# Water Allocation Plan

South East Catchment Water Management Board

Supported By
Government of South Australia

# PADTHAWAY PRESCRIBED WELLS AREA

**Water Resources Act 1997**

# Water Allocation Plan

**for the**

# Padthaway Prescribed Wells Area

I, Mark Brindal, Minister for Water Resources, hereby certify that this plan is the Water Allocation Plan for the Padthaway Prescribed Wells Area adopted by me on 29 June 2001 and amended pursuant to section 118 of the *Water Resources Act 1997*.

.....
Hon Mark Brindal MP
Minister for Water Resources

Date: 14/10/01

Prepared by

## South East Catchment Water Management Board

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# 1 The Padthaway Prescribed Wells Area

This document is the water allocation plan for the Padthaway Prescribed Wells Area, pursuant to Part 7, Division 3 of the *Water Resources Act 1997*. This Water Allocation Plan replaces the *Padthaway Prescribed Wells Area Water Allocation Plan* as varied by the Plan published in the Government Gazette on 27 July 2000.

The Padthaway Proclaimed Region was gazetted on the 13 May 1976 under the provisions of the *Water Resources Act 1976*. Upon the introduction of the *Water Resources Act 1997* the Padthaway Proclaimed Region became known as the Padthaway Prescribed Wells Area (PWA).

The Padthaway PWA is located approximately 300 km south-east of Adelaide and covers an area of approximately 700 $km^2$ and includes the Hundreds of Glen Roy, Parsons and the north-eastern half of Marcollat. It incorporates the towns of Padthaway and the locality of Keppoch. The eastern boundary of the PWA is formed along the Hundred line of Glenroy and Parsons. The northern boundary is located along the top of the Hundreds of Marcollat and Parsons, while the southern boundary is the bottom of the Hundred of Glen Roy. The western boundary trends NW-SE, and generally follows the foot of Harpers Range, the first sand ridge west of the Kanawinka Fault. The location and boundaries of the Padthaway PWA are shown in Figure 1.2.

The climate in the Padthaway PWA is typical of the South East; hot, dry summers and cool, wet winters. The average annual rainfall (1977 to present) from the Padthaway Southcorp Wines gauging station situated just north west of Padthaway township is 518 mm. The annual potential evapotransipiration is approximately 1600 mm.

A total of 8,746 hectares of irrigated crops were grown in the Padthaway PWA in 1998/99, representing 13% of total land area in the PWA. The principal irrigated industry in the Padthaway PWA is viticulture, both in terms of area (3,110 ha) and more significantly, economic value. There are substantial areas of irrigated pasture (2,110 ha), lucerne for seed production (732 ha), cereals (570 ha), coriander seed (444 ha) and canola (308 ha). Most of the remaining areas are made up of lucerne for hay or grazing and pasture seed (clovers).

The Padthaway PWA comprises two discrete land-forms separated by the NW-SE trending Kanawinka Fault. To the south-west of the fault, is a low-lying interdunal flat. The width of the flat is approximately ten kilometres and slopes gently downwards to the north-west. Northeast of the fault a remnant dunal ridge rises to about 50 to 60 metres above the flat, forming part of the Naracoorte Range.

## The Prescribed Resource

In the Padthaway PWA, underground water is extracted from two sub-aquifers which form part of the regional unconfined aquifer. These sub-aquifers occur within the Padthaway Formation and the Bridgewater Formation respectively. A schematic east-west cross section through the Padthaway PWA highlighting the main geological units is shown in Figure 1.1.

The Padthaway Formation sub-aquifer occurs only beneath the interdunal flat and generally ranges in thickness from six to fourteen metres. The formation consists mainly of an off-white, well-cemented fine-grained limestone. A well developed secondary porosity has resulted in a highly transmissive aquifer with ranges in transmissivity of between 1,100 and 11, 000 $m^3$/day/m. Depth to water generally ranges between two and six metres. This is the most used sub-aquifer in the PWA.

Underlying the Padthaway Formation sub-aquifer is the Bridgewater Formation sub-aquifer. Beneath the flat, the Bridgewater Formation is approximately 20 metres thick. It is made up of an orange to yellow calcareous sandstone and is moderately to well cemented.

In the main irrigation area (between Grub Road and the main highway) the two sub-aquifers are hydraulically connected and have a similar underground water salinity and aquifer characteristics. To the west of the main irrigation area there is a confining unit separating the two sub-aquifers. The water quality is better in the Bridgewater Formation, but the permeability (and well yields) of this sub-aquifer are significantly lower. Transmissivity ranges from 320 to 2,400 $m^3$/day/m. The majority of wells located on the flat are uncased or have shallow surface casing. Most wells penetrate both sub-aquifers and are therefore not separated.

Below the Padthaway and Bridgewater Formations are the Coomandook and Ettrick Formations. Both Formations may contain good quantities of good quality underground water, but they are restricted in their use as a water source due to fine grain size and poor consolidation.

The Bridgewater Formation sub-aquifer forms the main aquifer in the Naracoorte Range. Most of the wells are completed in the base of the Bridgewater Formation (and possibly the top of the Gambier Formation) as it is better cemented than the top section of the formation. Average well yields are approximately 30 Litres/second but they can be highly variable. The quality of the underground water from the aquifer is better than its equivalent on the flat, but the Formation is not as consolidated and can produce fine sand when pumped. The depth to water is greater than on the flat and reflects a steepening of topography away from the Kanawinka Fault.

The Dilwyn Formation aquifer (the confined aquifer) is generally absent, or thin (less than 2.5 metres in thickness), over much of the Padthaway PWA and is not utilised as a water resource.

# 2 Assessment of the Needs of Dependent Ecosystems

The needs of ecosystems include both the local influence of underground water within an ecosystem and the influence on receiving environments downstream.

**Ecosystem Water Needs**

In ecosystems dependent on underground water currently undisturbed by the taking and use of underground water, the present underground water conditions (that account for natural patterns such as climate) can be considered as providing the water needs of the ecosystem in question. Where undisturbed ecosystems dependent on underground water have been identified, the underground water data available during October 2000 has been interpreted as the Ecosystem Water Needs of dependent ecosystems (see Table 2.1). For ecosystems subject to changing underground water conditions, data that describes the most recent steady state underground water conditions have been interpreted from available records and adopted as the Ecosystem Water Needs (Table 2.1).

Water needs were collectively described for ecosystems sharing common environments, termed land units, in which current underground water conditions and trends were consistent. Four land units were identified within the Padthaway PWA (Figure 2.1) for the purposes of describing ecosystem water needs. These land units are the:

- West Naracoorte Ranges;
- Padthaway to Keppoch;
- Padthaway Flat; and
- Northern Watercourse, which comprises the small area of the Harper Range and Marcollat Watercourse in the south west of the PWA.

The quantity of underground water which ecosystems need was described in terms of water table elevation and underground water quality. Underground water quality was referred to in terms of salinity levels.

**Ecosystems Dependent on Underground Water in the Padthaway PWA**

**West Naracoorte Ranges Land Unit**

The West Naracoorte Ranges Land Unit comprises of steeply undulating hills of the Bridgewater Formation overlain by Molineaux Sand in the east. The following water dependent ecosystems were identified as being present, or are likely to be present within the West Naracoorte Ranges Land Unit:

- Wetlands – The only wetlands located in the area are located at Swede Flat near the northern boundary of the PWA at an elevation of around 65m AHD. It is interpreted that the wetlands occur approximately 15m above the water table, indicating that the systems are perched and can be considered independent of underground water.

- Streams – Morambro Creek flows through the south western part of the West Naracoorte Range at The Gap. Based on ground surface elevations and depth to the water table the creek is expected to be fed primarily by surface water (i.e. it is a losing stream). There are no reports of springs in the creek as it flows through the range. The streams of the West Naracoorte Ranges land unit can therefore be considered as independent of underground water.

- Phreatophytes – There are stands of River Red Gum *(Eucalyptus camaldulensis)* in the range associated with Morambro Creek and low lying depressions, which are relatively close to underground water. These trees may be susceptible to increasing underground water salinity and a rising water table, which may lead to water logging of roots, salt stress and die back.

- Karsts – There are likely to be karsts in this area, but it is not known where they exist, whether they intersect the water table or the nature of the biota they support.

- Hypogean Ecosystems – These macroinvertebrate and microbial ecosystems, where present, occur underground within the water filled pore spaces of the aquifer system. There are no records of such ecosystems within the West Naracoorte Ranges Land Unit. However, these ecosystems are likely to be present.

**Padthaway to Keppoch Land Unit**

The Padthaway Flat is a low relief interdunal flat between the West Naracoorte Range and the Harper Range. The Padthaway to Keppoch Land Unit encloses the subset of this area that is subject to salinity. The following ecosystems dependent on underground water were identified as present or are likely to be present within the Padthaway to Keppoch Land Unit:

- Phreatophytes – This land unit includes a number of relatively intact *Eucalyptus camaldulensis* woodland communities, as well as numerous scattered individual trees. The trees reach a height of over 10m and with the water table lying within 5m of the surface, they are highly likely to be dependent on underground water.

- Karsts – Karsts are expected to occur in this area, but it is not known where they exist, whether they intersect the water table or the nature of the biota they support.

- Hypogean Ecosystems – These macroinvertebrate and microbial ecosystems, where present, occur underground within the water filled pore spaces of the aquifer system. There are no records of such ecosystems within the Padthaway to Keppoch Land Unit. However, these ecosystems are likely to be present.

**Padthaway Flat Land Unit**

The Padthaway Flat Land Unit comprises the remainder of the Padthaway Flat area not enclosed by the Padthaway to Keppoch Land Unit. The geology of the area is comprised of the Padthaway Formation overlying the Bridgewater Formation. The following ecosystems dependent on underground water have been identified as present or are likely to be present within the Padthaway Flat Land Unit:

- Streams and Wetlands – Morambro Creek flows into the Padthaway PWA through a narrow flow path in the Naracoorte Range known as The Gap, in the south-eastern corner of the PWA. The creeks flows into Cockatoo Lake, which is permanent, and in turn overflows to the west during wet winters via a drainage channel. Both the creek and the lake are likely to interact with the unconfined aquifer.

  While the permanence of Cockatoo Lake might suggest the discharge of underground water to the wetland, surface water monitoring has not detected any increase in salinity in the creek or lake, which might indicate the discharge of underground water. However, the wetland may interact with the water table through underground water mounding.

  Another wetland at the foot of the range, to the north west of Padthaway, receives surface flows from a constructed drain. The wetland lies at an elevation of 33m AHD and may receive underground water discharge from the range to the east.

  The western section of the land unit receives surface runoff from Morambro Creek as it flows westerly from Cockatoo Lake to the Harper Range and then northerly to Nyroca. Most of the flow is contained within drains, however there is some sheet flow into Deep Water Swamp at the southern boundary of the PWA, during periods of high flow.

  Deep Water Swamp is a semi-permanent saline lake with little remnant vegetation except *Melaleuca halmaturorum*. The saline conditions probably reflect underground water discharge and evaporative concentration.

- Phreatophytes – There are substantial areas of vegetation growing over shallow underground water, particularly Tea Tree in the Talapar Conservation Park. The park receives local runoff from Bucham Swamp to the south and is used by local landholders to receive drainage water. Plant associations likely to be dependent on underground water include closed heaths of *Melaleuca neglecta, M. uncinata* and *Leptospermum juiperinum* and open *Melaleuca halmaturorum* scrub.

  Mature Red Gums are scattered throughout this area and a more substantial remnant is located near Nyroca. There are several wetland depressions in and around the Talapar Conservation Park, which fill from local runoff and are likely to form underground water mounds.

  At the foot of the West Naracoorte Range are stands of *Eucalyptus camaldulensis*, which are likely to be dependent on the shallow water table. Scattered trees are found elsewhere in the land unit. The central and western areas have remnants of *Leptospermum lanigerum* and *Melaleuca brevifolia* shrublands, which are also likely to be dependent on underground water.

- Karst Features – The distribution and ecological significance of karsts in this area is unknown.

- Hypogean Ecosystems - These macroinvertebrate and microbial ecosystems, where present, occur underground within the water filled pore spaces of the aquifer system. There are no records of such ecosystems within the Padthaway Flat Land Unit. However, these ecosystems are likely to be present.

**Northern Watercourses**

The Padthaway PWA encloses a small portion of the Drain E watercourse on the western side of the Harper Range. The drain lies at 35m above sea level and carries substantial seasonal surface flows from Naracoorte Creek and the Naracoorte Plain. Underground water elevations are generally shallow (34m AHD). The following ecosystems dependent on underground water have been identified as present or are likely to be present within the Northern Watercourses Land Unit:

- Wetlands – There are two unnamed wetland depressions that lie in this land unit which are likely to receive local runoff. At an elevation of less than 2m above the water table, they are likely to form underground water mounds. The biota they support is undocumented.

- Karst features – The presence and nature of karst ecosystems in this area is unknown.

- Hypogean Ecosystems - These macroinvertebrate and microbial ecosystems, where present, occur underground within the water filled pore spaces of the aquifer system. There are no records of such ecosystems within the West Northern Watercourses Land Unit. However, these ecosystems are likely to be present.

**Water needs of Identified Ecosystems Dependent on Underground Water**

Table 2.1 sets out the quantity (elevation and annual range), quality (salinity) and timing (seasonality of maximum and seasonality of minimum) of water needed by the ecosystems identified in each of the four land units of the Padthaway PWA. The current conditions (as at October 2000) within each land unit have been included to provide a comparison with the identified ecosystem water needs (most recent observed steady state conditions).

**Table 2.1: Needs of Identified Ecosystems Dependent on Underground Water**

| Land Unit | Parameter | Current Conditions at October 2000 | Ecosystem Water Needs | Most Recent Observed Steady State Period |
|---|---|---|---|---|
| | | | | |
| **West Naracoorte Ranges** | Salinity | minor increase | 1000-1500 mg/L | 1990-2000 |
| | Elevation | rising 0.15 m/yr since 1970 | 60-45 m AHD | 1970 |
| | Annual Range | no change | <0.1 m | 1970-2000 |
| | Seasonality of Maximum | no change | n.a. | 1970-2000 |
| | Seasonality of Minimum | no change | n.a. | 1970-2000 |
| | | | | |
| **Padthaway to Keppoch** | Salinity | 1000-2000 mg/L | 900-1500 mg/L | 1990 |
| | Elevation | + 0 m | 35-40 m AHD | 1970-2000 |
| | Annual Range | no change | 0.5-1.5 m | 1970-2000 |
| | Seasonality of Maximum | no change | Spring | 1970-2000 |
| | Seasonality of Minimum | no change | Autumn | 1970-2000 |
| | | | | |
| **Padthaway Flat** | Salinity | minor local increases | 1000-5000 mg/L | 1977-2000 |
| | Elevation | no change | 30-40 m AHD | 1977-2000 |
| | Annual Range | no change | 0.2-1.5 m | 1977-2000 |
| | Seasonality of Maximum | no change | Spring | 1977-2000 |
| | Seasonality of Minimum | no change | Autumn | 1977-2000 |
| | | | | |
| **Northern Watercourses** | Salinity | no change | 5000-6000 mg/L | 1977-2000 |
| | Elevation | no change | 33.5-34.5 m AHD | 1996-2000 |
| | Annual Range | no change | 0.5 m | 1996-2000 |
| | Seasonality of Maximum | no change | Spring | 1996-2000 |
| | Seasonality of Minimum | no change | Autumn | 1996-2000 |

## Glossary

| | |
|---|---|
| Amphipod | A small (approximately 5mm long) aquatic crustacean found in fresh waters including cave environments. |
| Hydraulic gradient | Spatial variation in the effective elevation of the water table, which drives lateral flow in underground water. |
| Hypogean ecosystems | Macroinvertebrate and microbial communities that occur within the water filled pore spaces of the saturated zone. |
| Invertebrate | An organism with an external skeleton. |
| Karst Feature | Cavity or cave formed by the solution of limestone by naturally occurring acids. |
| Macroinvertebrate | An invertebrate greater than 0.5 mm in length. |

| | |
|---|---|
| Microbial | Bacteria, fungi etc. that are invisible to the naked eye. |
| Phreatophyte | A plant that is dependent on underground water. |
| Recharge | Water that replenishes the aquifer by infiltration from the land surface. |
| Saturated zone | The zone in which voids within soils and rocks are completely filled with water, also known as the phreatic zone. |
| Stromatolite | Layered deposits of calcium carbonate and various other minerals which have been created by the action of living organisms such as microscopic algae, bacteria and other microbes. |
| Stygobite | An organism which exclusively inhabits underground habitats, such as caves and subterranean waters. |
| Syncarid | A small (approximately 3 mm long) aquatic invertebrate belonging to an ancient order of crustaceans, the Syncaridae. Their form has changed little over millions of years, and they are sometimes referred to as a living fossil. They are usually found in underground environments and are generally rare. |
| Through-flow | Lateral passage of underground water, driven by a hydraulic gradient. |
| Unsaturated zone | Region above the water table through which recharge infiltrates, also known as the vadose zone. |
| Water table | Upper surface of saturation in the unconfined aquifer. |

# 3 Assessment of Effects on Other Water Resources

Section 101 (4) (b) of the Act requires the Plan to contain an assessment of whether the taking of water will have a detrimental effect on the quality and quantity of water available from any other water resource.

Other water resources within the Padthaway PWA comprise the following:

- Morambro Creek;
- Cockatoo Lake; and
- Wetlands, including Deep Water Swamp and wetlands located at Swede Flat.

The potential detrimental impacts of taking, or using, water from the unconfined aquifer in the Padthaway PWA on the quantity or quality of water in the confined aquifer resource, and the impacts taking or using water from the confined aquifer may have on the quantity or quality of water in the unconfined aquifer resource, were also considered, as well as the impacts of taking and use of underground water from the Padthaway PWA on other water resources in adjacent PWAs.

**Morambro Creek**

Morambro Creek flows through the south western part of the West Naracoorte Range through a narrow flow path known as The Gap. Based on ground surface elevations and depth to the water table the creek is expected to be fed primarily by surface water (ie it is a losing stream) and there are no reports of springs in the creek as it flows through the range. Therefore the taking and use of underground water will not have a detrimental effect on the quantity or quality of water available in Morambro Creek.

**Cockatoo Lake**

Morambro Creek flows into Cockatoo Lake, which is a permanent lake, which in turn overflows to the west during wet winters via a drainage channel. While the permanence of Cockatoo Lake might suggest the discharge of underground water to the wetland, surface monitoring has not detected any increase in salinity in the lake, which might indicate the discharge of underground water. Therefore the taking and use of underground water will not have a detrimental effect on the quantity or quality of water available in Cockatoo Lake.

**Wetlands**

Wetlands in the Padthaway PWA vary in terms of their relationship with, and reliance on, underground water. The wetlands at Swede Flat occur approximately 15 metres above the water table, indicating that they are perched, and the taking and use of underground water will have no detrimental effect on the quality and quantity of water within these wetlands.

