Water

1 Why is it important?

The condition of South Australia's water resources, and trends in water quantity and quality are paramount issues for the state's future. Our water resources are critical to life, the environment and economic growth.

High-quality water supplies are needed to support our growing population and enrich our surroundings. Our water resources hold community and Aboriginal cultural significance.

The state's water resources support a diverse range of ecosystems, which include aquatic flora and fauna, wetland and riparian vegetation, and groundwater fauna. In addition, the state's marine waters are recipients of run-off and, in some areas, groundwater from South Australia's terrestrial areas. The state's marine ecosystems are unique and among the most biologically diverse in the world, with many endemic species, and internationally and nationally important species.

Future water availability will also be a key determinant of industry growth, including in mining, manufacturing and agriculture.

Despite its largely arid to semi-arid setting, the South Australian landscape supports a surprisingly rich variety of riverine and wetland habitats. Wetlands are places in the environment where water and land meet—occasionally or permanently—including swamps, lakes, marshes, springs and floodplains. In addition to their obvious conservation values, rivers and wetlands provide a range of cultural, economic and ecosystem services.

The state's water-related environmental assets include wetlands along the River Murray corridor that are included in the Ramsar List of Wetlands of International Importance, marshes in the south-east, significant rock holes in the northern parts of the state, and the rivers, creeks and estuaries of both urban and regional South Australia.

The Murray–Darling Basin is Australia's largest river system and catchment, and the River Murray, its tributaries and Lower Lakes sustain South Australian communities and their economies. The Lower Lakes and Coorong area is recognised as one of Australia's most significant ecological assets and is a Ramsar-listed wetland. This area is also of high cultural importance, particularly for the Ngarrindjeri people. The state also relies on a network of other rivers and creeks that, while not on the same scale as the River Murray, are also essential for the health and wellbeing of the South Australian environment and economy.

Less visible but no less important are the state's significant groundwater resources, which deliver environmental, social and economic benefits by supplying drinking water, base flow to creeks and other water-dependent ecosystems, water for irrigation and industry, and habitat for groundwater-dependent organisms.

Opposite page: The River Murray near Lake Alexandrina, 1846
State Library of South Australia B15276/25

In summary

Aspect and observation	Assessment grade (Very poor / Poor / Good / Very good)	Confidence: In grade	Confidence: In trend
Water use Water use generally decreased during the drought, in part due to restrictions. It has subsequently been influenced by factors, including above-average rainfall, that have reduced demand for water. Long-term planning and knowledge have improved (e.g Goyder Institute for Water Research). A 2012 assessment of the state's 67 water management areas concluded that, although 35 are managed within sustainable limits, 7 are not managed within sustainable limits and 25 are partially managed within sustainable limits.	Poor — Stable	Adequate high-quality evidence and high level of consensus	Limited evidence or limited consensus
Water quality Processes for monitoring and assessing the ecological condition of South Australia's rivers, lakes and coastal waters are in place. The extent and condition of aquatic ecosystems are variable, with many being in fair to very poor condition and few being in good or very good condition.	Poor — Stable	Adequate high-quality evidence and high level of consensus	Limited evidence or limited consensus
Water supply Short-term rainfall has increased. Water supply diversification, including wastewater recycling and stormwater reuse, has increased. South Australia has the highest percentage of households with rainwater tanks in Australia.	Good — Stable	Adequate high-quality evidence and high level of consensus	Limited evidence or limited consensus

Recent trend: Improving; Deteriorating; Stable; Unclear

Level of confidence:
- Evidence and consensus too low to make an assessment
- Limited evidence or limited consensus
- Adequate high-quality evidence and high level of consensus

Grades: Very poor; Poor; Good; Very good

Regional trends

Condition: Good; Poor; Fair; Unclear; Variable

Trend: Improving; Decreasing; Stable; Unclear; Variable

Aspect and observation	Assessment grade	Confidence
	Very poor · Poor · Good · Very good	In grade · In trend

Surface water quantity and quality

Salinity levels in the main channel of the River Murray are stable, and those in Lake Albert have decreased. Recent high inflows brought floodplain nutrients back into the river, and good flows and flood turbidity suppressed algal blooms. Management of localised sources of pollution improved water quality.

Many of the ephemeral watercourses and wetlands in agricultural and pastoral areas have responded to above-average rainfall in 2010–11.

Main pressures are unsustainable harvesting and extraction in some parts of the state; dryland salinity, loss of riparian vegetation, intensive agriculture practices, and/or soil and streambank erosion in some parts of the state; climate variability and climate change; and changes in land use.

Regional trends:

AMLR · AW · EP · KI · NY · SAAI · SAMDB · SE

Groundwater quantity and quality

The number of water resource management areas subject to formal management arrangements is increasing.

Groundwater levels that declined during the drought are generally beginning to recover as a result of recent increased rainfall.

Groundwater-use levels and quality (including contamination in some areas) remain an issue.

There are significant knowledge gaps in relation to trends in groundwater extent and condition in nonprescribed areas.

Main pressures are unsustainable levels of use in some areas, changes in land use and climate variability.

Regional trends:

AMLR · AW · EP · KI · NY · SAAI · SAMDB · SE

AMLR = Adelaide and Mount Lofty Ranges; AW = Alinytjara Wilurara ; EP = Eyre Pennisula ; KI = Kangaroo Island; NY = Northern and Yorke; SAAI = South Australian Arid Lands ; SAMDB = South Australian Murray–Darling Basin ; SE = South East

Aspect and observation	Assessment grade	Confidence In grade	Confidence In trend
Water for consumption Recent high flows in the River Murray and above-average rainfall improved the availability of water for consumptive use across most of the state. Salinity levels in the main channel of the River Murray are stable, and those in Lake Albert have decreased. In pastoral areas, significant flooding in 2010–11 has recharged aquifers after the drought. Initiatives through South Australia's Water for Good strategy are diversifying water sources for consumptive use (including desalination, stormwater and wastewater reuse), and improving the allocation and efficiency of water use. Consumption generally decreased during the drought. It has been mitigated by increased rainfall, and initiatives to reduce demand and increase the use of alternative water sources, including recycled stormwater and wastewater. Anecdotal information suggests that a number of community supplies in the arid regions are becoming increasingly saline, with decreasing water levels in some bores. Main pressures are unsustainable level of use in some areas; and sedimentation, eutrophication and pollution of water sources.	Poor, Stable	Adequate high-quality evidence and high level of consensus	Limited evidence or limited consensus

Regional trends:

AMLR	AW	EP	KI	NY	SAAI	SAMDB	SE
Fair, Stable	Variable, Decreasing	Good, Variable	Fair, Stable	Fair, Stable	Good, Unclear	Fair, Stable	Fair, Variable

Source: Government of South Australia (2012a)

Recent trend: Improving; Deteriorating; Stable; Unclear

Level of confidence: Evidence and consensus too low to make an assessment; Limited evidence or limited consensus; Adequate high-quality evidence and high level of consensus

Grades: Very poor; Poor; Good; Very good

Regional trends
Condition: Good; Fair; Variable; Poor; Unclear
Trend: Improving; Stable; Variable; Decreasing; Unclear

AMLR = Adelaide and Mount Lofty Ranges; AW = Alinytjara Wilurara ; EP = Eyre Pennisula ; KI = Kangaroo Island; NY = Northern and Yorke; SAAI = South Australian Arid Lands ; SAMDB = South Australian Murray–Darling Basin ; SE = South East

2 What do we know about it?

South Australia has diverse water resources. They range from relatively large quantities of surface-water resources in the south-east, inflows to South Australia from the Murray–Darling Basin, and groundwater of the Great Artesian Basin, to smaller creeks and groundwater systems. The state's natural geological and climatic conditions, which vary widely, as well as human-related factors, influence the condition, quantity and quality of water resources.

In addition to surface-water and groundwater resources, sea water has in recent years received increased attention as a source of water for desalination, to produce water for human consumption, mining and some other potential uses. Treated wastewater and urban stormwater are additional resources, which are increasingly being managed to address the environmental impacts they can have on natural water resources and, where appropriate, to also provide a source of water.

Box 1 provides information about South Australia's water use.

South Australia regularly monitors water quality, water management and the environmental condition of the states' rivers, lakes and coastal waters. The following section looks at sustainable management assessment, and environmental assessments for the River Murray and Lower Lakes, surface waters and groundwater.

Box 1 South Australian water use facts, 2010–11

- Water consumption in South Australia in 2010–11 was 1023 gigalitres (GL) compared with 1110 GL in 2009–10, a decrease of 8%.
- Water consumption per capita was 617 kilolitres (kL).
- Households consumed 115 GL in 2010–11, a slight decrease from 123 GL in 2009–10. Water consumption per household decreased from 75 kL in 2009–10 to 70 kL in 2010–11.
- Agriculture was the largest consumer of water, accounting for 646 GL (63%) of the total water consumption in South Australia.
- The manufacturing industry was a significant user of water, accounting for 8% of total water use. Its consumption increased 10% from 2009–10 to 84 GL. Mining consumed 24 GL of water, while the electricity and gas supply industry consumed 2 GL.
- Gross state product was $84 million per GL of water consumed, an increase of $9 million per GL from the previous year.
- The gross value of irrigated agriculture in South Australia in 2010–11 was $1429 million, up from $1360 million in 2009–10.
- The average water price was $3.09 per kL.
- South Australian households recorded an expenditure of $354 million on urban distributed water.
- The total volume of water distributed in South Australia in 2010–11 was 315 GL, a 17% decrease from 2009–10. Distribution water losses amounted to 26 GL (8%) of total distributed water supply.
- The use of reuse water decreased from 32 GL in 2009–10 to 25 GL in 2010–11. Agriculture used most of the reuse water (50%; 13 GL).

Source: ABS (2012)

2.1 Sustainable management assessment

South Australia is divided into 67 self-contained water management areas, defined by natural catchments, groundwater resource areas and administrative boundaries.

As part of reporting on *South Australia's Strategic Plan* targets (Government of South Australia 2011a), each area is assessed with regard to whether demand is being managed within sustainable limits. The most recent audit, prepared by the plan's independent Audit Committee in 2012, identified 35 areas as managed within sustainable limits, 25 as partially managed within sustainable limits and 7 as not managed within sustainable limits.

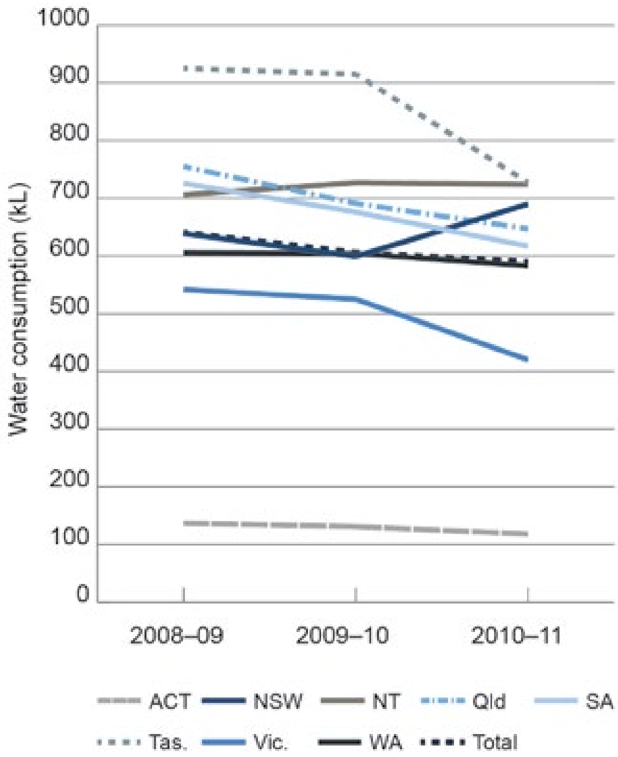
In *South Australia's Strategic Plan progress report 2012* (SASP Audit Committee 2010), the Audit Committee deemed that the proportion of South Australian water management areas assessed as being managed within sustainable limits had not changed significantly between 2003 and 2012, and it was unlikely that the Strategic Plan target—for South Australia's water resources to be managed within sustainable limits by 2018—would be achieved.

South Australia's per person water use decreased from 726 kilolitres in 2008–09 to 617 kilolitres in 2010–11 (Figure 1). Although this is an encouraging trend, the average consumption is still higher than in Victoria, Western Australia and the Australian Capital Territory, and the average for Australia.

