Natural Resources Management Act 2004

Water Allocation Plan

for the

Padthaway Prescribed Wells Area

I, Jay Weatherill, Minister for Environment and Conservation, hereby adopt this Water Allocation Plan pursuant to section 80(3)(a) of the Natural Resources Management Act 2004

Hon Jay Weatherill MP:
Minister for Environment and Conservation

Date: 26/4/05

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1. The Padthaway Prescribed Wells Area

1.1 The Prescribed Wells Area

Location

The Padthaway Prescribed Wells Area (PWA) is located approximately 150 km north of Mount Gambier and covers an area of approximately 67,000 hectares (700 km^2), including the Hundreds of Glen Roy, Parsons and the north-eastern half of Marcollat. It incorporates the town of Padthaway and the locality of Keppoch (Figure 1, Appendix of Figures and Tables).

Underground Water Resources

Underground water in the South East of South Australia flows through two major aquifer systems: the regionally unconfined limestone aquifer system and the regionally confined sand aquifer system. Lateral flow in both the confined and unconfined aquifers is from the topographic high of the Dundas Plateau in Western Victoria, from which it flows radially west and south towards the coast (Figure 2, Appendix of Figures and Tables). Underground water flow velocities are dependent on local aquifer characteristics. The confined and unconfined aquifer systems are separated by a low permeability aquitard.

In the Padthaway PWA, underground water is extracted from two sub-aquifers, which form part of the regional unconfined aquifer. These water resources have been fully allocated in most of the Prescribed Wells Area since the time of proclamation. The sub-aquifers occur within the Padthaway Formation and the Bridgewater Formation, respectively (Figure 3, Appendix of Figures and Tables). The Padthaway Formation sub-aquifer occurs beneath the inter-dunal flat and generally ranges in thickness from six to fourteen metres. The formation consists mainly of an off-white, well-cemented, fine-grained limestone. The aquifer is generally highly transmissive (has high well yields) and depth to water generally ranges between 2 and 6 metres. The Padthaway Formation is the most utilised sub-aquifer in the PWA.

The Bridgewater Formation sub-aquifer forms the main aquifer in the Naracoorte Range. Average well yields are approximately 30 litres/second and 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 confined aquifer is generally absent, or thin (less than 2.5 m in thickness), over much of the Padthaway PWA and is not utilised as a water resource.

Surface Water Resources

Morambro Creek is the only significant natural watercourse in the Padthaway PWA, although flow in the creek varies significantly. The mean annual flow in the creek is 3,400 ML/year, and the absence of flow in the creek is not unusual. Morambro Creek is prescribed separately from the underground water in the Padthaway PWA. A water allocation plan for the Morambro Creek and Nyroca Channel Prescribed Watercourses including Cockatoo Lake and the Prescribed Surface Water Area was adopted by the Minister for Environment and Conservation on 13 January 2006.

Management Areas

At the time the previous water allocation plan was adopted (see section 1.2, below), the unconfined aquifer (Tertiary Limestone Aquifer) in the Padthaway PWA was managed as four separate management areas. For purposes of this plan, the PWA has been divided into two unconfined management areas: Padthaway Flats to the West and Padthaway Range to the East (Figure 4, Appendix of Figures and Tables).

The confined aquifer (Tertiary Confined Sands Aquifer) is divided into management areas on a regional basis. The Padthaway PWA encompasses portions of the Fairview and Wirrega management areas (Figure 5, Appendix of Figures and Tables).

Climate

The climate in the Padthaway PWA is typical of the South East of South Australia, with hot, dry summers and cool, wet winters. The mean annual rainfall recorded for the 1977-2000 period at the Padthaway Climate Station (closed in 2000) was 502.3 mm and the annual potential evapotranspiration is approximately 1600 mm. The mean annual rainfall recorded at the Padthaway South Climate Station (opened May 2000) for the period 2001-2007 was 446.5 mm and the annual potential evapotranspiration is approximately 1643 mm (Australian Government Bureau of Meteorology, 2008).

Landforms

The Padthaway PWA comprises two discrete landforms separated by the north west-south east trending Kanawinka Fault. To the south west of the fault, is a low-lying inter-dunal flat. The width of the flat is approximately ten kilometres and slopes gently downwards to the north west. North east of the fault a remnant dunal ridge rises to about 50 to 60 m above the flat, forming part of the Naracoorte Range (DWLBC, 2004/61).

Vegetation

A relatively large amount of native vegetation existed in the Padthaway PWA prior to the mid 1950ûs. Since then, the majority of native vegetation has been cleared for agriculture. The percentage of remnant native vegetation within the Padthaway PWA in 2004 was 11% (Department of Environment and Heritage, 2008). The vegetation of the Naracoorte Range originally included low open forests and woodlands with heath understorey, while the eastern portion of the inter-dunal flat was dominated by red gum (*Eucalpytus camaldulensis*) and blue gum (*E. leucoxylon*) woodland. The western portion of the inter-dunal flat consisted of low open forests and woodlands with heath understoreys and closed sedgelands composed of various rushes and sedges.

Land Use

Most of the 67,000 hectares of the Padthaway PWA is comprised of irrigated agriculture and horticulture, and improved pastures for sheep and cattle grazing. Grapes are the main crop produced in the region, which are for the most part processed for the wine industry.

Irrigation is concentrated on the inter-dunal flat, along the main Keith-Naracoorte road, due to the combination of suitable soil types, good quality shallow underground water (compared to other areas) and high well yields.

1.2 Background to the water allocation plan

The Water Allocation Plan for the Padthaway Prescribed Wells Area (the Plan) is pursuant to Part 2, Division 2 of the *Natural Resources Management Act 2004* (the Act). This Plan replaces the Water Allocation Plan for the Padthaway PWA adopted by the Minister for Water Resources on 14 October 2001.

The Act requires the South East Natural Resources Management Board (the Board) to prepare a water allocation plan for each of the prescribed water resources in its area.

The Padthaway Proclaimed Region was gazetted on 13 May 1976 under the provisions of the *Water Resources Act 1976,* following concern that increasing irrigation activity may lower the water table. Upon introduction of the *Water Resources Act 1997* the Padthaway Proclaimed Region became known as the Padthaway PWA.

The purpose of the Plan is to provide criteria by which decisions about the regulation and use of water are made, that ensure that water resources are managed sustainably for current and future users and water dependent ecosystems. The Plan sets out the principles for the allocation, use and transfer of underground water in the Prescribed Area. In addition, the Plan provides a framework for the issue of permits for the control of relevant water affecting activities. The Plan complies with the objects and requirements of the Act, assisting in the achievement of ecologically sustainable development in the region.

2. Assessment of the Needs of Water Dependent Ecosystems

This section provides an assessment of the quantity and quality of water needed by the ecosystems that depend on the water resources and the times at which, or the periods during which, these ecosystems will need that water.

2.1 Ecosystems dependent upon underground water in the Padthaway PWA

Section 76(4)(a)(i) of the Act requires that ecosystems dependent on underground water be assessed. Ecosystem requirements include both the local influence of underground water within an ecosystem and the influence on receiving environments downstream.

The following four types of underground water dependent ecosystems are relevant to the Padthaway PWA (see Figure 6, Appendix of Figures and Tables, for a conceptual diagram of each):

1. Karst
2. Streams (watercourses)
3. Wetlands
4. Phreatophytic vegetation

2.1.1 Karst

Karst (aquifer) ecosystems occur within the voids (solution features) that have developed within carbonaceous rocks making up the unconfined aquifer of parts of the South East. Little is known of these systems, but it is expected that they represent another component of the regionôs biodiversity.

Karst features are known to occur in the Padthaway PWA, but their ecology or dependence on underground water is unknown. Karst features in the Lower South East such as Ewens Ponds and Piccaninnie Ponds, support biota such as stygobite syncarids and amphipods.

2.1.2 Streams (watercourses)

Watercourses are dependent on underground water where its discharge contributes to flow or water quality. In the Padthaway PWA, underground discharge typically varies seasonally as underground water levels rise in response to winter rainfall recharge, so that underground water prolongs flow in late spring and summer and increases stream salinity at this time. These types of underground water dependent ecosystems are also known as baseflow systems. In other cases, streams may be fed primarily by surface water and provide areas of preferential underground water recharge. In this case, the watercourse functions as a losing stream.

Morambro Creek (Figure 7, Appendix of Figures and Tables) flows into the Padthaway PWA through a narrow flow path in the Naracoorte Range known as The Gap, in the south east corner of the PWA. The creek flows into Cockatoo Lake (Figure 7, Appendix of Figures and Tables), which is listed as a permanent lake by the Department of Environment and Heritage (DEH), and in turn overflows to the west during wet winters via a drainage channel. The creek, lake and Nyroca Channel are all likely to interact with the unconfined aquifer.

The Padthaway PWA encloses a small portion of the Drain E watercourse on the western side of the Harper Range. The drain lies at 35 m above sea level and carries substantial seasonal surface flows from Naracoorte Creek and the Naracoorte Plain. Underground water elevations are generally shallow (34m AHD). Within this area there are two unnamed wetland depressions which are likely to receive local runoff. At an elevation of less than 2 m above the water table, they are likely to form underground water mounds. The biota they support is undocumented.

2.1.3 Wetlands

The discharge of underground water to the surface (or near the surface) can support wetlands by creating a damp, saturated or inundated soil environment. Surface runoff also contributes to the water in wetlands, but underground water influences the timing, duration and extent of wet conditions during dry periods. Wetlands support particular plants and animals such as frogs, invertebrates and water birds.

Monitoring has not detected any increase in salinity in Cockatoo Lake, suggesting that there is minimal discharge from underground water to the lake. However, the wetland may interact with the water table through mounding of the water table.

A further wetland (unnamed) 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 33 m AHD and may receive underground water discharge from the range to the east.

Deep Water Swamp (Figure 7, Appendix of Figures and Tables) is a semi-permanent saline lake with little remnant vegetation with the exception of *Melaleuca halmaturorum*. The saline conditions most likely reflect underground water discharge and evaporative concentration.

The only wetlands located in the northern area of the PWA are located at Swede Flat (Figure 7, Appendix of Figures and Tables) where the depth to water table is up to 30 m. Underground water dependent wetlands are interpreted to occur approximately 15 m above the water table. Consequently, the Swede Flat systems can be assumed to be perched and independent of underground water.

2.1.4 Phreatophytic vegetation

Phreatophytic vegetation is vegetation which exists specifically due to the presence of underground water, which sustains deep-rooted phreatophytic plants in an otherwise dry environment. Phreatophytic vegetation is often closely associated with wetlands.

Within the Naracoorte Range, stands of river red gum (*Eucalyptus camaldulensis*) can be found associated with Morambro Creek (Figure 7, Appendix of Figures and Tables), as well as in 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, resulting in water logging of roots, salt stress and die back.

Within the low relief inter-dunal flat between the West Naracoorte Range and the Harper Range, a number of relatively intact *Eucalyptus camaldulensis* woodland communities exist, as well as numerous scattered individual trees. The trees reach a height of over 10 m and the underlying water table is found within 5 m of the surface, indicating a likely dependence on underground water.

In addition, there are substantial areas of vegetation growing over shallow underground water, particularly tea tree in the Talapar Conservation Park (Figure 7, Appendix of Figures and Tables). The park receives local runoff from Bucham Swamp (Figure 7, Appendix of Figures and Tables) 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*, *Melaleuca uncinata* and *Leptospermum juniperinum* and open *Melaleuca halmaturorum* scrub. Mature *Eucalyptus camaldulensis* 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. The central and western areas of the Padthaway PWA have remnants of *Leptospermum lanigerum* and *Melaleuca brevifolia* shrublands, which are also likely to be dependent on underground water.

2.2 Assessment of the quantity and quality of water needs

This section provides an assessment of the underground water quantity and quality requirement of the environment, in accordance with the requirements of the Act.

2.2.1 Quantity and quality of water needs

Ecosystems dependent upon underground water are adapted to a particular quantity and quality of underground water and to receiving it in a particular annual and inter-annual pattern. Changes in the quality or availability of underground water will affect ecosystems and can reduce their spatial extent or reduce their biodiversity. Activities that affect these factors include vegetation clearance, land use practices, irrigation and underground water extraction and recharge.

The depth to underground water has increased in some areas of the Padthaway PWA and threatens to reduce access to underground water by dependent ecosystems. This poses the additional risks of reduction in numbers of individuals of dependent species, or even loss of species, as the spatial extent of ecosystems declines.

Although the exact level of dependence on underground water of ecosystems in the Padthaway PWA has not been fully studied, the Plan sets out principles for water management in order to maintain the current quantity and quality of underground water available for these ecosystems through:

- no further declines and, where possible, recovery in underground water table levels, to ensure underground water dependent ecosystems can continue to access this resource;
- no significant increases in salinity of underground water to ensure no detrimental impact on species sensitive to salinity levels; and
- the maintenance of lateral through-flow of underground water, in order to prevent recycling of irrigation water which can lead to increases in salinity, and to ensure salts are flushed from the region.

The level of underground water extraction at which the above conditions can continue to be met, was determined with the use of a numerical model of underground water and salinity flow for the Padthaway PWA (PadMod1). This number is known as the Acceptable Level of Extraction (see Section 4.3.1 for further details) and the Plan sets out the principles for the reduction of allocations to this level.

In addition, the Plan contains resource condition triggers for both underground water salinity and water table level. These resource condition triggers are used in assessing applications for allocations and transfers of underground water and in the periodic evaluation of the trends in the conditions of the resource and the setting of the Acceptable Level of Extraction.

Finally, the Plan intends to provide for the maintenance of the water requirements of underground water dependent ecosystems of high conservation value through an additional assessment in the form of the Dependent Ecosystems equation (see below) to determine a minimum set-back distance for any new wells or for increases in underground water extraction through transfers of allocation in the vicinity of these ecosystems.

2.2.2 Identification of ecosystems of high ecological importance

Each ecosystem with a dependence on underground water has unique water requirements and further research should clarify the particular requirements of such ecosystems in the PWA. The protection of ecosystems of particular conservation significance and of threatened ecosystems is a priority.

A risk assessment process was employed across the whole of the South East Natural Resources Management Region of South Australia to identify underground water dependent ecosystems of high and very high ecological importance. The process takes into account the likely magnitude of the threat from underground water extraction, the likelihood that there will be an adverse impact and the

consequence of that impact, and involved the three-tiered assessment approach outlined below (REM, 2005):

1. risk assessment ranking (REM, 2005);
2. CSIRO underground water dependence assessment; and
3. local knowledge.

The ranking of wetland sites by REM was based on conservation value, the threat posed to underground water conditions by water affecting activities such as pumping and plantation forestry, and the likelihood that the ecological function of individual wetlands (or wetland complexes) will be adversely affected by altered underground water conditions (REM, 2005). No priority wetlands were identified for immediate protection through the Dependent Ecosystems equation (see below for more details) in the Padthaway PWA, although 13 priority wetland complexes in the Lower Limestone Coast PWA were selected.

In addition to the priority ecosystems described above, a significant number of wetlands in the South East of South Australia have been identified as of high or very high ecological importance. Two of these wetlands can be found in the Padthaway PWA (Table 2.2). Topography indicates that Swede Flat is highly unlikely to depend on underground water, while Cockatoo Lake may possibly have some interaction with underground water. Where ecosystems of this category are underground water dependent, steps must be taken to prevent their degradation due to the taking and use of underground water.

As a result, the Plan proposes to protect underground water dependent ecosystems of high ecological importance in the Padthaway PWA, where the following circumstances apply:

a) the wetland is considered by the relevant authority to demonstrate a level of dependence on underground water; and
b) at the date of application for the taking or use of water, the wetland is listed as high or very high ecological value in the South Australia Wetland Inventory Database (SAWID) for the South East (Table 2.1); and
c) the proposed underground water extraction point is within 2.25 km of the wetland, as determined by a 16 km^2 circle centred on the proposed point of taking of the allocation intersecting the wetland as mapped in the SAWID; and
d) the wetland is considered by the relevant authority to be under significant or actual threat of degradation identified by, but not limited to, a mean (arithmetic) decrease in underground water levels of greater than 0.05 m/year (measured over the preceding 5 years) in the nearest observation well or wells.

Table 2.1 Ecosystems of high/very high ecological value in the Padthaway PWA at April 2008*

Management Area	Ecosystem/s	Underground water dependency
Padthaway Flats	Cockatoo Lake	Some likelihood
Padthaway Range	Swede Flat	Highly unlikely

*sourced from South Australian Wetland Inventory Database for the South East

2.2.3 The Dependent Ecosystems equation (DE equation)

The purpose of the additional assessment in the form of the Dependent Ecosystems (DE) equation is to maintain the available underground water conditions for any underground water dependent ecosystems of high or very high ecological value identified for protection according to the criteria described in the section above.