Deep Water Swamp is a semi-permanent saline lake. The saline conditions probably reflect the groundwater discharge and evaporative concentration. Other wetlands in the Padthaway PWA may receive underground water discharge. While the current level of underground water extraction and use is not affecting water levels in the Padthaway

PWA, underground water salinity is increasing from 5 to 18 mg/L/year in management areas 2 and 3, which is attributed to the recycling of irrigation water. However, given the only partial dependence of the wetlands on underground water, the taking and use of underground water is not expected to have a detrimental effect on the quality and quantity of water within either Deep Water Swamp, or other wetlands.

**Confined Aquifer**

As there is little or no confined aquifer at this locality, it is most unlikely that the taking or use of underground water from the unconfined aquifer will have a detrimental effect on the confined aquifer.

**Unconfined Aquifer**

As there is little or no confined aquifer at this locality, it is most unlikely that the taking or use of underground water from the confined aquifer will have a detrimental effect on the unconfined aquifer.

**Water Resources in Adjacent PWAs**

The taking and use of underground water from the Padthaway PWA is not expected to have any detrimental effects on the underground water resources of adjacent PWAs.

# 4 Assessment of the Capacity of the Resource to Meet Demands

## 4.1 The capacity of the resource

The capacity of the underground water resources of the Padthaway PWA to meet demand on a continuing basis will depend on several factors. One of the main factors is the rate of extraction of underground water by underground water users. Systems for appropriately allocating underground water and managing its use are required for the protection of the long-term condition of the resource.

The Permissible Annual Volume (PAV) as defined by the *Groundwater (Border Agreement) Act 1985* in effect relates to the volume that can be allocated for licensed extraction within the Border Designated Area. In calculating the PAV for the Border Designated Area, stock and domestic use has been excluded, as a water licence is not required for these purposes.

It is now recognised that it is preferable to calculate the volume of water to allocate throughout the area covered by this Plan, by making provision for stock and domestic use, along with, the expansion of plantation forestry, and the environment. For this reason, the concept of Volume for Licensed Allocation (VLA) has been developed.

The VLA is the total quantity of water (in megalitres) available for licensed extraction on an annual basis within each management area. The VLA is calculated differently for each aquifer.

The Volume for Licensed Allocation in each management area for the unconfined aquifer is calculated as follows:

- The Permissible Annual Volume, less provisions for the effect of forestry plantations on annual average vertical recharge, stock, domestic, and environmental demands, less a further 10% buffer in areas that were not fully allocated (or did not become fully allocated as a result of the buffer) at **date of adoption**.

The Volume for Licensed Allocation in each management area for the confined aquifer is calculated as follows:

- The Permissible Annual Volume, less provision for the effect of leaking wells, stock, domestic, and future town use.

## 4.2 The Unconfined Aquifer

### 4.2.1 The Capacity of the Resource

The Padthaway PWA was proclaimed in 1976 following concern that increased irrigation activity may lower the water table. The original water licences were issued on the basis of established irrigation activity or on proposed development. As such, there was no assessment of sustainable water use in the Padthaway PWA and therefore PAVs were never determined, rather, allocations were capped at 35,083 megalitres.

In the past, no management areas were delineated within the Padthaway PWA. Five water management areas were created following the introduction of transfer policy in 1994, but these management areas were never formally recognized. Management areas 1, 2A, 2B and 3 are situated on the flat. Management area 4 is the highlands area lying north-east of the Kanawinka fault. Management areas 2A and 2B are located immediately south-west of the Fault and are collectively known as the Intensely Irrigated Area. Viticulture is the main crop type in these management areas. Four management areas have now been formally adopted for the PWA. Management area 2A and 2B have been combined as one, and named management area 2 (Refer to Figure 1.2).

The annual rate of net removal of underground water should roughly equate to the estimated annual average vertical recharge to the water table. Underlying this approach is the principle that lateral throughflow is maintained in the aquifer, thereby allowing any salts accumulated during recharge to be flushed down-gradient. Importantly, consideration is also given to minimising salinity increases in the unconfined aquifer due to irrigation activity. Therefore in some areas the permitted annual rate of net removals should be lower than the estimated average yearly vertical recharge, where extraction of the estimated average yearly vertical recharge is anticipated to result in an unacceptable salinity increase in the unconfined aquifer

The PAV has been estimated by calculating the annual average vertical recharge to the aquifer in accordance with the following formula:

PAV for all management areas (in ML per year) = (sum of $(A_n X R_n))X S_f$

Where:

- $A_n$ is the land area (in square kms) of a defined recharge region within the individual management area;
- $R_n$ is the annual average vertical recharge rate (in mm per year) of the defined recharge region $A_n$;
- $S_f$ is the salinity factor adopted for the management area.

As shown in Figure 4.1, a management area can comprise one or more recharge regions, each of which is assigned an individual recharge rate.

In the Padthaway PWA the (now) Department for Water Resources estimated the rate of rainfall recharge beneath cleared agricultural land (open pasture) for each management area. The study was conducted in 1994. The method used to estimate rainfall recharge was to assess the relationship between seasonal changes in underground water level (measured from hydrographs) and an assumed specific yield of 0.1. Each management area was classified according to soil type, morphology and hydrogeological condition. These recharge zones were further subdivided to reflect depth characteristics of soil types, depth to water and vegetation cover. The upper and lower limits were determined from various seasonal hydrograph responses (low hydrograph response was equated to low recharge). The lower limits were adopted for the PAVs for each management area, as shown in Table 4.1.

The salinity factor is a proportional reduction of the total recharge in the management area, where the extraction of 100% of the annual average vertical recharge is expected to lead to unacceptable salinity impacts.

During 2001, the PAVs for each management area within the Padthaway PWA were assessed on the basis of the average annual vertical recharge rate attributed to that management area, as shown in Table 4.2. Thus the overall PAV for the Padthaway PWA has been reduced from 35,083 to 31,312 ML, with further changes in each management area (see Table 4.1).

**Table 4.1: Unconfined Aquifer PAVs, VLAs, and Total Licensed Allocations by management area in the Padthaway PWA**

| Management Area | PAV ML | VLA[(a)] ML | Total Licensed Allocations at 23/05/2001 [(b)] ML |
|---|---|---|---|
| Management area 1 | 15,774 | 14,019 | 12,415 |
| Management area 2 | 5,960 | 5,960 | 15,675 |
| Management area 3 | 2,900 | 2,859 | 3,807 |
| Management area 4 | 6,678 | 5,774 | 3,216 |
| **Total** | **31,312** | **28,613** | **35,113** |

**Table 4.2: Management Area Annual Average Vertical Recharge Rates**

| Recharge Rate (mm/a) | Management area 1 | Management area 2A | Management area 2B | Management area 3 | Management area 4 |
|---|---|---|---|---|---|
| Lower Limit | 66 | 90 | 50 | 58 | 21 |
| Upper Limit | 90 | 105 | 62 | 66 | 35 |

### 4.2.2 Historical Demand

The historical and current level of allocation and use in the Padthaway PWA gives a good indication of the present demands on the unconfined aquifer.

The historical and current estimated crop water use are shown on Table 4.3. However, as the management areas of the Padthaway PWA have only very recently been officially adopted, allocations and use are not linked back to a management area in the licensing system, and therefore the data is only available at the PWA level.

The significant increase in allocation from 30,222 ML in 1993/94 to 35,010 ML in 1994/95 was due to the adoption of the Irrigation Equivalent system that replaced the Lucerne Equivalent system. This increased the megalitres (ML) per hectare of irrigation from 5.40 ML to 5.92 ML. This in turn increased the water allocated, when the new allocations were introduced in the licensing year 1994/95.

However, underground water usage must be interpreted carefully, due to the method by which use for irrigation purposes is calculated. Historically, allocation of water licences for irrigation have been based on area and the irrigated crop water use requirement relative to a reference crop. The water usage volume is then estimated from annual seasonal returns supplied by water users and correlation with aerial photography. The volume of water used by crops is calculated by converting the area

of irrigated crops to megalitres, using crop area ratios (CARs). The irrigated crop water requirement method does not reflect the actual volume of groundwater extracted from the aquifer, and estimation of the volume used by each licensee relies on the veracity of the water user and the irrigated crop requirement method. A suitable method of measuring actual underground water use is required.

In contrast, allocations of water licences for industrial and recreational purposes are issued volumetrically. However, there is no recorded usage of these allocations. Even though allocations exist and some wells are equipped with meters, there is no regular meter reading program.

**Table 4.3: Padthaway PWA unconfined aquifer licensed allocation and usage**

| Year | Purpose | Licensed Allocation(ML) | Licensed Use[3] (ML) |
|---|---|---|---|
| 1985/1986 | Irrigation | 27,314 | 24,921 |
| 1986/1987 | Irrigation | 27,314 | 24,476 |
| 1987/1988 | Irrigation | 27,932 | 23,179 |
| 1988/1989 | Irrigation | 28,113 | 21,707 |
| 1989/1990 | Irrigation | 29,282 | 21,472 |
| 1990/1991 | Irrigation | 29,498 | 24,891 |
| 1991/1992 | Irrigation | 29,675 | 24,016 |
| 1992/1993 | Irrigation | 30,211 | 20,367 |
| 1993/1994 | Irrigation | 30,222 | 21,351 |
| 1994/1995 | Irrigation<br>Industrial and Recreation | 35,010[2]<br>14 | 22,440<br>N/A |
| 1995/1996 | Irrigation<br>Industrial and Recreation | 35,010<br>14 | 23,600<br>N/A |
| 1996/1997 | Irrigation<br>Industrial and Recreation | 35,069<br>14 | 23,766<br>N/A |
| 1997/1998 | Irrigation<br>Industrial and Recreation | 37,268[1]<br>14 | 24,164<br>N/A |
| 1998/1999 | Irrigation<br>Industrial and Recreation | 35,019<br>65 | 24,944<br>N/A |

1. The water allocation total for 1997/98 should be 35,010 ML. This discrepancy is due to the fact that the Water Licensing System is not an historical database. This introduces problems as associated with the 1997/98 water allocation total for Padthaway. A new relational database is being developed currently.
2. The significant increase in allocation following 1993/94 from 30,222 ML in 93/94 to 35,024 ML in 94/95 was due to the adoption of the Irrigation Equivalent system that replaced the Lucerne Equivalent system.
3. Use is not the volume extracted from the unconfined aquifer, but the crop water use, calculated using CARs. This figure also does not include bona fide unlicensed use for stock, domestic and town water supply purposes.

### 4.2.3 Current Demand

#### General

The total licensed allocations as at 23 May 2001 in the Padthaway PWA are 35,113 ML, which is 123% of the VLA, and hence the PWA as a whole is over allocated. Total underground water usage for the area in 1998/99 was estimated to be 24,944 ML which represents approximately 71% of the total allocation in 1998/99 of 35,084 ML.

Demand (and hence use) is very high in management area 2, where the VLA is 5,960 ML, and total licensed allocations as at 23 May 2001 were more than 2.5 times the VLA at 15,675 ML. Management area 2 is therefore heavily over-allocated. Viticuture is the main crop type in management area 2.

Demand is also high in management area 3, which is also over-allocated. In management area 3 the VLA is 2,859 ML and total licensed allocations as at 23 May 2001 were 3,807 ML. In contrast, management areas 1 and 4 are not fully allocated, as shown in Table 4.1 and Table A.

**Irrigation**

Irrigation is by far the greatest user of underground water in the PWA. A total of 8,746 hectares of irrigated crops were grown in the Padthaway PWA in 1998/99, representing 13% of total land area in the PWA. The principal irrigated industry in the Padthaway PWA is viticulture, both in terms of area (3,110 ha) and more significantly, economic value. There are substantial areas of irrigated pasture (2,110 ha), lucerne for seed production (732 ha), cereals (570 ha), coriander seed (444 ha) and canola (308 ha). Most of the remaining areas are made up of lucerne for hay or grazing and pasture seed (clovers).

**Industry and recreation**

65 megalitres was allocated in 1998/99 in the Padthaway PWA for both industrial and recreational use, combined. The licences in the recreation category are largely held by sporting clubs (for watering sports fields, greens and gardens) and Local Government (for the watering of parks and gardens).

**Stock and domestic**

Total annual stock underground water use from the unconfined aquifer for the PWA is estimated to be 500 ML (as shown in Table 4.4). These figures are based on stock numbers for the 1996-97 season in the Padthaway PWA, which were obtained from the Australian Bureau of Statistics (ABS), and multiplied by the average daily stock consumption figures from data supplied by the New South Wales Department of Agriculture. The stock underground water use estimates are to the nearest 5 ML.

As the stock number information from the ABS is only available by Hundreds, in order to determine the stock underground water use by management area in the Padthaway PWA, the 500 ML estimate was split on a proportional basis by area, with the exception of management area 2, where stock underground water use was considered to be zero due to the predominance of viticulture.

**Table 4.4: Estimated stock underground water use from the unconfined aquifer in the Padthaway PWA 1996/97**

| Management Area | Estimated Stock Under ground water Use (ML) |
|---|---|
| Management area 1 | 197 |
| Management area 2 | 0 |
| Management area 3 | 41 |
| Management area 4 | 262 |
| **Total** | **500** |

Domestic water use is considered to be relatively small as rainwater tanks are prominent in the area.

**Town Use**

Water use from two town water supply wells located just east of Padthaway township between 1991/1992 and 1998/1999 generally ranges from 9 to 15 ML. The exception was in 1994/1995 when 61 ML was used. The use for 1998/1999 was 11 ML, which ranks as insignificant when compared to the total allocation for the PWA. The town water supply wells are located in management area 4.

### 4.2.4 Future Demand

**Irrigation**

Total crop water use in the Padthaway PWA varies markedly on an individual management area basis. It is probable that the majority of unused allocations lie outside management area 2, and therefore there may be opportunities for expansion in irrigation through transfer of allocations from management areas 2 or 3 into other management areas, or greater use of allocations.

**Industry and recreation**

Demand for water for industrial and recreational use is expected to remain steady. No significant future new industrial users of underground water are known.

**Stock and domestic**

Whilst stock numbers will change with seasons and market conditions, such changes will have only a small effect on the relative magnitude of underground water use, therefore stock and domestic use is not expected to vary significantly from current use.

**Town Use**

SA Water believe that Padthaway's water use has stabilised and forecast a maximum usage over the next five years at 20 ML per year, from management area 4. SA Water may soon be issued with water licences for extraction of water for town water supply purposes, therefore 20 ML of licensed town water supply use has been included in the column titled 'Total Licensed Allocations' in Table 4.1 and Table A.

**Forestry Commitment**

While there are soils in the Padthaway PWA (management area 4 in particular) which may be suitable for plantations, there are no future forestry commitments known in the Padthaway PWA. It is unlikely that there will be forestry expansion on a large scale in the Padthwaway PWA, due to the lower rainfall in this area, and hence lower productivity, resulting in marginal returns for forestry investment. The distance of this region from processing facilities and the Port of Portland, and therefore the high cost of transporting logs, will also deter any large scale forestry investment in the region. However, forestry on a small scale, including farm forestry and landcare plantings, are likely to take place in the future.

**Environmental Commitment**

The ecosystems identified in section 2 are generally only partially dependent on underground water in the Padthwaway PWA, and as water levels are being maintained under the current extraction regime, no formal allocation to the environment has been made in this PWA.

### 4.2.5 Current Status of the Water Resources

**Underground water Flow**

Underground water flow is generally in a south-westerly direction east of the Kanawinka Fault. On the interdunal flat in the west of the PWA the flow direction changes to a north-westerly direction consistent with the slope of the ground surface.

**Water Level Trends**

Only wells with more than five years data were included in the study of water level trends. Long-term water level trends from bore hydrographs located in Sub-area 4 show a general rise in the water table of between 2 and 12 cm per year. A number of the wells show a higher rising trend beginning in the mid- to late 1980s. The rise in the water table is considered an outcome of the clearance of native vegetation and the failure of lucerne crops in the mid-1970s.

In the other sub-areas (1, 2 and 3) there has been no significant long-term change in the water table elevation. While there has been no overall long-term change in water level, many of the hydrographs from the wells on the flat show a sinusoidal trend. This trend may be related to rainfall patterns.

**Salinity Distribution**

The salinity distribution for the Padthaway PWA is shown on Figure 4.2. Generally, the salinity of underground water in the range is lower than on the flat. In management area 4, the salinity ranges between approximately 900 and approximately 2,000 mg/L. On the flat, the salinity ranges from 900 to 6,500 mg/L TDS. Salinity on the flat increases westward towards the Harper Range.

**Salinity Trends**

Management area 4

Associated with the rise in underground water levels in management area 4 is an increase in underground water salinity as shown on Figure 4.3. Generally the underground water salinity in this area is increasing by between 5 and 17 mg/L annually. This is a result of higher rates of recharge, reflected in the rising water table, flushing salts stored in the soil profile and the unsaturated zone into the aquifer.

Management area 4 is within the Upper South East Dryland and Flood Management project area, and grant funds are available for revegetation which would assist in controlling recharge. The rising water table could be advantageous, however, in that an increase in the hydraulic gradient would potentially increase the underground water

flow through the intensely irrigated area aiding salt removal. Further research is required into assessing the impacts of increasing underground water salinity in management area 4, specifically identifying salt accession mechanisms to the aquifer.

Management area 1

Observation wells in management area 1 show a declining underground water salinity trend of between 10 and 50 mg/L annually (Fig. 4.3). This is attributed to a lowering of the water table related to the establishment of the drainage system in the western margin and to an increase in lateral flow of lower salinity underground water from the east.

Management areas 2 & 3

In management areas 2 and 3 the underground water salinity is increasing. The recycling of irrigation water in the main irrigation area is considered to be the main cause for this increase. However there may also be a future lateral contribution of salt from the Ranges to the east. Salinity is rising, on average, between 5 and 18 mg/L annually. There has been long term salinity monitoring of the unconfined aquifer in the Padthaway PWA. The long term increasing salinity trend in management area 2 can be clearly seen in four selected observation well hydrographs, Figures 4.4, 4.5, 4.6 and 4.7.

The underground water salinity is generally considered to be well within the accepted limits for livestock use. Of more concern is the effect the rising salinity will have on crop yields. The salinity of the underground water from the unconfined aquifer in some parts of management area 2 already exceeds the recommended threshold for grape vines of 1,500 mg/L. The optimum underground water salinity for grape vines is about 550 mg/L TDS. At an underground water salinity level of about 1,500 mg/L the vines will have a reduced productivity of about 25%, at about 2,500 mg/L the yield will reduce to 50% of its optimum. The effect of rising underground water salinity is most notable in the western half of management area 2B.

**Water Balance**

A water balance also helps to determine whether the capacity of the resource is sufficient to meet demand on a continuing basis.

The most recent generalised water balance based on individual management areas was carried out in 1997 and results are shown in Table 4.5. They are based on the 1994/1995 irrigation season. The estimated crop water use significantly exceeds the recharge determinations for management areas 2A & 2B.

Lateral inflow and outflow calculations were estimated by flownet analysis using an assumed transmissivity of 750 $m^3$/day/m in the Range for the Bridgewater Formation sub-aquifer and 1,000 $m^3$/day/m on the flat. A transmissivity of 10,000 $m^3$/day/m was assigned to the Padthaway Formation sub-aquifer.