Agriculture continues to be the largest consumer of water, using more than 50% nationally and more than 60% in South Australia (ABS 2012). While water consumption by the agricultural sector for the whole of Australia remained stable between 2008–09 and 2010–11, it decreased by about 18% in South Australia over the same period (Figure 2).

2.2 Environmental assessment

The South Australian landscape supports a rich variety of riverine and wetland habitats with water-dependent ecosystems. We have a good understanding of the ecology of wetland systems of the South East and Murray–Darling Basin, but for some other areas scientific data are lacking. There is ongoing work to classify wetlands across South Australia to inform planning and management. This work is largely complete in the South East and Murray–Darling Basin, but not in many other areas of the state.



Source: ABS (2012)

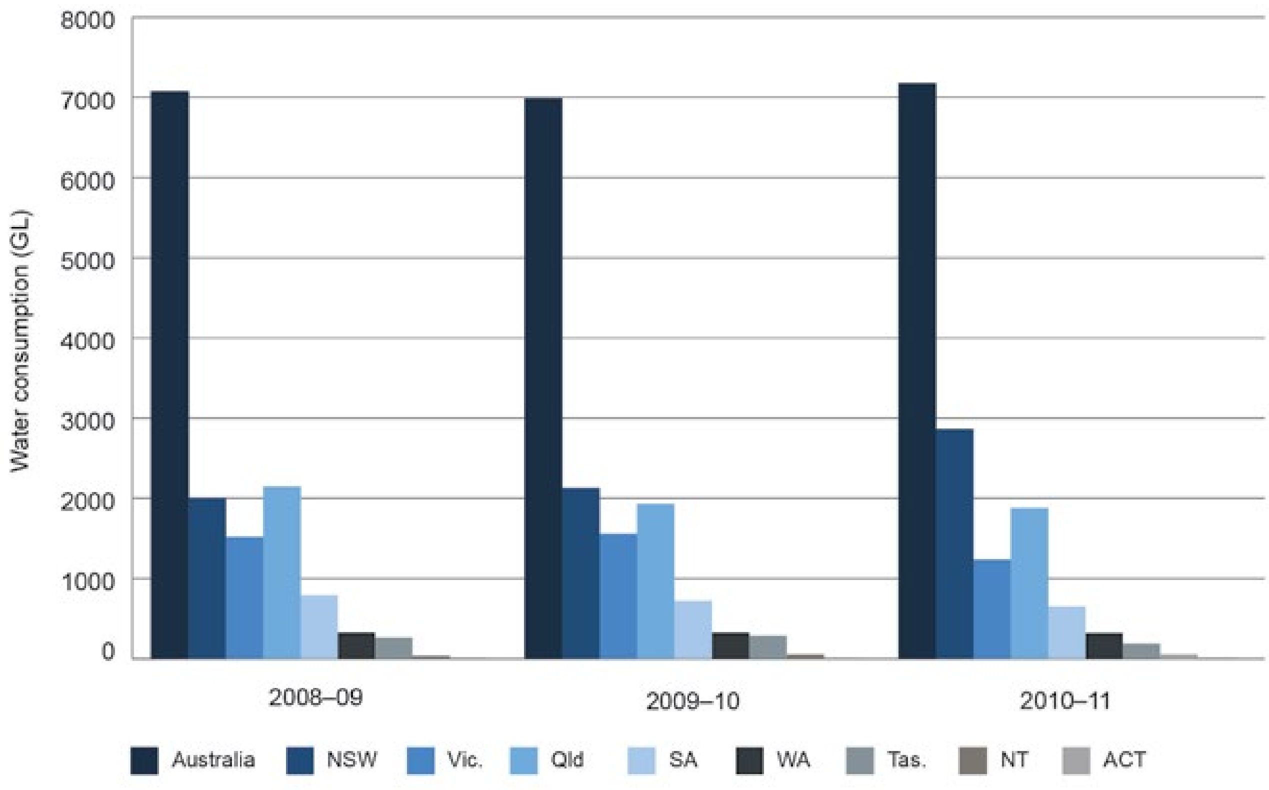
Figure 1 Total water use per person by jurisdiction, 2008–09 to 2010–11

The South Australian Environment Protection Authority (EPA) monitors South Australia's rivers, lakes and coastal waters to assess their environmental condition, based on a descriptive model for interpreting change in ecological condition in relation to increasing levels of human disturbance (Figure 3). Monitoring data are used to produce aquatic ecosystem condition reports that provide information on the location and special features of waterways, provide findings of assessments, and identify pressures and management responses. The reports rate aquatic ecosystems on a six-point scale, ranging from 'very poor' to 'excellent'. Additional information on the assessment process is provided in Section 4.5.3. The reports and more detailed information on the assessment process are also available on the EPA website: www.epa.sa.gov.au.

Assessments have been conducted in seven of the eight natural resource management (NRM) regions (see the *Introduction* for more information about NRM regions).

Overall, the aquatic ecosystem reports identify the condition of the majority of the state's rivers and creeks as lying on the rating spectrum between 'fair' and 'very poor'. Very few are observed to be in a 'good' or 'very good' condition, and none are in 'excellent' condition (EPA 2013).

Urrbrae Wetlands
Barbara Hardy Institute



Source: ABS (2012)

Figure 2 Agricultural water use by jurisdiction, 2008–09 to 2010–11

2.2.1 River Murray and Lower Lakes

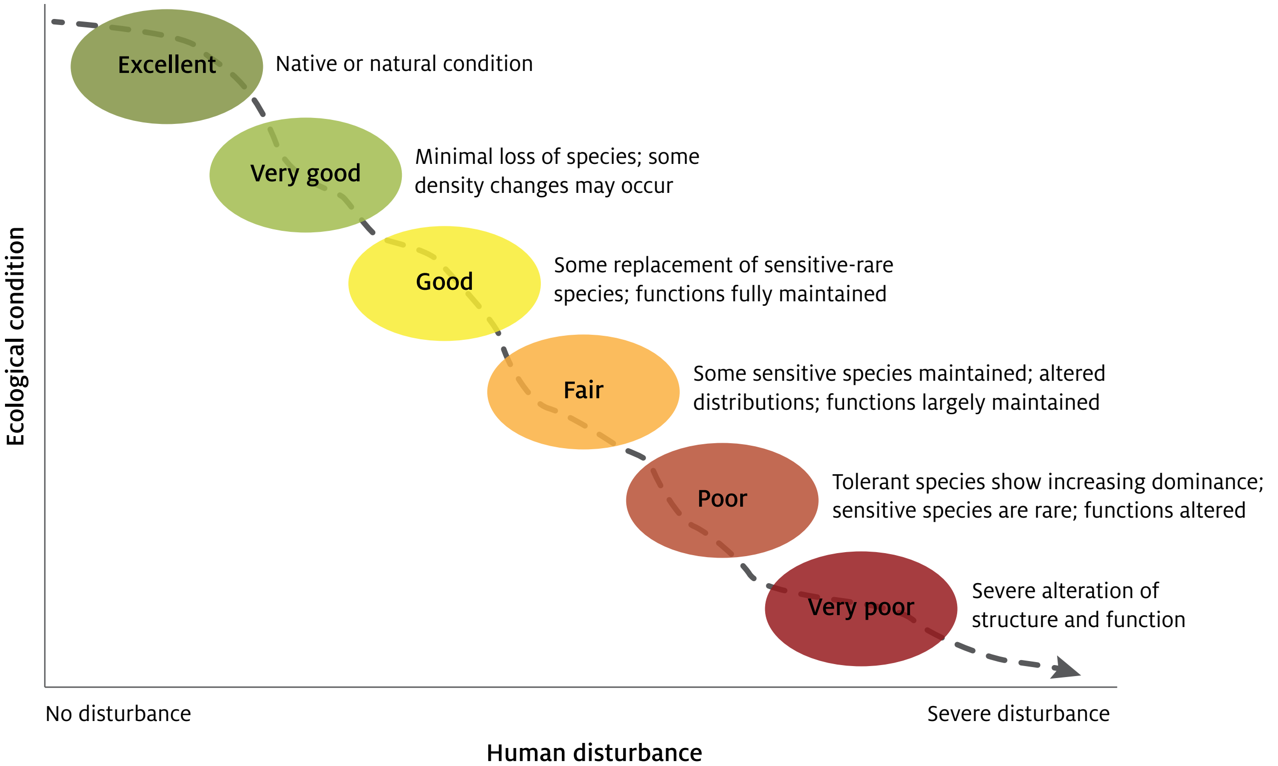
The River Murray and Lower Lakes were severely stressed in 2007–09, when the lowest flows in more than 100 years occurred. Many riverine wetlands were isolated and dried, and water quality in the Lower Lakes deteriorated as a result of the lack of flushing of the lake system, which led to very high salinity, turbidity, nutrient and algal levels (Mosley et al. 2012). Acidification due to exposure of acid sulfate soils was reported in dry riverine wetlands and around the lake margins (Lower Lakes Acid Sulfate Soils Scientific Research Committee 2010).

Since 2010, increased river flows have reconnected and flooded most riverine environments. Water quality has recovered well in Lake Alexandrina, but poorer water quality is persisting in Lake Albert as a result of limited water exchange between the lakes. Ecological recovery is in progress in many of the marginal river and lake environments, although some pre-drought species are still absent. Acidity persists in the sediments and pore water (water occupying the spaces between sediment particles) of parts of the Lower Lakes.

A major 'blackwater' event occurred in the middle reaches of the Murray in 2011, as low-oxygen water from flooded floodplains and wetlands returned to the river system. Blackwater is a natural process in which the breakdown of organic matter such as leaf litter in water uses up oxygen in the water at a rate faster than it can be replenished. The lack of dissolved oxygen can cause the death of fish, crayfish and other aquatic animals. Blackwater events are a high risk following floods and in the presence of large volumes of leaf litter, and are more likely in warm weather. In the 2011 blackwater event, no major fish kills were observed in South Australia, and the water was mostly re-oxygenated by the time it reached the Lower Lakes.

A new issue emerged in 2011 with discovery of acid drainage water in the Lower Murray Reclaimed Irrigation Area, due to exposure of acid sulfate soils by a falling watertable.

Eight sites within the Lower Lakes have been assessed over 2010–11 using the descriptive model shown in Figure 3. Most sites were given a 'poor' rating because the ecosystem showed evidence of major changes in animal communities and plant life, and moderate changes in the way the ecosystem functioned.



Source: Davies and Jackson (2006)

Figure 3 Ecological condition versus level of human disturbance

2.2.2 Other surface waters

The streams in the state that are classified as being in better condition typically occur where large areas of native vegetation have been retained and where streamflows occur in spring.

The rivers in the Lake Eyre Basin, which are among the last unaltered dryland river systems in the world, are generally considered by governments and the community to be in relatively good condition. However, our knowledge of the ecology of these arid rivers and their catchments is limited and not uniform across the basin.

In agricultural areas, streams are often nutrient enriched, are silted, have riparian zones with few or no native plants, and are dominated by introduced grasses and weed species. Urban streams invariably rate poorly because of disturbances that affect aquatic organisms, water quality and habitat structure. These disturbances include stormwater inflows, channelisation works, weed invasion, and occasionally point-source discharges from wastewater treatment plants and industries.

The most environmentally significant streams identified since sampling began in 1994 are:

- Adelaide and Mount Lofty Ranges NRM region: First, Sixth, Brownhill, Fourth and Aldgate creeks, and parts of Cox Creek and Sturt River
- Eyre Peninsula NRM region: Tod River catchment; and Coonta, Mine, Poonana and Yeldulknie creeks
- Kangaroo Island NRM region: Rocky, Breakneck, Stunsail Boom, North-west, Harriet and upper Cygnet rivers
- Northern and Yorke NRM region: Mary Springs upstream from Beetaloo Reservoir, and upper Skillogalee Creek
- South Australian Arid Lands NRM region: Spring and Mambray creeks, most streams north of the Willochra catchment (e.g. Parachilna, Brachina, Balcanoona creeks) and Cooper Creek
- South Australian Murray–Darling Basin NRM region: Finniss River catchment, including the tributary (e.g. Meadows, Tookayerta and Nangkita creeks)
- South East NRM region: Drain M, Mosquito Creek catchment, Drain L, Reedy Creek and the coastal drains east of Port MacDonnell (e.g. Eight Mile, Deep and Piccaninnie creeks).

Table 1 is a summary of the assessments by NRM region.

