e. those less than 10 m below the surface, are more likely to support GDEs than deeper watertables. The exception to this is stygofauna (animals that inhabit water filled cracks and pools below the ground), which can be found at greater depths.

Key groundwater dependent ecosystems within the Baroota PWRA have been identified and include persistent pools and plants known to have a dependence on groundwater. These ecosystems occur both upstream and downstream of the Baroota Reservoir.

Permanent pools support a range of biota such as riparian and in-stream vegetation, macroinvertebrates and frogs. There is no recorded evidence for the presence of native fish in the catchment (outside of estuary processes), although the exotic fish *Gambusia holbrooki*, is known to inhabit instream pool habitats. Current evidence suggests that these pools are partially maintained through groundwater contributions from the shallow perched aquifer associated with the Baroota stream bed, which is recharged through leakage from the Baroota Reservoir. The distribution of permanent pools decreases with increasing distance from the reservoir where the perched aquifer infiltrates directly into the deeper aquifer.

Riparian vegetation associated with the riverine corridor of Baroota Creek downstream of the reservoir includes tree species, most notably River Red Gum (*Eucalyptus camaldulensis*), with a dependence on groundwater. This also is thought to be provided through the perched shallow aquifer.

Other possible GDEs in the Baroota system include stygofauna and the near shore marine system which may well have an ecological response to the outfall of groundwater either via fluvial sediments associated with Baroota Creek, or from ambient discharge from plains sediments.

RAINFALL

Rainfall is a very important part of the groundwater balance because it is a source of replenishment or recharge to aquifers by infiltration through the soil or by percolation from streamflow in drainage lines.

The climate of the Baroota region is characterised by hot, dry summers and cool to cold, wet winters. Data from the Bureau of Meteorology rainfall station at Port Germein (19037) was chosen for analysis of rainfall trends on the plains (Fig. 3), while Melrose (19024) was selected to give trends in the catchment area for the Baroota Reservoir (Fig. 4). Annual rainfall is plotted in red.

Cumulative deviation from mean monthly rainfall is graphed in blue to identify periods where rainfall trends are above or below average. An upward slope indicates a period where the rainfall is greater than the average, while a downward slope indicates a period where the rainfall is below the average.

The station records for Pt Germein show alternating above and below average trends lasting between 15 and 25 years. Since the mid 1980s there has been a downward trend, interspersed with occasional wet years. The downward trend appears to be accentuated after 2002, reflecting recent drought conditions.