**Table 4.5: Unconfined Aquifer Water Balance for Padthaway PWA**

| Inputs (ML/year) | Management area 1 | Manage-ment area 2A | Management area 2B | Management area 3 | Manage-ment area 4 | Totals |
|---|---|---|---|---|---|---|
| Underground water inflow | 23,315 | 9,423 | 13,307 | 8,170 | 27,051 | 81,267 |
| Rainfall Recharge | 15,774 | 3,510 | 2,450 | 2,900 | 6,678 | 31,312 |
| Total In | | | | | | **112,579** |
| **Outputs (ML/year)** | | | | | | |
| Underground water outflow | 27,325 | 6,168 | 8,170 | 8,701 | 27,409 | 77,773 |
| Crop Use | 8,320 | 6,850 | 6,000 | 1,430 | 900 | 23,500 |
| Storage | 0 | 0 | 735 | 0 | 7,950 | 8,685 |
| Total Out | | | | | | **109,958** |

## Conclusion

In management areas 2 and 3 the capacity of the resource is insufficient to meet demand on a continuing basis. While water levels are in steady state, salinity increases of between 5 and 18 mg/L/year indicate the current level of extraction in these management areas is too high and therefore not sustainable in the longer term. However, in management areas 1 and 4 in the Padthaway PWA, the capacity of the resource is considered sufficient to meet demand on a continuing basis.

The Department for Water Resources recommends the following actions:

1. Water allocation and use in each management area in the Padthaway PWA be reduced so that underground water use does not exceed the average rainfall recharge volume;

2. A salinity increase not exceeding 10 mg/L per annum be used as a target for sustainable management of the underground water resource for the unconfined aquifer;

3. A suitable method of measuring actual underground water use be implemented as a matter of priority; and

4. No further underground water be allocated in the remaining management areas because of the complex aquifer interactions between the management areas.

## 4.3 Confined Aquifer

### 4.3.1 Capacity of the Resource

The PAV for the confined aquifer in the South East is the volume of underground water that can be used on an annual basis from the confined aquifer without causing significant adverse water level or water quality impacts to the underground water resource.

The PAV for each confined aquifer management area in the South East region was estimated by the Department for Water Resources in 2000 and is shown in Table 4.7, with the confined aquifer management areas shown in Figure 4.8.

Due to the confining layer (aquitard) the underground water in the confined aquifer is under pressure. Also, unlike the unconfined aquifer, the confined aquifer receives very little direct rainfall recharge. Therefore the proposed PAVs have been developed for each management area for the confined aquifer using a combination of underground water throughflow determinations and computer flow modelling. Various extraction scenarios were modelled to examine the longer term change in aquifer pressure and changes in leakage between the confined and unconfined aquifers.

Other key considerations in determining the PAV included:

- Limiting the magnitude of head decline as a result of increased withdrawals from the confined aquifer, and the impacts to existing users of the confined aquifer;

- Consideration of the impact on the unconfined aquifer of increased use of the confined aquifer for irrigation purposes (Confined aquifer water excess to crop requirements returns to the unconfined aquifer. This has the potential to increase salt accessions and water levels within the unconfined aquifer);

- Consideration of the impact of increased extractions from the confined aquifer on marine discharges. However, such impacts are difficult to assess given the lack of present understanding of these processes; and

- Modelling limitations in terms of uncertainty in the levels of extraction from the aquifer, and limited extraction data in some areas; both affect calibration of the model.

After consideration of all the above factors, a precautionary approach to the specification of the management prescription for the Tertiary Confined Sand Aquifer has been taken. Limiting the water available for allocation to a proportion (0.75) of the groundwater throughflow volume would adequately allow for the current limited technical understanding of the resource and the lack of knowledge of the environmental significance of the marine discharges from the confined aquifer.

The South East Catchment Water Management Board considered the regional declines in potentiometric (pressure) levels across the aquifer that would be acceptable based on its consultation with the community. The Board considered that a decline in the

potentiometric level of generally 2 metres in the next 20 years, with a limited area of 4 metres in the Kalangadoo management area, would be acceptable at this time.

The PAV has therefore been set at 50% of the upper limit of the proportion (0.75) of the groundwater throughflow to maintain recovered seasonal potentiometric levels within this acceptable range of 2 to 4 m, for all management areas except Kingston.

The management prescription recommended for the Kingston Management Area sets the PAV at the current level of allocation and use of water in this area. While this level of allocation is considered to be too high based on the current level of assessment and understanding of the resource, measures will be put in place to improve water use efficiency, and reduce underground water use, over the next five years. Such measures include introducing metering to gain a clear picture of extraction levels from the aquifer, and reducing water wastage through well rehabilitation. If after this time a review indicates that the level of allocation and use is not sustainable, then it is likely that the PAV for the Kingston management area will be reduced, and management strategies introduced to decrease allocations and use to the revised PAV, over the following five year period.

The management prescription for the confined aquifer in the South East is shown in Table 4.6.

**Table 4.6: Management Prescription for the Confined Aquifer**

| AREA | MANAGEMENT PRESCRIPTION |
|---|---|
| **Border Designated Area** - Zones 1A-11A | PAV = 50 % x (0.75 x throughflow volumes) |
| **Outside Border Designated Area** | PAV = 50 % x (0.75 x throughflow volumes) |
| **Kingston Management Area** | PAV = 25,000 ML/annum |

**Table 4.7: PAVs, VLAs and Licensed and Unlicensed Demands for the Confined Aquifer in South Australia (all in ML)**

| Management Area | PAV | Stock & Domestic Use | Future Town Use | Allowance for Leaking Wells | VLA (a) | Total Licensed Allocations at 23/05/01 (b) | Irrigation Extraction Factor (c) |
|---|---|---|---|---|---|---|---|
| Fairview | 290 | 6 | 0 | 0 | 284 | 0 | 0 |
| Kalangadoo | 3,900 | 78 | 0 | 0 | 3,822 | 1,993 | 386 |
| Keith | 2,500 | 50 | 0 | 0 | 2,450 | 130 | 0 |
| Kingston | 25,000 | 500 | 360 | 1,761 | 22,379 | 19,755 | 2,935 |
| Lucindale | 3,600 | 72 | 90 | 0 | 3,438 | 1,325 | 123 |
| Millicent | 10,800 | 216 | 0 | 0 | 10,584 | 4,376 | 676 |
| Taratap | 330 | 7 | 0 | 0 | 323 | 16 | 3 |
| Wirrega | 960 | 19 | 0 | 0 | 941 | 300 | 0 |
| Zone 1A | 9,200 | 184 | 210 | 0 | 8,806 | 404 | 81 |
| Zone 2A | 2,900 | 58 | 0 | 0 | 2,842 | 50 | 0 |
| Zone 3A | 1,900 | 38 | 0 | 0 | 1,862 | 0 | 0 |
| Zone 4A | 710 | 14 | 0 | 0 | 696 | 280 | 56 |
| Zone 5A | 540 | 11 | 0 | 0 | 529 | 0 | 0 |
| Zone 6A | 360 | 7 | 0 | 0 | 353 | 0 | 0 |
| Zone 7A | 350 | 7 | 0 | 0 | 343 | 0 | 0 |
| Zone 8A | 340 | 7 | 0 | 0 | 333 | 0 | 0 |
| Zone 9A | 570 | 11 | 0 | 0 | 559 | 0 | 0 |
| **Total** | **64,250** | **1,285** | **660** | **1,761** | **60,544** | **28,629** | **4,259** |

Notes:

1. SA Water may soon be issued with water licences for extraction of water for town water supply purposes. However, SA Water did not apply for the full estimated maximum annual usage in some areas. Therefore 560 ML in the Kingston management area, 90 ML in the Lucindale management area and 210 ML in Zone 1A has been set aside in the column titled 'Future Town Use'. Licensed town water supply volumes are included in the column titled 'Total Licensed Allocations'.

2. Stock and domestic use has been estimated at 2% of PAV, across all confined aquifer management areas.

3. An allowance of 10% of total irrigation use (Ha IE irrigation licences converted to a volume using CARs plus the irrigation extraction factor) has been made for loss from confined aquifer leaking wells in the Kingston management area.

4. As area based HaIE licences represent the irrigated crop water requirement, and not the actual volume extracted from the aquifer, a further 20% of HaIE irrigation licences (converted to a volume using CARs) was considered to be extracted from the confined aquifer and recharged to the unconfined aquifer through irrigation root zone drainage, in the column titled 'Irrigation Extraction Factor'.

### 4.3.2 Present and Future Demand

The confined aquifer is generally absent, or thin (less than 2.5 m in thickness), over much of the Padthaway PWA and it has not been utilised as a water resource.

However, the eastern portion of the Padthaway PWA falls within the Wirrega confined aquifer management area, and the western portion falls within the Fairview confined aquifer management area, as shown in Figure 4.8. 300 ML was allocated from the Wirrega management area as at 23 May 2001, but outside the boundaries of the Padthaway PWA. No confined aquifer water was allocated from the Fairview management area as at 23 May 2001.

There is not expected to be any significant future demand for water from the confined aquifer within the Padthaway PWA.

# 5 Definitions

Any terms used in this Plan that are defined in the *Water Resources Act 1997* have the definitions set out in that Act and in addition for the purposes of this Plan the following terms have the definitions set out below:

**"Adjoins"** or **"Adjoining"** means in relation to an allotment or management area that the allotment or management area, or any part of the allotment or management area, is contiguous with another allotment or management area and includes allotments or management areas that are separated only by a road, street, footpath, railway or thoroughfare.

**"AHD"** means the Australian Height Datum, which is the datum used for the determination of elevations in Australia. The determination used a national network of bench marks and tide gauges, and set mean sea level as zero elevation.

**"Allotment"** means:

(a) the whole of the land comprised in a certificate of title including a community or development lot or common property within the meaning of the *Community Titles Act 1996* or a unit or common property within the meaning of the *Strata Titles Act 1988*;

(b) the whole of the land comprised in a registered conveyance of land that has not been brought under the provisions of the *Real Property Act 1886*;

(c) a separately defined piece of land that is delineated on a public map and separately identified by a number or letter (not being a piece of land that is identified in a Treasury receipt, certificate or other document or instrument of title as being part only of an allotment);

(d) two or more separately defined pieces of land that are delineated on a public map and that are identified in a Treasury receipt, certificate or other document or instrument of title as forming one allotment for the purposes of the *Real Property Act 1886*;

(e) a separately defined piece of land delineated on a plan of division for the purpose of enabling the separate ownership in fee simple of that land;

(f) a separately defined piece of land identified as an allotment for the purposes of the Real Property Act in a plan prepared by the Registrar-General and accepted for filing in the Lands Titles Registration Office;

(g) where a primary plan of community division has been cancelled under Part 7 Division 3 of the *Community Titles Act 1996* or a strata plan has been cancelled under Part 2 Division 7 of the *Strata Titles Act 1988* – the land comprising the former community parcel or site shown on the plan.

**"Aquaculture"** means the propagating or keeping of stocks of any aquatic or marine organism.

**"Aquifer storage and recovery"** means the process of drainage or discharge of water directly or indirectly to a well for the purposes of refilling or replenishing the aquifer or storing water in the aquifer for subsequent extraction.

**"Confined Aquifer"** means the saturated sands and gravels of either the Dilwyn Formation or the Mepunga Formation in the Otway Basin, or the Renmark Group in the Murray Basin.

**"Draw down"** means the occasional, seasonal or permanent lowering of the water table or reduction in pressure (head) of an aquifer resulting from the extraction of underground water.

**"Exceptional circumstances"** means the death or serious illness of or serious injury to the licensee or, where the licence is held by a company, partnership or incorporated body, the death or serious illness or injury to a director, partner or office holder respectively, that prevents the licensee from using the allocation with the minimum of delay and in any case within 3 years of the date of the granting of the allocation.

**"Flood irrigation"** means irrigation where underground water is pumped or directed onto an irrigation bay or levelled land and flows uniformly across the bay or the land without the aid of sprinklers, drippers or other infrastructure.

**"Imported water"** means water which has been brought into a management area by means of a pipe or other channel, and the water (including surface water) has been extracted and piped, or directed into a channel, under licence or permit under the *Water Resources Act* 1997, or *Groundwater (Border Agreement) Act 1985* from the originating management area or zones within the Designated Border Area.

**"Industry"** means the carrying on, in the course of a trade or business, of any purposes for, or incidental to:

(a) The making of any article (or part thereof); or

(b) The altering, repairing, ornamenting, finishing, assembling, cleaning, washing, packing, bottling, canning or adapting for sale, or the breaking up or demolition of any article; or

(c) The getting, dressing, or treatment of materials.

**"Management area"** means for the unconfined aquifer, a part of a Prescribed Wells Area as shown in Figure 1.2 and for the confined aquifer, a part of a Prescribed Wells Area shown in Figure 4.8. Management area 2 comprises the areas labelled 2A and 2B on Figure 1.2.

**"Native underground water"** means the underground water (as that term is defined in the *Water Resources Act 1997*) that exists in the relevant aquifer excluding any such other water drained or discharged to that aquifer by artificial means.

**"Permissible Annual Volume (PAV)"**

**The Permissible Annual Volume for the unconfined aquifer** in the South East, is the volume of water that can be sustainably used or assigned from the unconfined aquifer on an annual basis, in a particular management area. For the purpose of this definition, "assigned" means the volume set aside for environmental and future forestry commitments.

**The Permissible Annual Volume for the confined aquifer** in the South East, is the volume of underground water that can be used from the confined aquifer without causing significant adverse water level or water quality impacts to the underground water resource, on an annual basis.

**"Pollution"** includes any solid, liquid, gas or heat (or any combination thereof) that directly or indirectly causes or has the potential to cause harm to the environment, structures, persons or organisms.

**"Potentiometric level"** means the level to which water rises in a well due to water pressure in the aquifer. May also be referred to as the "potentiometric surface" or the "potentiometric head".

**"Public water supply"** means the supply of water by reticulation primarily for domestic purposes.

**"Recharged water**" means water which has been drained or discharged directly or indirectly into a well in accordance with a permit granted under the *Water Resources Act 1997*.

**"Recreational use"** means the use of water for the irrigation of parks, gardens and sports grounds, whether publicly or privately owned.

**"Rotational crop"** means a crop or plantation of a species/cultivar that produces one harvest per planting and requires an inter-rotational break period of three years or greater from the date of the previous planting before the same crop or plantation can be replanted at the same location.

**"Same ownership"** means any allotment or allotments where the registered proprietor is, or proprietors are, a member of the same family. For the purpose of this definition, "same family" includes a company where the director, directors or shareholders are members of the family or a trustee of a trust where the beneficiaries of that trust are one or more members of the family.

**"Specific Yield"** means the ratio of the volume of water a rock or soil will yield by gravity drainage, to the volume of the rock or soil.

**"Unconfined Aquifer"** means the saturated sequence of rocks occurring above the aquitard on top of the Dilwyn Formation or the Mepunga Formation in the Otway Basin, or the Renmark Group in the Murray Basin, whether occurring within the Gambier Limestone of the Otway Basin, the Murray Group Limestone of the Murray Basin, or some other younger geological unit.

**"Volume for Licensed Allocation (VLA)"** means the total quantity of water (in megalitres) available for licensed extraction on an annual basis within each management area (see table A, annexed hereto).

**The Volume for Licensed Allocation in each management area for the unconfined aquifer** is calculated as follows:

> The Permissible Annual Volume less provisions for the effect of forestry plantations on annual average vertical recharge, stock, domestic, and environmental demands, less a further 10% buffer in areas that were not fully allocated (or did not become fully allocated as a result of the buffer) at **date of adoption**.

**The Volume for Licensed Allocation in each management area of the confined aquifer** is calculated as follows:

> The Permissible Annual Volume less provision for the effect of leaking wells, stock, domestic, and future town use.

**"Water use year"** means a period of 12 months commencing on the 1 July in any year.

**"Wild flooding"** means flood irrigation where no adequate system such as land levelling, or irrigation bays is used to ensure uniform distribution of water.

# 6 Water Allocation Criteria – Unconfined Aquifer

The present and future needs for water by the occupiers of land in the Padthaway Prescribed Wells Area have been outlined in section 4. The present needs for water of the occupiers of land in the Padthaway Prescribed Wells Area are mainly irrigation, stock and domestic water use, town water supplies, and industrial use. Stock, domestic and town water use is expected to remain relatively stable. Irrigation is expected to remain the largest water user in the Padthaway Prescribed Wells Area, and it has the potential to expand further in management areas outside the Intensely Irrigated Area (management areas 2 and 3), as unused allocations are brought into production, or through transfers from management areas 2 and 3 into management areas 1 or 4. Industrial and recreational uses are expected to remain steady.

An assessment of irrigated crop potential of the land in the Padthaway Prescribed Wells Area indicates that some areas have limitations due to the high salinity levels of the unconfined aquifer throughout management areas 2 and 3. These salinity levels are currently increasing at between 5 and 18 mg/L/year. This increase is attributed to the recycling of irrigation water. If this trend is to be negated, it will be necessary to reduce allocations and usage in these management areas to reduce the salinising effect of underground water recycling. This may reveal the need for changes in some areas that are currently irrigated, including improved water use efficiency, return to non-irrigated crops, or transition to some other activity. Irrigation will tend to concentrate in areas that combine good quality water with suitable soils. The productive capacity of the land will also depend on land management practices and standards directed at avoiding land degradation issues such as erosion, water logging and land salinisation.

The overall capacity of the water resources in the Padthaway Prescribed Wells Area are considered to be sufficient to meet all existing and reasonably foreseeable future demands for water, considering the capacity of the land, with the exception of management areas 2 and 3, which are currently over allocated. However, improvements in irrigation efficiency (where allocations are expressed volumetrically), more active trade of licensed water allocations, and the use of imported water, may accommodate further development of water–based enterprises within the Padthaway PWA, outside management areas 2 and 3.

Some of the policies contained within this Plan may have potential impacts on land values. The policies with this potential generally relate to the protection of the resource from degradation through over allocation, the concentration of water extraction and use, or inappropriate water use and management. It is considered that any potential impacts on the value of land are outweighed by the benefits of protecting the condition of the resource, so that it may continue to be used on a sustainable basis.

Land suitable for irrigation in an area with good quality underground water will tend to have a higher value than land that is not suitable for irrigation, or land located in an area where access is limited to underground water which is low yielding, unsuitable or marginal, for irrigation.

The South East Catchment Water Management Board has taken the above aspects into account in setting the policies and criteria within this plan.

## 6.1 Objectives

1. To ensure that underground water extractions do not exceed the sustainable limits of the unconfined aquifer by significantly contributing to a decline in underground water levels or an increase in the salinity of underground water, through initiating a program to reduce allocations in over allocated management areas in consultation with affected stakeholders;

2. To protect the resource locally, throughout each management area and the entire Prescribed Wells Area, by ensuring that the taking and use of underground water does not cause a significant increase in the salinity of underground water, or cause a significant decrease in the elevation of the water table.