Table 1 Summary of condition assessment results by natural resource management region

	Year assessed and NRM region									
	2008				2009	2010		2011	2012	
Condition	AMLR	KI	NY	MDB	SE	EP	SAMDB	AMLR	NY	SAAL
Excellent	0	0	0	0	0	0	0	0	0	0
Very good	0	0	0	0	0	0	1	1	1	5
Good	5	0	0	2	2	0	5	10	3	29
Fair	16	3	5	7	24	11	23	27	5	18
Poor	13	3	2	4	40	15	14	24	2	2
Very poor	6	0	1	0	5	4	0	10	0	0
Total	40	6	8	13	71	30	43	72	11	54

AMLR = Adelaide and Mount Lofty Ranges; EP = Eyre Peninsula; KI = Kangaroo Island; NY = Northern and Yorke; SAAL = South Australia Arid Lands; SAMDB = South Australian Murray–Darling Basin; SE = South East

Note: The method was tested on sites from several regions in 2008, but subsequent assessments only focus on one or two regions in each sampling year. The detailed monitoring results can be viewed on the EPA website (www.epa.sa.gov.au/environmental_info/water_quality/aquatic_ecosystem_monitoring_evaluation_and_reporting).

2.2.3 Groundwater

Groundwater extraction occurs from **unconfined aquifers,** which receive seasonal recharge from rainfall, and **confined aquifers**, which are not recharged directly from rainfall.

In 2006–09, below-average rainfall over most of South Australia reduced recharge to a number of unconfined aquifers, and groundwater levels fell. In some NRM regions, such as Eyre Peninsula and South East, these trends have been under way for much longer periods. As a consequence, salinity levels have risen in shallow unconfined aquifers.

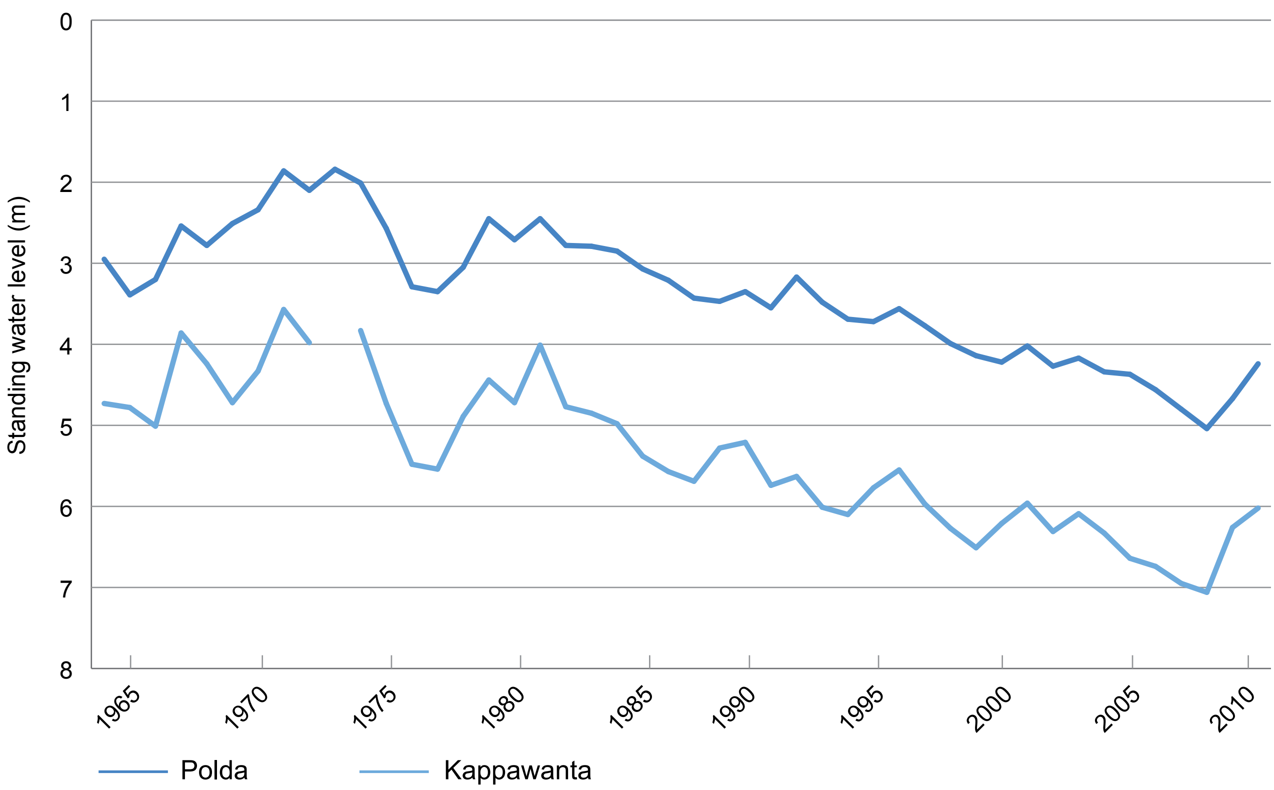
In some instances, the sustainability of the groundwater resources has been affected by below-average rainfall. For example, the Polda Basin on Eyre Peninsula is a shallow limestone aquifer that became dry in some locations over 2006–09, and salinities increased, most likely as a result of evapotranspiration from plants associated with the shallow watertable (Figure 4).

Since 2009, above-average rainfall in South Australia has improved recharge and led to a recovery of groundwater levels in most unconfined aquifers. In areas of long-term decline, the levels have not yet fully recovered to normal levels. Extractions from these resources have also decreased significantly, partly because higher rainfall has reduced the demand for irrigation.

Other issues for unconfined aquifers include salinity increases in the upper South East NRM region due to irrigation recycling, and the threat of seawater intrusion in coastal limestone aquifers south of Mount Gambier. Risks to the shallow aquifers beneath Adelaide include industrial spills and leaks of fuels and chemicals, fertilisation of horticultural areas (in particular, the northern Adelaide Plains) and illegal waste disposal.

Although not directly affected by annual rainfall recharge, some confined aquifers experienced an increase in demand and higher extractions from 2006 to 2009. In the Angas Bremer Prescribed Wells Area, where the confined aquifer is overlain by a shallow saline aquifer, the increased abstraction (extraction for human use) resulted in downward leakage and localised increases in salinity. Increased rainfall since 2009 has reduced extractions and restored pressure to pre-drought levels in most areas. Long-term gradual increases in salinity have occurred in the Barossa Valley, and in localised areas in the Willunga Basin, probably due to downward leakage from overlying aquifers.

Demand for groundwater in the far north is increasing as a result of mining activities, with a number of large-scale operations proposed or operating near important groundwater resources, such as the Great Artesian Basin. The far north relies on groundwater for domestic and agricultural uses, and requires a delicate balancing of demand against sustainability.



Source: DEWNR (2011)

Figure 4 Groundwater levels in Polda and Kappawanta basins, 1965–2011

Table 2 summarises the 2011 groundwater status reports produced by the Department of Environment, Water and Natural Resources (WaterConnect 2013). The summary reflects the overall increase in groundwater recharge and decline in salinity as a result of above-average rainfall since 2009.

Nutrients (mainly nitrogen) continue to be detected at elevated levels. Probable sources include intensive stock grazing and overapplication of fertilisers in agricultural and horticultural areas. Concentrations of metals occur at several locations, particularly in fractured rock aquifers of the Mount Lofty Ranges where there are, or have been, mines for metals such as copper, gold, lead, silver and zinc.

Historical point sources of contamination include industrial operations on the Adelaide Plains; wastes or spills from industrial sites such as timber mills, gasworks, cheese factories, abattoirs and septic systems in regional areas, including the South East; and mining, ore processing and associated activities in northern areas.

Table 2 Summary of 2011 groundwater status reports

Area	Status	Water level	Salinity
Angas Bremer PWA	Green	Rising	Declining
Baroota PWRA	Orange	Declining	Declining
Barossa PWRA	Orange	Stable	Rising
Booborowie Valley	Green	Rising	Declining
Central Adelaide PWA	Orange	Stable	Stable
Clare Valley PWRA	Orange	Rising	Stable
Far North PWA	Green	Stable	Stable
Lower Limestone Coast PWA	Green/Orange	Stable	Stable
Mallee PWA	Green	Rising	Stable
Marne Saunders PWRA	Orange	Declining	Rising
McLaren Vale PWA	Orange	Declining	Rising
Musgrave PWA	Green/Orange	Rising	Declining
Northern Adelaide Plains PWA T1 aquifer	Green	Rising	Declining
Northern Adelaide Plains PWA T2 aquifer	Green	Rising	Declining
Northern Adelaide Plains PWA Kangaroo Flat region	Red	Stable	Stable
Padthaway PWA	Orange	Stable	Rising
Peake–Roby–Sherlock PWA	Green	Stable	Stable
Southern Basins PWA	Green/Orange	Rising	Declining
Tatiara PWA	Orange	Declining	Rising
Tintinara–Coonalpyn PWA	Orange	Declining	Rising
Walloway Basin	Green	Stable	Stable
Willochra Basin	Green	Rising	Declining

Green: No adverse trends, indicating stable or improving situation
Green/Orange: Adverse trends, indicating low risk to the resource in the medium term
Orange: Adverse trends, indicating high risk to the resource in the short-to-medium term
Red: Degradation of the resource, compromising present use within the short term

Rising / Declining / Stable

PWA = prescribed wells area; PWRA = prescribed water resources area

3 What are the pressures?

Since the 2008 state of the environment report (EPA 2008), the risks facing our water resources have become more acute as severe and widespread drought has had significant impacts. The 'millennium drought'—southern Australia's extended drought that occurred from 2000 to 2010, in some areas beginning as early as 1997—brought a greater appreciation that complex interrelationships exist between the quantity and quality of the state's water resources and the health of water-dependent ecosystems.

Although the drought has ended, ongoing impacts continue to present significant management challenges. Water overallocation and unsustainable use in some areas, together with land-use change, are major concerns facing the state's water resources and water-dependent ecosystems. The integrity of river and wetland ecosystems is threatened by human-related activities. Many of South Australia's rivers and wetlands are affected by flow regulation, catchment disturbance and pest species. In addition, climate change projections suggest that much of South Australia could experience lower annual rainfall and increased temperatures in coming decades.

We need to sustainably manage the balance between competing uses and the environment in ways that recognise climatic variability and maximise the economic, social and environmental benefits. The following sections look at the main pressures affecting South Australian water resources, and particular pressures on the River Murray and Lower Lakes, surface waters and groundwater.

3.1 Climate change

The recent drought that affected the Murray–Darling Basin and other parts of South Australia has highlighted the need for improved understanding of the state's water resources, and for ensuring that the state's water planning and allocation processes are more responsive to climate variability and climate change.

Climate projections from the Commonwealth Scientific and Industrial Research Organisation (CSIRO) for South Australia (Suppiah et al. 2006) suggest a likelihood of increased future pressure on the state's water resources through:

- decreased rainfall in agricultural regions (especially in winter and spring)
- decline in groundwater levels in unconfined aquifers in the long term
- greater frequency and severity of drought, with decreased flows in water supply catchments
- increased flood risk due to extreme weather events (despite drier average conditions)
- higher temperatures, including more extreme hot days, with warming in spring and summer greater than in winter and autumn
- damage to infrastructure—for example, from coastal erosion and flooding.

3.2 Water availability and use

One of the most significant pressures on water availability is expected to come from climate change. With an expected trend of warmer and drier conditions, the amount of water available for all uses and users will come under increasing pressure.

At the same time, population growth in urban and regional areas is expected to increase the demand on drinking water supplies. Expansion of agricultural activities may lead to an increased demand for irrigation water, although increased efficiency in irrigation techniques may help to reduce this demand. Expansion of mining activities in the state will also increase demand for various forms of fit-for-purpose water supplies. At times, more water is needed by water-dependent ecosystems to sustain environmental values; in a changing climate, these needs may become more pressing.

Many forms of current human water use are climate dependent, including some human consumption, private and public uses such as garden watering and open-space irrigation, agricultural use and some industrial use. Climate change will necessitate changes in water use and allocation.

3.3 Land-use change

Land-use changes to support population and economic growth have major implications for the health of water-dependent ecosystems. Relatively unimpacted streams typically occur across South Australia in areas where large tracts of native vegetation have been retained. Southern parts of the state, in particular, have seen significant changes from naturally vegetated catchments to ones where agricultural and urban land uses dominate. Where this occurs, streams are often nutrient enriched and silted, and have riparian zones that are dominated by introduced grasses and weeds.

Land-use changes also affect the quantity and quality of water resources. An example that has received some attention in recent times is the potential impact of forestry in intercepting rainfall that would otherwise recharge unconfined groundwater systems. The anticipated increase in mining activity also has the potential to increase pressure on both the quality and the quantity of water resources. This is reflected in the high priority that has been given to assessing these impacts.