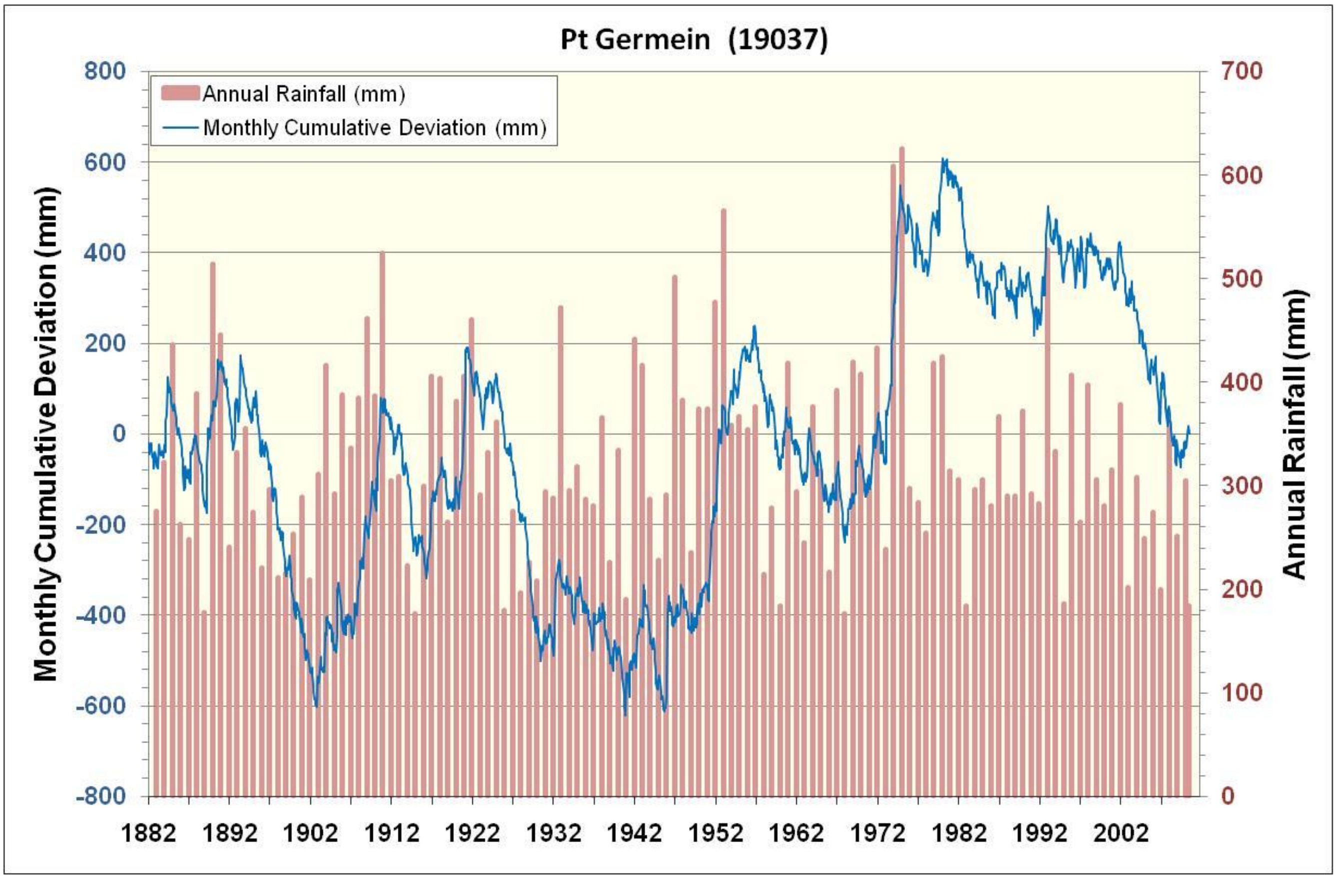

Figure 3. **Annual rainfall and cumulative deviation from mean monthly rainfall for Pt Germein in the Baroota PWRA**

The records for Melrose (Fig. 4) show a broadly similar pattern to that at Pt Germein, with a downward trend from the early 1990s that is accentuated after 2002.