3. To provide flexibility and equity in access to the underground water resource of the unconfined aquifer;

4. To protect ecosystems dependent on underground water by ensuring that the taking and use of water does not significantly degrade the ecology and biodiversity of the region;

5. To protect the environment generally by ensuring that the taking and use of underground water from the unconfined aquifer does not significantly degrade any other resource such as soils or other water resources;

6. To manage the underground water resource of the unconfined aquifer so that it may continue to be utilised by future generations;

7. To encourage and expedite an active water market so that water allocations are readily available for future economic development;

8. To promote the active and efficient use of water allocations according to industry best practice standards; and

9. To minimise the potential negative impacts of Aquifer Storage and Recovery on underground water quality, and the integrity of the unconfined aquifer.

## 6.2 Principles

**Limit to total allocation**

1. Water shall not be allocated from the unconfined aquifer (by water (holding) or water (taking) allocation) in any given water use year where the allocation would cause the amount allocated on all licences for the relevant management area, to exceed the total of the Volume for Licensed Allocation (VLA) plus the volume of imported water recharged to the unconfined aquifer (consistent with Sections 10.2 and 10.3 of this Plan) for that water use year and for that management area, except where:

    (a) Water is to be allocated to existing non-licensed water users in accordance with principles 6.2.2 and 6.2.3 (Unlicensed pre-existing water use); or

(b) The taking of water will not cause significant adverse impacts on the unconfined aquifer within the relevant management area; provided that where water is allocated above the VLA the total amount allocated on all licences for the relevant management area, does not exceed the total of the PAV plus the volume of imported water recharged to the unconfined aquifer (consistent with Sections 10.2 and 10.3 of this Plan) in any water use year for that management area. Where water is allocated above the VLA in the relevant management area at **date of adoption**, no further water will be allocated, except where principles 6.2.2 and 6.2.3 (Unlicensed pre-existing use) apply.

**Unlicensed pre-existing water use**

2. Water may be allocated to existing non-licensed water users where:

(a) It can be demonstrated that the water use in its present form at the date of application, was also in existence during the year prior to 10 April 1997;

(b) Water is used for the following:

- Operation of a dairy licensed by the Dairy Authority of South Australia at the date of application, (including wash down, washing up and milk cooling);
- Intensive animal keeping;
- An intensive plant production system such as greenhouses, hydroponics or nurseries;
- Industry; or
- Recreation;

(c) The source aquifer nominated on the application is the aquifer from which the unlicensed water was being taken at 12th February 2001; and

(d) An application for a water allocation is received no earlier than 5p.m. on 30th June 2002 and no later than 5 p.m. on the 31 July 2002.

3. Water shall be allocated for unlicensed pre-existing water use in the following manner:

(a) Where water remains available, or becomes available for allocation within a management area, up to 200ML shall be reserved for the purposes of allocation to unlicensed pre-existing water use, subject to 6.2.2 and 6.2.3 (b) – (d), until 5 p.m. on the 31 July 2002;

(b) The water allocation shall meet the applicant's reasonable requirements up to 10 megalitres per annum, except for dairies which milk in excess of 300 cows in which case the allocation shall meet the applicant's reasonable requirements;

(c) In the case of dairies, the water allocation shall be calculated as whichever is the greater of, the reasonable requirements of the water user at the time of application, or the average of the annual reasonable requirements over the preceding three year period; and

(d) Allocations granted under section 6.2.2 are exempt from 6.2.11 (Quantity for allocation), 6.2.14 to 6.2.18 (Active and expeditious use of water), and 6.2.19 to 6.2.23 (Hydrogeological effects).

Where the 200 ML set aside in accordance with this principle has not been allocated then any remaining water shall be available for allocation in accordance with this Plan.

**Taking and use**

4. There shall be no further allocations of unconfined aquifer water in the Padthaway PWA, except:

   (a) Where principles 6.2.2 and 6.2.3 apply;

   (b) Where a water (taking) allocation is permanently transferred out of management area 2 into management areas 1 or 4, in accordance with principle 7.2.14 of this Plan;

   (c) Where a water (taking) allocation is permanently transferred out of management area 3 into management areas 1 or 4, in accordance with principle 7.2.14 of this Plan; or

   (d) For the purpose of public water supply in management areas 1 or 4, consistent with principle 6.2.1.

**Underground water resource condition**

5. The taking and use of water shall not cause, or be likely to cause:

   (a) A mean (arithmetic) increase in salinity of the underground water resource of greater than 10 mg/L per year (measured over the preceding 5 years) within the vicinity of the point of use (including neighbouring properties and the nearest salinity monitoring wells), or within the relevant management area;

   (b) A mean (arithmetic) decrease in underground water levels within the vicinity of the point of taking (including neighbouring properties and the nearest underground water level monitoring wells), or within the relevant management area of greater than 0.1 metres per year (measured over the preceding 5 years), except where the taking and use of water is for the purposes of industry or energy generation; and/or

   (c) A decline in underground water levels over a period of greater than 3 years within the vicinity of the point of taking (including neighbouring properties and the nearest underground water level monitoring wells), or within the relevant management area, before a new stable equilibrium water level is achieved, where the taking and use of water is for the purposes of industry or energy generation.

**Water (holding) allocations**

6. No water (holding) allocation shall be endorsed on a licence after **adoption date** except where a water (taking) allocation, either in whole or part, endorsed on a licence, is converted to a water (holding) allocation, with the exception that any water (taking) allocation on a licence that is subject to a condition or conditions requiring the expeditious use of water (including a requirement that the equipment, or land by which or on which the water is used be developed in a certain time), shall not be converted to a water (holding) allocation, if the condition has, or conditions have, not been satisfied.

**Basis of allocation**

7. Allocations of water granted after 5.00 p.m. on **adoption date** will be expressed volumetrically, except for:

   (a) Allocations that have been obtained through transfers, which shall be expressed in the same units of measure as those used prior to transfer;

   (b) Allocations varied through conversion from a water (taking) allocation to a water (holding) allocation, which shall remain expressed in the same units of measure as those used prior to conversion; and

   (c) Allocations varied through conversion from a water (holding) allocation to a water (taking) allocation, which shall remain expressed in the same units of measure as those used prior to conversion.

**Purpose of use**

8. Water shall not be taken and used for the purpose of wild flooding.

9. Water shall not be taken from the unconfined aquifer and used for the purpose of aquaculture unless:

   (a) The volume of tail water produced for disposal does not exceed an amount reasonably produced according to current best industry practice;

   (b) The disposal of tail water does not result in an increase (above seasonal fluctuations) in underground water levels in the unconfined or confined aquifers at the boundary of the allotment or, at the boundary of any adjoining allotment held by the same owner, whichever is the greater distance from the point of disposal;

   (c) Disposal of tail water does not result in an accelerated increase in salinity of the unconfined or confined aquifers, or result in pollution of these aquifers by any other substance; and

   (d) The ponds, tanks, vessels or other places for the keeping of any water for the aquaculture process have no significant hydraulic connection with the unconfined or confined aquifers.

**Quantity of allocation**

10. Where water is to be used for irrigation purposes, the allocation shall not exceed the amount reasonably required to irrigate the area of the particular crop type, on the dominant soil type and given the local average meteorological conditions applicable to the relevant allotment.

11. Where water is to be used for purposes other than irrigation, the allocation shall not exceed the amount reasonably required (applying current industry best practice standards) for the purpose proposed.

**Efficient use of water**

12. Water shall be used and applied using water efficient technologies and techniques appropriate for the particular purpose and circumstance for and in which the water is to be used in accordance with current industry best practice standards.

13. For the purposes of principle 6.2.12 the particular circumstances for the use of water for irrigation include (but are not limited to):

    (a) The plant type;

    (b) The climate, dominant soil type and topography of the allotment;

    (c) The location of remnant native vegetation and/or other permanent structures such as powerlines, which may limit the method of application of water; and

    (d) The salinity of the water to be used.

**Active and expeditious use of water**

14. All water (taking) allocations granted on or **after adoption date**, excluding allocations which have been obtained through transfers, shall be used with the minimum of delay and in any case within 3 years of the granting of the allocation.

15. All water (taking) allocations granted **before adoption date**, with a condition requiring active and expeditious use, shall be used with the minimum of delay and in any case within 3 years of the granting of the allocation.

16. All water (taking) allocations granted **after 5pm 1 September 2000**, resulting from the conversion of a water (holding) allocation, shall be used with the minimum of delay and in any case within 3 years of the granting of the allocation.

17. For the purposes of principles 6.2.14, 6.2.15 and 6.2.16, the use of an allocation includes the development of the land and equipment upon or by which the water is used, to a capacity that enables the water (taking) allocation to be utilised at its maximum lawful rate.

18. Without in any other way affecting the operation of principles 6.2.14, 6.2.15 and 6.2.16, where exceptional circumstances apply to the licensee, the maximum period may be increased to 4 years from the granting of the allocation.

**Hydrogeological effects**

19. The taking of water for industrial, energy generation or public water supply use shall not adversely affect to a significant extent:

    (a) the quality of water in the unconfined aquifer by (including but not limited to) an increase in salinity by exceeding the rate specified in principle 6.2.5 (a);

    (b) the water level of the unconfined aquifer by causing or contributing to a long term decline in underground water levels by exceeding the rate specified in principle 6.2.5 (c) for industrial or energy generation use, or 6.2.5 (b) for public water supply; and

    (c) the structural integrity of the unconfined aquifer.

20. The taking of water for all purposes other than those mentioned in principle 6.2.19 shall comply with the 4 kilometre square test and the taking and use of water shall not adversely affect to a significant extent:

    (a) the quality of water in the unconfined aquifer by (including but not limited to) an increase in salinity by exceeding the rate specified in principle 6.2.5 (a);

    (b) the water level of the unconfined aquifer by causing or contributing to a long term decline in underground water levels by exceeding the rate specified in principle 6.2.5 (b);

    (c) the structural integrity of the aquifer;

    (d) any other water resource ( including but not limited to the confined aquifer, or any relevant surface water resource), both within and beyond the Padthaway Prescribed Wells Area; and

    (e) Ecosystems dependent on underground water, by contravening principle 6.2.24.

21. The “4 kilometre square test” requires that the granting of a water (taking) allocation shall not cause the total volume of water (taking) allocations within a square with 4 kilometre long sides to exceed 1.25 times the amount of annual average vertical recharge for the management area.

22. The 4 kilometre square shall be centred on the specified point of taking of the water or, where the precise point of taking is not specified, the 4 kilometre square shall be centred on the centremost point of the nominated allotment involved in the application. Where the point of taking of the water is not specified the well shall be constructed for the taking of the water within a 1 kilometre radius of the centremost point of the nominated allotment.

23. For the purposes of the 4 kilometre square test, the amount of annual average vertical recharge is which ever is the lesser of:

(a) The annual average vertical recharge rate set out in Table C for the relevant management area, multiplied by 16km$^2$; or

(b) The amount determined by the following formula – Specific yield within the 4 kilometre square multiplied by long term seasonal underground water level fluctuation.

**Ecosystems dependent on underground water**

24. Water shall not be taken and used if to do so may create a significant adverse affect on ecosystems that depend on the underground water by causing:

(a) The mean water table elevation within the vicinity of the point of taking or within the relevant land unit (see Figure 2.1) to drop below that identified for the relevant land unit as specified in Table 2.1;

(b) The seasonal water table range to exceed the range within the vicinity of the point of taking or within the relevant land unit (see Figure 2.1) identified for the relevant land unit as specified in Table 2.1;

(c) The seasonality of the minimum or maximum water table level within the vicinity of the point of taking or within the relevant land unit (see Figure 2.1) to vary from that identified for the relevant land unit as specified in Table 2.1; and

(d) Salinity of underground water within the vicinity of the point of use or within the relevant land unit (see Figure 2.1) to exceed the range identified for the relevant land unit as specified in Table 2.1.

25. Factors that will be considered in assessing the likelihood of significant adverse impacts include, but are not limited to the:

(a) Distance of the proposed extraction point from ecosystems that depend on the underground water; and

(b) Local hydrogeology.

**Piping of water more than 2km**

26. Where water is to be taken from one point and transported by pipe or other means to be used at another point at least 2 kilometres from the point of taking, both the taking and use of water shall comply with principle 6.2.19 to 6.2.23 (Hydrogeological effects). The 4 kilometre square test shall only apply at the point of taking.

**Divided allotments**

27. Where an allotment is, or two or more adjoining allotments held by the same owner, are divided by a management area or prescribed wells area boundary, but a water allocation is held in only one of the management areas or prescribed wells areas, the allocation may be taken and used anywhere throughout the allotment or adjoining allotments provided that:

    (a) An allocation from another management area is not taken in management areas 2 or 3 in the Padthaway PWA;

    (b) The taking and use of water meet the hydrogeological criteria defined in section 6.2.19 to 6.2.23 (Hydrogeological effects);

    (c) The point of extraction is not moved more than 2 kilometres into an adjacent management area or prescribed wells area unless it can be demonstrated that the allocation (or part thereof) was being extracted at the current location in an adjoining management area or prescribed wells area prior to **adoption date**;

    (d) The allocation remains referenced to, and accounted for in the originating management area or prescribed wells area; and

    (e) The allocation will not be available for further transfer within the receiving management area or prescribed wells area.

**Crop rotations**

28. An allocation of water from a management area within the Padthaway PWA may not be taken from another management area in the Padthaway PWA for the purposes of irrigating a rotational crop.

**The Allocation of Recharged Imported Water from Aquifer Storage and Recovery Schemes**

Principle 6.2.29 applies to the allocation of imported water recharged for the purpose of aquifer storage and recovery, pursuant to a permit under section 9 (3) (c) of the *Water Resources Act 1997.*

29. Recharged imported water shall not be allocated in the Padthaway PWA.

# 7 Transfer Criteria – Unconfined Aquifer

## 7.1 Objectives

1. To protect ecosystems dependent on underground water by ensuring that the taking and use of underground water from the unconfined aquifer does not degrade the ecology and biodiversity of the region;

2. To protect the environment generally by ensuring that the taking and use of underground water from the unconfined aquifer does not significantly degrade any other resource such as soils or other water resources;

3. To assist reductions in over-allocated areas by encouraging the permanent transfer of allocations out of over-allocated management areas into under-allocated management areas;

4. To provide flexibility and equity in access to the underground water resource of the unconfined aquifer;

5. To encourage and expedite an active water market so that water allocations are readily available for future economic development;

6. To promote the active and efficient use of water according to industry best practice standards;

7. To manage the underground water resource of the unconfined aquifer so that it may continue to be utilised by future generations;

8. To ensure that extractions remain within the sustainable limits of the unconfined aquifer by limiting the concentration of underground water use from the unconfined aquifer that may result through the transfer of water allocations; and

9. To minimise constraints to economic activity throughout the region that result from the under use of water allocations.

## 7.2 Principles

**Transfers of water (holding) allocations**

1. A licence endorsed with a water (holding) allocation, or the whole or a part of a water (holding) allocation may be transferred to any person or legal entity, but will continue to be recognised as being held from the same management area from which the allocation was originally granted.

**Transfer of water (taking) allocations**

2. A licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation from the unconfined aquifer, may not be transferred to the confined aquifer.

**Applications to transfer water (taking) allocations – Purpose of use**

3. Transfers of a licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation will not be granted where water is to be taken and used for wild flooding.

4. Transfers of a licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation that is to be used for the purpose of aquaculture will not be granted unless:

   (a) The volume of tail water produced for disposal does not exceed an amount reasonably produced according to current best industry practice;

   (b) Disposal of tail water does not result in an increase above seasonal fluctuations in underground water levels in the unconfined or confined aquifers at the boundary of the allotment or, at the boundary of any adjoining allotment held by the same owner, whichever is the greater distance from the point of disposal;

   (c) Disposal of tail water does not result in an accelerated increase in salinity of the unconfined or confined aquifers, or result in pollution of these aquifers by any other substance; and

   (d) The ponds, tanks vessels or other places for the keeping of any water for the aquaculture process have no significant hydraulic connection with the unconfined or confined aquifers.

**Applications to transfer water (taking) allocations – Efficient use of water**

5. A licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation shall only be transferred where the water shall be used and applied using water efficient technologies and techniques appropriate for the particular purpose and circumstances for and in which the water is to be used in accordance with current industry best practice standards.

6. For the purposes of principle 7.2.5, the relevant circumstances for the use of water for irrigation include (but are not limited to) the:

   (a) Plant type;

   (b) Climate, dominant soil type and topography of the allotment;

   (c) Location of remnant native vegetation and/or other permanent structures such as powerlines, which may limit the method of application of water; and

   (d) Salinity of the water to be used.

**Applications to transfer water (taking) allocations – Hydrogeological effects**

7. The transfer of a licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation, for industrial, energy generation or public water supply use shall not adversely affect to a significant extent:

(b) The quality of water in the unconfined aquifer by (including but not limited to) an increase in salinity by exceeding the rate specified in principle 6.2.5 (a);

(c) The water level of the unconfined aquifer by causing or contributing to a long term decline in underground water levels by exceeding the rate specified in principle 6.2.5 (c) for industrial or energy generation use, or 6.2.5 (b) for public water supply use; and

(d) The structural integrity of the aquifer.

8. Subject to principle 7.2.9, a licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation, for all purposes other than those mentioned in principle 7.2.7, shall only be transferred where the taking of water complies with the 4 kilometre square test (as defined in sections 6.2.19 and to 6.2.23) and the taking and use of water shall not adversely affect to a significant extent:

   (a) The quality of water in the unconfined aquifer by (including but not limited to) an increase in salinity by exceeding the rate specified in principle 6.2.5 (a);

   (b) The water level of the unconfined aquifer by causing or contributing to a long term decline in underground water levels by exceeding the rate specified in principle 6.2.5 (b);

   (c) The structural integrity of the aquifer;

   (d) Any other water resource (including but not limited to the confined aquifer, or any relevant surface water resource), both within and beyond the Padthaway Prescribed Wells Area; and

   (e) Ecosystems dependent on underground water, consistent with principle 7.2.10.

9. A transfer application shall be deemed to have complied with the 4 kilometre square test (as defined in principles 6.2.21 to 6.2.23) without further assessment, where:

   (a) A water (taking) allocation is to be transferred but will continue to be taken from the same well; or is replaced by a new well within 1 kilometre of the original well, and is to be used on the same allotment or allotments; or

   (b) An application to renew a temporary transfer (of the same quantity) that proposes taking the water allocation from the same well (or a well that replaces the original well, but lies within 1 kilometre of the original well) and the use of the allocation on the same allotment or allotments, is received and processed prior to the date and time of expiry of the original temporary transfer.