3.4 River Murray and Lower Lakes

Since the early 20th century, Basin-wide flow regulation and diversions for agriculture have reduced the average total river flow at the River Murray mouth. CSIRO (2008) states 'integrating the flow impacts down through the connected rivers of the Basin shows that total flow at the Murray mouth has been reduced by 61 per cent'. Projections in the same CSIRO report are that, by 2030, the median surface water availability for the Murray–Darling Basin will have fallen by 11% (9% in the north of the Basin and 13% in the south).

From 2007 to 2009, the Murray–Darling Basin experienced the worst drought in more than 100 years of records (see Box 2). Basin-wide climatic shifts resulted in a severe hydrological drought period of extreme low flows. Subsequently, the water level in pool one (waters below Lock 1 located at Blanchetown) fell below sea level for the first time in modern history, with the barrages preventing seawater ingression. The drought resulted in major water quality, ecological and socio-economic impacts across the Basin. Many parts of the South Australian Murray–Darling Basin environment are still recovering from this severe drought event. Persistent legacies of drought include high salinity in Lake Albert, limited ecological recovery in the Lower Lakes and Coorong, submerged acid sulfate sediments in the Lower Lakes, acid drainage from the Lower Murray Reclaimed Irrigation Area, bank slumping and destabilisation, and infrastructure damage.

Other pressures in the Basin include:

- regulated and reduced flows that disrupt flow patterns and biological cues, and prevent flushing and maintenance of a functioning Murray mouth
- nutrient enrichment and high fine-sediment loads; these are exacerbated by land clearing, agricultural practices, urbanisation and stormwater run-off, which promote nuisance algal growth
- intensification of recreational uses (e.g. holiday homes, houseboats and other vessels)
- degradation and weed infestation in riparian zones, associated with farming and livestock access to riverbanks
- increased salinity during low flows, as a result of groundwater inflows and evaporation
- limited refuge habitats in the Lower Lakes due to widespread drying during drought.

3.5 Other surface waters

Pressures in the southern areas of the state largely relate to the change from naturally vegetated catchments to those where agricultural and urban land use dominate. Nutrient enrichment, siltation, weed invasion in riparian zones and dam development affect the condition of streams in the Adelaide and Mount Lofty Ranges, Eyre Peninsula, Kangaroo Island, Northern and Yorke, and South East NRM regions. In many cases, cattle and sheep are allowed access to the streambed and riverbanks, and cropping often occurs up to streambanks.

High salinity and the episodic nature of many streams affect the condition of waterways in parts of the south-east, the eastern Mount Lofty Ranges, central and eastern Kangaroo Island, Eyre Peninsula, the mid-north, and the Willochra catchment in the Flinders Ranges, and streams on the western side of Lake Eyre. In many cases, their generally poor condition is caused by catchment clearance since European settlement and the ensuing mobilisation of naturally occurring salts in soil and groundwater systems, leading to inflows of saline groundwater. However, low rainfall patterns have exacerbated the problems. Such issues exemplify the complex interface between land use, climate variability and change, and local geologies.

Further north, feral animals and stock damage riparian zones and streambeds. Flow patterns in the streams in the Lake Eyre Basin may be affected by management actions in the upstream states. Water abstraction in

Box 2 Case study: Murray–Darling Basin

The River Murray is an iconic river in Australia that supports floodplain, woodland and wetland communities of national and international significance. There are about 30 000 wetlands in the Murray–Darling Basin, with 16 listed under the Convention on Wetlands of International Importance (the Ramsar Convention). The Basin supports agriculture, tourism and other productive industries, and is home to more than two million people.

The River Murray is essential for the economic, social, cultural and environmental wellbeing of South Australians. We rely on a healthy river to protect our floodplains, and the wetlands of the Coorong, Lower Lakes and Murray mouth. Our irrigators and primary producers rely on a healthy river so that they can produce high-quality food, wine and fibre. Metropolitan Adelaide and country towns all rely on the river to supply water for human needs. Traditional owners and river communities rely on the river as the centrepiece of their cultural and social activities.

The ecological health of the Murray–Darling Basin river system is in decline, largely because of reduced flows caused by river regulation and overallocation. Under natural conditions, the median flow to the sea at the Murray mouth was 11 880 gigalitres per year, but by 1994 it was only 21% of this level. The recent drought and the prospect of further reductions in flow associated with climate change brought the Basin's water resource problems to national attention. The CSIRO Murray–Darling Basin Sustainable Yields Project suggests that, by 2030, the median surface water availability for the Murray–Darling Basin will have fallen by 11% (9% in the north of the Basin and 13% in the south) (CSIRO 2008).

Salinity is a significant management issue for the Murray–Darling Basin, and the Lower Murray in particular. The river acts as a conduit for salt mobilised within naturally saline sediments, but the mobilisation of salt has been increased by irrigation and land clearing, and the lack of flow in recent years has caused salt to accumulate in the water of floodplain soils. Flows to dilute and flush salt from the system are critical if we are to avoid:

- salt accumulating in the lower reaches during dry periods
- continued accumulation of salinity in floodplain soils and wetlands, degrading these environments as habitats for flora and fauna
- the effects of severe drought in the Lower Lakes and Coorong, affecting habitats for native fish and migratory waterbirds
- lack of water for floodplains at mid and high elevations, with adverse consequences for black box and river red gum woodlands.

Although South Australia uses about 7% of the total surface water resources within the Basin, the state has taken a responsible approach to managing water from the Murray. For example, South Australia:

- was the first state to put a voluntary cap on water entitlements, in 1969
- first prescribed the River Murray in 1976 and first adopted a water allocation plan in 2002. The state has subsequently issued various notices and variations of restriction, and has issued notices of the volume of water available for allocation from the River Murray Consumptive Pool
- was the first state to meet its water recovery target under the Living Murray Initiative (MDBA 2008)
- has enacted the *River Murray Act 2003*, for protection and enhancement of the River Murray, and associated areas and ecosystems.

continued

Box 2 continued

The Murray–Darling Basin Plan, which was adopted on 22 November 2012, is a historic step in addressing overallocation and improving water management across the Basin to deliver a healthy and working Murray–Darling Basin.

The South Australian Government actively championed the interests of the River Murray and its communities during the development of the Murray–Darling Basin Plan. Along with the public support gained through the Fight for the Murray campaign, these efforts helped to secure a number of significant key improvements to the Basin Plan, associated legislation and agreements. Key changes include provisions that support the return of 3200 gigalitres of environmental water to the river system, and removing or relaxing constraints on environmental water delivery to deliver improved environmental flows for the health of the river and floodplains; and end-of-system salinity targets and environmental objectives to protect the Coorong and Lower Lakes wetland site and the river channel below Lock 1.

support of mining and other developments also requires careful management in the arid regions of the state. Rainfall and run-off are highly variable in these areas, and there are few permanent surface-water resources. Surface-water data are generally sparser than in more intensively settled areas of South Australia. Available surface-water data, including rainfall, stream water level, flow rate and salinity, are publicly accessible from the state's WaterConnect water information website (see Section 4.5.4).

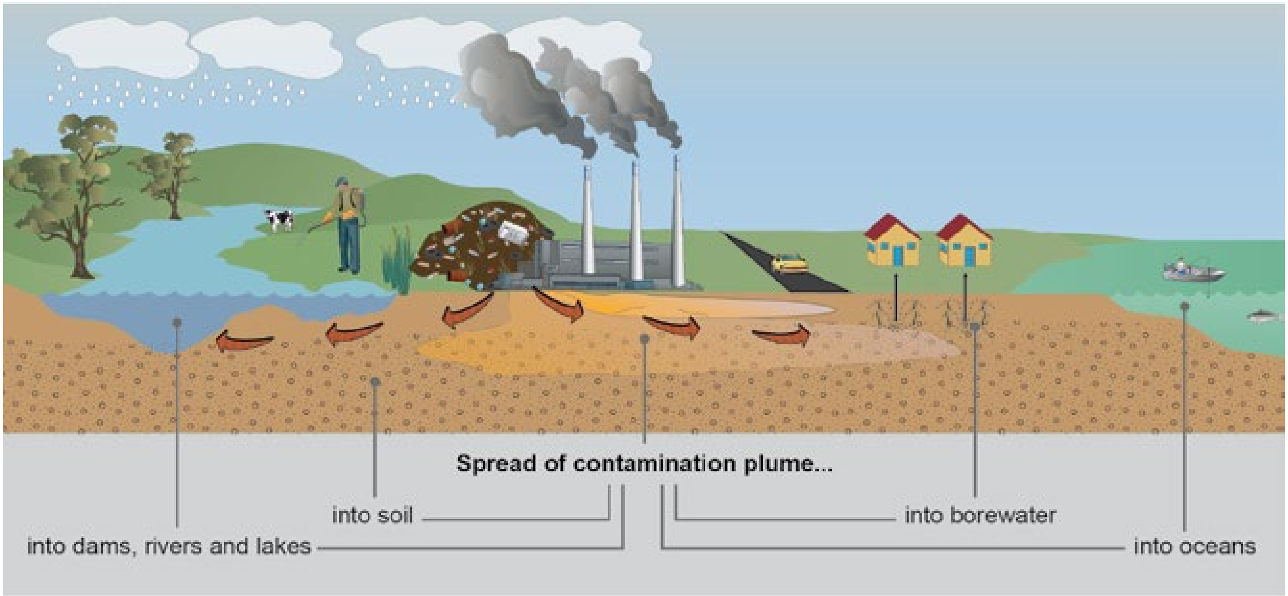
Modification to the terrestrial environment in South Australia has been profound. Given widespread changes to most streams in the southern part of the state, there is likely to be a significant lag before we start to see significant regional-scale benefits from the range of catchment management activities being carried out by government and nongovernment organisations. It may take years before fencing, stock exclusion, buffer installation, erosion-control works, flow-diversion programs and other interventions occur over a sufficiently wide area to lead to major improvements in the environmental condition of our many streams and rivers.

Meanwhile, however, local initiatives undertaken within the framework of activities needed at a broader scale provide modest improvements to the local environmental over a short timeframe.

3.6 Groundwater

Groundwater aquifers face a variety of risks. Water quantity is affected by climate change, as well as the increased use of groundwater in mining and high abstraction rates by industry. Groundwater quality can be affected by contamination from either point or diffuse pollution sources. A number of industrial and commercial activities have contributed to most of the legacy impacts that affect near-surface aquifers in metropolitan areas and rural aquifers in South Australia. These include the production of coal gas during the late 19th to early 20th centuries, which resulted in contamination of underlying aquifers with waste products such as cyanide, metals, polycyclic aromatic hydrocarbons and other hydrocarbons. Between 1940 and 1980, industrial and commercial activities (such as manufacturing factories and drycleaners) that used chlorinated hydrocarbons as solvents led to trichloroethylene plumes remaining in watertable aquifers in part of the western suburbs of Adelaide. Inappropriate disposal of industrial wastes to 'pug holes' during the mid-20th century has affected the watertable aquifers in the western suburbs of Adelaide. Service stations and fuel depots across South Australia from the early 20th century to the present are known to have contributed to many hydrocarbon plumes. Agricultural activities since the early 20th century that used industrial fertilisers have contributed to nutrient plumes in both metropolitan and rural areas.

The interconnection of groundwater and surface waters means that impacts on one of these waters will affect the other. The reporting period saw an increase in groundwater contamination incidents in the Adelaide metropolitan area that were responded to by the EPA. The EPA uses a site conceptual model to assess reported incidents of groundwater contamination (Figure 5).



Source: EPA (2013)

Figure 5 Site conceptual model of contamination

Aquifers in the South East generally have a high potential contamination risk rating because of their karstic nature (which promotes comparatively rapid subterranean drainage), shallow standing water levels, the range of agricultural and industrial operations, and potable (drinking-water) use. Groundwater in the South East is highly valued for agricultural, industrial and drinking-water purposes. Stormwater in Mount Gambier is discharged via disposal bores into the underlying karstic aquifer. High nutrient (mainly nitrate and nitrite) concentrations have existed in the South East for a number of years, with threats apparent to groundwater-dependent ecosystems.

Groundwater is used in southern and western Eyre Peninsula for drinking water. The shallow karstic aquifer in the peninsula is also at a high risk of impact from nutrients and microbiological parameters. This is especially the case in areas where shallow trenches have been dug to access groundwater for stock use.