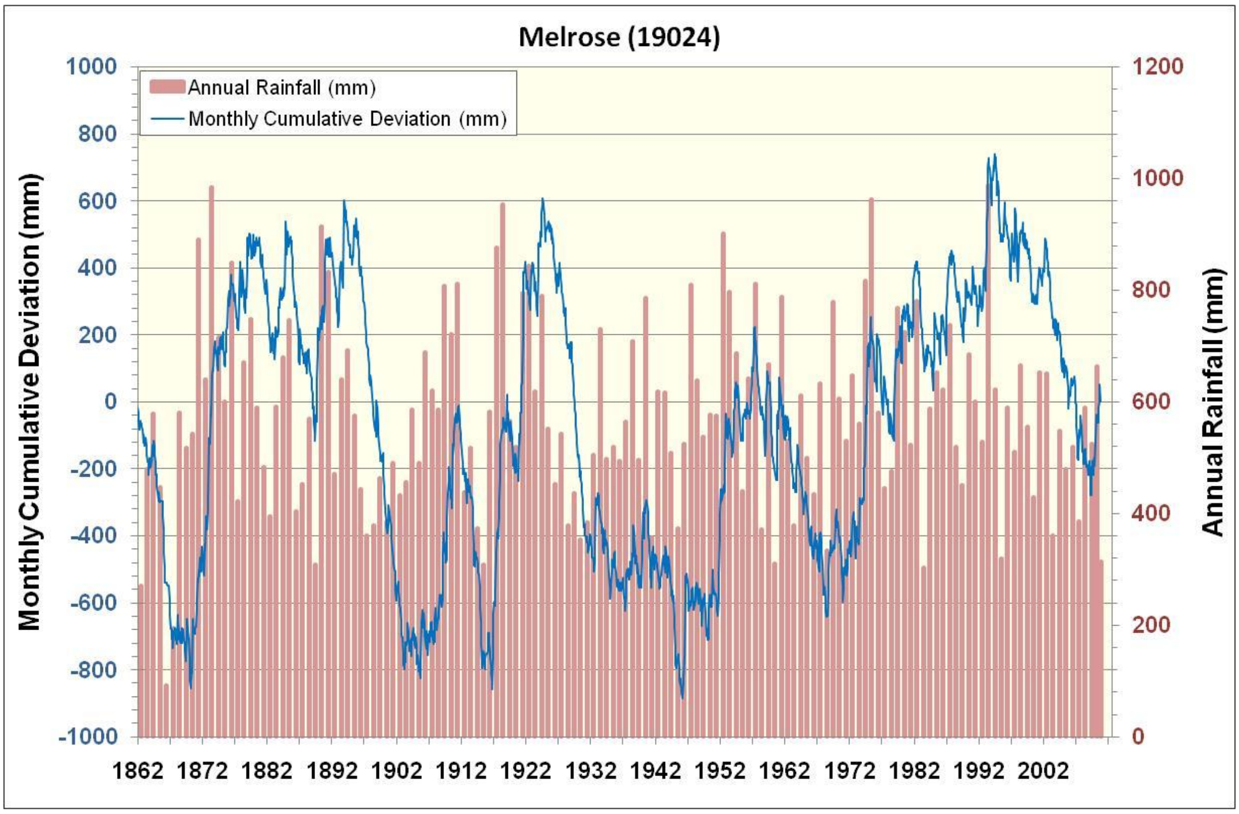

Figure 4. **Annual rainfall and cumulative deviation from mean monthly rainfall for Melrose in the Baroota PWRA**

GROUNDWATER USE

Meters have been installed on all irrigation wells in the Baroota PWRA since 2002 in response to the Local Area Catchment Plan. The total metered extraction for the Baroota PWRA is shown in Figure 5, averaging about 1500 ML/yr since 2002. Extraction for 2009-10 totalled 961 ML which continues a decreasing trend since the 2006 drought, and a decrease of 22% from the previous year due to higher rainfall in 2009. Groundwater extractions are augmented by reticulated water from the Whyalla pipeline.

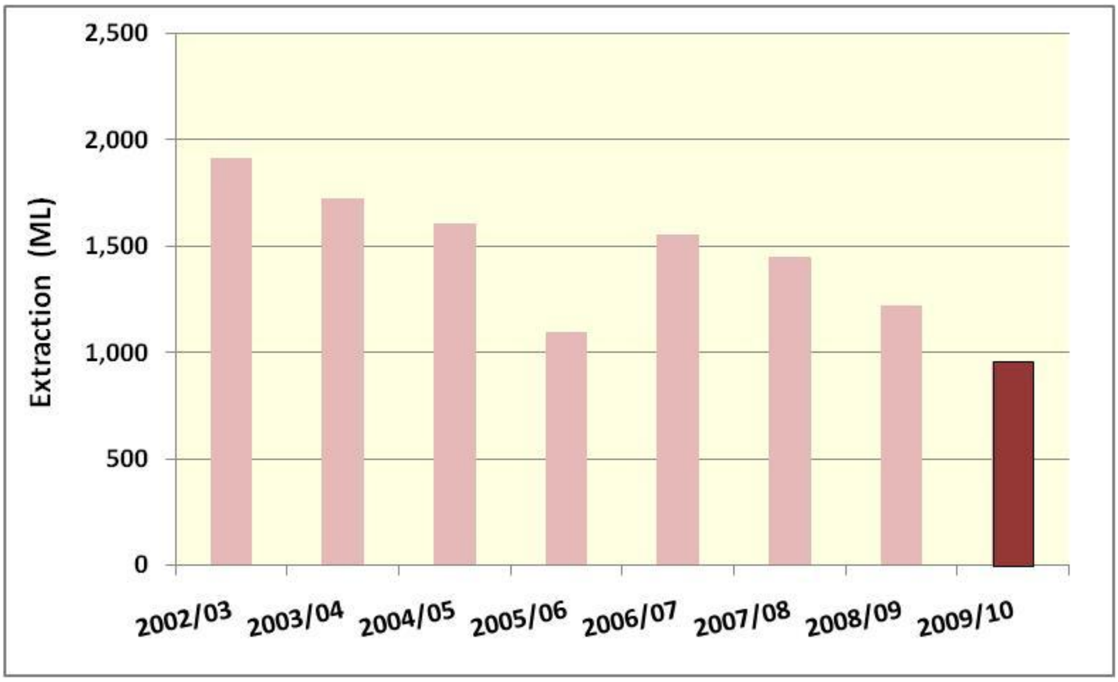

Figure 5. Historical metered groundwater use in the Baroota PWRA

Figure 6 shows the volume applied to the various irrigated crops in 2009-10. Grape vines receive the greatest volume of 347 ML, followed by potatoes with 275 ML. Other major uses are lucerne (178 ML) and olives (81 ML).