**Ecosystems dependent on underground water**

10. Transfer of a licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation will not be granted if to do so will create a significant adverse effect on ecosystems that depend on the underground water by causing the:

(a) Mean water table elevation within the vicinity of the point of taking or within the relevant land unit (see Figure 2.1) to drop below that identified for the relevant land unit as specified in Table 2.1;

(b) Seasonal water table range within the vicinity of the point of taking or within the relevant land unit (see Figure 2.1) to exceed the range identified for the relevant land unit as specified in Table 2.1;

(c) Seasonality of the minimum or maximum water table level within the vicinity of the point of taking or within the relevant land unit (see Figure 2.1) to vary from that identified for the relevant land unit as specified in Table 2.1; and

(d) Salinity of underground water within the vicinity of the point of taking or within the relevant land unit (see Figure 2.1) to exceed the range identified for the relevant land unit as specified in Table 2.1.

11. Factors that will be considered in assessing the likelihood of significant adverse impacts include, but are not limited to the:

(a) Distance of the proposed extraction point from ecosystems that depend on the underground water; and

(b) Local hydrogeology.

**Applications to transfer water (taking) allocations – Piping of water more than 2km**

12. Transfer applications that propose the taking of water from one point and transporting it by pipe or other means to be used at another point at least 2 kilometres from the point of taking, both the taking and use of water shall comply with principles 7.2.7 and 7.2.8 (Hydrogeological effects). The 4 kilometre square test shall only apply at the point of taking.

**Applications to transfer water (taking) allocations – Destinations**

13. A licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation may be transferred either permanently or temporarily where the proposed location of the point of extraction lies within the same management area as the existing location of the point of extraction from which the allocation may lawfully be taken.

14. A licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation may be permanently transferred into another management area, as follows:

(a) A licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation may be permanently transferred out of management area 2 into management areas 1, or 4, where the transfer will not cause the Volume for Licensed Allocation (VLA) in the receiving management area to be exceeded; or

(b) A licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation may be permanently transferred out of management area 3 into management areas 1 or 4, where the transfer will not cause the Volume for Licensed Allocation (VLA) in the receiving management area to be exceeded.

15. A licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation may be transferred from a management area to an adjacent management area which lies within an adjoining Prescribed Wells Area, where the proposed point of extraction and use is less than or equal to a maximum of 2 kilometres inside an adjacent management area which lies within the adjoining Prescribed Wells Area, on an allotment which adjoins the management area boundary and which lies within the adjoining Prescribed Wells Area, consistent with the following criteria:

    (a) The maximum period of transfer shall be 5 years;

    (b) The provisions of this principle shall not apply where the receiving management area lies within the area designated under the *Groundwater (Border Agreement) Act 1985* ;

    (c) The allocation shall continue to be deemed to be taken from and accounted for in the management area of its origin;

    (d) Water transferred for extraction and use up to a maximum of 2 kilometres into an adjacent management area which lies within an adjoining Prescribed Wells Area will not then be available for subsequent transfer elsewhere in the receiving Prescribed Wells area except to other allotments adjoining the same management area boundary and where the proposed point of extraction and use lies less than or equal to a distance of 2km from the boundary of the original management area;

    (e) Use and extraction shall be consistent with the relevant Water Allocation Plan for the receiving management area.

    (f) The transfer of a licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation up to 2 kilometres into an adjacent management area which lies within an adjoining Prescribed Wells Area shall not cause the total allocations that may be used in the receiving management area to exceed 110% of its Volume for Licensed Allocation. An application to transfer a licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation up to 2 kilometres into an adjacent management area which lies within an adjoining Prescribed Wells Area, which would cause the total allocations that may be used in that adjacent management area which lies within an adjoining Prescribed Wells Area to exceed 110 % of its Volume for Licensed Allocation, shall not be permitted and subsequent applications to transfer a licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation up to 2 kilometres into that adjacent management area which lies within an adjoining Prescribed Wells Area, shall not be permitted unless and until total allocations that may be used in that management area become less than or equal to 105 % of its Volume for Licensed Allocation.

    (g) The transfer shall be subject to principles 7.2.2 (Transfers of water (taking) allocations), 7.2.3 & 7.2.4 (Purpose of use), 7.2.5 and 7.2.6 (Efficient use of water), 7.2.7 and 7.2.8 (Hydrogeological effects), and 7.2.16 (Development of allocation before transfer).

For the purposes of this clause, an "adjacent management area" includes all management areas within an adjoining Prescribed Wells Area that adjoin the management area from which the allocation or licence was initially granted.

**Applications to transfer water (taking) allocations – Development of allocation before transfer**

16. For licences granted by the Minister with a condition or conditions imposed requiring the expeditious use of water (including a requirement that the equipment, or land by which or on which the water is used be developed in a certain time), the following applies:

    (a) The allocation (or part thereof) or licence may be transferred where the equipment or land has been fully developed to allow use of the water at its maximum lawful rate;

    (b) Where the expeditious use conditions have not been fully completed, only the portion of the allocation that may be used in accordance with the extent of development at the date of receipt of the application to transfer by the Minister may be transferred; or

    (c) Where the licence or allocation is to be transferred in its entirety, but will be taken and used on the same allotment, it may be transferred whether or not the land or equipment has been fully developed in accordance with the condition(s), provided that the new landholder fully develops the land and equipment in order to allow use of the allocation at its maximum lawful rate, in accordance with the original conditions.

# 8 Allocation Criteria - Confined Aquifer

## 8.1 Objectives

1. To ensure that underground water extractions remain within the sustainable limits of the confined aquifer by preventing over allocation of the underground water resource at the local, and management area scale and throughout the entire Prescribed Wells Area;

2. To protect the resource locally, throughout each management area and the entire Prescribed Wells Area, by ensuring that the taking and use of underground water does not cause a significant decrease in the elevation of the potentiometric level of the confined aquifer.

3. To cautiously manage the confined aquifer, due to it being an ancient resource, with limited recharge;

4. To ensure that underground water from the unconfined aquifer is allocated and used in precedence to underground water from the confined aquifer;

5. To protect ecosystems dependent on underground water by ensuring that the taking and use of underground water from the confined aquifer does not significantly degrade the ecology and biodiversity of the region;

6. To protect the environment generally by ensuring that the taking and use of underground water from the confined aquifer does not significantly degrade any other resource, such as soils or other water resources;

7. To manage the confined aquifer underground water resource so that it may continue to be utilised by future generations;

8. To encourage and expedite an active water market so that water allocations are readily available for future economic development; and

9. To promote the efficient use of water according to industry best practice standards.

## 8.2 Principles

Except where otherwise expressly stated, all of the following principles apply to the allocation of water (taking) allocations from the confined aquifer.

**Limit to total allocation**

1. Water shall not be allocated from the confined aquifer where the allocation would cause the total amount allocated on all licences for the relevant management area plus the Irrigation Extraction Factor (as defined in Section 4.3.1, note 4 to Table 4.7), to exceed the Volume for Licensed Allocations (VLA) for the relevant management area (as shown in Figure 4.8), except where:

   (a) Water is to be allocated to existing non-licensed water users in accordance with principles 8.2.2 and 8.2.3 (Unlicensed pre-existing water use); or

(b) The total amount allocated on all licences plus the Irrigation Extraction Factor exceeds the VLA in the relevant management area at the **date of adoption**, in which case the taking of the water will not cause significant adverse impacts on the confined aquifer within the relevant management area and provided that where the total amount allocated on all licences plus the Irrigation Extraction Factor exceeds the VLA in the relevant management area, the total amount allocated on all licenses plus the Irrigation Extraction Factor within the relevant management area, does not exceed the PAV for that management area (see Table B). Where the total amount allocated on all licences plus the Irrigation Extraction Factor exceeds the VLA in the relevant management area at **date of adoption**, no further water will be allocated, except where principles 8.2.2 and 8.2.3 apply.

**Unlicensed pre-existing water use**

2. Water may be allocated to existing non-licensed water users where:

(a) It can be demonstrated that the water use in its present form at the date of application, was also in existence during the year prior to 10 April 1997;

(b) Water is used for the following:

- Operation of a dairy licensed by the Dairy Authority of South Australia at the date of application, (including wash down, washing up and milk cooling);
- Intensive animal keeping;
- An intensive plant production system such as greenhouses, hydroponics or nurseries;
- Industry; or
- Recreation;

(c) The source aquifer nominated on the application is the aquifer from which the unlicensed water was being taken at 12th February 2001; and

(d) Applications for a water allocation are received by no earlier than 5 p.m. on 30 June 2002 and no later than 31 July 2002.

3. Water shall be allocated for unlicensed pre-existing use in the following manner:

(a) The water allocation shall meet the applicant's reasonable requirements up to 10 megalitres per annum, except for dairies which milk in excess of 300 cows in which case the allocation shall meet the applicant's reasonable requirements;

(b) In the case of dairies, the water allocation shall be calculated as whichever is the greater of, the reasonable requirements of the water user at the time of application, or the average of the annual reasonable requirements over the preceding three year period;

(c) Allocations granted under section 8.2.3 are exempt from principles 8.2.12 (Quantity for allocation), 8.2.15 to 8.2.19 (Active and expeditious use of water), and 8.2.20 to 8.2.22 (Hydrogeological effects).

**Taking and use of water**

4. There shall be no further allocations of confined aquifer water in the Padthaway PWA, except:

   (a) Where principle 8.2.2 and 8.2.3 apply; or

   (b) For the purpose of public water supply.

**Underground water resource condition**

5. The taking and use of water shall not cause or be likely to cause a mean (arithmetic) decrease in the potentiometric level of the confined aquifer within the vicinity of the point of taking (including neighbouring properties and the nearest potentiometric level monitoring wells), or within the relevant confined aquifer management area, of greater than 0.1 metres per year (measured over the preceding 5 years);

**Water (holding) allocations**

6. No water (holding) allocation shall be endorsed on a licence after **adoption date** except where a water (taking) allocation, either in whole or part, endorsed on a licence, is converted to a water (holding) allocation, with the exception that any water (taking) allocation on a licence that is subject to a condition or conditions requiring the expeditious use of water (including a requirement that the equipment, or land by which or on which the water is used be developed in a certain time), shall not be converted to a water (holding) allocation, if the condition has, or conditions have, not been satisfied.

**Basis of allocation**

7. Allocations of confined aquifer water granted after 5 pm on adoption date will be expressed volumetrically, except for:

   (a) Allocations that have been obtained through transfers, which shall be expressed in the same units of measure as those used prior to transfer;

   (b) Allocations varied through conversion from a water (taking) allocation to a water (holding) allocation, which shall remain expressed in the same units of measure as those used prior to conversion; and

   (c) Allocations varied through conversion from a water (holding) allocation to a water (taking) allocation, which shall remain expressed in the same units of measure as those used prior to conversion.

8. From 1 January 2005 all confined aquifer allocations will be expressed volumetrically.

**Purpose of use**

9. Water shall not be taken and used for the purposes of wild flooding.

10. Water shall not be taken from the confined aquifer and used for the purpose of aquaculture unless:

    (a) The volume of tail water produced for disposal does not exceed an amount reasonably produced according to current industry best practice;

    (b) Disposal of tail water will not result in an increase (above seasonal fluctuations) in underground water levels in the unconfined or confined aquifers at the boundary of the allotment where the tail water is disposed of or, at the boundary of any adjoining allotment held by the same owner, whichever is the greater distance from the point of disposal;

    (c) Disposal of tail water will not result in an accelerated increase in salinity of the unconfined or confined aquifers, or result in pollution of these aquifers by any other substance; and

    (d) The ponds, tanks, vessels, or other places for the keeping of any water for the aquaculture process have no significant hydraulic connection with the unconfined or confined aquifers.

**Quantity of allocation**

11. Where water is to be used for irrigation purposes, the allocation shall not exceed the amount reasonably required to irrigate the area of the particular crop type, on the dominant soil type and given the local average meteorological conditions applicable to the relevant allotment.

12. Where water is to be used for purposes other than irrigation, the allocation shall not exceed the amount reasonably required (applying current industry best practice standards) for the purpose proposed.

**Efficient use of water**

13. Water shall be used and applied using water efficient technologies and techniques appropriate for the particular purpose and circumstances for and in which the water is to be used in accordance with current industry best practice standards.

14. For the purposes of principle 8.2.13, the relevant circumstances for the use of water for irrigation include (but are not limited to) the:

    (a) Plant type;

    (b) Climate, dominant soil type and topography of the allotment;

    (c) Location of remnant native vegetation and/or other permanent structures such as powerlines, which may limit the method of application of water; and

    (d) Salinity of the water to be used.

**Active and expeditious use of water**

15. All water (taking) allocations granted on or **after adoption date**, excluding allocations which have been obtained through transfers, shall be used with the minimum of delay and in any case within 3 years of the granting of the allocation.

16. All water (taking) allocations granted **before adoption date**, with a condition requiring active and expeditious use, shall be used with the minimum of delay and in any case within 3 years of the granting of the allocation.

17. All water (taking) allocations granted after adoption date, resulting from the conversion of a water (holding) allocation, shall be used with the minimum of delay and in any case within 3 years of the granting of the allocation.

18. For the purposes of principles 8.2.15, 8.2.16 and 8.2.17 the use of an allocation includes the development of the land and equipment upon or by which the water is used, to a capacity that enables the water (taking) allocation to be utilised at its maximum lawful rate.

19. Without in any other way affecting the operation of principles 8.2.15, 8.2.16 and 8.2.17, where exceptional circumstances apply to the licensee, the maximum period may be increased to 4 years from the granting of the allocation.

**Hydrogeological effects**

20. The taking and use of water shall not adversely affect to a significant extent:

    (a) The quality of water in the confined aquifer by (including but not limited to) an increase in salinity;

    (b) The potentiometric level of the confined aquifer by causing or contributing to a long term decline in the potentiometric level by exceeding the rate specified in principle 8.2.5;

    (c) The structural integrity of the aquifer;

    (d) Any other water resource (including but not limited to the unconfined aquifer, or any relevant surface water resource), both within and outside the Padthaway Prescribed Wells Area; and

    (e) Ecosystems dependent on underground water.

21. The taking of water from the confined aquifer shall not cause a seasonal draw-down at any point beyond the 2 km radius from the proposed well(s) of greater than 2.0 metres, except where water is taken and used for the purpose of public water supply by SA Water Corporation or a local government authority and that Corporation or authority had supplied the public with water from the well(s) on or before adoption date.

22. The taking of water from the confined aquifer shall not occur if it is likely to cause the potentiometric level in the confined aquifer to to permanently fall below the potentiometric level in the unconfined aquifer in areas where the existing potentiometric level of the confined aquifer is greater than the potentiometric level of the unconfined aquifer.

**Piping of water more than 2km**

23. Where water is to be taken from one point and transported by pipe or other closed vessel to be used at another point at least 2 kilometres from the point of taking, the taking of water shall comply with principle 8.2.20 to 8.2.22 and use of the water shall comply with principle 8.2.20.

24. Confined aquifer water (taking) allocations granted **after adoption date** shall not be transported from the point of taking by means of an open channel.

# 9 Transfer Criteria – Confined Aquifer

## 9.1 Objectives

1. To protect ecosystems dependent on underground water by ensuring that the taking and use of underground water from the confined aquifer does not degrade the ecology and biodiversity of the region;

2. To protect the environment generally by ensuring that the taking and use of underground water from the confined aquifer does not significantly degrade any other resource, such as soils or other water resources;

3. To promote the efficient use of water according to industry best practice standards;

4. To manage the underground water resource of the confined aquifer so that it may continue to be utilised by future generations;

5. To ensure that extractions remain within the sustainable limits of the confined aquifer by limiting the concentration of water use that may result through the transfer of water allocations;

## 9.2 Principles

Except where otherwise expressly stated, all the following principles apply to the transfer of a water (taking) licence or the whole or part of a water allocation of a licence, from the confined aquifer.

**Transfers of water (holding) allocations**

1. A licence endorsed with a water (holding) allocation, or the whole or a part of a water (holding) allocation may be transferred to any person or legal entity, but will continue to be recognised as being held from the same management area from which the allocation was originally granted.

**Transfer of Water (Taking) Allocations – Purpose of use**

2. A licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation, shall not be transferred where water is to be taken and used for wild flooding.

3. A licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation, shall not be transferred for the purpose of flood irrigation where the water will continue to be taken from the same point of extraction (or a well that replaces the original well, but lies within 1 kilometre of the original well) and is to be used on the same allotment or allotments.

4. The transfer of a licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation that is to be taken from the confined aquifer for the purpose of aquaculture will not be granted unless:

   (a) The volume of tail water produced for disposal does not exceed an amount reasonably produced according to current industry best practice;

(b) Disposal of tail water will not result in an increase (above seasonal fluctuations) in underground water levels in the unconfined or confined aquifers at the boundary of the allotment where the tail water is disposed of, or, at the boundary of any adjoining allotment held by the same owner, whichever is the greater distance from the point of disposal;

(c) Disposal of tail water will not result in an accelerated increase in salinity of the unconfined or confined aquifers, or result in pollution of these aquifers by any other substance; and

(d) The ponds, tanks, vessels, or other places for the keeping of any water for the aquaculture process have no significant hydraulic connection with the unconfined or confined aquifers.

**Transfer of water (taking) allocations**

5. A licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation may be transferred either permanently or temporarily only where the proposed point of extraction is in the same confined aquifer management area as the existing point of extraction from which the allocation may lawfully be taken.

**Applications to transfer water (taking) allocations – Efficient use of water**

6. A licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation shall only be transferred where the water shall be used and applied using water efficient technologies and techniques appropriate for the particular purpose and circumstances for and in which the water is to be used in accordance with current industry best practice standards.

7. For the purposes of principle 9.2.6, the relevant circumstances for the use of water for irrigation include (but are not limited to) the:

(a) Plant type;

(b) Climate, dominant soil type and topography of the allotment;

(c) Location of remnant native vegetation and/or other permanent structures such as powerlines, which may limit the method of application of water and

(d) Salinity of the water to be used.

**Applications to transfer water (taking) allocations – Hydrogeological effects**

8. A licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation shall only be transferred where the taking and use of water shall not adversely affect to a significant extent:

(a) The quality of water in the confined aquifer by (including but not limited to) an increase in salinity;

(b) The potentiometric level of the confined aquifer by causing or contributing to a long term decline in the potentiometric level by exceeding the rate specified in principle 8.2.5;

(c) The structural integrity of the aquifer;

(d) Any other water resource (including but not limited to the unconfined aquifer, or any relevant surface water resource), both within and outside the Padthaway Prescribed Wells Area;

(e) Ecosystems dependent on underground water.

9. The transfer shall not cause the taking of water from the confined aquifer from the proposed well(s) of extraction to result in a seasonal draw-down at any point beyond the 2 km radius from the proposed well(s) of greater than 2.0 metres,

10. The transfer shall not occur where the taking of water from the confined aquifer from the proposed bore(s) of extraction is likely to cause the potentiometric level in the confined aquifer to permanently fall below the potentiometric level in the unconfined aquifer in areas where the existing potentiometric level of the confined aquifer is greater than the potentiometric level of the unconfined aquifer.