The DE equation protects underground water availability by requiring that any new wells or increases in extraction be located at a distance from the wetland that should ensure no reduction in the level of the water table will occur due to this activity. The equation takes into account the distance between the proposed point of taking and the underground water dependent ecosystem (as mapped in the SAWID), the volume of water proposed to be extracted and the local aquifer characteristics, among other parameters, to determine whether the taking or use of water at that point will have a detrimental effect on water levels (identified as a 0.05 m decline) in the vicinity of the underground water dependent ecosystem. As a result, the minimum setback distance for new wells or a maximum volume that can be extracted from a well can be determined for any point in the vicinity of the wetland. The DE equation is derived from the Theis well equation and is shown below (REM, 2006).

$$s = \frac{Q}{4\acute{}\ KD} W(u) \qquad \text{where} \qquad u = \frac{r^2 S}{4KDt}$$

The input parameters for the DE equation are described in Table 2.2. A specific equation for each management area has been developed on a line of best fit that has been derived at various pumping rates (REM, 2006).

Table 2.2 Input parameters for calculating the required setback distance for underground water extraction in the vicinity of underground water dependent ecosystems identified for protection (REM, 2006).

Parameter	Data source
r, distance from pumping well (in metres)	Determined from application for allocation transfer
Q, pumping rate (m^3/day)	Determined from application for allocation transfer
KD, aquifer transmissivity (m^2/day) determined as hydraulic conductivity (*K*, m/day) x aquifer thickness (*D*, m)	Based on geometric mean of the available data per Management Area or (where available) individual site
S, specific yield	Based on geometric mean of the available data per Management Area or (where available) individual site
t, time over which pumping takes place (days)	Based on length of irrigation season in the Upper South East (REM, Stage 2 report): 66 days
u, dimensionless parameter of the Theis well function	= $r^2S/4KDt$
W(u), the Theis well function (known as the exponential integral, E1, in non-hydrogeology literature).	= -0.5772-ln(u)
s, drawdown at distance r from pumping well (in m)	Maximum drawdown allowed: 0.05m

References

Ecological Associates. 2006. Environmental water requirements of underground water dependent ecosystems in the South East Prescribed Wells Area - field studies to support new and amended policy. Prepared for REM.

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REM. 2005. A review of the environmental water requirements of the underground water dependent ecosystems of the South East Prescribed Wells Areas Stage 1 report. Prepared for the South East Catchment Water Management Board by Resource & Environmental Management Pty Ltd, and Ecological Associates Pty Ltd.

REM. 2005b, Integrated Monitoring Review of the South East of South Australia ï Phase 1- Final Report. Prepared for the South East Catchment Water Management Board. This report is the prelude to the Final report and provides information on the stakeholders, their statutory commitments and monitoring requirements.

REM. 2006. A review of the environmental water requirements of the underground water dependent ecosystems of the South East Prescribed Wells Areas Stage 2 report. Prepared for the South East Catchment Water Management Board by Resource & Environmental Management Pty Ltd, and Ecological Associates Pty Ltd.

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3 Assessment of Effects on Other Water Resources

Section 76(4)(a)(ii) of the Act requires this water allocation plan to include an assessment as to whether the taking or use of water from the resource will have a detrimental effect on the quantity or quality of water that is available from any other water resource.

Other water resources within the Padthaway PWA comprise the following:

a) Morambro Creek;

b) Cockatoo Lake; and

c) wetlands, including Deep Water Swamp and wetlands located at Swede Flat.

Morambro Creek

Morambro Creek (Figure 7, Appendix of Figures and Tables) 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 likely to be fed primarily by surface water (i.e. it is a losing stream) and provide areas of preferential underground water recharge. There are no reports of springs in the creek as it flows through the range.

Morambro Creek and its floodplain have likely made significant contributions to recharge to the aquifers beneath the Padthaway Flats in the past, however because flows in the creek have been much lower in recent times this recharge mechanism has been relatively insignificant in this time.

It is considered unlikely that the taking and use of underground water will 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 listed as a permanent lake by DEH, which in turn overflows to the north west during wet winters via a drainage channel. Surface monitoring has not detected any increase in salinity in the lake, suggesting that there is minimal discharge of underground water. Therefore it is considered unlikely that the taking and use of underground water will have a detrimental effect on the quantity or quality of water available in Cockatoo Lake.

Although it is recognised that recharge of underground water may occur from mounded lakes such as Cockatoo Lake, quantifying this recharge has proven extremely difficult and for that reason is normally assumed to be low. Ephemeral lakes often have high levels of silt which can accumulate at the bottom and are therefore not considered to contribute significantly to the water balance.

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 it is unlikely that the taking and use of underground water will have a detrimental effect on the quality and quantity of water within these wetlands.

Deep Water Swamp is a semi-permanent saline lake. The saline conditions most likely reflect the underground water discharge and evaporative concentration. Other wetlands in the Padthaway PWA may receive underground water discharge. While it is unknown whether the current level of underground water extraction is affecting water levels in the Padthaway PWA, underground water salinity is increasing in a number of areas throughout the PWA, which is partly attributed to the recycling of irrigation water. Given the only partial dependence of the wetlands on underground water, it is unknown whether the taking and use of underground water will 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 Prescribed Water Resources Areas

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 Morambro Creek and Nyroca Channel Prescribed Watercourses including Cockatoo Lake and the Prescribed Surface Water Area, and the Tatiara or Lower Limestone Coast PWAs.

References

Ecological Associates. 2006. Environmental water requirements of underground water dependent ecosystems in the South East Prescribed Wells Area - field studies to support new and amended policy. Prepared for REM.

Fass T and PG Cook. 2005. Reconnaissance survey of underground water dependence of wetlands, South East, South Australia, using a mass balance of radon and chloride. In: P Howe, R Evans and P Cook. Eds. (Final Draft) A framework for assessing environmental water requirements for underground water dependent ecosystems; Report 2 Field studies. Prepared for Land & Water Australia. December 2006.

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URS Australia. 2000. Assessment of the environmental requirements of underground water dependent ecosystems in the South East Prescribed Wells Areas. Prepared for South East Catchment Water Management Board.

4 Assessment of the capacity of the resource to meet demands

Section 76(4)(d) of the Act requires water allocation plans to contain an assessment of the capacity of the resource to meet the demands for water on a continuing basis and to provide for regular monitoring of that capacity.

During the review of the 2001 Padthaway PWA water allocation plan, the Department of Water, Land and Biodiversity Conservation (DWLBC), in collaboration with the Board, conducted several major underground water resource management projects. The projects evaluated the aquifer response using the latest water level and salinity monitoring data and adopting the most recent scientific reasoning with the aid of numeric models and assessment tools. This approach provided:

- a methodology for incorporating estimates of volumetric allocations and actual extractions into the water balance; and
- an indication of which areas in the Padthaway PWA required greatest attention for future underground water resource management.

The projects resulted in a comprehensive re-evaluation of the capacity of the resource to meet the demand for underground water, and provide for the allocation and use of water so that:

- an equitable balance is achieved between the social, economic and environmental needs for underground water; and
- the rate of use of underground water is sustainable.

4.1 Trends in underground water levels and salinity

Trends in underground water levels and salinity have been assessed for the unconfined aquifer only. Although there is potential for licenced extraction from the confined aquifer, it has limited capacity and is only utilised for stock and domestic use.

In the Padthaway PWA, underground water is extracted from two sub-aquifers which form part of the regional unconfined aquifer. These water resources have been fully allocated in the Padthaway Flats since the time of proclamation. The sub-aquifers occur within the Bridgewater Formation beneath the Padthaway Range and the Padthaway Formation beneath the Padthaway Flats.

4.1.1 Underground water levels

The five year water level trends for 2003-2007 shown in Figure 8 (Appendix of Figures and Tables) indicate there has been a general decline in water level across the whole region at an average rate of between 0.01 m/year and 0.40 m/year. The decline in the Padthaway Range was generally less than 0.15 m/year while the decline on the Padthaway Flats was generally greater than 0.15 m/year. This decline is in excess of the average 0.1 m/year limit for water table declines set out in this Plan.

The depth to the water table in the Padthaway Flats is between 3 m and 4.5 m, and is much less than that of the Padthaway Range, where the water table can be found between 5 m and 30 m below ground level. Therefore, the fluctuations in underground water levels in the Padthaway Flats have a strong correlation with the timing and magnitude of rainfall events.

This relationship is evident from the hydrographs of Padthaway Flats observation wells (Figure 8, Appendix of Figures and Tables) and a plot of cumulative deviation from mean annual rainfall at Padthaway (Figure 9, Appendix of Figures and Tables). The cumulative deviation from the annual mean provides an indication of rainfall trends compared to the long-term average determined using data from 1970 to present. Rainfall for the period 1999 to 2004 was generally above the long-term average, illustrated by the rising trend in the cumulative deviation from the annual mean. However, the period 2004 to 2008 was below average, illustrated by the falling trend in the cumulative deviation from the annual mean.

The long-term trend in water levels from 1970 shows little overall change to late 2004 as shown in hydrographs PAR029, MAR027, PAR042, GLE017 and GLE034 in Figure 8 (Appendix of Figures and Tables). Since 2004 the Padthaway Flats have been experiencing a regional fall of the water table,

which has been associated with both drought conditions and an increase in underground water extraction, to compensate for the decrease in rainfall.

The Padthaway Range hydrographs from observation wells show long-term underground water level rises of between 0.04 and 2.0 m/year over the monitoring record. The overriding influence in the rise in the water table is considered to be a result of the clearance of native vegetation and the failure of lucerne crops in the late 1970s. The majority of these hydrographs indicate the water table has reached or is approaching a new state of equilibrium as illustrated in the water level plateau in the hydrograph of observation well PAR 044 (Figure 8, Appendix of Figures and Tables).

The unconfined aquifer water table contours (Figure 8, Appendix of Figures and Tables) show that regional underground water flow moves down potentiometric gradient from east to west in the Padthaway Range into the Padthaway Flats where the flow changes to a north-westerly direction through the valley.

4.1.2 Salinity

In the main irrigated area on the Padthaway Flats, the salinity of the underground water has been increasing for more than 20 years. Detailed studies initiated in 2002, which quantified underground water extraction, irrigation application, crop water use, evaporation and salt accession to the aquifer under different irrigation practices, concluded that the historical salinity increase had been predominantly caused by the increased recharge due to the clearance of native vegetation between the 1950s and 1970s which has flushed the salts from the unsaturated zone in the Padthaway Range. This historic salt load has then moved with the natural underground water flow out beneath the Padthaway Flats.

A large quantity of salt still remains in the unsaturated zone in significant areas of the Padthaway Range and is predicted to continue to move into the underground water system over the next decades, causing further salinity impacts in the Padthaway Flats. However, this unsaturated zone salt store is finite and results show that parts of the Padthaway Range have been completely flushed and fresh water is being recharged in its place.

Salinity impacts from irrigation drainage water are also considered to be significant on the Padthaway Flats. Rainfall events and drainage from irrigation can flush the salts, which have been delivered and stored in the soil profile from previous irrigation. The impact of saline irrigation drainage water on underground water salinity is much more evident in the north of the PWA than in the south, possibly due to the greater occurrence of flood and centre pivot irrigation in that area, or the cumulative effect of all irrigation practices along the underground water flow path. In addition to this, bodies of saline soil water have built up in the unsaturated zone under drip and centre pivot irrigation.

Generally, the salinity of underground water in the Padthaway Range is lower than on the flats. Underground water salinity in 2007 in the Padthaway Range varied between approximately 1038 mg/L (GLE 103) and 1583 mg/L (PAR 043), with an average increase of up to 2 mg/L/year over the last 10 years and an average decrease of 11 mg/L/year over the last 5 years being observed (Figure 10, Appendix of Figures and Tables).

On the Padthaway Flats, underground water is more saline. Underground water salinity in 2007 ranged between 1000 mg/L and 2000 mg/L (PAR042, MAR023, MAR043 and GLE099) with salinity greater than 3000 mg/L on the western margin of the PWA (MAR 002). An average increase in salinity of up to 43 mg/L/year over the last 10 years and 18 mg/L/year over the last 5 years has been observed; however, many observation wells show a decrease in salinity (GLE099, GLE103 and PAR042).

4.2 Present and future needs of water users

Section 76(4)(c) of the of the Act requires water allocation plans to take into account the present and future needs of the occupiers of land in relation to existing requirements and future capacity of the land and the likely effect of those provisions on the value of the land.

4.2.1 Economic needs

A total of 5,923 hectare irrigation equivalents (haIEs) have been allocated in the Padthaway PWA. Based on the volumetric conversion model developed by DWLBC and published in 2006 (Report DWLBC 2006/29), the volume of water required by irrigators to irrigate this area, based on their system type, climate, predominant soil types and other factors, can be estimated as 86,546 ML/year (Table 4.1). Under flood irrigation, it is assumed that a significant percentage of this volume returns to the unconfined aquifer. Actual volumes pumped over the last years have ranged between 33,515 ML/year to 40,740 ML/year (Table 4.1). The majority of the water allocated was used for irrigation, with the remainder being allocated to industry, recreational use and public water supply. The principal irrigated industries in the Padthaway PWA are vines, pasture, pasture seed, lucerne seed and cereals.

Currently, there is one water licence used for industrial purposes in Padthaway. Demand for industrial water is expected to remain steady since no other significant future industrial use of underground water is predicted.

4.2.2 Social needs

SA Water has a water licence of 20 ML for public water supply from the unconfined aquifer in the Naracoorte Range for the township of Padthaway. Public water use generally ranges from 9 to 15 ML/year. SA Water believes that Padthaway's water use has stabilised and has estimated that a maximum usage of 20 ML/year will meet future demand.

There are two water licences in Padthaway used for recreational purposes for the irrigation of sports grounds. There is not expected to be any future increases in underground water usage for recreational purposes.

As stock and domestic water use is not required to be licenced, actual use is unknown. Domestic water use is considered to be relatively small as rainwater tanks are prominent in the area. Stock water use based on stock numbers for 1996/97 has been estimated at a total of 500 ML, and is not expected to vary significantly in the future.

4.2.3 Indigenous and cultural requirements for water

Access to, and use of, water from prescribed water resources by Aboriginal people is exempt from licensing for the purpose of social, cultural or spiritual use, provided that the taking does not involve stopping, impeding or diverting the flow of water for the purpose of collecting the water or diverting the flow of water from water resources.

The current and future Aboriginal needs for water have not been identified or quantified at this time. The traditional owners of the land that is now the Padthaway PWA are the Potaruwutj people. Representatives of all traditional owners in the South East region are working closely with the South East Natural Resource Management Board through the South East Indigenous Focus Group to identify and quantify these needs.

4.2.4 Environmental needs

Environmental water requirements are a relatively new area of scientific research and for the purpose of this Plan are described in terms of water table elevation and underground water quality rather than volumes. The future needs of the environment are expected to remain the same as present needs.

A re-evaluation of the volume of underground water that can be extracted sustainably by metered underground water users was undertaken during the 2001 water allocation plan review to ensure water was allocated at a sustainable rate in order to protect the long-term viability of underground water resources within the Padthaway PWA. This is further described in section 4.3.1 below.

Table 4.1. Summary of Padthaway PWA unconfined aquifer underground water allocations and usage for irrigation years 2005/06 and 2006/07

Management Area	Padthaway Flats*	Padthaway Range**	Total for Prescribed Wells Area
No. of licences	97	19	116
Total area-based allocations (haIEs)	5,650	273	5,923
Conversion of area-based allocations to ML[1]	83,721	2,825	86,546
Holding allocations (ML)	56	0	56
Public water supply (ML)	0	20	20
Aquaculture (ML)	0	0	0
Industrial (ML)	50	0	50
Recreational (ML)	27	10	37
Total indicative allocations (ML)	83,854	2,855	86,709
Irrigation use[2] 2004/05 (ML)	32,676	839	33,515
Irrigation use[3] 2005/06 (ML)	39,577	1,163	40,740
Reserve allocation (ML)	0	0	0

* Formerly management areas 1,2 & 3.
** Formerly management area 4.
[1] Calculated by applying DWLBC's 2006 volumetric conversion model to haIE (area-based) allocations.
[2] Estimated from Annual Water Use Reports for the 2004/05 water use year.
[3] Estimated from Annual Water Use Reports for the 2005/06 water use year.