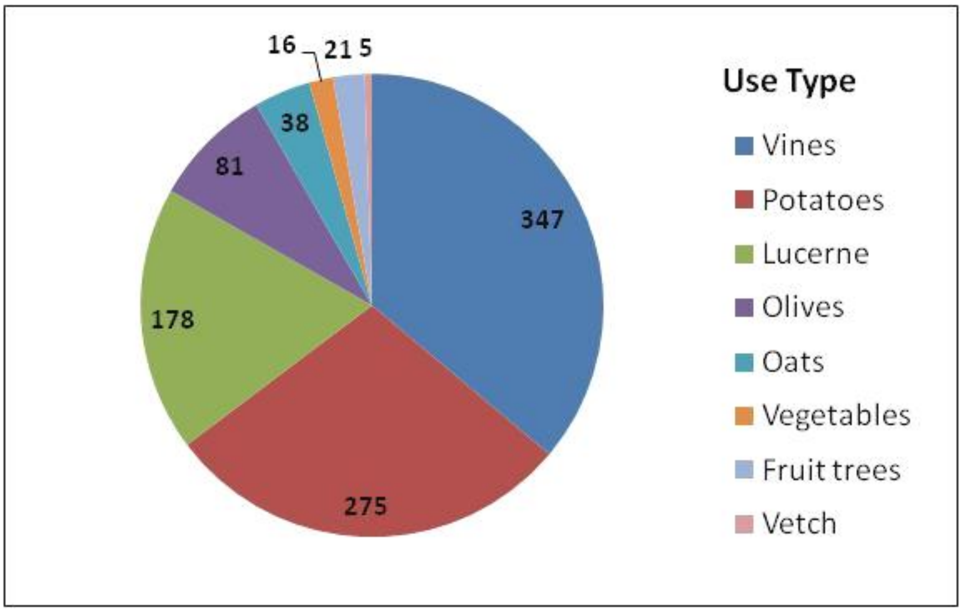

Figure 6. Groundwater volumes extracted per type of use for the 2009-10 season (ML)

WATER LEVEL NETWORK

The groundwater level observation network for the Baroota PWRA is shown in Figure 7. Up to 24 wells have been monitored for groundwater levels since 1977. Seventeen wells are being monitored currently on a semi regular six-monthly frequency.