11. The proposed taking of water shall be deemed to have complied with principles 9.2.8, 9.2.9 and 9.2.10 without further assessment where:

(a) A licence endorsed with a water (taking) allocation, or the whole or a part of a water (taking) allocation is to be transferred but will continue to be taken from the same well or is replaced by a new well within 1 kilometre of the original well and is to be used on the same allotment or allotments; or

(b) An application to renew a temporary transfer (of the same quantity) that proposes taking the water allocation from the same well (or a well that replaces the original well, but lies within 1 kilometre of the original well), and the use of the allocation on the same allotment or allotments, is received and processed prior to the date and time of expiry of the original temporary transfer.

**Applications to transfer water (taking) allocations – Piping of water more than 2km**

12. Transfer applications where water is to be taken from one point and transported by pipe or closed vessel to be used at another point at least 2 kilometres from the point of taking, the taking of water shall comply with principles 9.2.8, 9.2.9 and 9.2.10, and use of the water shall comply with principle 9.2.8.

13. Transfer applications that propose transporting confined aquifer water from the point of taking in an open channel, shall not be granted.

**Applications to transfer water (taking) allocations – Development of allocation before transfer**

14. Licences from the confined aquifer with a condition or conditions imposed requiring the expeditious use of water (including a requirement that the equipment, or land by which or on which the water is used be developed in a certain time):

    (a) The allocation (or part thereof) or the licence may be transferred where the equipment or land has been fully developed to allow use of the water at its maximum lawful rate;

    (b) Where the expeditious use conditions have not been fully completed, only the portion of the allocation that may be used in accordance with the extent of development at the date of receipt of the application to transfer by the Minister may be transferred; or

    (c) Where the licence or allocation is to be transferred in its entirety, but will be taken and used on the same allotment, it may be transferred whether or not the land or equipment has been fully developed in accordance with the condition(s), provided that the new landholder fully develops the land and equipment in order to allow use of the allocation at its maximum lawful rate, in accordance with the original conditions.

# 10 Permits

## 10.1 Wells

The following objectives and principles apply to permits for activities pursuant to section 9(3)(a) & (b) of the *Water Resources Act 1997* comprising drilling, plugging, backfilling or sealing a well and the repairing, replacing or altering the casing, lining, or screen of a well.

### 10.1.1 Objectives

1. To ensure the drilling, plugging, backfilling or sealing of a well occurs in a manner which will protect the quality of the underground water resource.

2. To minimise the impact of repair, replacement or alteration of the casing, lining or screen of wells on the water resource.

3. To protect the underground water resources from pollution, deterioration and undue depletion.

4. To ensure the integrity of the headworks of wells are maintained.

5. To ensure that wells are constructed in the correct aquifer system.

### 10.1.2 Principles

**Impact of well works on water quality & integrity of the aquifer**

1. The equipment, materials and method used in the drilling, plugging, backfilling or sealing of a well, or the replacement or alteration of the casing, lining or screen of a well, shall not adversely affect the quality of the underground water resource.

2. Aquifers shall be protected during the drilling, plugging, backfilling or sealing of a well, or the replacement or alteration of the casing, lining or screen of a well, to prevent adverse impacts upon the integrity of an aquifer.

**Seals between aquifers**

3. Where a bore passes, or will pass through two or more aquifers, an impervious seal shall be made and maintained between such aquifers.

**Design of headworks**

4. The headworks of a well from which a licensed allocation is to be taken shall be constructed so that the extraction of water from the well can be metered without interference.

**Wells for artificial recharge**

5. The headworks of a well for the draining or discharge of recharged water shall be constructed so that recharge and draining or discharge operations can be metered without interference.

## 10.2 Draining or Discharging of Imported Water into a Well – Artificial Recharge

### 10.2.1 Objectives

1. To provide for the draining or discharging of imported water directly or indirectly into a well in a manner which does not adversely affect the underground water quality, the aquifer or any ecosystem that depends on that water.

### 10.2.2 Principles

The following principles apply to permits, pursuant to section 9 (3) (c) of the Act, for the activity of draining and discharging of **imported water** directly into a well.

1. Imported water may be drained or discharged into the confined or unconfined aquifers.

2. Subject to principles 10.2.2.4 and 10.2.2.5 imported water may be drained or discharged into a well for the purpose of aquifer storage and recovery where the concentrations, levels or amounts of the substances, materials or characteristics set out in principle 10.2.2.4 below, in the water to be drained or discharged, do not exceed the concentrations, levels or amounts of those substances, materials or characteristics in the native underground water.

3. For the purposes of principles 10.2.2.2, 10.2.2.4 and 10.2.2.5, the relevant concentrations, levels or amounts shall be measured by sufficient representative samples of:

   (a) the water to be drained or discharged, collected either from an existing dam or directly from the source; and

   (b) native underground water collected from the proposed point of injection, or as near as possible to the proposed point of injection, and from the same aquifer as that in which storage is proposed.

   "Sufficient representative samples" means suitable samples, collected with equipment appropriate for the substance, material or characteristic to be measured and taken at suitable locations and times to accurately represent the quality of the relevant water.

4. The draining or discharge of imported water directly or indirectly into a well may occur (despite principle 10.2.2.2) where the concentrations, levels and amounts of the substances, materials or characteristics of or in the water set out in principle 10.2.2.6 are not sufficient to degrade ecosystems dependent upon underground

water within the prescribed water resource or to reduce the suitability of the underground water for other purposes for which it might reasonably be used.

5. The draining or discharge of imported water directly or indirectly into a well may not be granted (despite principles 10.2.2.2 and 10.2.2.4) where the cumulative effects of the discharge of water to the aquifer are considered sufficient to degrade ecosystems dependent upon underground water within the prescribed water resource or to reduce the suitability of the underground water for other purposes for which it might reasonably be used.

6. For the purposes of principles 10.2.2.2,10.2.2.4 and 10.2.2.5 above, the list of substances, materials and characteristics comprises substances, materials and characteristics that may be reasonably be expected to be present in the imported water to be drained or discharged and have the potential to degrade the native underground water and the ecosystems that depend upon the native underground water, including where relevant (but not limited to):

   (a) pH, TDS, turbidity, ammonia, nitrate, nitrite, total phosphorous, sodium, chloride, sulphate, calcium, magnesium, bicarbonates, iron, total arsenic, total boron, total cadmium, total chromium, total lead, total manganese, total zinc, total coliforms and faecal coliforms; and

   (b) where the water to be drained or discharged comes from a source likely to contain pesticides, *Giardia, Cryptosporidium*, volatile organic compounds and petroleum hydrocarbons (including but not limited to water from land used for intensive agriculture or industrial purposes) those substances, materials and characteristics likely to be present in the source of the water; and

   (c) trihalomethanes where the water to be drained or discharged has been treated by chlorination.

7. The draining or discharging of imported water directly or indirectly to a well must not detrimentally affect the ability of other persons to lawfully take from that underground water or damage any ecosystem that depends on the underground water.

8. Draining or discharging imported water directly or indirectly into a well may only occur where:

   (a) the headworks of the well are constructed such that both recharge and recovery operations can be metered without interference;

   (b) continued recharge of water at the site will not result in detrimental impacts on water quality or on the integrity of the aquifer, for example, but not limited to:

      (i) unacceptable interference with the water supply from neighbouring wells,

      (ii) an increase in salinity of the underground water,

(iii) secondary water quality issues such as increased susceptibility to dryland salinity,

(iv) increased secondary porosity, which may affect the stability of the aquifer and result in land subsidence,

(v) perched water tables, or

(vi) waterlogging.

9. Licence or permit holders draining or discharging imported water into a well will be required to implement an ongoing water quality monitoring program, with the following minimum analysis of the water to be drained or discharged into the well:

   (a) minimum of four (4) samples per season during which the drainage or discharge to the well occurs; and

   (b) at least one sample per ten (10) megalitres of water drained or discharged to the well.

   Parameters to be analysed will be determined after assessment of the quality of the water to be drained or discharged directly or indirectly into the well and of the underground water into which the drainage or discharge is to occur, as undertaken at 10.2.2.6.

## 10.3 Importation of Water

Except for the purpose of public water supply, a permit is required for the activity prescribed by the *Regulations* pursuant to section 9(4)(k) of the *Water Resources Act* 1997 comprising using water in the course of carrying on a business at a rate that exceeds 1 megalitre/annum where the water has been brought into the a management area by means of a pipe or other channel ("use of imported water").

### 10.3.1 Relevant Authority

The relevant authority for determining a permit application for the activity of using water in the course of carrying on a business at a rate that exceeds 1 megalitre/annum where the water has been brought into a management area by means of a pipe or other channel is the Minister responsible for the administration of the *Water Resources Act 1997*.

The following objectives and principles apply to the use of imported water:

### 10.3.2 Objectives

1. To ensure that the use of imported water occurs in a manner that does not adversely affect the prescribed underground ground water resource.

### 10.3.3 Principles

1. Use of imported water shall not cause a rise in the underground water levels that detrimentally affects a structure or ecosystem.

2. For the purposes of principle 10.3.3.1, “structure” is defined as, but is not limited to, a building, fence or wall.

3. Use of imported water shall not adversely affect the quality of the prescribed underground water resource.

4. Use of imported water shall not adversely affect the productive capacity of the land by causing salinity, waterlogging or perched watertables or other such impacts.

5. The salinity of imported water shall not exceed the native background underground water salinity levels or 1500 mg/L, whichever is lower.

# 11 Monitoring

Section 101 (4) (e) of the Act requires the Plan to assess the capacity of the resource to meet the demands for water on a continuing basis and provide for regular monitoring of the capacity of the resource to meet those demands.

## 11.1 Monitoring the capacity of the underground water resource - The Water Level and Salinity Monitoring Network

The Department for Water Resources and its predecessors have undertaken monitoring of the water resources in the Padthaway PWA since 1970 when a water level monitoring network was established. Salinity monitoring began slightly later in 1978. A number of wells are also regularly sampled and analysed for major ion chemistry.

### Unconfined Aquifer

The water level monitoring network in the Padthaway PWA has been in operation for more than 30 years. Over this period, the network has been constantly upgraded and enlarged to meet the agricultural expansion in the PWA. There are currently 42 wells monitored for water level in the Padthaway PWA. These wells are measured quarterly by the Department for Water Resources (DWR).

There are two underground water salinity monitoring networks operating in the Padthaway PWA, the Padthaway Monitoring Network and the Padthaway Irrigation Network. The main network is the Padthaway Monitoring Network and is sampled by DWR. There are currently 28 wells in the network, which are sampled quarterly. The second network, the Padthaway Irrigation Network, monitors privately owned irrigation wells. They are either sampled by the irrigators themselves or by DWR, but on an irregular basis. There are currently 53 wells in the private network. The use of the Padthaway Irrigation Network to augment the main network ensures public involvement and increases the data points, especially in the main irrigation area.

### Confined Aquifer

There are no monitoring wells, water level or salinity, in the confined aquifer in the Padthaway PWA.

**Table 11.1: Underground water monitoring**

| What | Where | When |
|---|---|---|
| Underground water levels in the unconfined aquifer | Unconfined aquifer water level monitoring network locations in the Prescribed Wells Area | Quarterly |
| Underground water salinity in the unconfined aquifer | Unconfined aquifer salinity monitoring network locations in the Prescribed Wells Area | Quarterly |

## 11.2 The strategy for regular monitoring of the demands placed on the underground water resource

The strategy for regular monitoring of the demands placed on the underground water resource is provided below. The monitoring program will include:

### 11.2.1 Annual Water Use Report

An Annual Water Use Report is to be prepared by each licensee and submitted to the Department for Water Resources, Mount Gambier office, on or by 5 pm 31 July each year. Each licensee will provide the following information in the Annual Water Use Report:

(a) the volume of water and/or HaIE allocated on the licence;

(b) for licences expressed volumetrically, the volume of water actually used by the licensee and recorded on each meter during the water-use year (ie. opening and closing meter readings);

(c) the period of water use (eg. from 12 November to 30 April);

(d) the purpose for which water has been taken;

(e) the salinity reading, date and well number of any underground water salinity measurements taken during the Water Use Year;

(f) the total amount of imported water recharged for each meter for the purpose of Aquifer Storage and Recovery in the water-use year (where applicable); and

(g) where the water taken by the licensee is used for irrigation:

  (i) the area of each crop type irrigated;

  (ii) An estimate of the quantity of water taken from each licensed well (in megalitres) and a description of the method used to calculate extraction(s);

  (iii) a sketch plan of the area irrigated, the plant type, and how many hectares were irrigated;

  (iv) the number of irrigations;

  (v) the irrigation method; and

  (vi) the nature of services used to schedule when irrigation is required. (eg. neutron probes, external irrigation scheduling service, tensiometer etc)

**Table 11.2: Monitoring the use of underground water**

| What | Where | When |
|---|---|---|
| Underground water use and extraction | The wells used by all licensed users by way of an annual water use report | Submitted by 5.00pm 31 July each year |
| The salinity of underground water | The wells used by all licensed users by way of an annual water use report | Submitted by 5.00pm 31 July each year |

### 11.2.2 Monitoring of the Water Needs of Ecosystems Dependent on Underground Water

The water needs of ecosystems dependent on underground water are described in Table 2.1. Monitoring arrangements must be established to evaluate whether the policies in this Plan protect the water needs that have been identified.

This requires monitoring of critical hydrogeological and ecosystem parameters that can be used for this evaluation. These parameters include:

- mean underground water levels;
- seasonal underground water fluctuations;
- underground water salinity;
- species composition and abundance;
- species recruitment; and
- specific vegetation health measures such as canopy density.

A detailed program to monitor the parameters listed above will be formulated and implemented through the investigations program detailed in the Catchment Water Management Plan.

# 12 Miscellaneous

The preparing the policy, the Board has had regard to the issues set out in section 6 (2) of the *Water Resources Act 1997,* the *Groundwater (Border Agreement) Act 1995* and the *South Eastern Water Conservation and Drainage Act 1992*.

The Plan also shows relevant benefits of consistency with the following plans and policies as listed in Section 101(9) of the Act:

(a) relevant management plans under the *Coast Protection Act 1972*;

(b) relevant Development Plans under the *Development Act 1993*;

(c) relevant environment protection policies under the *Environment Protection Act 1993*;

(d) relevant plans of management under the *National Parks and Wildlife Act 1972*;

(e) relevant district plans under the *Soil Conservation and Land Care Act 1989*;

(f) guidelines relating to the management of native vegetation adopted by the Native Vegetation Council under the *Native Vegetation Act 1991*;

(g) State Water Plan.

**Table A: Volume for Licensed Allocation (VLA) for the unconfined aquifer management areas of the Padthaway PWA**

| Management Area | PAV ML | VLA[(a)] ML | Total Licensed Allocations at 23/05/2001 [(b)] ML | Difference (a - b) ML | Volume Reserved for Allocation to Unlicensed Pre-Existing Use ML | Volume Available for Allocation at 23/05/01 ML |
|---|---|---|---|---|---|---|
| Management area 1 | 15,774 | 14,019 | 12,415 | 1,604 | 200 | 0[3] |
| Management area 2 | 5,960 | 5,960 | 15,675 | -9,715 | 0 | 0 |
| Management area 3 | 2,900 | 2,859 | 3,807 | -948 | 0 | 0 |
| Management area 4 | 6,678 | 5,774 | 3,216 | 2,558 | 200 | 0[3] |
| **Total** | **31,312** | **28,613** | **35,113** | | | |

[3] Water is not available for allocation from management areas 1 and 4 due to the levels of over-allocation in management areas 2 and 3. The PAV was previously set for the entire PWA, which has allowed the concentration of allocations to occur in management areas 2 and 3. This Plan enables allocations from management areas 2 and 3 to be transferred into management areas 1 and 4, therefore remaining water in management areas 1 and 4 has been reserved specifically for this purpose.

**Please Note:** At the **date of adoption** the PAV and VLA figures in this table cannot be altered during the life of this Plan. The figures shown in the columns titled 'Total Allocations' and 'Difference' may change during the life of this Plan.

**Table B: Volume for Licensed Allocation (VLA) for the confined aquifer management areas in South Australia (all in ML)**

| Management Area | PAV | VLA (a) | Total Licensed Allocations at 23/05/01 (b) | Irrigation Extraction Factor (c) | Difference (a)-(b)-(c) | Volume available for allocation at 23/05/01 |
|---|---|---|---|---|---|---|
| Fairview | 290 | 284 | 0 | 0 | 284 | 284 |
| Kalangadoo | 3,900 | 3,822 | 1,993 | 386 | 1,443 | 1,443 |
| Keith | 2,500 | 2,450 | 130 | 0 | 2,320 | 2,320 |
| Kingston | 25,000 | 22,379 | 19,755 | 2,935 | -311 | 0 |
| Lucindale | 3,600 | 3,438 | 1,325 | 123 | 1,990 | 1,990 |
| Millicent | 10,800 | 10,584 | 4,376 | 676 | 5,532 | 5,532 |
| Taratap | 330 | 323 | 16 | 3 | 304 | 304 |
| Wirrega | 960 | 941 | 300 | 0 | 641 | 641 |
| Zone 1A | 9,200 | 8,806 | 404 | 81 | 8,321 | 8,321 |
| Zone 2A | 2,900 | 2,842 | 50 | 0 | 2,792 | 2,792 |
| Zone 3A | 1,900 | 1,862 | 0 | 0 | 1,862 | 1,862 |
| Zone 4A | 710 | 696 | 280 | 56 | 360 | 360 |
| Zone 5A | 540 | 529 | 0 | 0 | 529 | 529 |
| Zone 6A | 360 | 353 | 0 | 0 | 353 | 353 |
| Zone 7A | 350 | 343 | 0 | 0 | 343 | 343 |
| Zone 8A | 340 | 333 | 0 | 0 | 333 | 333 |
| Zone 9A | 570 | 559 | 0 | 0 | 559 | 559 |
| **Total** | **64,250** | **60,544** | **28,629** | **4,259** | **N/A** | **27,967** |

**Table C: Annual Average Vertical Recharge Rates for the Unconfined Aquifer Management Areas in the Padthaway PWA**

| Management Area | Annual Average Vertical Recharge Rate (mm/yr) |
|---|---|
| Management area 1 | 75 |
| Management area 2 | 75 |
| Management area 3 | 75 |
| Management area 4 | 25 |