4.3 Capacity of the resource to meet demands

4.3.1 Unconfined aquifer

Until the adoption of this water allocation plan, licenced underground water extracted in the Padthaway PWA was allocated on an area basis rather than by volume of water applied. This allocation system managed irrigation extraction by controlling the area of crops grown. The irrigation area could not exceed the equivalent value of the Irrigation Equivalents (IE) endorsed on the water licence. However under this system it was difficult to accurately determine levels of extraction from the resource to identify and manage areas with sustainability problems.

Several major water resource projects were conducted during the review of the 2001 water allocation plan and have been integrated to develop a volumetric conversion model that allows a more realistic representation of the true level of development of underground water resources in the region.

The reissuing of existing area-based water licences as licences with volumetric allocation has commenced with the adoption of this water allocation plan.

Padthaway Flats

A review of the condition of the region's unconfined aquifer found that the potential demand on the unconfined aquifer exceeded the capacity of the resource and is insufficient to meet demand on a continuing basis.

The results showed that the Padthaway Flats are over-allocated and in some sub-areas (formerly management area 2) are over-extracted.

Underground water salinity in the Padthaway PWA is generally considered to be within the accepted limits for livestock. However the rising salinity may potentially impact on crop yields. The salinity of the underground water from the unconfined aquifer in some parts of the Padthaway Flats already exceeds the recommended threshold for grape vines (1500 mg/L).

Whilst the potential impacts of salt accumulation beneath different irrigation activities on the Padthaway Flats are still to be quantified, maintaining the lateral inflow of fresh underground water from the Padthaway Range is crucial for ensuring the long-term sustainability of irrigation development in this area.

Padthaway Range

The results showed that the current allocation in the Padthaway Range is within the capacity of the resource. Nevertheless, a salt accession project carried out by DWLBC has indicated that maintaining the current levels of recharge in this area is essential to ensuring the flow of fresher underground water towards the Padthaway Flats.

A number of activities have the potential to affect the current levels of recharge in the Padthaway Ranges, including an increase in the current levels of water allocation and extraction. As a result, the Plan provides for no further allocation of underground water from this management area for the life of the Plan. In addition, recent studies in the Lower South East have allowed the quantification of the effects of land use change on the water balance due to afforestation activities. Plantation forestry has been regulated as a significant water-affecting activity in the Lower South East and the potential impact of afforestation in the Upper South East is currently being considered.

Acceptable Level of Extraction

As a result of several underground water resource science and management projects undertaken over the last 5 years, new methodologies were developed for estimating the volume of underground water that can be extracted sustainably by licenced underground water users from the unconfined aquifer at a management area scale. A numerical underground water flow and salt transport model was the ultimate output of these projects, which has determined a new variable called Acceptable Level of Extraction (ALE) (Table 4.2). The current ALE for the Padthaway PWA has been estimated to be 48,000 ML/year, significantly lower than the 86,709 ML/year that would be required to irrigate the area currently allocated on licences in Padthaway. As a result, the Plan sets out principles to ensure volumetric allocations are reduced to this value during the life of the water allocation plan by issuing allocations to a total of 55,096 ML/year at date of adoption, followed by a further reduction to the Acceptable Level of Extraction in the fifth operational year of the Plan.

Table 4.2 Comparison of the Level of Allocation and the Acceptable Level of Extraction for the Padthaway PWA

Indicative volumetric allocations following volumetric conversion	86,709 ML/year
Licenced Allocation*	55,096 ML/year
Acceptable Level of Extraction**	48,000 ML/year

*Based on indicative allocation at date of adoption.
**Subject to change due to input of additional data to numerical model of underground water and salinity fluxes (PadMod1) developed by DWLBC.

4.3.2 Confined aquifer

The Padthaway PWA overlies parts of the more extensive Fairview and Wirrega confined aquifer management areas.

The confined aquifer is generally absent, or thin (less than 2.5 m in thickness), within much of the Padthaway PWA and therefore the yield is poor and the capacity of the confined aquifer resource is limited. Although there is a potential for licenced extraction from this aquifer it is generally not utilised as a water resource and currently it is only used for stock and domestic use.

4.3.3 Climate change

Climate change presents a significant challenge to South Australia. While the water policy decisions included in this plan were based on the most recent meteorological, hydrological and hydrogeological information and trends, the effects of climate change are not yet clearly understood and therefore predicting the consequences for future water allocation demand is difficult.

Increasing temperatures, low frequency and high intensity rainfall predictions will lead to an increased demand for water and associated increased length of irrigation seasons, potentially placing additional stresses on underground water. Therefore, ongoing monitoring during the life of this water allocation plan and technical investigations will be critical to reviewing the future sustainability of the underground resource.

Projected changes in climatic conditions from modelling results indicate an increase in future annual average temperatures, as well as variations in the seasonal temperature and rainfall across the State. In the south east region climate modelling has indicated a significant variation from the current weather pattern. Predicted changes include a continuation of the increasing temperature trend and an overall decreasing annual rainfall trend, most significantly occurring in the spring. Annual decreases in rainfall of up to 15% are predicted for 2030 and up to 60% by 2070.

The close relationship between climate and underground water levels in the unconfined aquifer will, in turn, continue to have a negative impact on the underground water resources in the Padthaway PWA.

It is critical that water policy decision makers apply precaution with effective risk and adaptive management and planning. Management may lead to a change in planting seasons for annual crops to adjust and utilise the change in rainfall pattern. There may also be a demand for alternative crops to suit the climatic conditions. The requirements will be resistance to disease, heat tolerance and lower water use. The intense rainfall events may assist in leaching salt loads from the crop root zones, which will be a benefit to irrigated crops where increasing salt loads from irrigated soils may become an issue.

Future changes in climate can be incorporated into modelling scenarios using the numerical model of underground water and salinity flows in the Padthaway PWA. This will allow the Acceptable Level of Extraction to be updated and allocations to be adjusted accordingly, in order to protect the resource from detrimental impacts.

This plan follows a precautionary approach in its aquifer response management of the underground water resource for which it is responsible. It provides for the collection of the most recent monitoring data, and adopts the most current scientific reasoning with the aid of numeric models and assessment tools to weigh up and balance the uncertainties associated with this data in a manner consistent with the objectives of the Act.

Management decisions are taken bearing such uncertainties in mind and in a manner which strives to minimise the risk of long-term adverse effects on the underground resource rather than delaying decisions until all necessary data are available.

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Section 5 - Definitions and Abbreviations

Any terms used in this Plan that are defined in the *Natural Resources Management Act 2004* (the Act) have the definitions set out in that Act. In addition, for the purposes of this water allocation plan the following terms have the definitions set out below:

ñ**Acceptable Level of Extraction (ALE)**ò means the maximum volume of water that can be sustainably allocated from the unconfined aquifer on a yearly basis and is based on the maximum volume that can be extracted from the unconfined aquifer in the Padthaway PWA such that resource condition limits for water table depth and lateral throughflow continue to be met. This volume is determined using the PadMod computer model developed for DWLBC and at date of adoption was 48,000 ML/year.

ñ**Adjacent management area**ò includes all management areas that adjoin the management area in which the allocation or licence was initially granted, including those that may lie within an adjoining Prescribed Wells Area.

"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.

"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 1886* 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* ï the land comprising the former community parcel or site shown on the plan.

"Ambient underground water" means the underground water (as that term is defined in the Act) that exists in the relevant aquifer without any impact from artificially drained water.

"Amphipod" means a member of a group of small (approximately 5 cm long) aquatic crustaceans found in fresh, saline and marine environments including underground cave environments.

"Annual allocation" means the sum of the tradeable component, any delivery supplement and any specialised production requirements with the exception of water for frost control for grapevines. Annual allocation does not include bridging volumes, carry-overs or additional water transferred in temporarily.

"Annual water use report" means a report produced by a licensee and submitted to the Department of Water, Land and Biodiversity Conservation, Mount Gambier office, by 5pm 31 July each year, in accordance with section 11 (*Monitoring*) of this Plan.

ñ**Aquaculture"** means the farming of aquatic organisms of any species, including their reproductive products and body parts, for the purposes of business or research, but does not include an activity declared by regulation not to be aquaculture (for the purposes of the *Aquaculture Act 2001*).

ñ**Aquifer"** means a formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield economical quantities of water to wells and springs.

"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.

"Aquitard" means a saturated but poorly permeable bed, formation, or group of formations that does not yield water freely to a well or a spring. An aquitard may transmit appreciable water to or from adjacent aquifers.

ñ**Bridging Volume**ò is a temporary allowance which is granted to all licensees in the first and second operational years of this Plan.

ñ**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.

"Dam" means an excavation, wall or other structure designed to hold water diverted or pumped from a watercourse, a drainage path, an aquifer or from another source and includes clay pits.

"Date of adoption" means the date that the Minister adopts this Plan. Also known as ñadoption dateò

"Delivery supplementò means the volume of water in addition to the tradeable component that eligible flood irrigators are allowed to extract from the aquifer, and which is assumed to return to the aquifer.

ñ**Domestic water use**ò means the taking of water for ordinary household purposes; includes the watering of land in conjunction with a dwelling not exceeding 0.4 hectares.

"Draw down" means the occasional, seasonal or permanent lowering of the water table or reduction in potentiometric level of an aquifer resulting from the extraction of underground water.

"Ecosystem" means the term used to describe species in an environment and their relationship with one another and the non-living (abiotic) community.

"Ecosystem dependent on underground water" means an ecosystem that relies either wholly or partially on underground water to sustain them for some portion of the year.

"Ecosystem response function" means the fundamental characteristic of ecosystems related to conditions and process necessary for maintaining ecosystem integrity, which implies intact abiotic components (e.g. soils and water), biodiversity and reliance to natural successional cycles (e.g. fire, flooding, predation). Ecosystem function will include such processes as decomposition, nutrient cycling and production. It is generally considered that maintenance of biodiversity is integral to ecosystem function. The term is sometimes used interchangeably with ecosystem condition.

ñ**Environmental water provision**ò means that part of environmental water requirements that can be met; what can be provided at a particular time after consideration of existing usersôrights, and social and economic impacts.

ñ**Environmental water requirement"** means the water regime needed to sustain the ecological values of aquatic ecosystems, including their processes and biological diversity, at a low level of risk.

"Extenuating 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.

"Farm" means a place being used solely or predominantly for the business of agriculture, pasturage, horticulture, viticulture, animal farming or any other business consisting of the cultivation of soils, the gathering in of crops or the rearing of livestock.

"Flood irrigation" (also known as lasered flood; surface; border-check) 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.

"Hectare irrigation equivalent (halE)" means the quantity of irrigation water (in addition to rainfall) required to equal the water use from one hectare of a reference crop (usually pasture) grown in the region. Conversion factors have been calculated to allow the growth of different crops based on the same quantity of water. Area-based allocations are expressed in hectare irrigation equivalents.

"Imported water" means water which has been brought into a management area from another 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 Act, or the G*roundwater (Border Agreement) Act 1985* from the originating management area or zones within the Designated Area. Imported water excludes water that would have, prior to diversion, formed part of the water balance of the prescribed resource.

"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 obtaining, dressing or treatment of materials.

"Irrigation system type" means the specific type of irrigation system used to irrigate, for example flood irrigation, drip irrigation (sub-surface drip; micro-sprinklers; trickle; micro-jet) or spray irrigation (pivots ï mobile, fixed, lateral move; sprinklers ï overhead, under-tree, pop-up, fixed, portable; travellers ï water winch, wheel line, mobile gun/spray).

ñ**Karst feature"** means a cavity or cave formed by the dissolution of limestone by naturally occurring acids.

"Licensee" means a person or entity who holds a water licence pursuant to section 146 of the Act.

"Limited extraction zone" means the 800 m wide area centred along the entire length of the boundary between the Padthaway Flats and the Padthaway Range management areas.

"Management area" means the following management areas for the unconfined aquifer and confined aquifers as follows:

a) for the unconfined aquifer, the part of the PWA as shown in Figure 4 (Appendix of Figures and Tables); and
b) for the confined aquifer, the part of the PWA shown in Figure 5 (Appendix of Figures and Tables).

"Maximum production pasture" means a system where forage (pasture) is being managed to maximise feed quality and optimise productivity. The pasture is maintained in optimal growing conditions.

"Pollution" includes any solid, liquid, gas or thermal influence (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. It may also be referred to as the ñpotentiometric surfaceòor the ñpotentiometric headò

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

"Recharge rate" means the volume of water that replenishes groundwater via infiltration or percolation of water to an aquifer.

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

"Recreational use" means the use of water for the irrigation of parks, gardens and sports grounds of greater than 0.4 hectares in area, whether publicly or privately owned.

"Reserved water" means water reserved by notice published in the South Australian Government Gazette under section 166 of the Act.

ñ**Resource condition limits"** means for the Padthaway PWA a minimum water table depth of that at June 2004, no changes to underground water salinity values at date of adoption and continued lateral underground water throughflow through the PWA.

"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 the proprietors are, a member or members of the same family. For the purpose of this definition, ñsame familyòincludes 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.

ñ**Specialised production requirements (SPRs)**ò means the water required for crop production in addition to crop water use and delivery volumes. This may include activities such as frost protection for vines, drift control for potatoes and maximum production pasture.

"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.

ñ**Stock water use**ò means the taking of water to provide drinking water for stock other than stock subject to intensive farming (as defined by the Act).

"Three year rolling average" means for the purpose of managing specialised production requirements in the form of water for frost control of grapevines that within any water use year the allocation available for extraction for that purpose will be no greater than the sum of the special production allocation for that year, plus the allocation for that purpose for the next two consecutive years and in any 3 year period, the maximum volume that can be extracted cannot exceed three times the special production allocation.

"Tradeable component" means that portion of a water allocation permissible for trade. The tradeable component of a water (taking) allocation is the volume allocated on the licence, minus any delivery supplement, special production requirements, carry-overs and/or bridging volumes. The tradeable component of a water (holding) allocation means the entire volume expressed on the water (holding) allocation licence.

"Unconfined aquifer" means the saturated sequence of rocks within the Padthaway PWA 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.

"Underground water" means ï

a) Water occurring naturally below ground level;
b) Water pumped, diverted or released into a well for storage underground.

"Underground water access trench" means a shallow trench of up to 2.5 m in depth, excavated into the aquifer with the purpose of providing direct access to underground water for stock watering or other purposes.

"Underground Water Dependent Ecosystem" see ñEcosystem dependent on underground waterò

"Water table" means the upper surface of saturation in the unconfined aquifer.

"Water use year" means a period of 12 months commencing on the 1 July in any year and ending 30 June of the following 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.

Abbreviations

The following abbreviations shall have the meanings set out below.

"the Act" Natural Resources Management Act (2004)

"the Board" South East Natural Resources Management Board

"DWLBC" Department of Water, Land and Biodiversity Conservation

"DEH" Department for Environment and Heritage

"PWA" Prescribed Wells Area

"the/this Plan" the Water Allocation Plan for the Padthaway Prescribed Wells Area

"the Minister" the Minister to whom administration of the *Natural Resources Management Act 2004* is committed

Measurements

halE	hectare irrigation equivalents
km^2	square kilometre(s)
m	metre(s)
mg/L	milligram(s) per litre
ML	megalitre(s)

6. Allocation Criteria – Unconfined Aquifer

6.1 Objectives

a. To manage the underground water resource of the unconfined aquifer so that it may continue to be available for the social, economic and environmental needs of current and future generations.

b. To protect the resource locally, throughout each management area and the entire PWA.

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

d. To maintain and/or improve the availability of underground water to ecosystems dependent on underground water.

e. To protect the environment generally by ensuring that the taking and use of underground water from the unconfined aquifer does not cause significant degradation of any other resource such as soils or other water resources.

f. To provide principles for water management so that water allocations are available to sustain economic development.

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

h. To bring at risk and/or over- allocated management areas back to environmentally sustainable levels of allocation.

i. To provide for the implementation of the volumetric conversion of unconfined aquifer allocations.