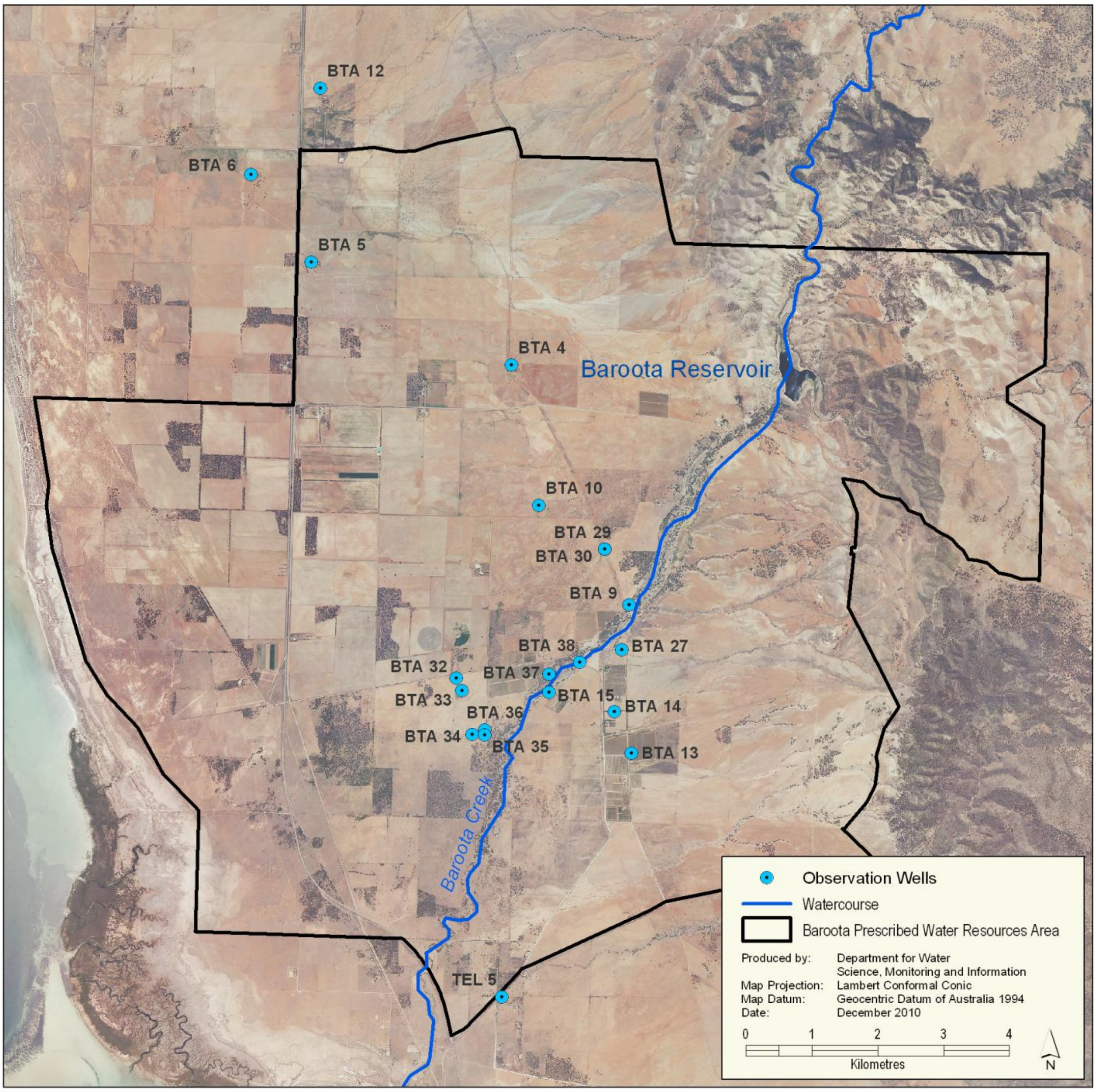

Figure 7. Location of groundwater level observation wells in Baroota PWRA

SALINITY NETWORK

The groundwater salinity observation network for the Baroota PWRA is shown in Figure 8. Up to 22 wells have been monitored for groundwater salinity since 1977. There are currently 17 wells being monitored on a semi regular six-monthly frequency. The regular sampling of irrigation wells will augment the data collected from this network.