# Figures

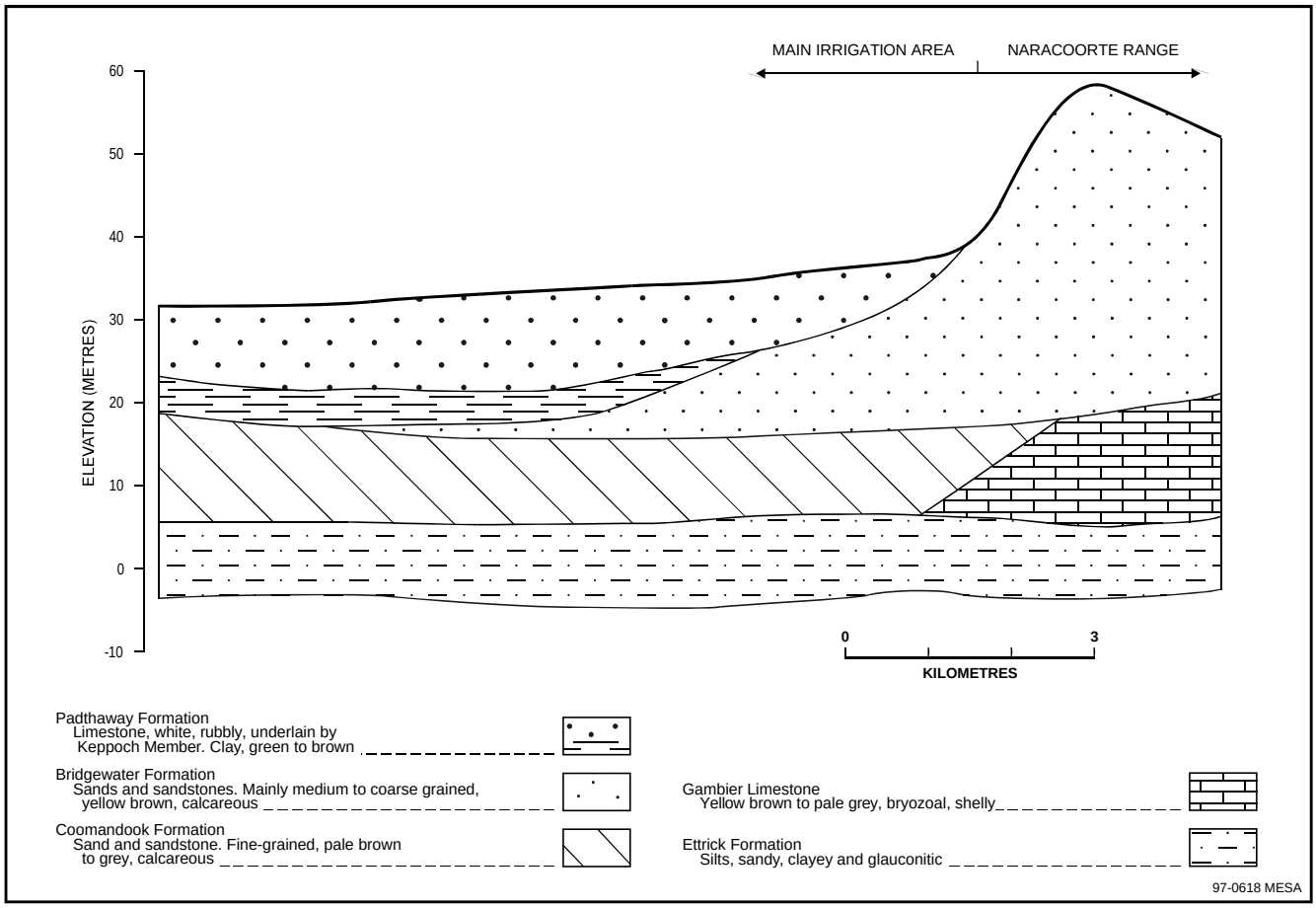
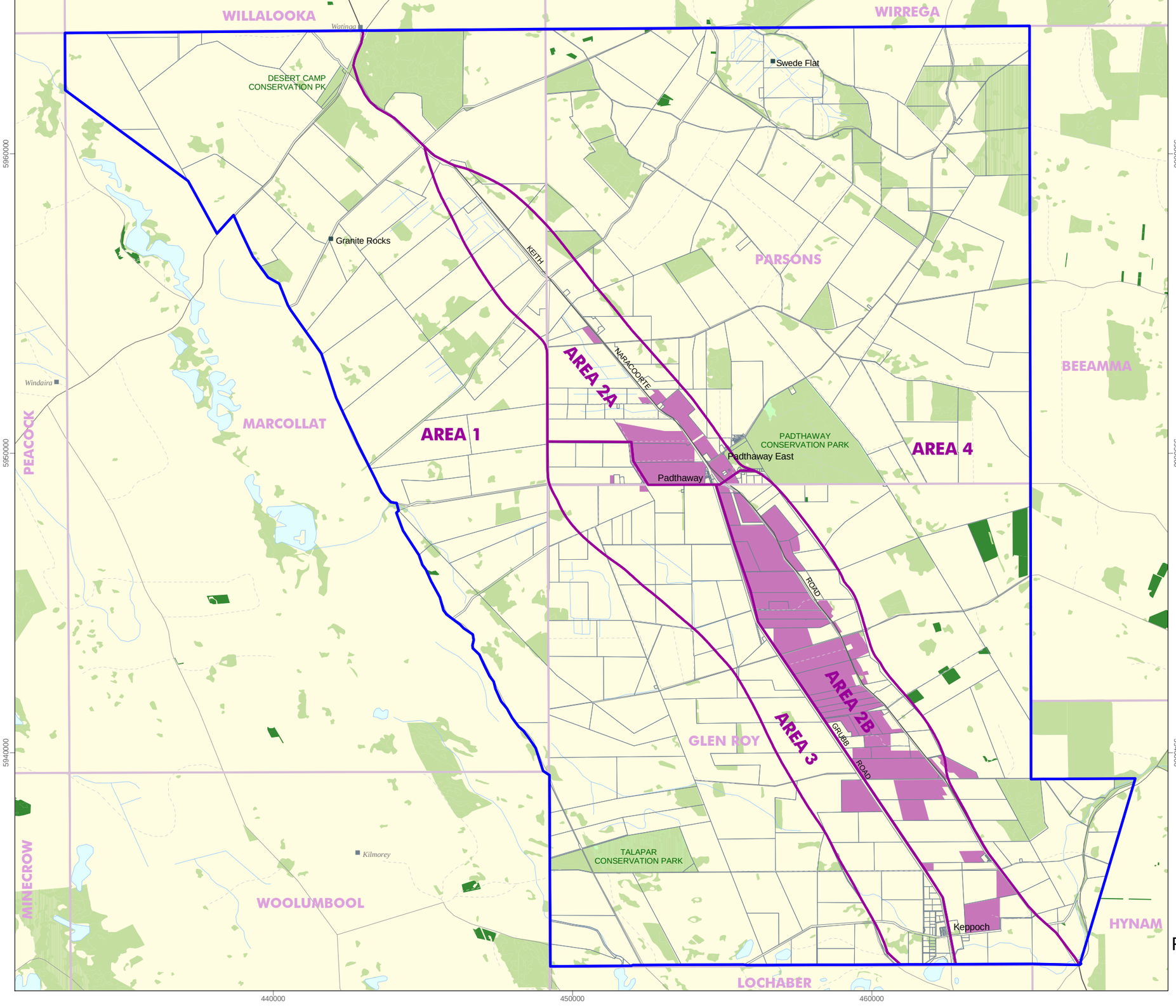



***Fig. 1.1*** *Schematic east-west geological cross section through the Padthaway PWA*





**Land use**

- Vines (1999)
- Native vegetation
- Forest (1999)

- Padthaway Prescribed Wells Area
- AREA 1 — Management Areas
- PARSONS — Hundreds

Cadastre data only shown within Padthaway Prescribed Wells Area

0 1 2 3 4 5 Kilometers

Datum GDA 94 Projection UTM MGA Zone 54

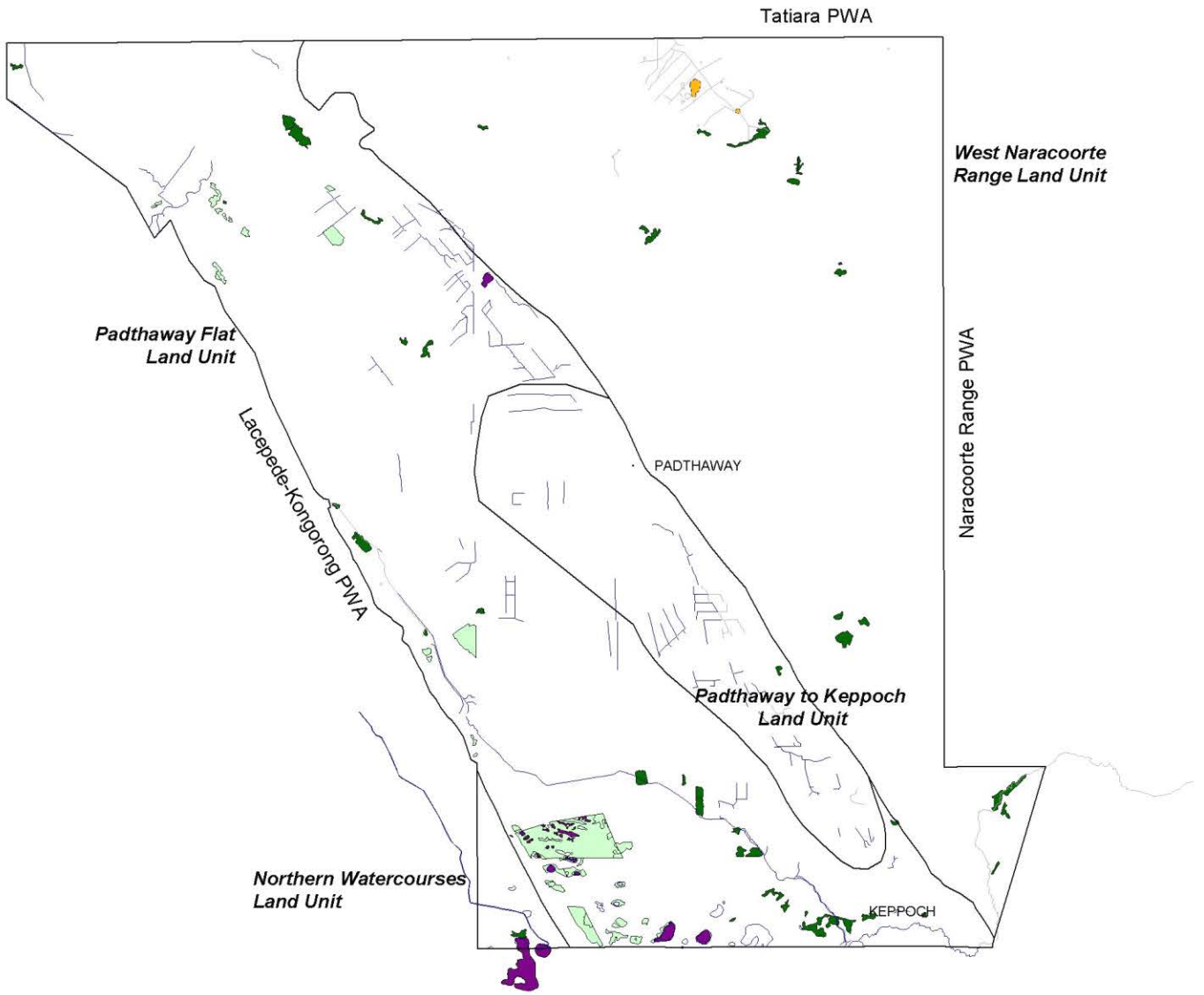
PADTHAWAY PRESCRIBED WELLS AREA

# UNDERGROUND WATER MANAGEMENT AREAS FOR THE UNCONFINED AQUIFER AND LAND USE

August 2000

AV: 200454_007

Figure 1.2




- Towns
- Karst Ecosystems
- Land Unit Boundaries

Wetlands
- Perched
- Groundwater Dependent

Phreatophytes
- Inferred Phreatophytes - Deep Groundwater
- Inferred Phreatophytes - Shallow Groundwater

Streams
- Inferred Groundwater Dependent Streams
- Inferred Groundwater Independent Streams

N

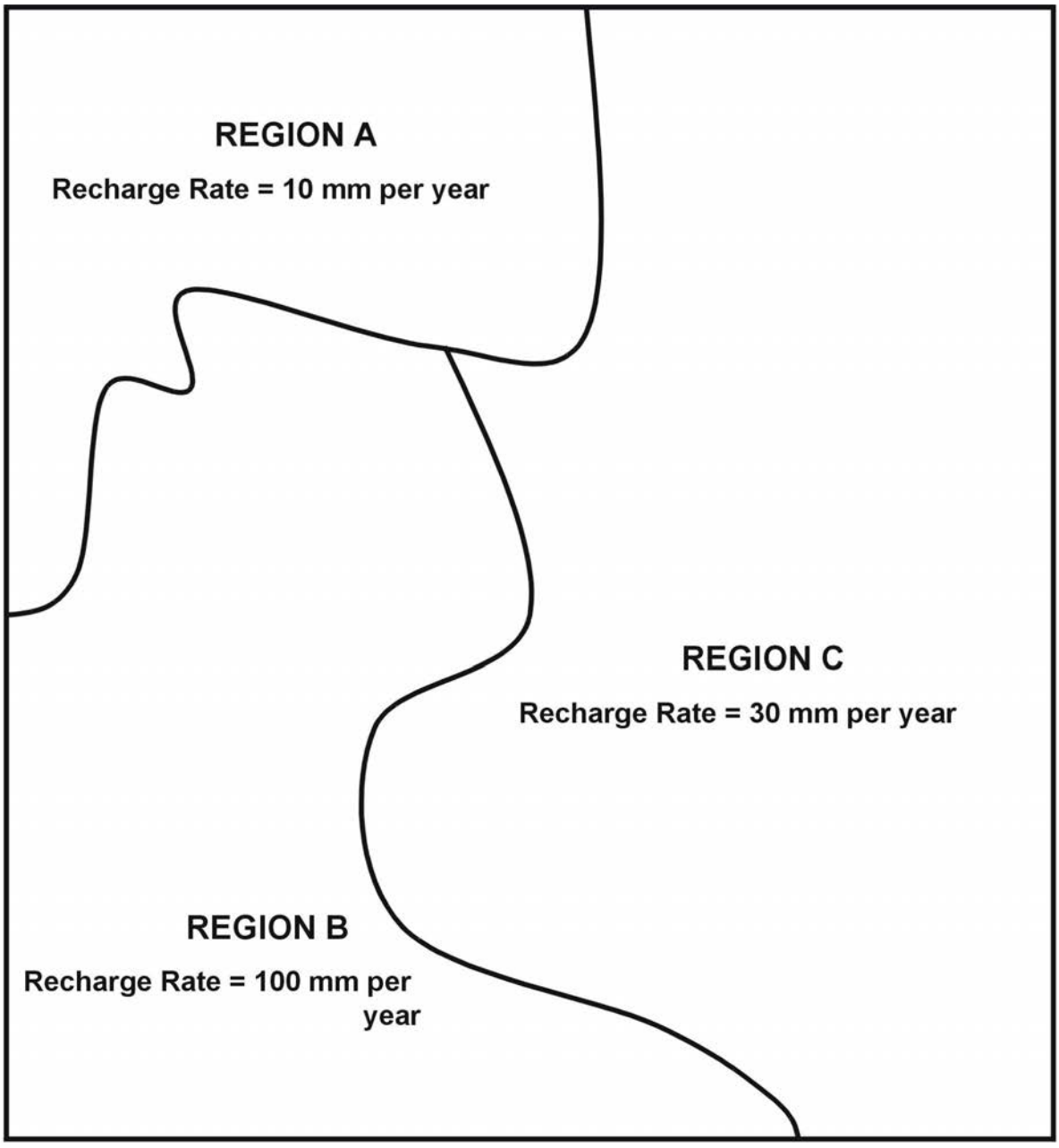
4 0 4 Kilometers

SOUTH EAST CATCHMENT WATER MANAGEMENT BOARD

URS

**Figure 2.1:**
**Ecosystems Dependent on Underground Water**
**Padthaway PWA**

**Figure 4.1: Example Determination of Permissible Annual Volume (PAV) for the Unconfined Aquifer in an Example Management Area**




PAV (in ML per year)

= (Sum of all recharge in regions A, B and C) x Salinity factor

= ((Land area of A ($km^2$) x 10) + (Land area of B ($km^2$) x 100)

+ (Land area of C ($km^2$) x 30)) X Salinity Factor

440000 450000 460000

5960000 5950000 5940000

WILLALOOKA WIRREGA PARSONS BEEAMMA MARCOLLAT PEACOCK GLEN ROY HYNAM MINECROW WOOLUMBOOL LOCHABER

AREA 1 AREA 2A AREA 2B AREA 3 AREA 4

Watinga Swede Flat Granite Rocks Windaira Padthaway East Padthaway Kilmorey Keppoch

2397 1396 1300 1815 1850 1979 2064 1945 1698 1362 1351 1440 1317 1306 1266 1423 1524 1072 1631 1272 1295 1272 1295 1468 1222 1244 1306 1239 1051 1418 1005 944 895 938 1116 1228 1216 1188 1261 1440 1485 1188 1149 1172 1049 1804 1088 1205 1043 2528 2008 2984 1328 2681 2909 1726 927 1390 2340 2058 1108 1631 1692 1266 1923 1446 1872 1524 1105 1138 1045 1340 1575 1205 1216 944 1676 1200 1334 1105 835 1045 1250 1515 1289 1250 6370 1300 972 955 1320

Marla Oodnadatta Moomba Coober Pedy Andamooka Leigh Creek Tarcoola Ceduna Port Augusta Port Lincoln ADELAIDE Mount Gambier

Water Search

Department for Water Resources

PRIMARY INDUSTRIES AND RESOURCES SA

**SALINITY (mg/L)**

- 0 - 750
- 750 - 1000
- 1000 - 1250
- 1250 - 1500
- 1500 - 2000
- 2000 - 3000
- 3000 - 7000

**SALINITY ZONES (mg/L)**

- 0 - 750
- 750 - 1000
- 1000 - 1250
- 1250 - 1500
- 1500 - 2000
- 2000 - 3000
- 3000 - 7000

Padthaway Prescribed Wells Area

Groundwater area

Hundreds

Cadastre data only shown within Padthaway Prescribed Wells Area

0 1 2 3 4 5 Kilometers

Datum GDA 94 Projection UTM MGA Zone 54

**PADTHAWAY PRESCRIBED WELLS AREA**

# GENERALISED SALINITY DISTRIBUTION IN THE UNCONFINED AQUIFER

**Prepared August 2000**

AV: 200454_004

Figure 4.2

440000 450000 460000

5960000 5950000 5940000

WILLALOOKA WIRREGA PARSONS BEEAMMA MARCOLLAT PEACOCK GLEN ROY MINECROW WOOLUMBOOL LOCHABER HYNAM

AREA 1 AREA 2A AREA 2B AREA 3 AREA 4

Watinga Windaira Kilmorey

Swede Flat Granite Rocks Padthaway East Padthaway Keppoch

DESERT CAMP CONSERVATION PK

PADTHAWAY CONSERVATION PARK

TALAPAR CONSERVATION PARK

MAR 4 8
MAR 45 0
MAR 205 0
MAR 26 0
MAR 201 9
MAR 200 13
MAR 27 0
MAR 25 0
MAR 204 32
MAR 29 -10
MAR 2 -35
MAR 206 19
MAR 34 28
MAR 35 42
MAR 22 -50
MAR 23 12
MAR 38 3
MAR 36 14
MAR 37 10
MAR 209 25
MAR 210 10
MAR 211 15
MAR 213 7
MAR 216 13
MAR 217 18