6.2 Principles

Limit to total allocation

1. No new water shall be allocated from the unconfined aquifer for the life of this Plan.

2. Notwithstanding principle 1, water from the unconfined aquifer may be allocated during the life of this Plan for the following purposes:

   a) to give effect to the volumetric conversion of existing area-based allocations; or

   b) to give effect to the conversion of a water (taking) allocation to a water (holding) allocation; or

   c) to give effect to the conversion of a water (holding) allocation to a water (taking) allocation; or

   d) to give effect to the temporary or permanent transfer of allocation according to section 7 of the Plan (*Transfer Criteria – Unconfined Aquifer*); or

   e) to give effect to whole of licence transfer where the allocation will continue to be taken and used on the same allotment/s and for the same purposes; or

   f) to give effect to the recalculation of volumetric allocations in existence at date of adoption according to principles 28 and 29; or

   g) to give effect to the allocation of water drained or discharged according to principles 67-71;

h) to give effect to delivery supplements issued in accordance with principles 85-87; or

i) to give effect to bridging volumes in the first and second operational years of this Plan.

Ecosystems dependent on underground water

3. Water shall not be allocated pursuant to principle 2(a)-(i) if to do so may create or may contribute to a significant adverse effect on ecosystems that depend on underground water. Factors that will be considered in assessing the likelihood of significant adverse impacts include, but are not limited to:

   a) the distance of the proposed extraction point from any wetland listed on the Department of Environment and Heritage's South Australian Wetland Inventory Database (SAWID) for the South East of South Australia at the date of application, as a wetland of high or very high conservation value, determined by whether a 16 km^2 (2.25 km radius) circle centred on the proposed point of taking of the allocation intersects the wetland as mapped in the SAWID; and

   b) whether the wetland identified in principle 3(a) is considered by the Minister to

      i. demonstrate a level of dependence on underground water; and

      ii. be under significant or actual threat of degradation identified by, but not limited to, a mean (arithmetic) decrease in underground water levels of greater than 0.05m/year (measured over the preceding 5 years) in a representative observation well within the 16 km^2 circle specified in principle 3(a) above or, in the absence of any representative wells within the 16 km^2 circle, in the nearest representative well or wells as determined by the Minister.

4. For any underground water dependent ecosystem identified for protection under principle 3, the set-back distance for any new wells shall be calculated using the DE equation described in Section 2 of the Plan (*Assessment of the needs of water dependent ecosystems).* Also taken into account shall be the current demand for underground water determined by the level of allocation within the management area and the volume of water proposed to be taken.

Basis of allocation

5. Water shall be allocated by volume.

Volumetric conversion of allocations expressed in hectare irrigation equivalents

6. Allocations presently expressed in hectare irrigation equivalents (haIE) shall be converted to a volume, in accordance with principles 7 to 27.

7. The allocation of water for irrigation purposes shall not exceed a volume determined as indicated in principles 8 to 29.

8. Water (holding) allocations endorsed as haIE shall be issued at a volume of 3.95 ML per each haIE.

9. The portion of a water (taking) allocation endorsed as haIE determined to be used for irrigation for the purposes of principle 10, shall be calculated based on the greatest area reported as under irrigation for the 2005-06 and 2006-07 water use years based on the licensee's Annual Water Use Reports, unless the Minister, having regard to relevant and verifiable information, considers that the Annual Water Use Reports materially underestimate the greatest area under irrigation in these years, in which case the Minister may determine that area according to that relevant and verifiable information. For the avoidance of doubt, a statutory declaration or sworn statement shall not amount to "relevant and verifiable" information for these purposes.

10. The irrigated area shall be allocated a volume based on the lesser of:

a) the average volume for the irrigation system type (drip, spray or flood) in place at 30 June 2007 (see principle 11); or

b) the average volume pumped by the licensee in the 2004-05 and 2005-06 water use years, as determined from the licenseeôs Annual Water Use Reports for these years, unless the Minister, having regard to relevant and verifiable information, considers that the Annual Water Use Reports materially underestimate the average volume pumped in these years, in which case the Minister must determine that the average volume pumped in these years is equivalent to the average volume of the irrigation system type. For the avoidance of doubt, a statutory declaration or sworn statement shall not amount to "relevant and verifiable" information for these purposes.

11. The average volumes for the irrigation system types are:

    a) for drip: 5.41 ML/haIE

    b) for spray: 5.79 ML/haIE

    c) for flood: 18.24 ML/haIE

12. Notwithstanding principles 10 and 11, the minimum allocation issued shall be 3.95 ML/haIE.

13. If a licensee submitted an Annual Water Use Report for either or both of the 2004-05 and 2005-06 water use years but has not reported a volume pumped, then the average volume pumped shall be deemed to be the average volume of the irrigation system.

14. If a licensee failed to submit an Annual Water Use Report for either or both the 2004-05 or 2005-06 water use year/s, then the allocation for the unreported year/s shall be calculated as 3.95 ML/haIE.

15. Allocations for hectare irrigation equivalents determined not to be under irrigation shall be issued at a volume of 3.95 ML/haIE. The portion of the water (taking) allocation endorsed as hectare irrigation equivalents that was not used for irrigation shall be determined by subtracting the numbers of hectare irrigation equivalents used for irrigation, according to principle 9 from the licenseeôs total haIEs.

16. Where a licensee has failed to submit an Annual Water Use Report for both the 2005-06 and 2006-07 water use years, the licensee will be assumed to have carried out no irrigation for the purposes of principle 9.

Tradeable component

17. The tradeable component of water allocations issued under principles 8, 12, 14 and 15 shall be 3.95 ML/haIE.

18. The tradeable component of a water (taking) allocation allocated according to principles 10,11 or 13 for the purpose of drip or spray irrigation, shall be the whole of the volume calculated.

19. The tradeable component of a water (taking) allocation allocated according to principles 10, 11 or 13 for the purpose of flood irrigation, shall be 5.79 ML/haIE.

Delivery Supplement

20. Delivery supplements will be issued for the purposes of flood irrigation and will only be issued in the following circumstances:

    a) upon volumetric conversion of existing area-based licences and based on the portion of water (taking) allocation endorsed as hectare irrigation equivalents under flood irrigation at 30 June 2006 or 30 June 2007, whichever is the greatest area;

    b) as the result of a whole of licence transfer and where the delivery supplement will continue to be used for the same purpose and on the same allotment/s.

21. Delivery supplements will be calculated by subtracting the tradeable component of 5.79 ML/haIE from the allocation calculated according to principles 10, 11 and 13.

22. The delivery supplement shall be allocated on a temporary basis until 30 June 2014 and subject to review will be reissued at a volume lesser than or equal to the volume allocated at date of adoption.

23. Where a licence is endorsed with a delivery supplement for flood irrigation, a licensee shall not use that delivery supplement for a different irrigation method.

24. The conversion of all or part of an existing flood irrigation system to a different irrigation system type, requires the licensee to notify the Minister in writing prior to applying any water through the different system so that the delivery supplement can be adjusted or removed.

Specialised Production Requirements

25. A licensee may receive a volume known as specialised production requirements, subject to principle 25 (a)-(f) below:

    a) the licensee must make application by 5 pm on the nearest business day following six months after date of adoption. Applications will not be considered if received after this date;

    b) the application must be for specified areas of the eligible crops for the additional volume of water listed in Table 1 (Appendix of Figures and Tables);

    c) the licensee can demonstrate that they have grown one or more of the eligible crops during at least one of the 2002/03, 2003/04 or 2004/05 water use years (on the basis of Annual Water Use Reports supplied by the licensee) and that the crop is, or the crops are, the subject of the application for a specialised production requirements allocation; and can demonstrate:

        i. for grapevines, that infrastructure in the form of an overhead spray system for frost protection of grapevines was in place prior to 1 July 2005 or a significant financial commitment was made prior to that date for the installation of an overhead spray system for frost protection of grapevines and, where separate frost control infrastructure has been installed, a separate meter has been installed to measure this allocation by date of application; or

        ii. for fruit trees, that infrastructure in the form of a spray system for crop cooling of fruit trees was in place prior to 1 July 2005 or a significant financial commitment was made prior to 1 July 2005 for the installation of infrastructure for these purposes; or

        iii. for maximum production pasture, that the pasture management system, irrigation system, irrigation management system, pasture species and stock and pasture productivity meet the requirements of maximum production pasture; or

        iv. for potatoes, onions and subterranean clover seed, that the crop was grown under irrigation.

    d) the allocation shall not exceed an amount calculated by multiplying the average area of the eligible crop grown in the 2002/03 and 2003/04 and 2004/05 water use years by the extra ML/ha required (as set out in Table 1, Appendix of Figures and Tables). In the case of maximum production pasture, the irrigation system type shall also be considered;

    e) where an allocation is endorsed with a specialised production requirements volume relating to a particular crop and purpose, a licensee may not use that volume for a different crop or purpose;

    f) a specialised production requirements allocation shall be allocated on a temporary basis until 30 June 5 years after date of adoption and subject to review will be reissued at a value either less than or equal to the value issued at date of adoption;

26. In the case of specialised production requirements in the form of water for frost control for grapevines, water can only be extracted between 1 July and 30 November in each water use year.

Bridging Volumes

27. In the first and second operational years of this Plan, all licensees will receive a temporary allocation known as a bridging volume, subject to:

    a) the allocation granted as a bridging volume will be a volume equal to 10% of the sum of the licenseeôs tradeable component and any delivery supplement;

    b) all bridging volumes shall expire 30 June of the second operational year of this Plan; and

    c) unused bridging volumes may not be carried over into the following water use year.

Volumetric allocations granted prior to date of adoption

28. Existing licences at the date of adoption endorsed with a volumetric allocation will not be recalculated, with the exception of licences with allocations for recreational purposes granted as a volume based only on the net irrigation requirement for the reference crop, with no allowance for delivery losses.

29. Licences endorsed with allocations as described in principle 28 shall be allocated an additional 18% of volume.

Seasonal variability – carry-over and temporary trading

30. Licences endorsed with a water (taking) allocation will be granted access to water in addition to their annual allocation, and subject to the licensee having submitted an Annual Water Use Report for the preceding water use year by the required date, where:

    a) at the end of any water use year a licensee has not used all of their annual allocation, the licensee may apply to carry over a volume of unused annual allocation corresponding to a maximum of 20% of the licenseeôs annual allocation, into the following water use year; and/or

    b) a licensee has applied to temporarily transfer water according to principles 85 to 87 (*Temporary transfers to manage seasonal variability*).

31. With the exception of water for frost control for grapevines, the total amount of water available for use in any one water use year will not exceed 140% of the licenseeôs annual allocation composed, respectively, of the sum of:

    a) the licenseeôs annual allocation;

    b) a maximum carry-over of 20% of the licenseeôs annual allocation; and

    c) any volume temporarily transferred in and corresponding to a maximum of 20% of the licenseeôs annual allocation in accordance with principles 85 to 87 (*Temporary transfers to manage seasonal variability*).

32. With the exception of water for frost control for grapevines, the deemed order of use of each of these components in the water use year is the following:

    a) carry over;

    b) temporary trade portion;

    c) the licenseeôs annual allocation;

    d) bridging volume.

33. In the case of specialised production requirements in the form of water for frost control for grapevines, this volume will be managed on a three-year rolling average.

34. Where a licensee does not have a separate meter to account for the volume of water extracted for specialised production requirements in the form of water for frost control for grapevines, any water extracted through the meter between 1 July and 30 November in any year shall be considered to be water extracted for that purpose. Any water extracted between 1 December and 30 June in the water use year shall be considered to be use of the licenseeôs annual allocation.

35. For the purposes of principles 30 to 34, annual allocation comprises the sum of the tradeable component, and any delivery supplement and any specialised production requirements with the exception of water for frost control for grapevines, but not carry-overs, bridging volumes or additional water transferred in temporarily under principles 85 to 87 (*Temporary transfers to manage seasonal variability)*.

Water (holding) allocations

36. Following the date of adoption, water (holding) allocations shall be endorsed on a licence only:

    a) where a water (holding) allocation is already endorsed on a licence at the date of adoption; or

    b) where a water (taking) allocation is converted to a water (holding) allocation at the request of the licensee.

Conversion of a water (holding) allocation to a water (taking) allocation

37. A water (holding) allocation may be converted to a tradeable component of a water (taking) allocation of the same volume.

38. The conversion of a water (holding) allocation to a tradeable component of a water (taking) allocation within the same management area, is subject to principles 44 to 51 (*Hydrogeological effects and assessment*) and principles 3 and 4 (*Ecosystems dependent on underground water).*

39. The conversion of a water (holding) allocation from one management area to a tradeable component of a water (taking) allocation in another management area, is subject to principles 44 to 51 *(Hydrogeological effects and assessment),* principles 3 and 4 (*Ecosystems dependent on underground water)* and to the transfer principles set out in section 7 of this Plan.

40. A licensee with a water (taking) allocation resulting from the conversion of a water (holding) allocation is not eligible to apply for a delivery supplement, bridging volume or special production requirements.

Conversion of a water (taking) allocation to a water (holding) allocation

41. In the case of the conversion of a water (taking) allocation to a water (holding) allocation, the volume corresponding to the tradeable component of the water (taking) allocation will be endorsed as the water (holding) allocation, but any specialised production requirements, bridging volumes, seasonal carry-overs or delivery supplements shall be forfeited to the Minister.

42. The conversion of a water (holding) allocation according to principle 41 back to a tradeable component of a water (taking) allocation, will be subject to principles 37 to 40 (*Conversion of a water (holding) allocation to a water (taking) allocation*) as well as any relevant changes in access to allocations or reductions in allocations since the date of conversion to a water (holding) allocation.

Returned water

43. Where all or part of a water allocation endorsed on a licence is surrendered or otherwise forfeited to the Minister, that water will not be available for allocation.

Hydrogeological effects and assessment

44. The allocation of water for all purposes other than industry, energy generation and public water supply, shall comply with the 16 km^2 circle test. In addition, no allocation shall be made which appears to have potential to cause:

    a) one or more of the following underground water resource condition triggers to be exceeded:

        i. a mean (arithmetic) increase in salinity of the underground water resource of greater than 1% per annum (measured over the preceding 5 years) in any representative observation well within a 16 km^2 circle (2.25 km radius) centred over the point of taking or, in the absence of any representative wells within the 16 km^2 circle, in a representative observation well or wells as determined by the Minister; or

        ii. a mean (arithmetic) decrease in underground water levels of greater than 0.1 m per annum (measured over the preceding 5 years) in any representative observation well within a 16 km^2 circle centred over the point of use or, in the absence of any representative wells within the 16 km^2 circle (2.25 km radius), in a representative well or wells as determined by the Minister;

    b) a significant adverse effect on the structural integrity of the aquifer;

    c) a significant adverse effect on any other water resource, either within or beyond the PWA;

    d) a significant adverse effect on ecosystems dependent on underground water, by contravening principle 44(a)(ii) and principles 3 and 4 (*Ecosystems dependent on underground water).*

Hydrogeological assessment for allocations resulting from temporary transfers to manage seasonal variability

45. The granting of a water allocation resulting from the temporary transfer of allocation for the purposes of managing seasonal variability according to principles 85 to 87 is exempt from principle 44.

The 16 km^2 circle test

46. The ñ16 km^2 circle testò requires that the granting of a water (taking) allocation shall not cause the total volume of water which may be used within a circle of 16 km^2 area to exceed 1.25 times the amount of annual average vertical recharge for the management area.

47. For the purposes of principle 46, the total volume of water which may be used comprises the sum of the tradeable component and any specialised production requirements, but not delivery supplements, carry-overs or additional water transferred in temporarily under principles 85 to 87 (*Temporary transfers to manage seasonal variability)*.

48. The 16 km^2 circle shall be centred on the specified point of taking or, where not specified, on the centremost point of the nominated allotment. Where the point of taking is not specified, the well shall be constructed within a 1 kilometre radius of the centremost point of the nominated allotment.

49. The annual average vertical recharge rate for a management area is calculated using the amount of annual average vertical recharge rate set out in Table 2 (Appendix of Figures and Tables) for the relevant management area multiplied by the area within the 16 km^2 circle less the area occupied by bodies of water or native vegetation.

Hydrogeological assessment for irrigation of rotational crops for a period equal or less than 12 months

50. For the purpose of irrigating a rotational crop for a period equal to or less than one water use year, the ñ16 km^2 circle testò requires that the granting of a water (taking) allocation shall not cause the total volume of underground water (minus any delivery supplements) extracted within the 16 km^2 circle during the water use year prior to the application, to exceed 1.25 times the amount of annual average vertical recharge for that management area.