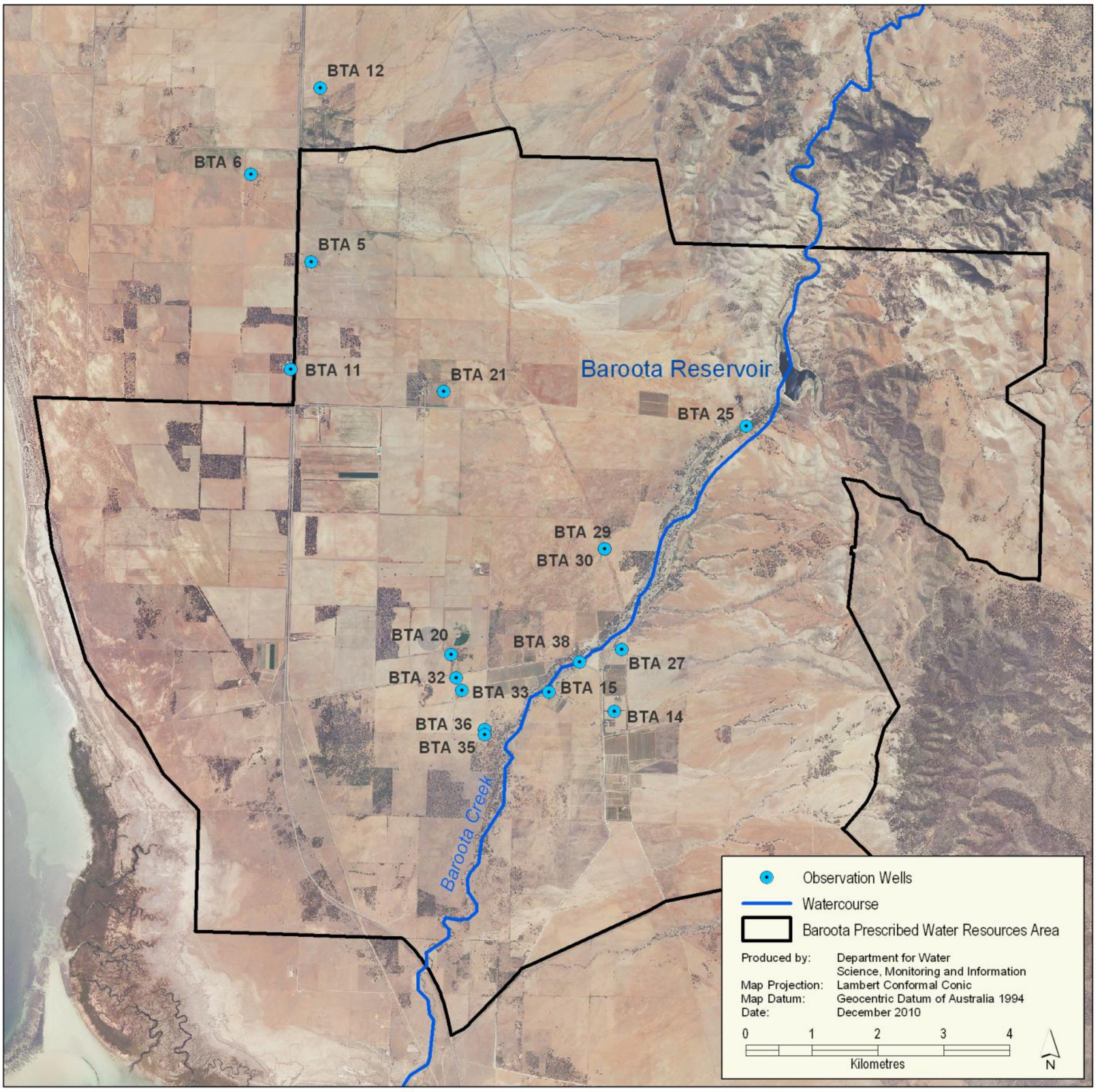

Figure 8. Location of groundwater salinity observation wells in Baroota PWRA

GROUNDWATER LEVEL TRENDS

Groundwater level hydrographs (Fig. 9) have been recorded from observation wells located more than three kilometres away from the irrigated areas. They are reliable sites because they are unlikely to be influenced by short-term effects of extraction (locations are shown on Fig. 7). Figure 9 also displays the cumulative deviation from mean rainfall (in blue) for Melrose as presented above in Figure 4.

The groundwater levels for these more distant wells have a muted response to episodic wet years (such as 1979-80 and 1992-93). There have been significant periods of below average rainfall, especially since 2002, which have contributed to a slow decline in water levels. The magnitude of the decline since 1993 varies in the range of 0.9 to 2.5 m.