Areas of the far north are under increasing pressure from mining, with a number of large-scale operations near important groundwater resources (e.g. the Great Artesian Basin). The far north relies on groundwater for domestic and agricultural uses. Mining operations are increasing abstractions of groundwater, with potential adverse impacts on groundwater levels and quality. Abstractions of groundwater occur for mine dewatering, camp water supply, dust suppression, process water use and testing of technologies (e.g. geothermal), and as part of recovery mining, where acid is injected, circulated and extracted to recover uranium. Appropriate management of water from process and hydrogeological testing is also a concern. The energy sector is also a significant user of groundwater in areas such as Moomba.

The increase in managed aquifer recharge schemes (Box 3) in recent years introduced a risk of contamination of deep tertiary or fractured-rock aquifers. Managed aquifer recharge operations inject water (usually stormwater, but also wastewater or river water) of variable quality in winter and then extract most of it in summer. These schemes must be managed to ensure that quality control of injected water is maintained.

Box 3 Managed aquifer recharge

Managed aquifer recharge (MAR) is a systematic process of intentionally storing water in aquifers for later reuse or for the benefit of the environment. It has become an increasingly important component of integrated water management over recent years. A number of councils, golf courses and other organisations use MAR to improve the security of their operations by temporarily storing recharged water, such as stormwater or treated wastewater, and recovering it for suitable uses when it is needed.

The term 'MAR' takes into account a number of the different ways that water can be recharged into aquifers, including aquifer storage and recovery, and aquifer storage, transfer and recovery. It can also encompass different types of water, from river water to stormwater, and roof run-off to treated wastewater. Where the water is not drained or injected for the benefit of the aquifer, or extracted at a later date, the activity is classified as a method of disposal rather than MAR.

MAR schemes can vary significantly in scale, from small domestic schemes recharging roof run-off, to regional schemes that capture large amounts of water and recharge to aquifers via a field of wells or infiltration basins.

South Australia is recognised internationally as a leader in MAR. Across the Adelaide Plains, there are areas where suitable aquifers exist to recharge and store water, and this area in particular has seen a rapid growth in projects involving MAR in recent years. Although the majority of Adelaide's MAR schemes are associated with growth in stormwater harvesting and reuse, a MAR scheme using treated wastewater from the Christie Beach wastewater treatment plant has been developed at Aldinga.

4 What are we doing about it?

Managing the state's water resources to maximise economic, environmental and social benefit is a critical priority for the South Australian Government and the broader community.

The *Natural Resources Management Act 2004* (NRM Act) is the legislative foundation for the sustainable management of water in South Australia. The *Environment Protection Act 1993* provides the legislative basis for managing water quality and pollution. The *River Murray Act 2003* provides for the protection and enhancement of the River Murray, and related areas and ecosystems.

Although the NRM Act is sometimes thought of as 'quantity focused', and the Environment Protection Act as 'quality focused', the relationship between quantity (particularly in relation to the suitability of a water resource for use) and quality is well recognised and reflected in the state's approach to managing its water resources.

Water management arrangements are somewhat complex in South Australia. The Department of Environment, Water and Natural Resources (DEWNR) has the lead for managing the state's water resources under the NRM Act, including water allocation planning through the NRM boards. The EPA has the lead responsibility for water-quality management; SA Water is the state's water utility; and the Department of Planning, Transport and Infrastructure manages land-use planning and major infrastructure upgrades that interface with water resources.

Other state agencies with roles relevant to the management and protection of the state's water resources include the Department for Health and Ageing, which has lead responsibility for public health–related issues, and the Department of Primary Industries and Regions (e.g. in relation to biosecurity matters, including those relevant to protecting the state's water resources).

In addition, local government has responsibility for some areas of stormwater management, particularly in relation to flood mitigation, and wastewater management, associated with local council owned wastewater schemes.

The Stormwater Management Authority, a statutory body established under the *Local Government Act 1999*, has a role in facilitating stormwater management. It administers the Stormwater Management Fund, to which the state makes an annual contribution.

A significant number of nongovernment and community organisations, as well as the broader community, are also involved in the management of our water resources.

4.1 Statewide actions

A range of policies and procedures are in place to guide water management across the state.

4.1.1 *Natural Resources Management Act 2004*

Under the NRM Act, a water resource may be 'prescribed' by the state government, beginning a process that requires the development of a water allocation plan (WAP) by the relevant NRM board (for more information about WAPs, see Section 4.2.1). In 2011, the NRM Act was amended to ensure that the use of, and impacts on, water by commercial plantation forestry can be treated in a similar way to irrigation allocations. This places South Australia at the forefront of policy and legislative reform, since it is possibly the first legislation in the world treating irrigation and forestry water impacts in a consistent way. It creates new tools to manage forest water, including an improved forest permit system and a forest water licensing scheme. These tools aim to ensure that water resources in a particular region can be optimally managed, in consultation with the local community.

4.1.2 Environment Protection (Water Quality) Policy 2003

The South Australian Environment Protection (Water Quality) Policy 2003 (Government of South Australia 2003) is the key regulatory tool in ensuring that water quality is maintained or improved, as appropriate. The policy sets out a statewide approach to the protection of water quality in surface-water, marine and groundwater environments. This policy, together with the *Environment Protection Act 1993*, provides the legislative framework to minimise the risk of contamination, and outlines the appropriate penalties for companies and individuals who do not comply with the legislation. Education of the public and industry is also a key aspect of pollution prevention. The EPA is responsible for enforcing this legislation.

4.1.3 *Water Industry Act 2012*

The *Water Industry Act 2012* (Water Act) is part of the recent modernisation of water industry legislation. The Water Act provides increased security and accountability across the water industry to ensure that water service delivery is safe, reliable, affordable and environmentally sustainable. It aims to recognise industry needs, and to provide greater consumer protection and independent water pricing for the first time. The Act is expected to encourage greater innovation in service provision, including the development of alternative water supplies from stormwater and wastewater.

The Water Act appoints the Essential Services Commission of South Australia (ESCOSA) as the independent regulator for urban and regional water and sewerage services, as in the gas and electricity industries. This gives ESCOSA the power to regulate prices and standards for water and sewerage services. The legislation also allows for an independent Water Industry Ombudsman, along with a Consumer Advisory Committee, to ensure that customers' complaints are investigated.

4.1.4 Water for Good

Underpinning the state's legislative requirements, the government's water security plan to 2050, Water for Good (Government of South Australia 2009), outlines 94 actions to ensure the future availability of water.

Released in 2009, the plan was developed during a time of severe drought. While having a focus on water quantity, it also addresses quality and supports other state initiatives; these include the recommendations of the Adelaide Coastal Waters Study for improving the quality of water discharged into Gulf St Vincent from Adelaide's urban and peri-urban areas.

4.2 Regional actions

A range of regional and local water plans are in place for managing water resources in a more localised context.

4.2.1 Water allocation plans

Water allocation plans (WAPs) are statutory instruments used for various purposes in the administration of the NRM Act to guide the granting of licences to take water, and the transfer of a licence or water allocation. WAPs aim to ensure that an area's water resources are allocated fairly, taking into account the needs of all water users and the environment.

WAPs set the principles or rules under which water can be allocated on water licences. This involves placing limits on how much water can be allocated from each prescribed water resource in the prescribed water resources area. Current science is used to set allocations, and water users, stakeholder groups and the community are consulted to ensure that allocations are fair and equitable. The plans are a 'living' document; they are reviewed at least every five years and, where necessary, amended following a review.

Since the 2008 state of the environment report, progress has been made towards establishing WAPs for a number of water resources, including Mount Lofty Ranges surface water and groundwater, and updating WAPs in some other areas, as provided for under the NRM Act.

The current status of WAPs, as well as the capacity and current and anticipated future demands for South Australian prescribed water resources, is shown in Table 3.

4.2.2 Regional demand and supply statements

Regional demand and supply statements (RDSSs) provide a long-term (40-year) overview of water demand and supply. They provide information on the condition of water resources in a region for drinking and non-drinking quality water. They also list major demands on these water resources and identify expected timeframes for any possible future gaps between demand and supply. Once prepared, RDSSs are reviewed annually as a guide to assist decision-makers in planning for the timing and nature of future demand management or supply options. If an RDSS indicates a shortfall in supply, this obliges the state government to initiate an independent planning process to assess demand or supply options to address the shortfall.

RDSSs are progressively being prepared for each of South Australia's eight NRM regions. RDSSs were released for the Eyre Peninsula region in April 2011 and for the Northern and Yorke region in December 2011.

4.2.3 SA Water long-term plans

Long-term plans are prepared by SA Water to ensure that customers have a secure water supply and that the wastewater treatment plants have capacity to meet potential increases in demand. These regional plans have a 25–30-year timeframe. They provide a proactive approach to planning the strategic direction for augmenting SA Water's assets and guiding investment in new infrastructure, with a focus on ensuring that infrastructure and resources have the capacity to meet future customer requirements.

Since 2008, long-term plans have been released for Eyre Peninsula (November 2008), Kangaroo Island (December 2009), Yorke Peninsula (October 2010) and upper Spencer Gulf (April 2012).

4.2.4 Regional natural resource management plans

Regional NRM plans are prepared by each of the state's eight NRM boards in accordance with the NRM Act. These plans seek to recognise and address water management issues, as part of the overall plan for managing the regional natural resources. In accordance with these plans, the NRM boards undertake a range of activities aimed at improving the sustainability of water resources and preventing contamination. Activities include:

- fencing of springs, creeks and rivers to prevent stock access
- assessing surface water and groundwater and their interactions
- modelling of groundwater and solute transport
- providing support for rehabilitation of groundwater access trenches
- providing advice and education about efficient and sustainable chemical and fertiliser use and other farming practices.

4.3 Specific regional initiatives

The state is also implementing other initiatives that help to promote sustainable water management outcomes in specific regions.

4.3.1 Murray–Darling Basin salinity management

Significant work has already occurred on salinity management in the Murray–Darling Basin. South Australia is a signatory to the Murray–Darling Basin Authority's Basin Salinity Management Strategy 2001–2015 (MDBA 2001) and undertakes works to reduce the salinity impact of past and present actions, reporting annually on progress to the authority. Such activities are often undertaken in collaboration with the community, as outlined in locally based management plans.

Within South Australia, actions to control salinity within the River Murray include:

- salt interception schemes
- improving irrigation efficiency
- revegetation
- salinity zoning and planning
- altering land use and modernising farming systems
- securing and managing sufficient water flow to dilute and flush salt from the system.

4.3.2 Great Artesian Basin Sustainability Initiative

The Great Artesian Basin Sustainability Initiative (GABSI) is a partnership between the Australian and state governments to conserve and manage groundwater across the Great Artesian Basin.

Until the 1950s, artesian water brought to the surface under natural pressure by the drilling of wells was allowed to flow uncontrolled into open drains and creeks for distribution to stock. However, even in well-maintained drains, water was wasted through evaporation and seepage. This threatened the health of groundwater-dependent ecosystems and continued access to artesian water by pastoralists.

Under GABSI, work is under way to repair uncontrolled artesian wells and replace open earthen drains with piped water reticulation systems. Recent work has seen the decommissioning of the Big Blythe well, preventing the annual release of more than one billion litres of water and almost 2500 tonnes of salt.

4.3.3 South East REFLOWS project

The REFLOWS project has involved the construction of 90 kilometres of floodways to reconnect the lower and upper South East NRM region, recreating the historic south to north movement of water in the region and delivering fresh water to wetlands and watercourses in the upper South East (Figure 6). The REFLOWS floodway enables water from high-rainfall catchments in the south to be diverted to where it is most needed in the upper South East environment in the north. In high-flow years, REFLOWS water may reach the Coorong, and help to reduce salinity in the lagoons.

The REFLOWS floodway complements the network of more than 620 kilometres of drains that were constructed under the recently completed Upper South East Dryland Salinity and Flood Management Program. The project has been funded by the Australian and South Australian governments.

Figure 6 REFLOWS project location

4.3.4 Mount Lofty Ranges Waste Control Program

Failing or faulty onsite wastewater treatment systems in the Mount Lofty Ranges watershed are currently being targeted by the Mount Lofty Ranges Waste Control Program. The program is designed to improve the maintenance of existing systems, upgrade to a more effective system, or connect onsite systems to a community wastewater management scheme or a sewer network. The program is being delivered by the Adelaide Hills Council, in partnership with the Adelaide and Mount Lofty Ranges NRM Board, SA Water, the South Australian Department for Health and Ageing, and the EPA.