Hydrogeological assessment for allocation for the purposes of industry, energy or public water supply

51. The taking of water for industry, energy generation or public water supply shall not adversely affect:

a) the quality of water in the unconfined aquifer by (including, but not limited to) having the potential to cause or contribute to an increase in salinity in excess of the rate specified in principle 44(a)(i);

b) the water level of the unconfined aquifer by having the potential to cause or contribute to a long term decline in underground water levels at the point of taking and in the nearest observation wells exceeding 0.1 m/year after 3 years from the start of taking; or

c) the structural integrity of the aquifer, or have the potential to adversely affect the structural integrity of the aquifer.

Purpose of use

52. Water shall not be taken for the purposes of wild flooding.

53. Water shall not be taken for the purpose of aquaculture unless:

a) the volume of tail water produced for disposal will not exceed an amount reasonably produced according to current best industry practice (current at the time of assessment of the application) as determined by the Minister; and

b) the disposal of tail water will not result in an increase (above seasonal fluctuations) in underground water levels in the unconfined aquifer or the potentiometric pressure in the 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; and

c) disposal of tail water will not result in an accelerated increase in salinity or pollution of either aquifer, 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 either aquifer.

Quantity of allocation

54. Where an allocation is granted 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

55. Water shall be used and applied using water efficient technologies and techniques appropriate for the particular purpose and circumstances for which the water is to be used in accordance with industry best practice standards, as determined by the Minister.

Piping of water for a distance greater than 2 km

56. With the exception of public water supply, where water is to be taken from one point and transported by pipe or other enclosed means to be used at another point at least 2 km from the point of taking, both the taking and use of water shall comply with principles 44 to 51 (*Hydrogeological effects and assessment)*. The 16 km^2 circle test shall only apply at the point of taking.

Imported water

57. Water may not be imported from the Padthaway Range management area into the Padthaway Flats.

58. Where water has been brought into a management area from across a management area or PWA boundary by means of a pipe or other channel at a rate that exceeds 1 megalitre/year, its use must comply with Section 10.6 (*Importation of water*).

Divided allotments and allotments held in adjacent management areas

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

    a) the taking and use of water complies with principles 44 to 51 (*Hydrogeological effects and assessment*) & principles 3 and 4 (*Ecosystems dependent on underground water*);

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

    c) an allocation from outside the Padthaway PWA is not taken in the Padthaway PWA, unless it was being extracted within the Padthaway PWA, prior to the adoption date of this Plan;

    d) the allocation remains referenced to, and accounted for, in the originating management area and PWA; and

    e) the allocation will not be available for further transfer within the receiving management area or PWA under this principle.

Endorsement of Certificates of Title on licences

60. On or after the date of adoption, a licence endorsed with a water (taking) allocation may not be varied to enable the water to be used on additional allotments, unless the subject land is owned by the applicant, or an application to do so is accompanied by a legally binding agreement between the licensee and the registered proprietor of the land. Upon expiration of the legally binding agreement, the Certificate of Title shall be removed from the water licence.

61. An additional allotment may only be endorsed on a licence where the licensee is able to physically extract and use the allocation endorsed on the water licence on the relevant allotment and is not prevented from doing so by the presence of, for example, but not limited to, native vegetation, plantations, roadways or structures.

62. Allotments endorsed on licences prior to the date of adoption, where the licensee is not the registered proprietor of the land or does not have legal access to the land, may only remain endorsed on the licence if the registered proprietor of the land provides evidence of his or her

written permission in the form of a statutory declaration to DWLBC by 5 pm on the nearest business day following 6 months after date of adoption of the plan.

Rotational crops

63. Variations of a water licence for the purposes of irrigating a rotational crop must comply with principles 44 to 51 (*Hydrogeological effects and assessment*) and principles 3 and 4 (*Ecosystems dependent on underground water*).

64. An allocation of water from the Padthaway Flats may be taken from the Padthaway Range or a management area outside the Padthaway PWA to irrigate a rotational crop for a maximum period of 5 years.

65. An allocation of water from the Padthaway Range may be taken from the Padthaway Flats or a management area outside the Padthaway PWA to irrigate a rotational crop for a maximum period of 5 years.

Addressing overallocation

66. If at 5 years from date of adoption, the Padthaway PWA remains over-allocated with respect to the Acceptable Level of Extraction (see Table 2, Appendix of Figures and Tables), all components of allocations (ie tradable components and/or delivery supplements and/or specialised production requirements) with the exception of those for public water supply, industrial or recreational purposes in the PWA, will be reduced proportionally by 1 July 2014, such that the total allocation in the PWA equals the Acceptable Level of Extraction.

Basis of Allocation of Water Drained or Discharged

67. Water that is drained or discharged into a well will not be available for allocation where it is considered that it would have contributed to the natural vertical recharge of the unconfined or confined aquifer systems.

68. Water that is drained or discharged into a well consistent with a permit granted under Section 127(3)(c) of the Act will only be available for allocation where:

    a) the drainage or discharge has been metered and a meter reading has been taken by the Minister; and either

        i. the water has been taken under a licence issued under the provisions of the Act and treated by a desalination plant; or

        ii. the water has been imported for the purposes of drainage or discharge and discharge into a well and has been taken and used under a licence issued under the provisions of the Act.

69. An allocation of water drained or discharged into a well must be taken and used within a period of three years calculated from 1 July in the year in which the water was drained or discharged.

70. An allocation of water drained or discharged into a well shall only be taken from the original well of drainage or discharge of the imported water to the aquifer, or from a well within a radius of 500 metres of the original well.

71. Subject to principles 67 to 70, a maximum of 100% of the volume of any water drained or discharged into a well in the Padthaway PWA under a permit granted pursuant to section 127 (3) (c) of the Act may be allocated to the permit holder.

7 - Transfer Criteria – Unconfined Aquifer

7.1 Objectives

a. To manage the underground water resource of the unconfined aquifer so that it may continue to be available for the social, economic and environmental needs of current and future generations.

b. To protect the environment generally by ensuring that the taking and use of underground water from the unconfined aquifer does not cause significant degradation of any other resources such as soils and other water resources.

c. To maintain and/or improve the availability of underground water to ecosystems dependent on underground water.

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

e. To minimise constraints on transfers of water allocations so that these are available to sustain economic development.

f. To promote the active and efficient use of water to drive best practice water use.

g. To ensure that allocations resulting from transfers remain within the sustainable limits of the unconfined aquifer in the relevant management area.

h. To provide for the transfer of volumetric allocations from the unconfined aquifer.

7.2 Principles

Transfers of allocations

72. All transfers of water (holding) allocations and water (taking) allocations are subject to the allocation principles set out in section 6 of the Plan.

73. Allocations from the unconfined aquifer may not be transferred to the confined aquifer.

74. A licence endorsed with a water (holding) allocation or a water (taking) allocation or the whole or a part of a water (holding) allocation or a water (taking) allocation, may be:

    a) temporarily or permanently transferred within the same management area; or

    b) permanently transferred from the Padthaway PWA into an under-allocated management area outside the Padthaway PWA; or

    c) temporarily transferred for a maximum of 5 years from the Padthaway PWA into an adjacent under-allocated management area outside the Padthaway PWA.

75. For the purposes of principle 74(c), ñadjacent management areaò includes all management areas that adjoin the management area from which the allocation or licence was initially granted.

76. No allocations may be transferred into the Padthaway Range management area.

77. No allocations may be transferred into the Padthaway Flats management area.

78. Water transferred temporarily into another management area will not be available for subsequent transfer into other adjacent management areas.

79. In the case of a temporary transfer, the allocation shall be accounted for in both the originating and receiving management areas.

80. A delivery supplement associated with a tradeable component shall be surrendered upon transfer and shall be reissued as a temporary allocation only where the tradeable component will continue to be used for the purposes of flood irrigation.

81. Special production requirements, seasonal carry-overs and/or bridging volumes may not be transferred, except where the licence or allocation is transferred in its entirety and is to be taken and used on the same allotment or allotments for the same purpose.

82. Where a part of an allocation is transferred, any delivery supplement and/or specialised production requirements and/or bridging volume for the remaining allocation not transferred will be reduced proportionately.

83. Taking and use shall be consistent with the relevant water allocation plan for the receiving management area.

84. Upon expiry of any temporary transfer period, the corresponding land parcel or allotment shall be removed from the licence.

Temporary transfers to manage seasonal variability

85. Licensees with a water (taking) allocation used for the purpose of irrigation are eligible to apply for the transfer of additional water for the purpose of managing seasonal variability, as follows:

    a) in three of every five consecutive years from date of adoption, a licensee can apply to temporarily transfer in a tradeable component unused in the current water use year from another licensee within the same management area, to a maximum volume of 20% of the transferee's annual allocation, but only for the current water use year;

    b) water transferred in under principle 85 a) is exempt from principles 44 to 51 (*Hydrogeological effects and assessment*) and principles 3 and 4 (*Ecosystems dependent on underground water);*

    c) any delivery supplement associated with a tradeable component unused in the current water use year and transferred according to principle 85a) will be forfeited temporarily to the Minister, and will be issued to the transferee temporarily at a volume not exceeding the volume forfeited and only where it will continue to be used for the purposes of flood irrigation.

86. For the purposes of principle 85 a), annual allocation comprises the sum of the tradeable component and any specialised production requirements with the exception of water for frost control for vines, but does not include delivery supplements, carry-overs, bridging volumes or additional water transferred in temporarily.

87. Temporary transfers for the purpose of managing seasonal variation shall expire at the end of the water use year in which the transfer was made and the corresponding land parcel or allotment shall be removed from the licence.

Endorsement of Certificates of Title on licences

88. For the purposes of the transfer of a water (taking) allocation, the relevant allotment shall only be endorsed on a water licence where:

    a) The subject land is owned by the applicant, or an application to do so is accompanied by a legally binding agreement between the licensee and the registered proprietor of the land. Upon expiration of the legally binding agreement, the Certificate of Title shall be removed from the water licence; and

    b) the licensee is able to physically extract and use the allocation endorsed on the water licence on the allotment and is not prevented from doing so by the presence of, for example, but not limited to, native vegetation, plantations, roadways or structures.

Applications to transfer water allocated from aquifer storage and recovery schemes

89. Water drained and discharged (as defined in principles 67 to 71) may only be transferred where the water will continue to be taken from the same point of extraction or the proposed well of extraction is within a 500 metre radius of the point where the imported water was drained or discharged.

Hydrogeological effects and assessment

90. A transfer application shall be deemed to have complied with the 16 km^2 circle test (as defined in principles 46 to 49) 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.

91. Notwithstanding principle 90, the renewal of any temporary transfer of an allocation which has been in place for 5 years or greater, is subject to principles 44 to 51 (*Hydrogeological effects and assessment*).

92. Notwithstanding principles 90 and 91, in the case of applications for transfer of allocations, where one or more of the resource condition triggers specified in principle 44(a) have been exceeded, the application may be approved subject to the resource condition triggers for both underground water salinity and water table levels at the destination having been exceeded at a lesser rate than at the point of origin, and where approval would not cause the resource condition triggers at the destination to exceed those existing at the origin prior to transfer.

8. Water Allocation Criteria – Confined Aquifer

8.1 Objectives

a. To conservatively manage the confined aquifer, due to it being an ancient resource, with limited recharge.

b. To manage the underground water resource of the confined aquifer so that it may continue to be available for the social, economic and environmental needs of current and future generations.

c. To protect the resource locally, throughout each management area and the entire PWA.

d. 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, including soils and other water resources.

8.2 Principles

Limit to total allocation

93. No water shall be allocated from the confined aquifer during the life of this Plan.

9 - Transfer Criteria – Confined Aquifer

9.1 Objectives

a. To manage the underground water resource of the confined aquifer so that it may continue to be available for the social, economic and environmental needs of current and future generations.

b. 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, including soils and other water resources.

c. To protect ecosystems dependent on underground water.

9.2 Principles

Transfers of water allocations

94. An allocation from the unconfined aquifer may not be transferred to the confined aquifer.

10 - Permits

An activity of the kind listed in this section can only be undertaken if authorised by a permit granted by the relevant authority.

Permits will only be granted if the activity complies with the relevant objectives and principles of this section.

In some cases a permit may not be required for the activities above because the provisions of section 129 of the Act remove the requirement.

Drainage works constructed under the *South Eastern Water Conservation and Drainage Act 1992* and the *Upper South East Dryland Salinity and Flood Management Act 2002* are exempt from requiring a permit under this Plan where they are licensed for under the *South Eastern Water Conservation and Drainage Act 1992* and the *Upper South East Dryland Salinity and Flood Management Act 2002*.

Relevant authority

The **relevant authority** in relation to a permit means the authority that is for the time being the relevant authority under section 126 of the Act for the purpose of granting or refusing the application for a permit of that kind.

10.1 General objectives

The following objectives apply to all water affecting activities within the boundaries of the Padthaway PWA. They are in addition to the objectives set out in the relevant NRM plan.

a) To protect the quantity and quality of the water resources.

b) To maintain natural hydrological systems and environmental flows.

c) To prevent deterioration in the quality of surface water, underground water or water in watercourses or lakes.

d) To protect the ecological functions of water resources and dependent biological diversity.

e) To ensure any water discharged to the environment is of suitable quality to:

   i. sustain the existing uses of the water; and

   ii. protect ecosystems dependent on these resources.

10.2 Well siting, construction and maintenance

A permit is required for the activities of drilling, plugging, backfilling or sealing of a well and for the repairing, replacing or altering of the casing, lining or screen of a well, pursuant to section 127(3)(a) and (b) of the Act, respectively.

The objectives and principles that follow apply specifically to an activity under section 127(3)(a) and (b) of the Act. They are additional to those expressed for all water affecting activities and are intended to apply for wells of a depth equal or greater than 2.5 metres.

10.2.1 Well siting, construction and maintenance - objectives

a) To ensure the drilling, plugging, backfilling or sealing of a well occurs in a manner that will protect the quality of the surface water, underground water resources and underground water dependent ecosystems.

b) To minimise the impact of repair, replacement or alteration of the casing, lining or screen of wells on the surface water, underground water resources and underground water dependent ecosystems.

c) To protect the surface water, underground water resources and water dependent ecosystems from pollution, deterioration and undue depletion.

d) To ensure the integrity of the headworks of wells is maintained.

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

10.2.2 Principles

95. 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 have the potential to adversely impact on the quality of the surface water, underground water resources and underground water dependent ecosystems.

96. 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 impact aquifers, surface water flows and underground water dependent ecosystems.

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

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

99. The headworks of a well for the drainage or discharge of water (artificial recharge) for the purpose of taking and use according to section 6 of this Plan, shall be constructed so that the draining or discharge operations and extraction can be metered without interference.

100. No new wells for the purpose of taking and use of a licenced allocation will be constructed within the limited extraction zone shown in Fig 4 (Appendix of Figures and Tables), with the exception of replacement wells for existing wells. If replacing an existing well, the replacement well shall be constructed no closer to the boundary between the Padthaway Flats and Padthaway Range management areas than the existing well.

101. A permit for the construction of a well shall not be granted if to do so may create or may contribute to a significant adverse effect on ecosystems that depend on underground water. Factors that will be taken into consideration in assessing the likelihood of significant adverse impacts include, but are not limited to:

    a) the distance of the proposed extraction point from any wetland listed on the Department of Environment and Heritage's South Australian Wetland Inventory Database (SAWID) for the South East of South Australia at the date of application, as a wetland of high or very high conservation value, determined by whether a 16 km^2 circle (2.25 km radius) centred on the proposed point of taking of the allocation intersects the wetland as mapped in the SAWID; and

b) whether the wetland identified in principle 101(a) is considered by the Minister to:

i. demonstrate a level of dependence on underground water; and

ii. be under significant or actual threat of degradation identified by, but not limited to, a mean (arithmetic) decrease in underground water levels of greater than 0.05 m/year (measured over the preceding 5 years) in a representative observation well within the 16km^2 circle specified in principle 101(a) above or, in the absence of any representative wells within the 16km^2 circle, in the nearest representative observation well or wells as determined by the Minister.

102. For any underground water dependent ecosystem identified for protection under principle 101, the set-back distance for any new wells shall be calculated using the DE Equation described in Section 2 (*Assessment of the needs of dependent ecosystems)*. Also taken into account shall be the current demand for underground water determined by the level of allocation within the management area and the volume of water proposed to be taken.

103. Notwithstanding principles 101 and 102, a permit for the construction of a replacement well shall be granted if the location of the replacement well is no closer to the wetland than the original well.

10.3 Groundwater access trenches (wedgeholes)

The operation of principles under 10.3 is subject to a regulation being made to ensure wells of this class require a permit.

104. The maximum depth of a groundwater access trench shall be 2.5 m otherwise the Principles under 10.2 apply.

105. The maximum surface area of a groundwater access trench shall not exceed the area recommended by the relevant authority, for that area where the groundwater access trench is to be constructed.