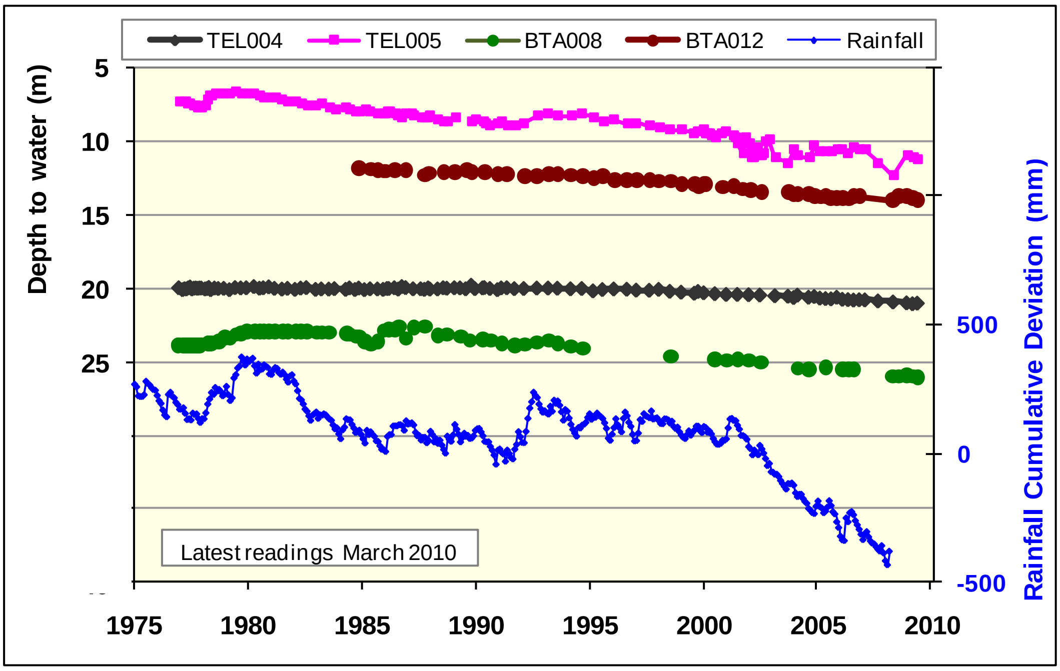

Figure 9. **Groundwater level trends and rainfall cumulative deviation for wells in the Baroota PWRA away from the irrigation area**

Observation wells downstream of Baroota Reservoir (Fig. 10) display a very different response to recharge which is predominantly driven by overflow recharge from the reservoir. The graph below shows the pronounced peaks in water levels which occur in response to recharge events corresponding to overflow of the reservoir wall which occurs when water levels (in blue) reach a critical level exceeding 23 m (local datum). The high groundwater levels are sustained for longer periods if the overflow persists, as occurred in 1992-93. Extractions are thought to have only a minor impact on water level trends.

The water level response to recharge diminishes laterally with distance from the Baroota Creek (compare BTA009 adjacent to the creek, with BTA010 located 2 km northwest of the creek). Similarly, the response also diminishes with distance downstream from the reservoir (compare BTA003 located 2 km downstream, with BTA010 at 4 km downstream).