4.3.5 Lake Eyre Basin

The Lake Eyre Basin Agreement establishes a cooperative framework for the Australian, Queensland and South Australian governments to jointly address the management of water and related natural resources of the cross-border rivers within the Lake Eyre Basin Agreement area. The agreement recognises the ecological importance of the Lake Eyre Basin, and its social and economic values (see page xviii).

The Lake Eyre Basin Ministerial Forum requires a review of the condition of all watercourses and catchments within the Lake Eyre Basin Agreement area.

Methodologies and techniques used to assess other river systems are not necessarily applicable or appropriate for the Lake Eyre Basin rivers and catchments. The vastness and extreme flow variability of arid rivers means that a broadscale and long-term approach is required to understand how these systems work. Ongoing habitat and wetlands surveys are contributing to our understanding of the ecology of these arid river systems. These projects have also identified many gaps in our knowledge of the dynamics of arid rivers and the kinds of information required to assess and maintain their health.

4.4 Urban water management

Considerable challenges face South Australian urban areas in providing safe and secure water supplies, and managing urban stormwater and wastewater.

The Water for Good plan (Government of South Australia 2009) aims to transition South Australia to a 'water-sensitive state'. It describes many actions that are relevant to the Adelaide region and other population centres of South Australia, including actions to:

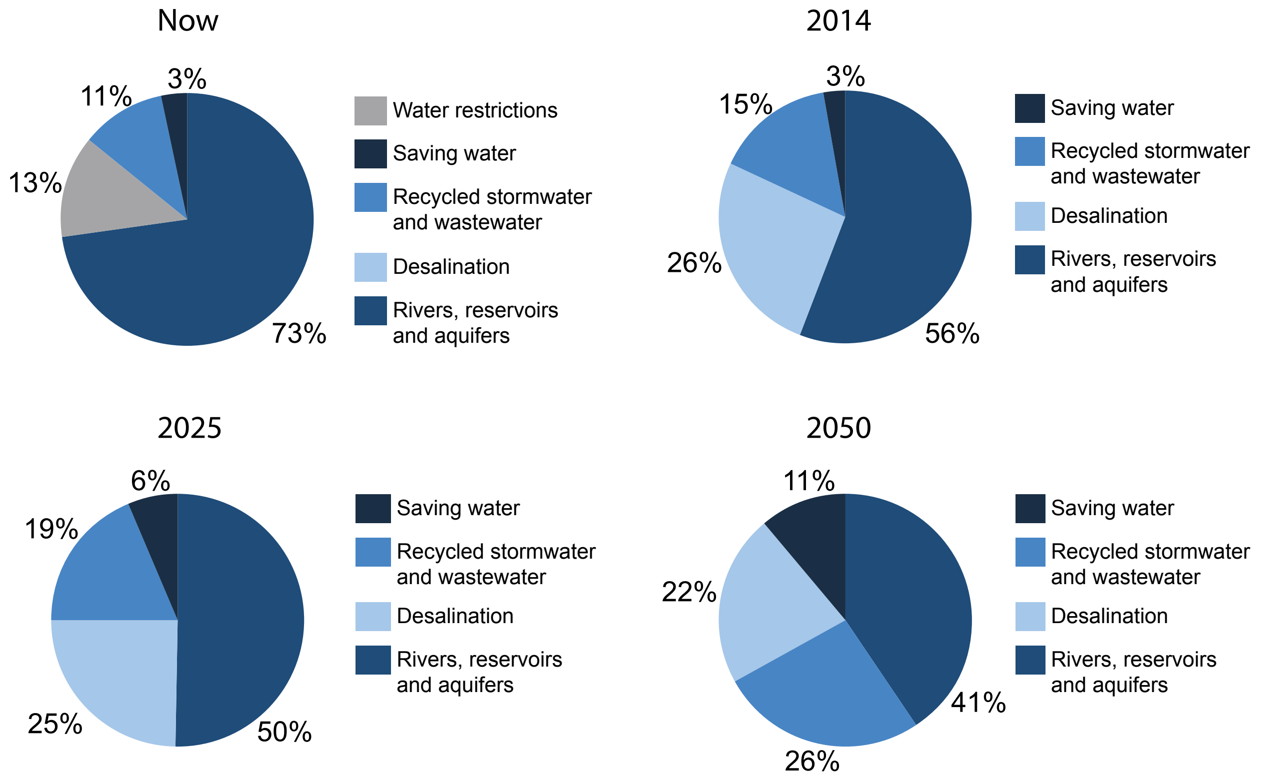
- increase the state's stormwater harvesting capacity
- identify and develop new stormwater projects
- develop master plans for stormwater and wastewater for Greater Adelaide
- develop water quality improvement plans for the Mount Lofty Ranges Watershed priority areas to ensure that new developments have a neutral or beneficial impact on water quality
- comprehensively review current management and protection of the Mount Lofty Ranges Watershed
- work with the Murray–Darling Basin Authority and others to ensure a healthy, working River Murray
- complete WAPs for key areas of the Mount Lofty Ranges
- develop environmental values for priority water bodies, including those in the Mount Lofty Ranges and Adelaide's coastal waters
- introduce targets for water-sensitive urban design (see Section 4.4.3), and develop and implement the best regulatory approach for South Australia to mandate this approach.

A key aim of Water for Good is to increase the state's water security and to provide environmental and other benefits from diversified water supply sources (Figure 7). In recent years, there has been growing interest in stormwater and wastewater reuse, and use of desalinated groundwater and sea water.

4.4.1 Stormwater management

The Stormwater Management Authority (SMA) was established on 1 July 2007 as a consequence of the *Local Government (Stormwater Management) Amendment Act 2007*. The SMA operates as the planning, prioritising and funding body in accordance with the Stormwater Management Agreement between the State of South Australia and the Local Government Association. A key element is the development of stormwater management plans for catchments or specified areas. The purpose of these plans is to ensure that stormwater management is addressed on a total catchment basis. The relevant NRM board, various local government authorities and state government agencies responsible for the catchment work together to develop, implement and fund a coordinated and multi-objective approach to management of stormwater for the area.

The capacity for stormwater harvesting and wastewater reuse is increasing progressively. A joint application by the state and local governments to the Australian Government has been successful in attracting funding for seven major stormwater projects in Adelaide, which were announced in late 2009; another was announced



Source: Government of South Australia (2009)

Figure 7 Greater Adelaide's water supplies under Water for Good

in 2010. In 2012, three further council-sponsored projects were successful in attracting Commonwealth funding. These projects will see more than $150 million invested in stormwater harvesting and use projects by 2013. Most of these projects address water quality improvement and community amenity, in addition to water reuse.

The state released a Stormwater Strategy in 2011 (Government of South Australia 2011b), as a road map for achieving the stormwater-related actions in Water for Good. A key action is the development of an integrated blueprint for urban water for Greater Adelaide by 2014. The blueprint will ensure that master planning initiatives for stormwater and wastewater in Water for Good are integrated. As well, investments in stormwater and wastewater infrastructure will be undertaken within a framework that ensures the optimal management, development and use of these resources, in conjunction with the region's other available water resources. The blueprint will take account of the social, environmental and economic benefits that can be delivered under an integrated regional water planning and investment framework. It will also consider planning and the prioritising of water-related infrastructure.

The Adelaide Coastal Waters Study (Fox et al. 2007) found that sediments and nutrients from urban stormwater, along with industrial and wastewater discharges, impact negatively on Adelaide coastal waters. The Adelaide Coastal Water Quality Improvement Plan (ACWQIP) (EPA 2013) sets targets to reduce discharges from industry, wastewater treatment plants and stormwater, to improve coastal water quality and, over time, allow the return of seagrass and improvement in reef condition.

The ACWQIP identifies eight strategies for implementation, which have been developed in partnership with other agencies, local government and communities. Much of the focus of the ACWQIP is on improved stormwater management across the Adelaide region, with the aim of reducing the nutrient and sediment loads affecting Adelaide's coastal waters. The stormwater focus of the ACWQIP is linked to key government policies, including the 30-Year Plan, Water for Good, and the Adelaide and Mount Lofty Ranges Natural Resources Management Regional Plan.

4.4.2 Wastewater management

Capacity for wastewater reuse is being increased. Recent projects include the following:

- Glenelg to Adelaide Parklands Recycled Water Project—this project will provide extra treatment facilities, a 10-kilometre pipeline from Glenelg to Adelaide's central business district, and around 30 kilometres of pipeline around the Park Lands. It will have the capacity to provide an extra 3.8 billion litres of recycled water for reuse.
- Southern Urban Reuse Project—the South Australian and Australian governments are investing $62.6 million in a project to supply 1.6 billion litres of treated wastewater per year to new housing developments in Adelaide's southern suburbs.
- Christies Beach Wastewater Treatment Plant upgrade—the plant currently provides about 3 billion litres of treated wastewater each year for horticultural purposes. The $272 million upgrade of the plant will increase the plant's capacity and improve the quality of the treated wastewater being produced. This will enable further opportunities to increase reuse and reduce the nutrient load discharged to the environment.

In addition to Adelaide-based projects, there has been significant progress in developing stormwater and wastewater reuse in many regional areas. Examples are the Statewide Wastewater Recycling Project, an initiative of South Australian local government, which has seen many South Australian local councils implement water recycling schemes associated with council-owned community wastewater management schemes. In addition, many local councils have undertaken water projects through other water conservation, stormwater and wastewater initiatives, such as those under the Statewide Cities and Towns Project (DSEWPaC 2012). Local councils have also supported efforts to conserve water and improve water-use efficiency.

Point-source discharges from wastewater treatment plants, community wastewater management systems and industry are licensed by the EPA. Industries responsible for point-source discharges are expected to develop continuous improvement programs to reduce and eventually cease discharging effluent to the environment.

Inputs of nutrients and sediments from industrial, wastewater and stormwater discharges were found by the Adelaide Coastal Waters Study (Fox et al. 2007) to be the main cause of poor water quality and seagrass loss along the Adelaide coastline. The ACWQIP is based on these findings. The EPA's role under strategy one in the ACWQIP is focused on achieving nutrient and sediment reductions for discharges from industry and wastewater treatment plants to Adelaide's coast. The EPA is the lead agency seeking reduction of nutrients and sediments from point-source discharges through licensing conditions.

Christies Beach Wastewater treatment plant
Barbara Hardy Institute

4.4.3 Water-sensitive urban design

Water for Good builds on South Australia's Strategic Plan target to increase the state's recycled stormwater harvesting capacity to 35 gigalitres by 2025 (from 12.4 gigalitres in May 2012). It acknowledges the role that water-sensitive urban design (WSUD) can play in the development of creative, water-sensitive urban communities. Water for Good includes actions to introduce WSUD targets and support greater uptake of WSUD in South Australia. In 2011, the state government endorsed the release of a WSUD consultation statement, which outlined possible statewide WSUD targets to address water conservation, and the quantity and quality of run-off. Feedback on proposals in the WSUD consultation statement are assisting the development of WSUD policy recommendations for consideration by the state government.

The 30-Year Plan supports new urban development and redevelopment that contribute to sustainable management of water resources, and includes a range of policies to support WSUD. Not only will broadscale application of WSUD across the Adelaide region benefit urban waterways, including streams and wetlands, but it will also have benefits in reducing the impact of sediment and nutrient loads from stormwater on Adelaide's coastal waters. The ACWQIP promotes the catchment-to-coast application of WSUD to improve water quality from stormwater, and reduce sediment and nutrient loads reaching the coast. Implementation of WSUD requires coordinated efforts by many groups, including the Adelaide and Mount Lofty Ranges NRM Board, local governments, a range of state agencies and local communities. Implementation of the ACWQIP will include capacity building to promote the uptake of WSUD across Adelaide.

The EPA, NRM boards, other state agencies and some local councils also promote WSUD and best-practice stormwater management guidelines in planning new developments. This is expected to provide water quality benefits for local urban streams and wetlands in the future.

4.5 Knowledge underpinning planning and policy

Science and monitoring are needed to understand the extent to which the state's water resources are being sustainably managed, and to underpin policy development and decision-making to achieve sustainable water use. Some key initiatives that have contributed to improving our understanding of the state's water resources are described below.

4.5.1 Goyder Institute for Water Research

The Goyder Institute for Water Research was established in 2010 to support the security and management of South Australia's water supply and contribute to water reform in Australia. It is a partnership between the South Australian Government through DEWNR, CSIRO, Flinders University, the University of Adelaide and the University of South Australia. The institute has a $50-million, five-year research program that aims to provide independent scientific advice to inform good policy decision-making, identify future threats to water security and assist in an integrated approach to water management.