106. Stock access shall be negated by the construction and maintenance of a fence around the groundwater access trench.

107. Ingress of surface water flow into groundwater access trench shall be negated by the building of a bund wall/earthen levee around the underground water access trench at least 500 mm high.

108. All new groundwater access trenches shall be maintained in a manner that prevents contamination of the water resources by, but not limited to, the removal of debris and minimising pollution to the underground watertable.

109. Completion of a groundwater access trench must be reported to the relevant authority for inspection.

10.4 Draining or discharging of water into a well

The objectives and principles that follow apply specifically to an activity under section 127(3)(c) of the Act comprising the draining or discharging of water directly or indirectly into a well (artificial recharge). They are additional to those expressed for all water affecting activities.

10.4.1 Objectives

a. To protect the underground water resource from waste or pollutants (as defined in the Environment Protection (Water Quality) Policy 2003 under the *Environment Protection Act 1993*) to the receiving underground water resource during the draining or discharging of water into a well.

b. To provide for the draining or discharging (artificial recharge) of water directly or indirectly into a well in a manner that does not have the potential to adversely affect:

i. the quality of surface water and underground water resources;
ii. the integrity of the relevant aquifer, for example, but not limited to, the ability of the aquifer to transmit water;
iii. water tables, for example, but not limited to, water logging, land salinisation and damage to infrastructure (roads, buildings, foundations, etc.);
iv. any water-dependent ecosystem or ecologically sensitive area that depends on the underground water resource;
v. the ability of other persons to lawfully take from that underground water;
vi. the longevity of operations; and
vii. the sustainable operation and management of aquifer storage and recovery schemes.

10.4.2 Principles

110. A permit is required for the draining or discharging of water directly or indirectly into a well. However, where an environmental authorisation has already been granted under the *Environment Protection Act 1993,* a permit under the Act may not be required.

111. Water that is drained or discharged into a well must comply with the *Environment Protection Act 1993* and any associated policy.

112. A permit to drain or discharge water into a well will not be issued unless a risk assessment is undertaken to the satisfaction of the Minister. This risk assessment must be consistent with the *National Water Quality Management Strategy – Australian Guidelines for Water Recycling: Managing Health & Environmental Risks, Phase 1 2006* and other related documents current at the time, and include:

a) an investigation into the suitability of the draining or discharging site, including but not limited to tests for transmissivity, effective porosity and storage coefficient, maximum injection pressures and calculated likely impacts on the integrity of the well and confining layers, and impacts of potentiometric head changes to other underground water users;

b) an appropriate operation or management plan demonstrating that operational procedures are in place to protect the integrity of the aquifer on an ongoing basis;

c) a water quality assessment which identifies hazards in the water being drained or discharged; and

d) a report on the consequences and impacts to the ambient underground water resource where the water quality characteristics (salinity and chemistry composition) of the water to be discharged differs to that of the ambient underground water.

113. Water that is drained or discharged into a well by means of gravity is exempt from meeting the requirements of principle 112 (a).

114. Roof runoff (surface water) that is drained or discharged into a well via a closed system of capture and transport is exempt from meeting the requirements of principle 112(a), (c) and (d), provided that the system is equipped with a mechanism to divert first flush water.

115. Paddock runoff (surface water) that would have contributed to the natural vertical recharge of the unconfined or confined aquifer systems within the management area and that is drained or discharged into a well, is exempt from meeting the requirements of principle 112(a), (c) and (d), provided reasonable and practicable measures have been applied to protect water quality.

116. Further to principle 112(b), draining and discharge is dependent on an annual report that addresses the impacts to the ambient underground water at the draining and discharge site. Roof runoff captured in a closed system and then drained or discharged into a well is exempt from this principle.

117. For the purposes of principles 115 and 116, the relevant concentrations, levels or amounts shall be measured in sufficient representative samples of:

    a) the water to be drained or discharged; and

    b) ambient underground water collected from the proposed point of injection, or as near as possible to the proposed point of injection.

118. For the purposes of principle 117, ñsufficient representative samplesò 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.

119. For the purposes of principles 116 and 117, the term ñambient underground waterò means the underground water (as that term is defined in the Act) that exists in the relevant aquifer absent of any such water drained or discharged to that aquifer by artificial means.

120. The draining or discharging of water directly or indirectly into a well must not detrimentally affect the ability of other persons to lawfully take from that underground water, or degrade ecosystems dependent on the underground water.

121. The headworks for the draining or discharge of water shall be constructed so that extraction and draining and discharge operations can be metered without interference.

122. The headworks for the draining or discharge of water shall be constructed so that water cannot leak if the well becomes clogged.

123. For the purposes of principles 121 and 122, the term ñheadworksò means any assembly on top of a well and located between the well casing and the water delivery system.

124. Wells constructed for the draining or discharge of water at pressures greater than gravity, must be pressure cemented along the full length of the casing. This does not exempt the need to follow the general specifications for well construction.

10.5 Aquifer Storage and Recovery (ASR)

125. ASR developments are subject to the principles 110 to 124 outlined for drainage and discharge into a well set out in this Plan.

126. ASR developments require a water licence for the recovery component of the scheme, which must be in accordance with principles 67 to 71 (*Basis of allocation of water drained or discharged).*

127. The recovery of discharged water from a well other than the one used for discharge purposes, will also need to consider principle 89 (*Applications to transfer water allocation from aquifer storage and recovery schemes*).

128. Any ASR scheme must (subject to any authorisation to the contrary) be operated in a manner which is consistent with the Environment Protection (Water Quality) Policy 2003 under the *Environment Protection Act 1993*.

10.6 Importation of Water

The following objective and principles apply to activities prescribed by Regulation 14 of the *Natural Resources Management (General) Regulations 2005* indicating that except for the purpose of public water supply, a permit is required for the activity comprising using water in the course of carrying on a business at a rate that exceeds 1 megalitre/year where the water has been brought into a management area by means of a pipe or other channel (ñuse of imported waterò), or from a water resource in some other part of the NRM region. The principles outlined in this section are additional to those expressed for all water affecting activities.

10.6.1 Objective

a) To ensure the application of imported water is conducted in a manner that does not adversely impact on the quality and quantity of water resources in the PWA or surface water resources, downstream areas, water dependent ecosystems or the productive capacity of the land.

10.6.2 Principles

129. Use of imported water shall not cause a rise in the underground water level sufficient to detrimentally affect structures or ecosystems.

130. For the purposes of principle 129 the definition of ñstructureò includes, but is not limited to, a building, fence or wall.

131. Use of imported water shall not have the potential to adversely affect the quality of the prescribed underground water resource.

132. Use of imported water shall not have the potential to adversely affect the productive capacity of the land by causing salinity, waterlogging, perched water tables or other impacts.

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

11 - Monitoring, Evaluation and Reporting

Section 76(4)(d) 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.

Monitoring, evaluation and reporting is part of the systematic process of optimising performance through measurements against an agreed reference point. For this Plan, the reference points relate to effectiveness of policies and health of the underground water resource. There is therefore a need to monitor and evaluate to make sure that the underground water resource is used sustainably and to make sure that the policies of this plan are effective.

A comprehensive monitoring program that considers the ecological and hydrogeology performance of the PWA is recommended to compare desired management outcomes with actual outcomes and to evaluate the effectiveness and efficiency of water provisions. A detailed program to monitor the parameters listed below will be formulated and implemented through an investigations program detailed in the Natural Resources Management Plan for the South East Natural Resources Management Region.

11.1 Objectives

The monitoring strategy set out in this plan aims to ensure:

a. sufficient data is available to assess the capacity and health of the underground water resource and dependent ecosystems;
b. the timely evaluation and reporting of monitoring data;
c. the sustainable use of underground water resources; and
d. the adequate protection of underground water dependent ecosystems.

11.2 Monitoring the capacity of the underground water resource

Existing monitoring network

The Department of Water, Land and Biodiversity Conservation (DWLBC) and its predecessors have undertaken regular water-level monitoring in the unconfined aquifer 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 over 30 years, and is monitored by DWLBC (Table 11.1). Over this period, the network has been upgraded and enlarged to meet the agricultural expansion in the PWA.

There are two underground water salinity monitoring networks operating in the Padthaway PWA: the Padthaway Monitoring Network and the Padthaway Irrigation Network. The principal network is the Padthaway Monitoring Network and is sampled by DWLBC on a regular basis. The Padthaway Irrigation Network is sampled by irrigators or by DWLBC, but on an irregular basis during the irrigation season. 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.

Data collected will be used to determine trends in the conditions of the aquifer, which will be compared to the resource condition triggers (principle 44) established for this Plan and inform the implementation of the policy set out in the Plan.

Confined Aquifer

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

Table 11.1 Summary of existing underground water monitoring wells network and monitoring requirements at a regional level

Property measured	Number of Observation Wells in the Padthaway PWA	Frequency	Responsible
Underground water levels in the unconfined aquifer	66	Quarterly	Minister
Underground water salinity in the unconfined aquifer (Padthaway Monitoring Network)	54	Quarterly	Minister
Underground water salinity in the unconfined aquifer (Padthaway Irrigation Network)	62	Random	Minister and licensees

11.3 Monitoring the taking and use of underground water at property level

Annual Water Use Report

1. An Annual Water Use Report is to be prepared by each licensee and submitted to DWLBC, Mount Gambier office, on or by 5 pm 31 July each year.

2. Each licensee will provide the following information in the Annual Water Use Report:
   a) the volume of water allocated on the licence;
   b) 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 (ie start date and end date of irrigation for the season);
   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 irrigation method;
      ii. a sketch plan showing location of each area irrigated, a description of the equipment type used, and area and location of each irrigation method or equipment type;
      iii. the area of each crop irrigated;
      iv. the number of irrigations; and

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

Evaluation of the demands on the resource and the capacity of the resource to meet demands

1. Once each year, DWLBC is to prepare a summary of the patterns in use of underground water.
2. In the third operational year of the Plan, the Board is to commence a review of the Water Allocation Plan, including the initiation of a review of the conditions of the underground water resource in the Padthaway PWA including:
   a) trends in underground water level salinity;
   b) trends in underground water table levels; and
   c) levels of underground water extraction.

   The data collected, together with the numerical model of underground water throughflow developed in 2007, will be used to determine whether any changes are required to the acceptable level of underground water extraction.

11.4 Monitoring the water needs of ecosystems dependent on underground water

All monitoring programs developed and implemented by the Board will be consistent with the National Natural Resource Management Monitoring and Evaluation Framework, Resource Condition Indicators (Inland Aquatic Ecosystem Integrity).

Current Management and Monitoring

There are a large number of wetlands in the South East of South Australia. A number of these are managed by the Department of Environment and Heritage (DEH) through site specific management plans. Specific management plans have also been developed for high value features such as Bool Lagoon. One common example of a management action is the implementation of ongoing monitoring programs to establish resource condition and trends. Management actions also often relate to the integration of Government and Non-Government Organisations such as community groups.

The majority of the current water dependent ecosystem monitoring programs are focused around baseline monitoring for ecological values. Water quantity and quality are often measured in conjunction with the monitoring programs with the primary aim of assessing upper and lower limits required to maintain ecological function.

DEH manages and maintains a significant number of spatial Geographical Information System (GIS) data sets relevant to wetlands and national parks. Historical aerial photography and satellite imagery of varying resolutions are also available. DEH has established 16 separate programs across the NRM region for the monitoring of specific species including bats, swamp antechinus, southern bandicoots, frogs, and threatened orchids. A community-based water watch program is coordinated by DEH and the Board and supported by funding applications from the Board.

DWLBC is also involved in the collection of wetland baseline and ongoing monitoring data as part of the Upper South East Dryland Salinity and Flood Management Program.

For the purpose of a monitoring program, underground water dependent ecosystems identified as priority, high or very high ecological value systems found within the PWA should be included in the monitoring to assess the success with which the environmental protection policy (principles 3 and 4) protects these underground water dependent ecosystems, both at each site and more generally at a regional scale. The following parameters should be measured, recorded, evaluated and made publicly available/reported on, ideally on an annual basis:

a) seasonal underground water level fluctuations;

b) volume of underground water extracted;

c) seasonal underground water salinity fluctuations;

d) species composition and abundance (flora and fauna);

e) species recruitment of both flora and fauna;

f) specific terrestrial and aquatic vegetation health; and

g) ecosystem water use.

In the absence of information on the quality and quantity of underground water required by each ecosystem, the Acceptable Level of Extraction (see section 4) for the Padthaway PWA was established based on maintaining the condition of the resource within established resource condition limits for changes in underground water salinity and depth to water table (ie June 2004 water table levels, no increases in underground water salinity beyond the values at date of adoption, maintenance of lateral throughflow). This approach essentially maintains access to underground water at agreed levels. In addition, the Plan provides for the underground water requirements of priority ecosystems through the management of the taking of underground water around underground water dependent ecosystems of high environmental value. Essentially, applications to extract underground water in the vicinity of an ecosystem are subject to an assessment to establish a minimum setback distance for the point of extraction that ensures no changes to underground water levels in the vicinity of the ecosystem.

Currently, no priority ecosystems have been identified for protection through this mechanism in the Padthaway PWA, but the Plan includes provisions to allow its establishment around ecosystems during the life of the Plan where certain conditions are met.

11.5 Identification of knowledge gaps and further research required

Current knowledge gaps with respect to the needs of water dependent ecosystems include:

1. Intrinsic knowledge of underground water/surface water interaction and dependency of water dependent ecosystems including:
   a) water level and quality thresholds; and
   b) long term implications of climate change.

2. A regional integrated approach for the collection and interpretation of monitoring data, including:
   a) defining roles and responsibilities; and
   b) establishing reporting mechanisms.

3. Definition of the threatening processes, the risks they pose and the consequences of not addressing them including:
   a) development of shallow and deep drains; and
   b) land use change (including cross-border issues).

4. Intrinsic knowledge of cause and effect relationships and the development of effective management tools to address the following issues:
   a) declining underground water discharge due to interception of recharge in inland areas by high water use crops and timber plantations; and
   b) declining underground water discharge due to lowering of the water table as a result of climatic trends.

5. Contamination of the aquifer, particularly with nitrates.

Environmental response functions (ERFs) for individual ecosystems dependent on underground water will need to be developed so as to better inform the determination of environmental protection policy. ERFs describe the relationship between ecosystem function and water regimes that the ecosystems exist within (eg. depth to water table fluctuations, soil water content, and soil water and underground water salinity). The types of investigations undertaken should be consistent with those conducted during 2006 (Ecological Associates, 2006). In addition to those parameters listed above, at the more local (high value underground water dependent ecosystem) scale, monitoring programs should focus on the following:

a) intra-annual underground water level and salinity trends (say at two monthly intervals), to assist in assessing whether the unconfined aquifer is responding to management (this will require appropriately constructed monitoring wells within the high ecological value underground water dependent ecosystem to provide representative data);

b) proximity of the pumping wells or plantation forestry to underground water dependent ecosystems, to assist in assessing whether underground water dependent ecosystem policy is adequate; and

c) the amount of existing underground water pumping occurring around underground water dependent ecosystems.

11.6 Evaluation

The evaluation of monitoring data should focus on assessing the effectiveness of the policies of this plan in maintaining the ecological function of ecosystems dependent on underground water entered on the South Australian Wetlands Inventory Database for the South East region. Evaluation of monitoring data should be undertaken in a manner that considers underground water and ecosystem condition trends primarily in relation to the proximity of water affecting activities in the vicinity of underground water dependent ecosystems, but also recognising that other factors such as climate variability and land management may be contributing to observed ecosystem condition. Evaluation and reporting of monitoring data for all protected underground water dependent ecosystems should ideally be undertaken annually. The Board in association with State agencies will need to determine who is best placed to undertake the evaluation of monitoring data.

References

Ecological Associates. 2006. Environmental water requirements of underground water dependent ecosystems in the South East Prescribed Wells Area - field studies to support new and amended policy. Prepared for REM.

Fass T and PG Cook. 2005. Reconnaissance survey of underground water dependence of wetlands, South East, South Australia, using a mass balance of radon and chloride. In: P Howe, R Evans and P Cook. Eds. (Final Draft) A framework for assessing environmental water requirements for underground water dependent ecosystems; Report 2 Field studies. Prepared for Land & Water Australia. December 2006.

REM. 2005. A review of the environmental water requirements of the underground water dependent ecosystems of the South East Prescribed Wells Areas Stage 1 report. Prepared for the South East Catchment Water Management Board by Resource & Environmental Management Pty Ltd, and Ecological Associates Pty Ltd.