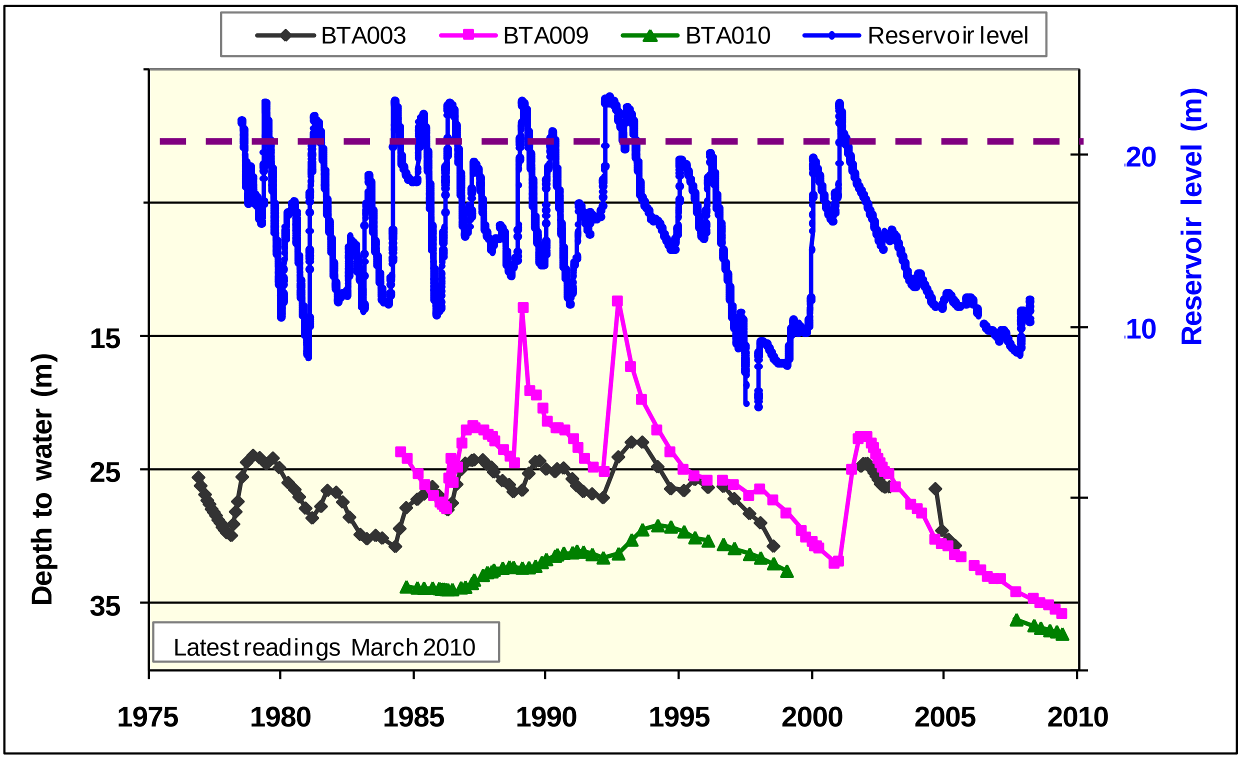

Figure 10. Groundwater level trends and reservoir level downstream of Baroota Reservoir

The groundwater levels have fallen consistently to the lowest levels recorded in 30 years with declines of up to 10 m. Given that there has been a fundamental change in one of the primary recharge mechanisms through the significant reduction in streamflow into Baroota Reservoir, these reductions in groundwater level are expected to continue until higher rainfall occurs. However, this consistent trend of falling groundwater levels should be seen in the context of a substantial aquifer thickness (up to 100 m). There will be sufficient time to develop an adaptive management approach and make any necessary adjustments through the Water Allocation Planning process established for this area.

GROUNDWATER SALINITY TRENDS

The sporadic nature of salinity monitoring in the past, and the variation in production zone intervals of the wells sampled, make interpretation of any groundwater salinity trends difficult. The salinity trends are shown in Figure 11 for wells in the irrigation area, together with Baroota Creek in blue. A variety of trends are evident below. There does not appear to be any significant negative trend in salinity (ie less than a rate of 2% increase per year). Well BTA021 is completed in the deep Tertiary sand aquifer. Despite the widespread fall in groundwater levels, the change in operation of Baroota Reservoir and a significant period of drought, there is no evidence of any corresponding rise in salinities throughout the irrigation area. This indicates there is a level of resilience in groundwater salinity to such pressures.

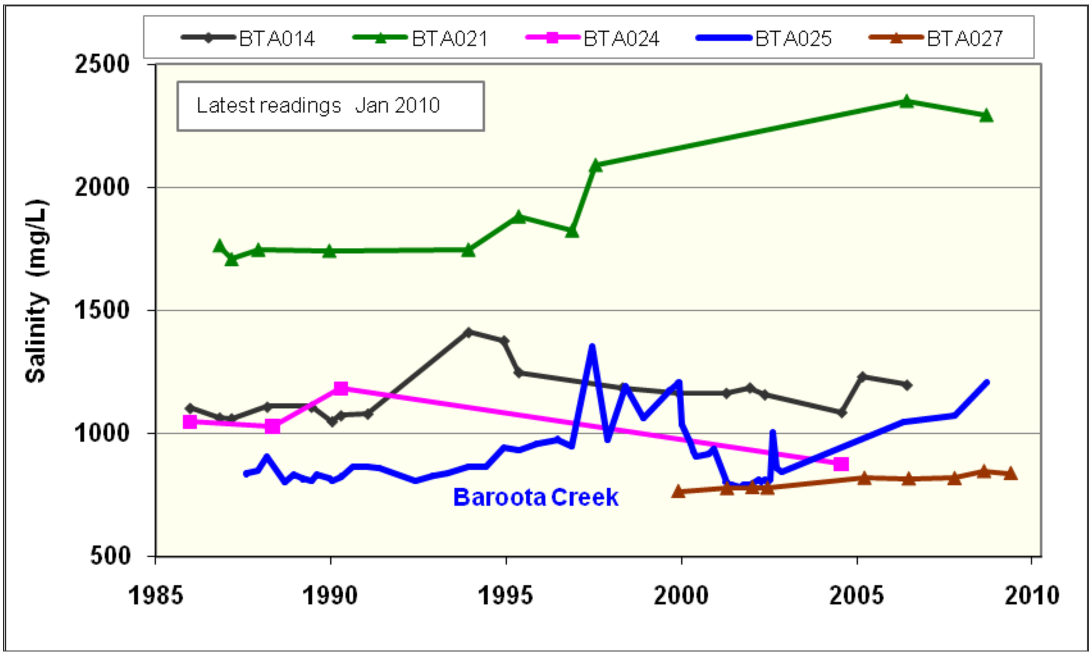

Figure 11. Groundwater salinity trends in the Baroota PWRA