PAR 36 17
PAR 28 12
PAR 201 0
PAR 43 13
PAR 4 0
PAR 6 10
PAR 44 0
PAR 203 3
PAR 42 15
PAR 205
PAR 10 11

GLE 106 5
GLE 222 17
GLE 214 8
GLE 107 8
GLE 215 44
GLE 216 5
GLE 218 23
GLE 221 55
GLE 217 0
GLE 220 -42
GLE 109 0
GLE 240 35
GLE 103 6
GLE 242 23
GLE 244 17
GLE 243 8
GLE 85 16
GLE 245 14
GLE 102 5
GLE 101 12
GLE 42 12
GLE 88 5
GLE 226 0
GLE 14 30
GLE 86 10
GLE 203 9
GLE 227 15
GLE 53 5
GLE 200 7
GLE 100 7
GLE 204 28
GLE 207 22
GLE 205 13
GLE 209 18
GLE 211 12
GLE 212 0
GLE 89 9
GLE 28 -21
GLE 99 18
GLE 71 6
GLE 30 0
GLE 34 16
GLE 93 7
GLE 223 3
GLE 104 4


GLE 28 -21 Observation well and number Falling salinity trends (mg/L/year)

GLE 88 5 Observation well and number Rising salinity trends (mg/L/year)

Padthaway Prescribed Wells Area

Groundwater Areas

PARSONS Hundreds

Observation wells and cadastre data only shown within Padthaway Prescribed Wells Area

0 1 2 3 4 5 Kilometers

Datum GDA 94 Projection UTM MGA Zone 54

PADTHAWAY PRESCRIBED WELLS AREA

UNCONFINED AQUIFER SALINITY TRENDS to JUNE 2000

AV: 200454_006

Figure 4.3

**Figure 4.4: Hydrograph from PAR 42, Management Area 2A**

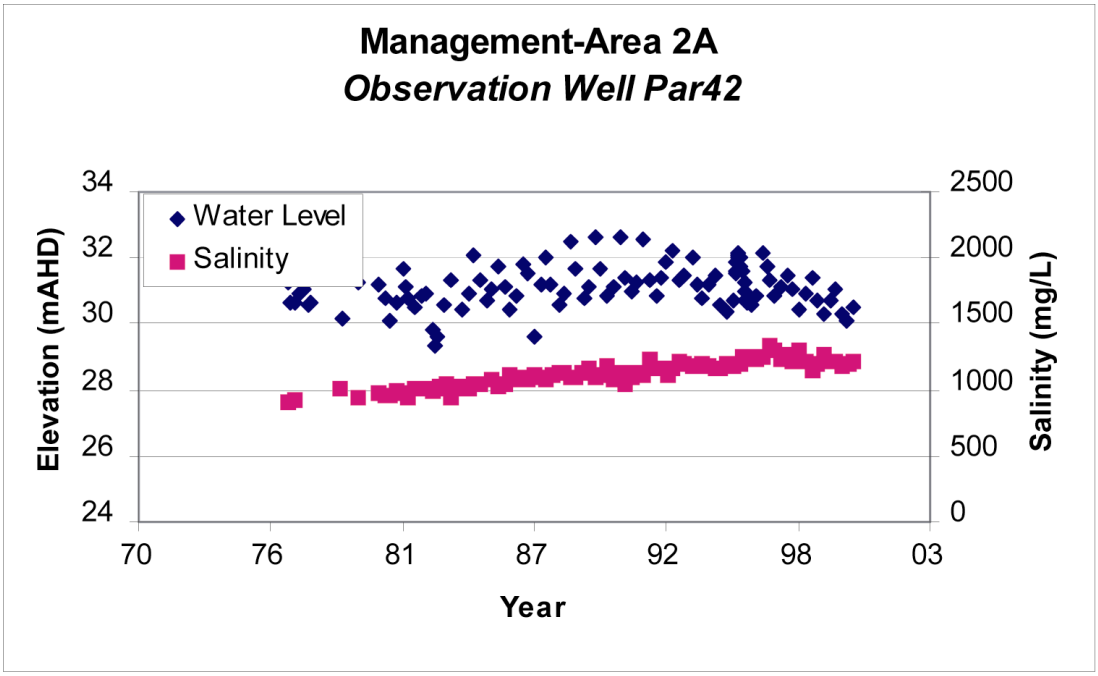



**Figure 4.5: Hydrograph from PAR 43, Management Area 2A**

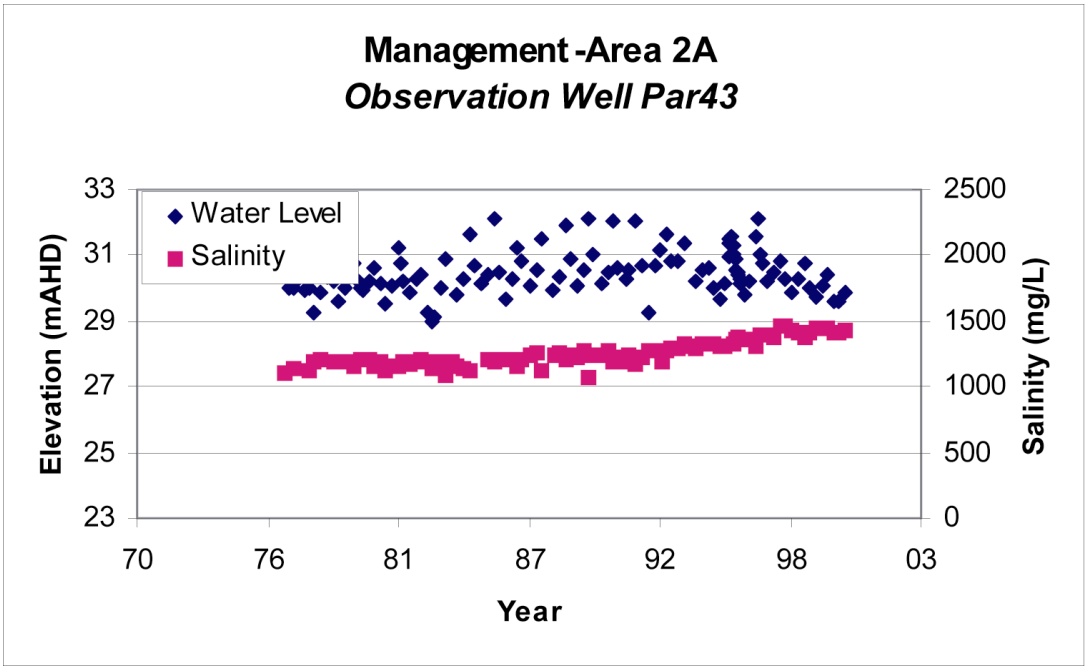


**Figure 4.6: Hydrograph from GLE 93, Management Area 2B**

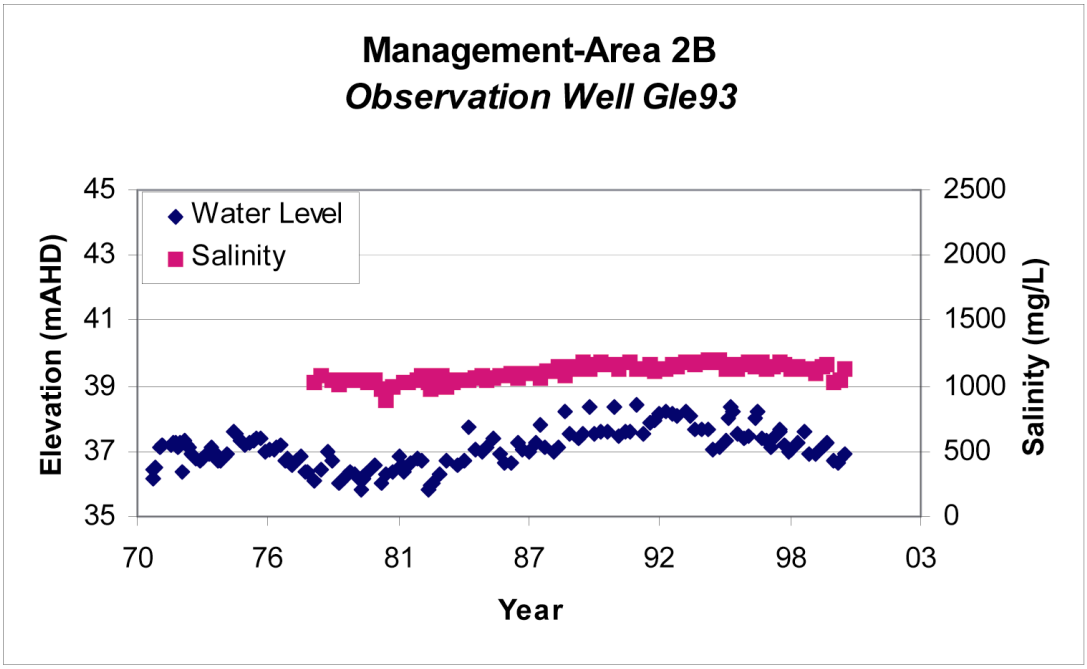
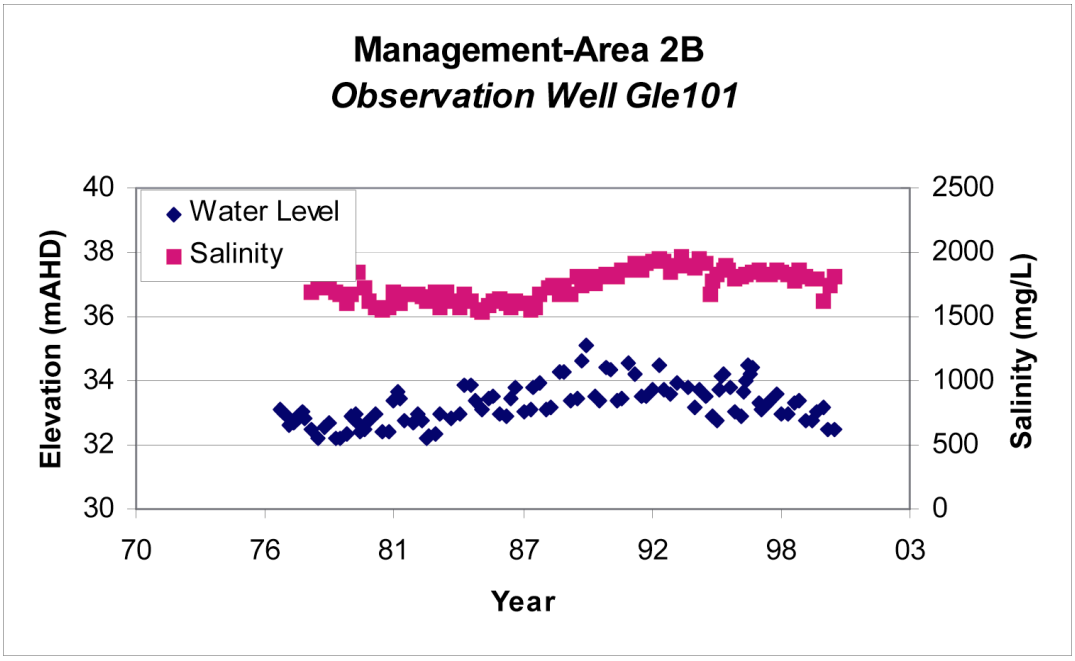
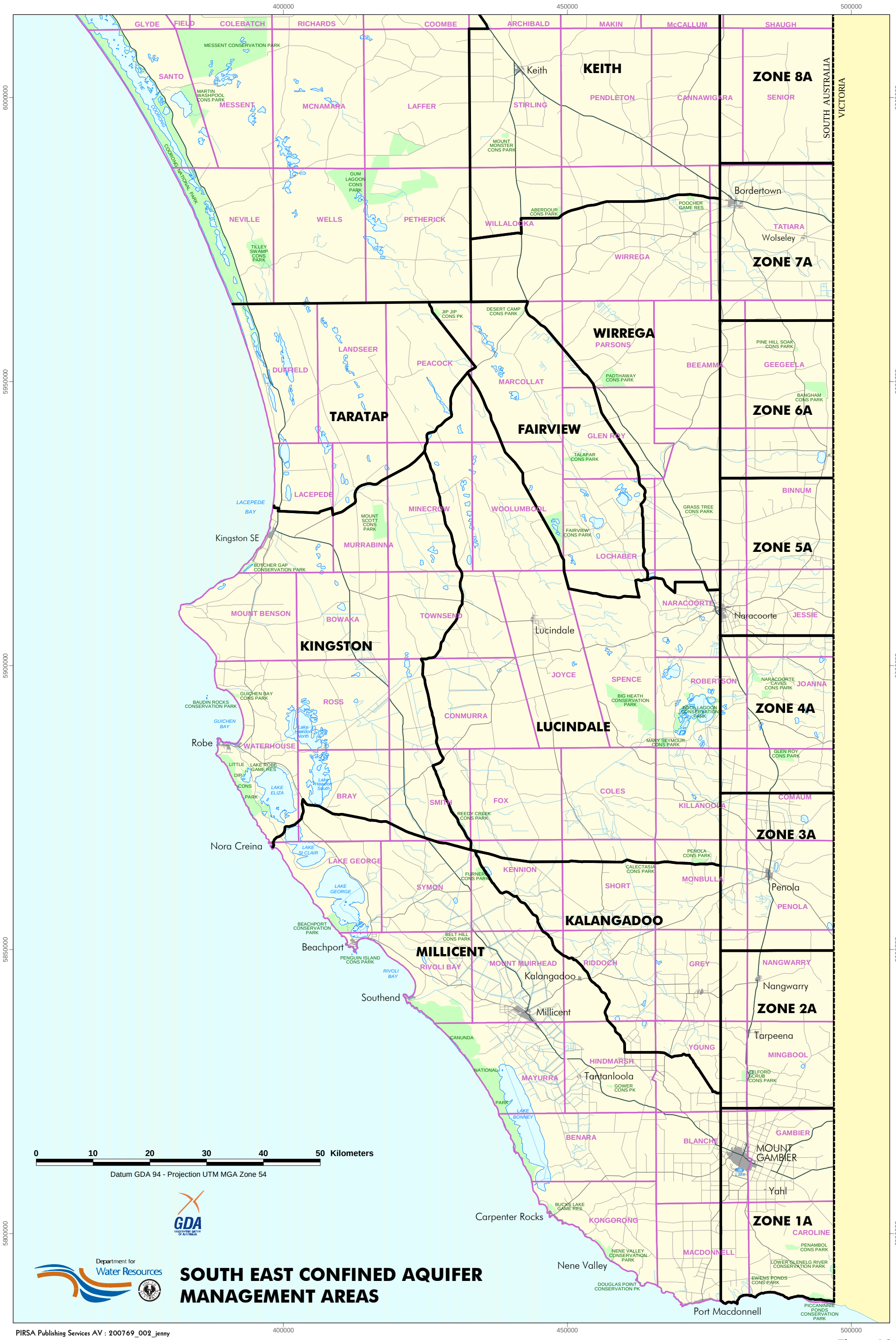



**Figure 4.7: Hydrograph from GLE 101, Management Area 2B**




400000
450000
500000
6000000
5950000
5900000
5850000
5800000
GLYDE
FIELD
COLEBATCH
RICHARDS
COOMBE
ARCHIBALD
MAKIN
McCALLUM
SHAUGH
MESSENT CONSERVATION PARK
SANTO
MARTIN WASHPOOL CONS PARK
MESSENT
MCNAMARA
LAFFER
STIRLING
Keith
KEITH
PENDLETON
CANNAWIGARA
SENIOR
ZONE 8A
SOUTH AUSTRALIA
VICTORIA
THE COORONG
COORONG NATIONAL PARK
MOUNT MONSTER CONS PARK
GUM LAGOON CONS PARK
Bordertown
POOCHER GAME RES
ABERDOUR CONS PARK
NEVILLE
WELLS
PETHERICK
WILLALOOKA
TATIARA
Wolseley
TILLEY SWAMP CONS PARK
WIRREGA
ZONE 7A
JIP JIP CONS PK
DESERT CAMP CONS PARK
WIRREGA
PARSONS
LANDSEER
PEACOCK
DUFFIELD
MARCOLLAT
BEEAMMA
PINE HILL SOAK CONS PARK
GEEGEELA
PADTHAWAY CONS PARK
BANGHAM CONS PARK
ZONE 6A
TARATAP
FAIRVIEW
GLEN ROY
TALAPAR CONS PARK
LACEPEDE
LACEPEDE BAY
MINECROW
WOOLUMBOOL
MOUNT SCOTT CONS PARK
FAIRVIEW CONS PARK
GRASS TREE CONS PARK
BINNUM
Kingston SE
MURRABINNA
LOCHABER
ZONE 5A
BUTCHER GAP CONSERVATION PARK
NARACOORTE
Naracoorte
JESSIE
MOUNT BENSON
BOWAKA
TOWNSEND
Lucindale
KINGSTON
JOYCE
SPENCE
ROBERTSON
NARACOORTE CAVES CONS PARK
JOANNA
GUICHEN BAY CONS PARK
BAUDIN ROCKS CONSERVATION PARK
ROSS
CONMURRA
BIG HEATH CONSERVATION PARK
POOL LAGOON CONSERVATION PARK
ZONE 4A
GUICHEN BAY
LUCINDALE
Robe
WATERHOUSE
MARY SEYMOUR CONS PARK
GLEN ROY CONS PARK
LITTLE DIP CONS PARK
LAKE ROBE GAME RES
LAKE ELIZA
BRAY
SMITH
FOX
COLES
KILLANOOLA
COMAUM
REEDY CREEK CONS PARK
ZONE 3A
Nora Creina
LAKE ST CLAIR
LAKE GEORGE
KENNION
SYMON
SHORT
MONBULLA
PENOLA CONS PARK
CALECTASIA CONS PARK
FURNER CONS PARK
Penola
PENOLA
KALANGADOO
BEACHPORT CONSERVATION PARK
BELT HILL CONS PARK
Beachport
PENGUIN ISLAND CONS PARK
MILLICENT
RIVOLI BAY
MOUNT MUIRHEAD
RIDDOCH
GREY
NANGWARRY
Kalangadoo
Nangwarry
Southend
Millicent
ZONE 2A
Tarpeena
CANUNDA
YOUNG
MINGBOOL
HINDMARSH
NATIONAL PARK
MAYURRA
Tantanloola
TELFORD SCRUB CONS PARK
GOWER CONS PK
LAKE BONNEY
BENARA
BLANCHE
GAMBIER
MOUNT GAMBIER
Yahl
BUCKS LAKE GAME RES
Carpenter Rocks
KONGORONG
ZONE 1A
CAROLINE
PENAMBOL CONS PARK
NENE VALLEY CONSERVATION PARK
MACDONNELL
LOWER SLENELG RIVER CONSERVATION PARK
Nene Valley
EWENS PONDS CONS PARK
DOUGLAS POINT CONSERVATION PK
Port Macdonnell
PICCANINNIE PONDS CONSERVATION PARK
0 10 20 30 40 50 Kilometers
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GDA
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Department for Water Resources
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Figure 4.8