REM. 2005b. Integrated Monitoring Review of the South East of South Australia ï Phase 1- Final Report. Prepared for the South East Catchment Water Management Board. This report is the prelude to the Final report and provides information on the stakeholders, their statutory commitments and monitoring requirements.

REM. 2006. A review of the environmental water requirements of the underground water dependent ecosystems of the South East Prescribed Wells Areas Stage 2 report. Prepared for the South East Catchment Water Management Board by Resource & Environmental Management Pty Ltd, and Ecological Associates Pty Ltd.

REM. 2006b. Integrated water monitoring review of the South East of South Australia ï Phase 2. Final report prepared for the South East Natural Resources Management Board by Resource & Environmental Management Pty Ltd.

URS Australia. 2000. Assessment of the environmental requirements of underground water dependent ecosystems in the South East Prescribed Wells Areas. Prepared for South East Catchment Water Management Board.

12 - Consistency with other Plans and Legislation

In preparing this water allocation plan, the Board has had regard to the issues set out in section 7 of the *Natural Resources Management Act 2004,* the *South Eastern Water Conservation and Drainage Act 1992 and the Native Vegetation Act 1991.*

The Plan shows consistency with the following plans and policies:

a) Relevant management plans under the *Coast Protection Act 1972*;
b) Relevant Development Plans under the *Development Act 1993*;
c) The *Environment Protection Act 1993* and any associated policies;
d) Relevant management plans under the *National Parks and Wildlife Act 1972*;
e) The Initial South East Natural Resources Management Plan 2006;
f) The State Natural Resources Management Plan 2006; and
g) An Intergovernmental Agreement on a National Water Initiative 2004.

Appendix of Figures and Tables

Table 1: Specialised Production Requirements (ML per ha of crop/infrastructure)

MANAGEMENT AREA	Vines - Frost Protection	Fruit Trees	Potatoes	Olives	Onions	Sub Clover Seed	Maximum Production Pasture		
							SPRAY	FLOOD	DRIP
Padthaway Flats	1.55	0.38	1.70	0.28	1.47	0.38	0.72	0.94	0.68
Padthaway Range	1.55	0.38	1.70	0.28	1.47	0.38	0.72	0.94	0.68

Table 2: Annual Average Vertical Recharge, Licenced Allocation and Acceptable Level of Extraction

Management Area	Annual Average Vertical Recharge (mm/year)	Licenced Allocation* (ML/year)	Acceptable Level of Underground water Extraction (ML/year) at date of adoption
Padthaway Flats	75	53,447	n/a
Padthaway Range	25	1,649	n/a
Total PWA	n/a	55,096	48,000**

* based on indicative allocations at date of adoption

** subject to change due to input of additional data to numerical model of underground water and salinity fluxes developed by DWLBC.

Table 3: Allocation from the Confined Aquifer

Management Area	Permissible Annual Volume (ML/year)	Volume for Licenced Allocation* (ML/year)	Total Licenced Allocations at April 2008 (ML/year)	Volume Available for Allocation at April 2008** (ML/year)
Fairview	290	284	0	284
Wirrega	960	941	300	641

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

**Not available for allocation in the PWA during the life of the Plan.

Figure 1: Prescribed Water Resources Areas within the South East Natural Resources Management Region

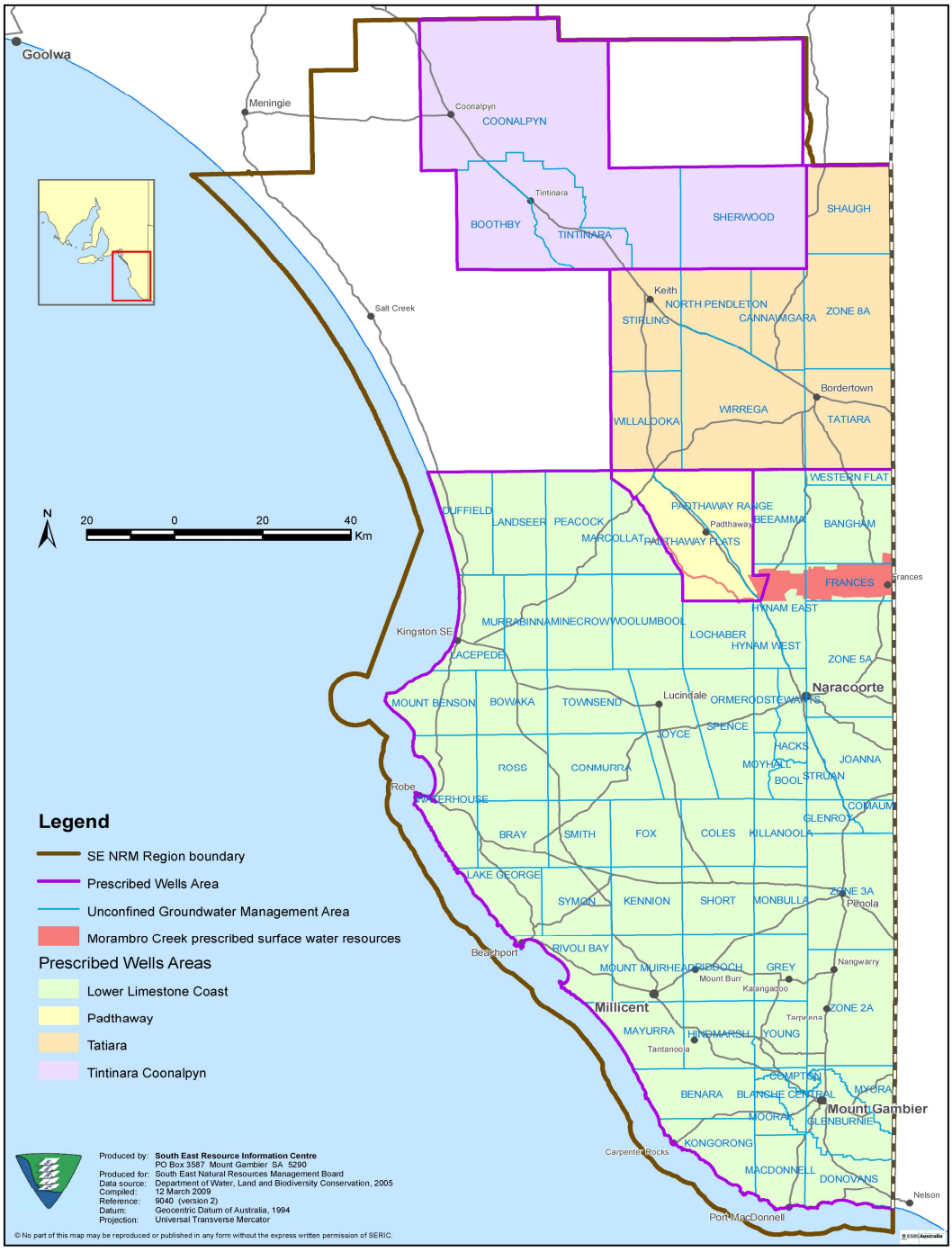

Figure 2. Unconfined aquifer water level contours

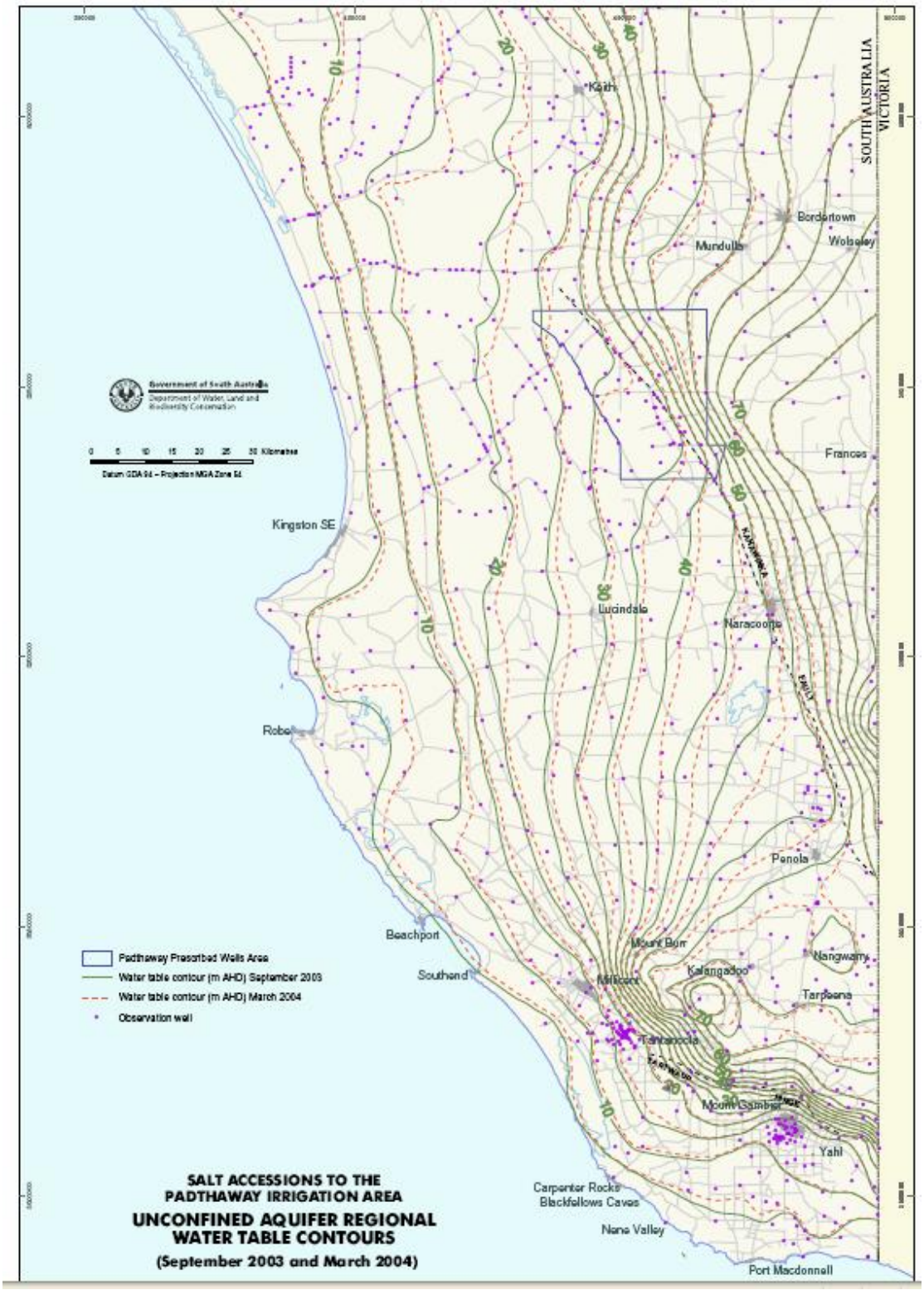

Figure 3. Schematic east-west geological cross- section through the Padthaway PWA

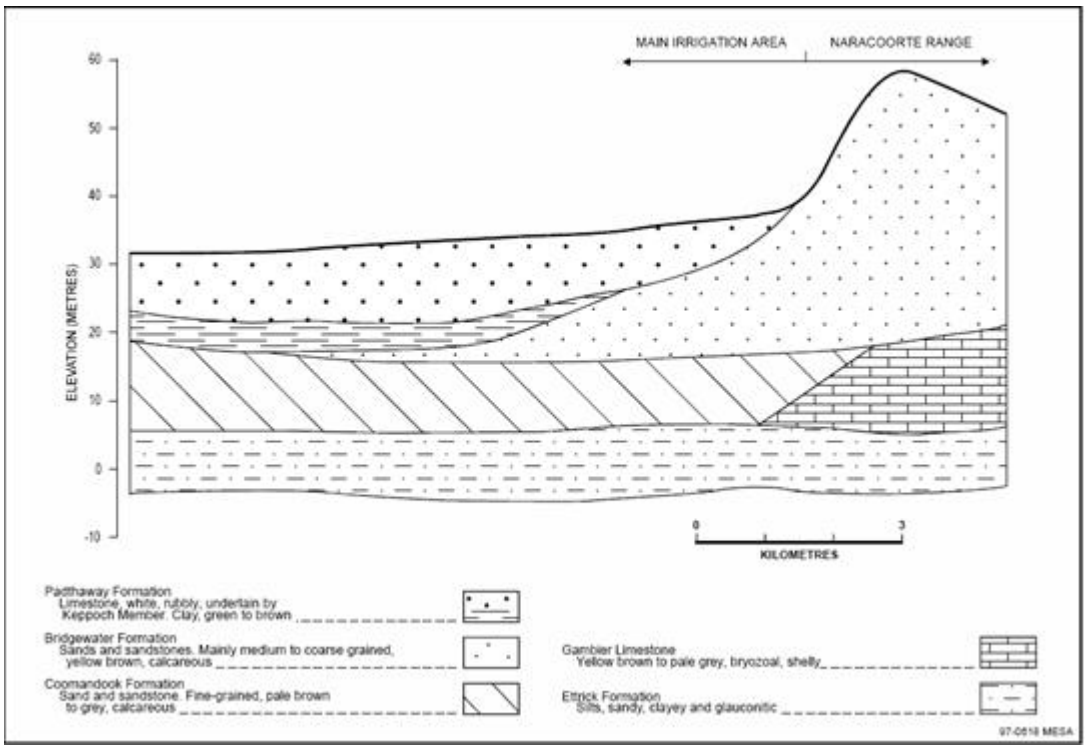

Figure 4: Management areas & limited extraction zone for the unconfined aquifer in the Padthaway Prescribed Wells Area

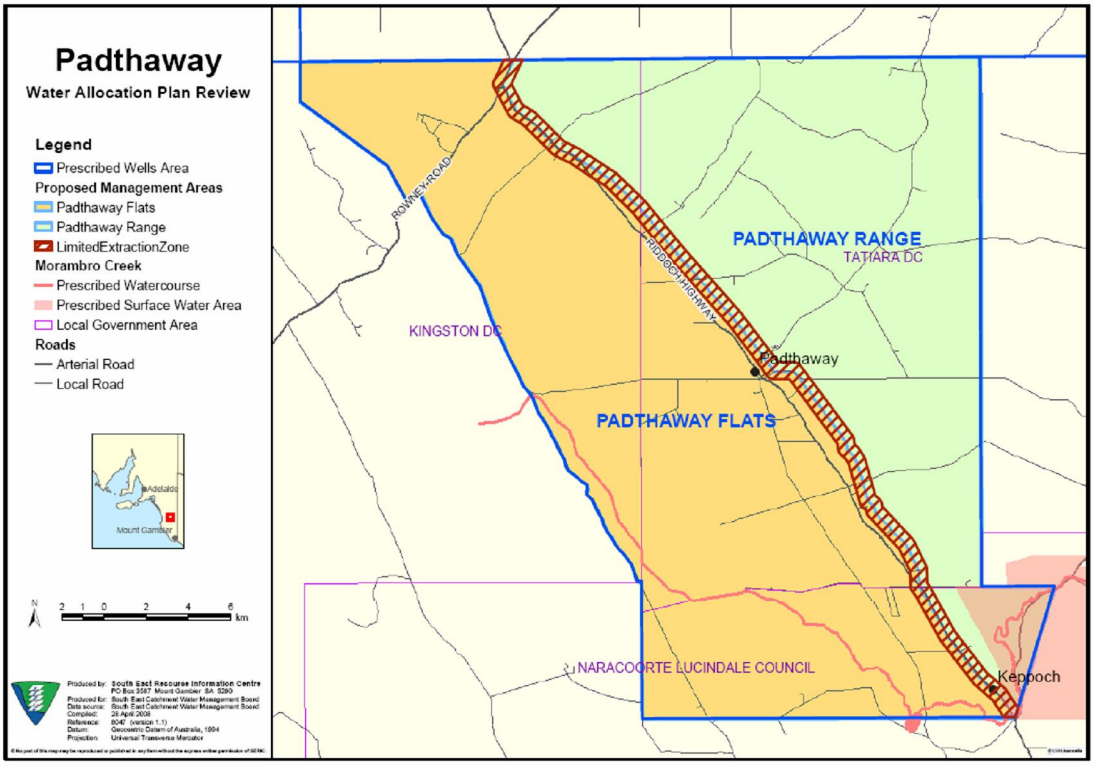

Figure 5. Confined aquifer management areas for the South East Natural Resources Management Area