The institute's research focuses on the themes of urban water, water for industry, environmental water and climate change. Desired outcomes that support policy are identified in cooperation with government agencies and other relevant stakeholders.

In 2010, the Goyder Institute was asked by the South Australian Government to review the science that had been used in the *Guide to the proposed Basin Plan* (MDBA 2010). This analysis considered whether the proposed sustainable diversion limits would meet the South Australian Government's environmental water requirements, and assessed some of the socio-economic implications for the state. When the proposed Basin Plan was released for public consultation at the end of 2011, the South Australian Government was able to evaluate the consequences of the proposed water recovery scenario itself. In the interests of sound governance and quality assurance, the Goyder Institute was requested to provide expert judgement about the adequacy of the methods used by the South Australian Government in its evaluation of the proposed plan, to provide advice about perceived limitations in development of the plan, and to provide advice about the ecological benefits, risks and opportunities of the proposed water recovery scenario.

The Goyder Institute has also recently published reports of relevance to other areas of water resource management in the state. These include a study of approaches to modelling interactions between surface water and groundwater around drains in the south-east, and an assessment and recommendations for WSUD targets relevant to South Australian circumstances. Publications are available at: www.goyderinstitute.org/publications.

4.5.2 Department of Environment, Water and Natural Resources

DEWNR was established in 2012 through the merger of the former Department of Environment and Natural Resources and the Department for Water. It is the lead agency for policy, management and administration of the state's water and other natural resources. A key role of DEWNR is to undertake monitoring and improve knowledge of the state's water resources, including the potential implications of climate change.

DEWNR monitors, investigates and prepares reports on prescribed and nonprescribed water resources. Recent science and monitoring initiatives from DEWNR (including some commenced by the former Department for Water) include the following:

- analyses of Murray–Darling Basin Authority modelling scenarios to inform the state government's response to the proposed Murray–Darling Basin Plan (Government of South Australia 2012b)—these include hydro-ecological analyses of the proposed Basin Plan with respect to the South Australian section of the River Murray and its floodplains, and the Coorong, Lower Lakes and Murray mouth.
- preparation of groundwater status reports—these provide a snapshot of the current status of groundwater resources. They include information on regional hydrogeology, groundwater-dependent ecosystems and groundwater monitoring sites (including water level and salinity trends), and

an assessment of the status of the groundwater resource at current climatic and use conditions. Groundwater status reports can help decision-making about sustainable groundwater allocations, identify emerging trends in groundwater resource condition, identify risks to water supplies and determine whether further monitoring is needed.

- a Groundwater Program—this provides information to assist natural resource managers and regional industries, with a valuable insight into future opportunities to access groundwater resources from regions that are currently nonprescribed. To date, DEWNR has published nonprescribed groundwater assessments for the NRM regions of Alinytjara Wilurara, Eyre Peninsula, Kangaroo Island, Northern and Yorke, and South Australian Arid Lands.
- the Impacts of Climate Change on Water Resources project—this entails a staged approach to assessing the implications of climate change for South Australia's water resources (both groundwater and surface water). Work to date under this project has included
  - an assessment of risk and prioritisation of South Australia's water resources for subsequent modelling of climate change impacts
  - investigations of downscaling methodologies as the basis of climate impact modelling
  - investigations of the impacts of climate change on the prescribed surface-water and groundwater resources of the Northern and Yorke NRM region, and on the prescribed groundwater resources and Tod catchment in the Eyre Peninsula NRM region.

4.5.3 Environment Protection Authority aquatic ecosystem assessments

The EPA prepares aquatic ecosystem reports on the health of South Australia's creeks and lakes. These are designed to:

- provide a statewide monitoring framework for streams that cycles through the NRM regions with sufficient frequency to allow for regular state of the environment reporting
- describe aquatic ecosystem condition in a manner that is suitable to inform public understanding
- identify the key pressures and management responses
- provide a useful reporting format that can support environmental decision-making within government, the community and industry.

Each stream site is assessed using a descriptive model for interpreting change in aquatic ecosystems in relation to increasing levels of disturbance. The assessment uses a range of science-based approaches and models that capture the biological, chemical and physical changes occurring in South Australia's streams and lakes.

4.5.4 WaterConnect

The state's key water information has been brought together under a single website, WaterConnect: www.waterconnect.sa.gov.au.

The website provides access to the most current information about South Australia's water resources and water activities, including:

- information about current water permits, licences, allocations and approvals
- groundwater status reports
- aquatic ecosystems reports
- technical publications about the state and condition of specific water resources, including published reports on climate change impacts.

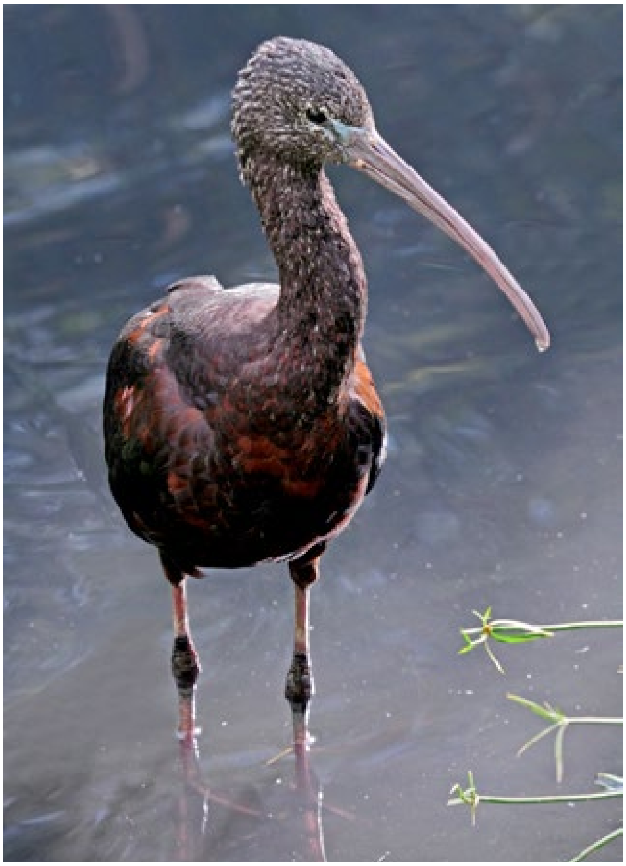


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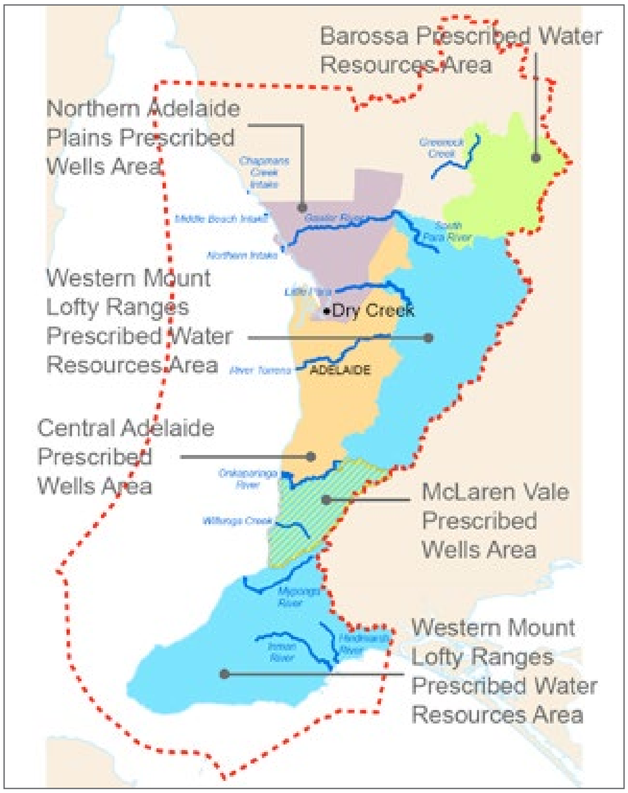
Table 3 South Australia’s prescribed water resources: status of water allocation plans, supply capacity and current demand by natural resource management region

Adelaide and Mount Lofty Ranges		
Prescribed water resource	Resource capacity (ML/year)	Current demands (ML/year)
Barossa PWRA	27 147	9 109
McLaren Vale PWA	6 560	2 530
Northern Adelaide Plains PWA	26 500	11 100
Western Mount Lofty Ranges PWRA	356 731	206 500
Central Adelaide PWA		
Chapmans Creek Intake		
Dry Creek PWA		
Little Para prescribed watercourse	No plan	
Middle Beach Intake		
Northern Intake		

ML = megalitre; PWA = prescribed wells area; PWRA = prescribed water resources area



Eyre Peninsula		
Prescribed water resource	Resource capacity (ML/year)	Current demands (ML/year)
Musgrave PWA	1 786	96
Southern Basins PWA	8 136	5 631

ML = megalitre; PWA = prescribed wells area

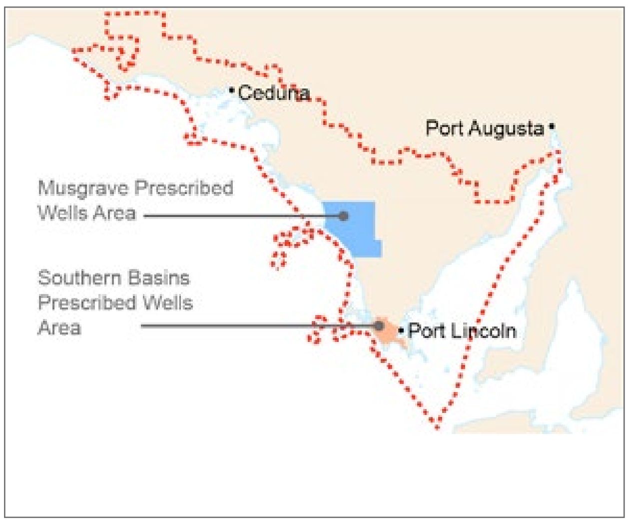
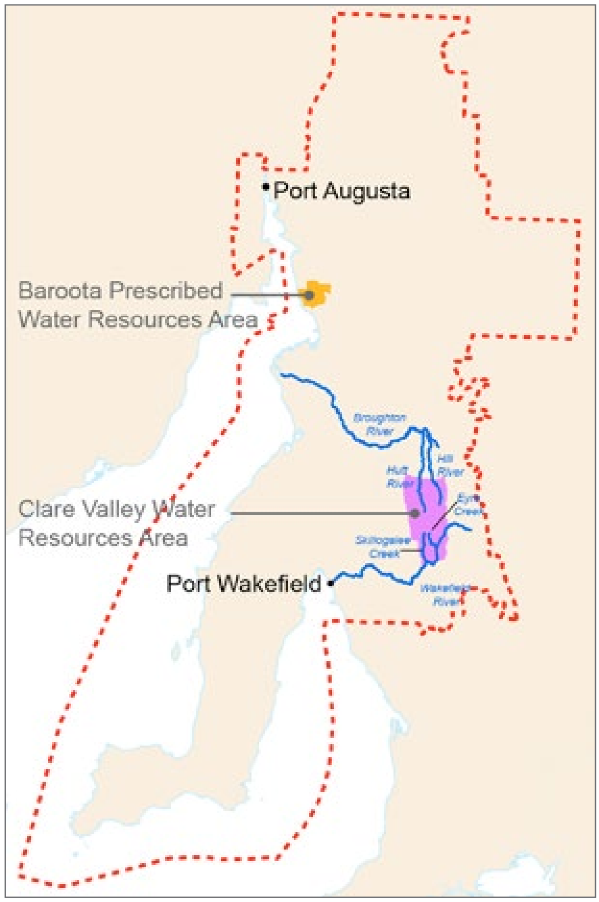


Table 3 continued

Northern and Yorke		
Prescribed water resource	Resource capacity (ML/year)	Current demands (ML/year)
Clare Valley PWRA	20 350	6 100
Baroota PWRA	Plan under way	