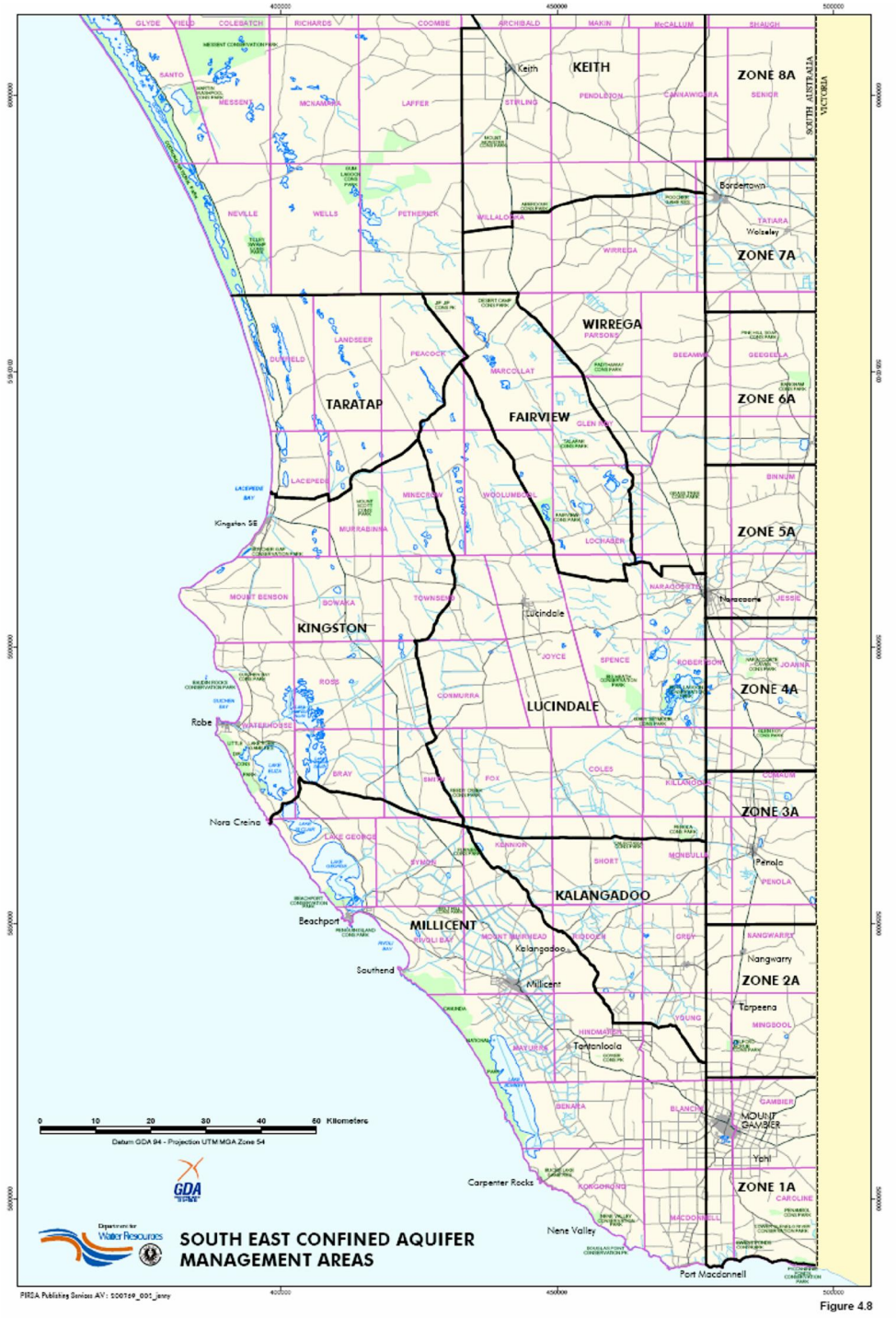

Figure 6. Types and categories of underground water dependent ecosystems (URS, 2000)

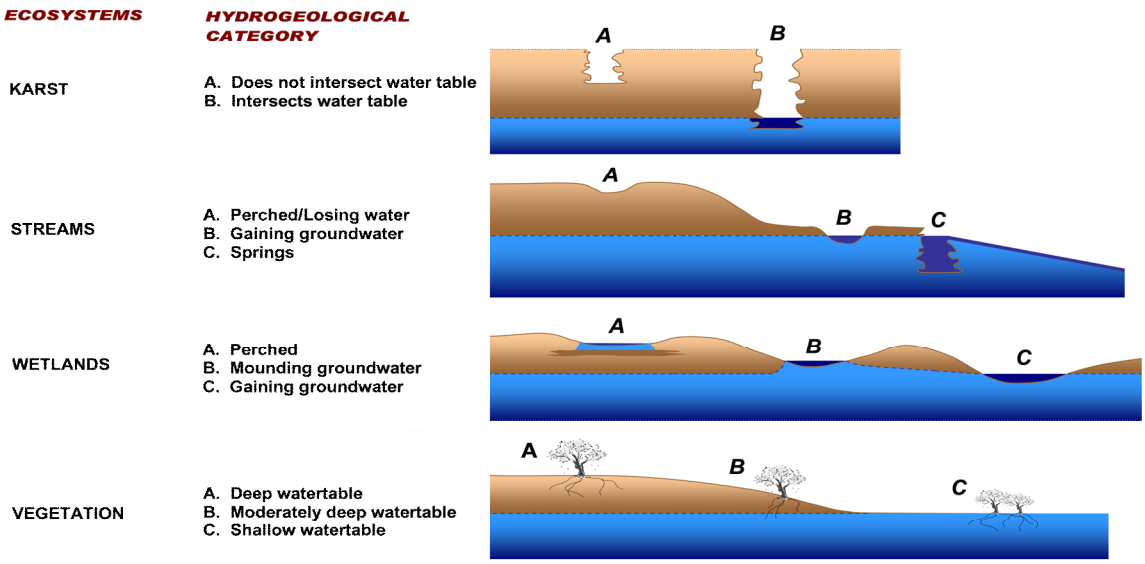

Figure 7. Ecosystems of high ecological importance in the Padthaway PWA

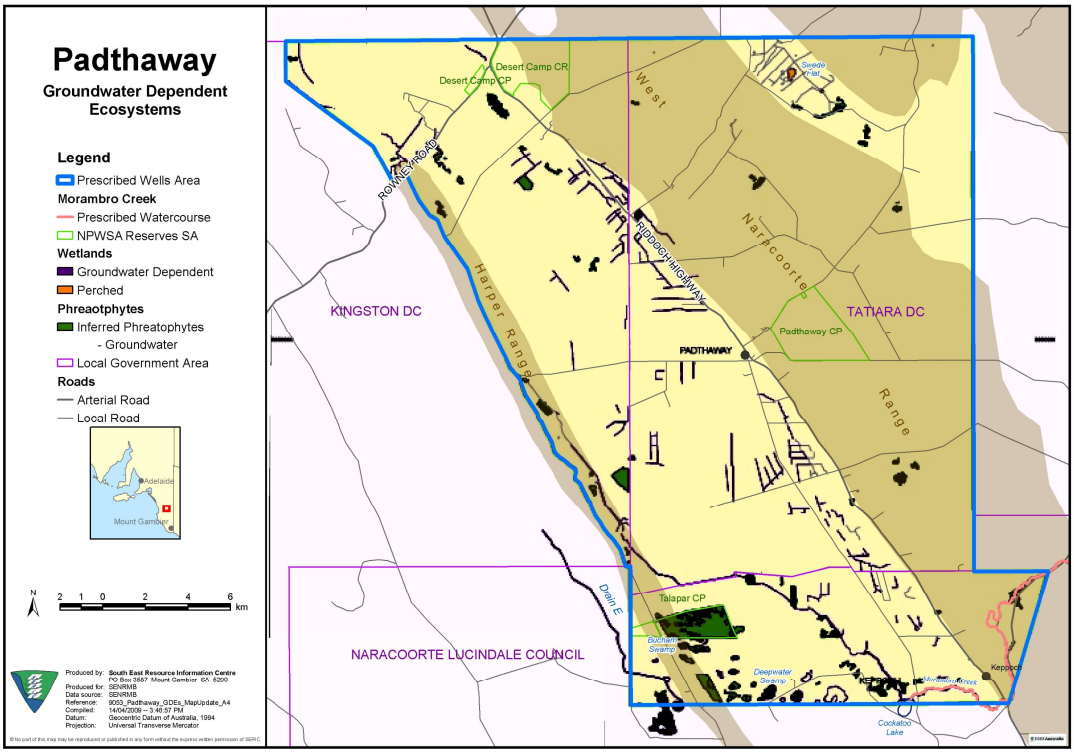

Figure 8. Underground water table level trends in the Padthaway PWA

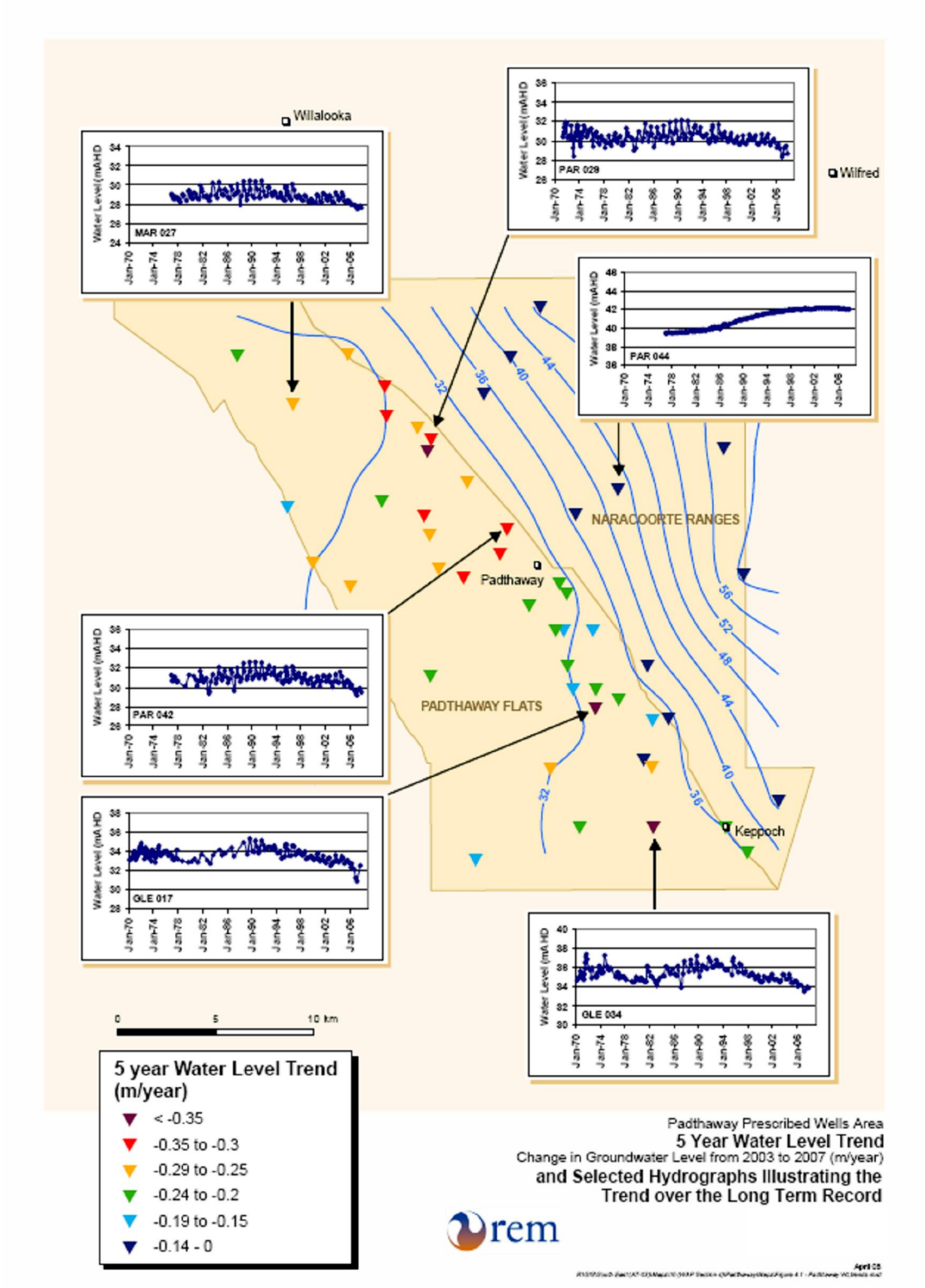

Figure 9. Monthly rainfall and cumulative deviation from monthly rainfall for the Padthaway PWA

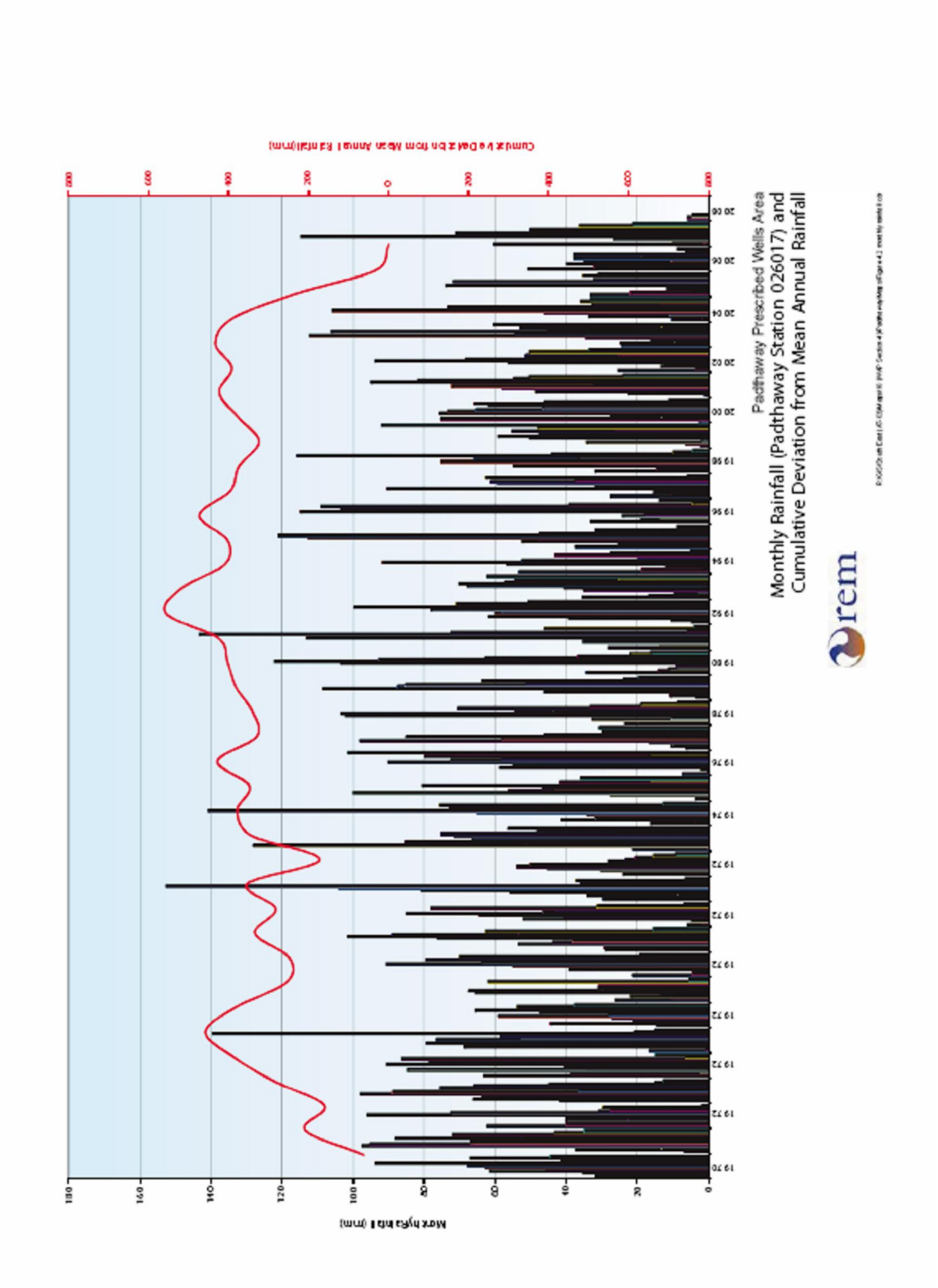

Figure 10. Underground water salinity trends in the Padthaway PWA