ML = megalitre; PWRA = prescribed water resources area



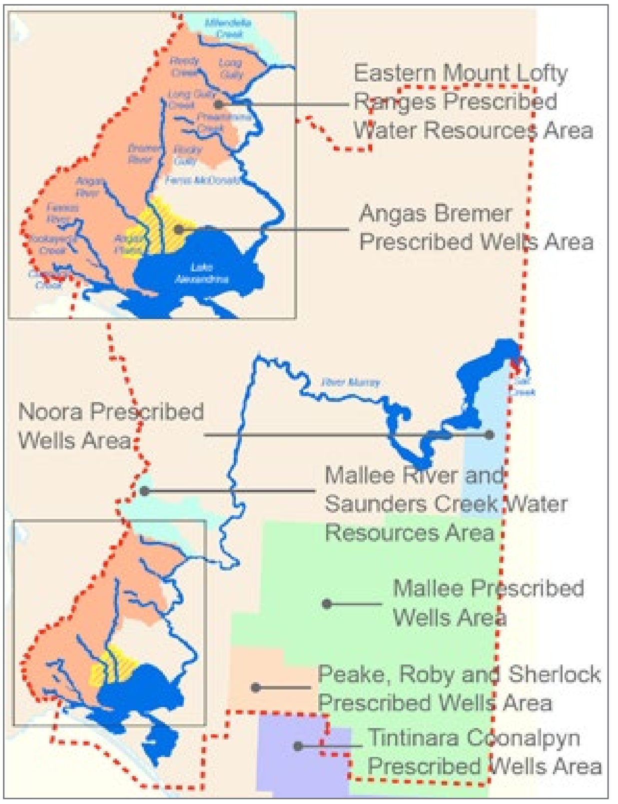
South Australian Arid Lands		
Prescribed water resource	Resource capacity (ML/year)	Current demands (ML/year)
Far North PWA	127 750	69 869

ML = megalitre; PWA = prescribed wells area

Table 3 continued

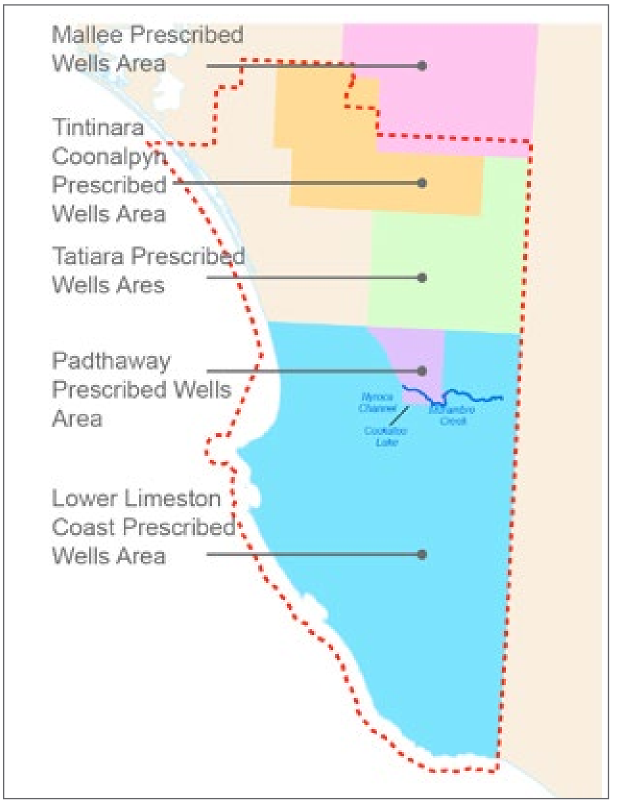
South Australian Murray–Darling Basin		
Prescribed water resource	Resource capacity (ML/year)	Current demands (ML/year)
Eastern Mount Lofty Ranges PWRA	188 404	56 540
Mallee PWA	61 300	24 365
Marne Saunders PWRA	14 605	4 106
Noora PWA	5 138	28
Peake, Roby and Sherlock PWA	2 489	1 820
River Murray prescribed watercourse	6 592 000	573 800
Angas Bremer PWA	To be included in Eastern Mount Lofty Ranges water allocation plan	

ML = megalitre; PWA = prescribed wells area; PWRA = prescribed water resources area



South East		
Prescribed water resource	Resource capacity (ML/year)	Current demands (ML/year)
Lower Limestone Coast PWA	756 487	140 587
Morambro Creek	870	200
Padthaway PWA	55 096	19 404
Tatiara PWA	151 356	55 437
Tintinara Coonalpyn PWA	109 100	22 215

ML = megalitre; PWA = prescribed wells area



5 What can we expect?

Although the process to reverse many historical impacts on the state's water resources and associated ecosystems is challenging, significant progress is being made. The foundational elements are already in place or are being implemented. This gives cause to believe that projected population and economic growth can be significantly decoupled from future pressures facing the state's water resources. The elements include:

- current legislative and planning frameworks that promote sustainable water resource management (within an integrated NRM framework) and build on existing environmental protection efforts
- scientific research, monitoring, assessment and reporting on the condition of water resources and water-dependent ecosystems
- significant investment in water diversification projects, including stormwater and recycled wastewater schemes in metropolitan Adelaide and regional South Australia to deal with long-term variability in supply and demand, as well as responding to climate effects.

Recent work to improve the way in which the results from monitoring and assessment programs are communicated to the wider public, industry and government is also expected to assist in prioritising works, protecting waterways and helping us to understand the time it will take to improve the condition of our more degraded waterways.

5.1 Issues and priorities

A key uncertainty in this positive outlook is the complex hydrological consequences of climate change, with its anticipated impact on water resources and water-dependent ecosystems. Impacts may include reduced stream flows and groundwater recharge as a result of forecast reductions in overall rainfall, and increased occurrences and severity of droughts and floods, which can affect water users and water-dependent ecosystems.

It is therefore vital to continue to monitor and evaluate the status of the state's water resources and ecosystems. Also essential is scientific research to advance our knowledge of climate change, and the opportunities for mitigation and adaptation measures that are necessary to respond to climate change and other significant risks described in this chapter. Key management priorities over the coming three to five years include:

- continued investment in building knowledge of our water resources and risks, to underpin policy development and to focus management
- implementation of the Murray–Darling Basin Plan and associated programs, such as the Commonwealth Water Recovery Strategy, in South Australia and across the Basin
- ongoing development of water allocation plans for prescribed water resources across the state
- ongoing investment to diversify the state's water supplies
- addressing issues regarding the interface between mining development and water
- development of water quality improvement plans for key areas of the state—in particular, the ACWQIP and the Adelaide and Mount Lofty Ranges Watershed Quality Improvement Plan
- development of the blueprint for urban water as an integrated urban water management plan for Greater Adelaide (the first for a capital city in Australia)
- ensuring water security for remote communities and developing approaches to ensure appropriate access to water for these communities.
- development and use of strategic forecasting and monitoring capabilities for water resources
- use of markets and technology (such as real-time data apps) to improve the availability of information and access to data for government, industry and communities.

Major priorities and emerging issues to help improve the ecological condition of the state's inland waters relate to improving farm management practices so that nutrients and sediments are retained in the landscape, rather than being washed into streams and wetlands. This may involve a range of social, economic and environmental approaches to support a wider uptake of fencing, stock exclusion, revegetation and other programs to manage farmland more effectively than in the past.

Further work also needs to be done to understand and design appropriate buffers to effectively trap nutrients and sediments throughout the range of environments in the state, particularly during prolonged drought and high-rainfall periods.

Urban streams will always be difficult to improve, but recent research is helping us to understand the role of large stormwater inflows in the degradation of local stream environments. Future work on this and other stream restoration programs will help to define strategies to minimise human disturbances to urban and peri-urban rivers and creeks. Although some large-scale interventions may be required to improve stream conditions, it is also hoped that increased implementation of water-sensitive urban design practices will reduce stormwater flooding.

An anticipated mining boom in South Australia, and related activities, are expected to increase the demand for water resources in those areas. This will require increased consideration and priority to be given to assessing the potential impacts on both the quantity and quality of water resources, and providing an appropriate management and regulatory regime so that such developments occur in an appropriate manner.

The South Australian Government's 2013 Economic Statement describes the potential of unconventional gas to transform energy supply, provide energy security and create a new source of export income (Government of South Australia 2013). It is anticipated that there will be increased exploration of, and production from, a range of unconventional gas prospects in South Australia during the next reporting period (DMITRE 2012). These projects include a range of shale gas, tight gas and coal-seam gas deposits across a number of basins in South Australia. A number of state government agencies are working together in a co-regulatory approach to minimise the potential impacts of these activities on water resources. In addition, the recent National Partnership Agreement on Coal Seam Gas and Large Coal Mining Development will ensure that future regulation of coal-seam gas is informed by substantially improved science, as well as independent expert advice.

The government's focus on Premium Food and Wine from Our Clean Environment (Government of South Australia 2012c), together with a growing population, will be key drivers for the suite of measures aimed at managing South Australia's waters so that they can sustainably provide the ecosystem services needed to underpin the state's social, environmental and economic wellbeing in the face of increasing and serious pressures.

Onkaparinga River near Old Noarlunga

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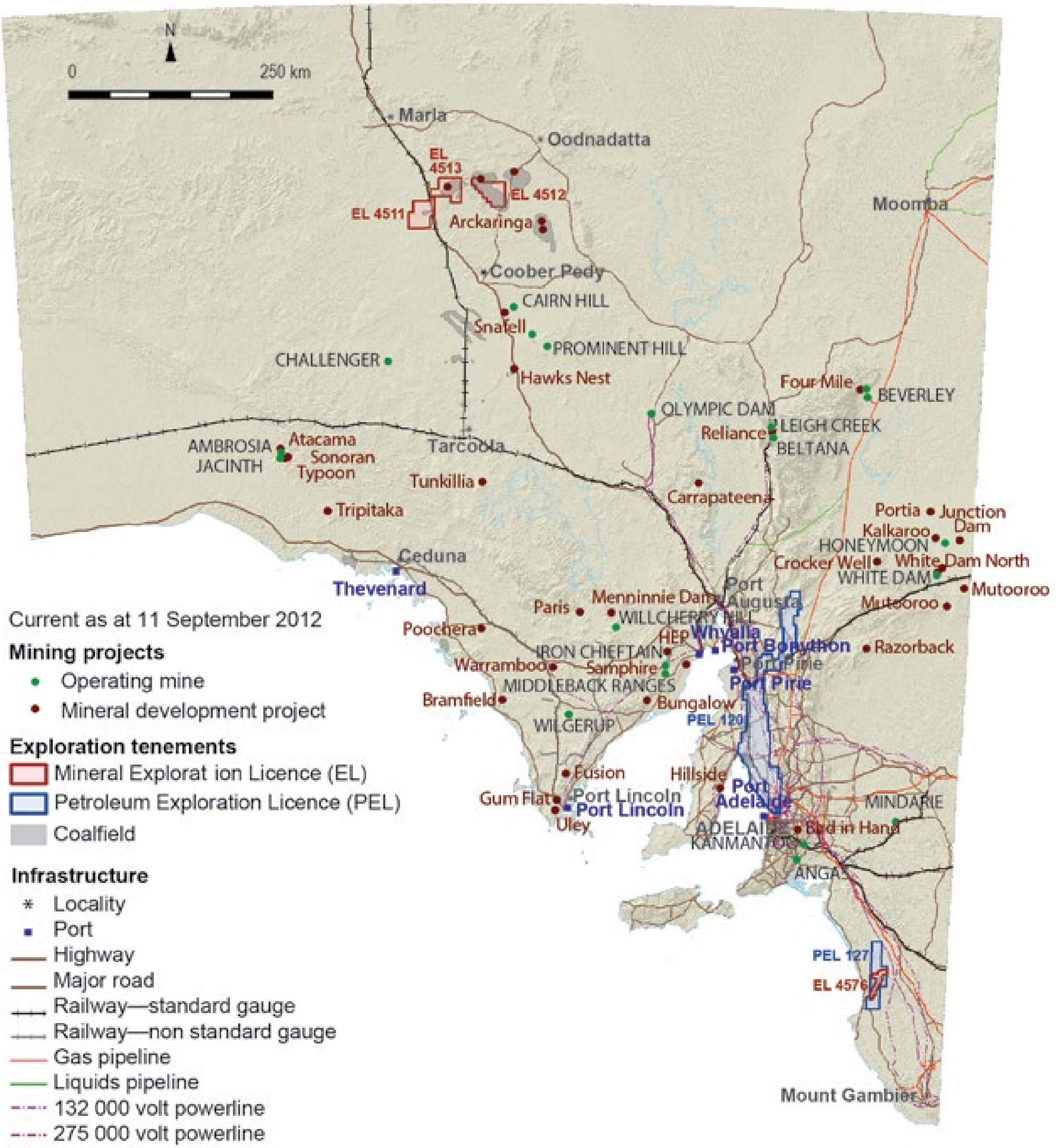

Source: DMITRE (2012)

Figure 8 Location of oil and gas infrastructure, mining projects and coal gasification projects in South Australia

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