

State Plan target

By 2015, there is an improvement in the ability of groundwater systems to support groundwater dependent ecosystems and designated beneficial uses.

The intent of the target as defined by the Natural Resources Commission (NRC) is to 'ensure that groundwater continues to support ecosystem function, human health and economic activity'.

Background

The target is broad-ranging in terms of the values that it is attempting to improve. The three key areas addressed by the target are outlined below:

Ecosystem function

Ecosystems that are fully or partially reliant on groundwater to maintain ecosystem function are known as groundwater dependent ecosystems (GDEs). These occur across both surface and subsurface landscapes and are highly variable. GDEs have their species composition and natural ecological processes determined by groundwater (ARMCANZ & ANZECC 1996).

A detailed technical report describes the methods used to derive the information contained in this report. At the time of publication of the *State of the catchments (SOC) 2010* reports, the technical reports were being prepared for public release. When complete, they will be available on the NOW website: www.water.nsw.gov.au.

Note: All data on natural resource condition, pressures and management activity included in this SOC report, as well as the technical report, was collected up to January 2009.

GDEs are classified into six broad types:

- karst and caves
- groundwater dependent wetlands
- aquifers
- base flow rivers and streams
- terrestrial vegetation
- estuarine and near-shore marine ecosystems.

Human health

This element of the target refers to the maintenance of beneficial uses of groundwater by preventing deterioration in groundwater quality or contamination by the pollutants. Groundwater pollution can take many forms, ranging from saltwater intrusion and the release of such matrix elements as iron and arsenic from over-extraction, to contamination from pollution events (eg chemical spills, leakages, or contaminated runoff into poorly constructed bores).

Economic activity

Maintenance of a range of beneficial uses (as defined by the NRC) is achieved by keeping groundwater extraction at sustainable levels. This provides a level of security of supply and decreases the risk of contamination and ecological harm occurring from over-extraction.

Within the Lower Murray Darling region there are alluvial, fractured rock and porous rock aquifer province groundwater management areas (GWMAs). Table 1 identifies the GWMAs in the region. The locations of the GWMAs are shown in Figure 1.

Table 1 GWMAs in the Lower Murray Darling region

Alluvial GWMAs	Fractured rock GWMAs	Porous rock GWMAs
Lower Darling Alluvium	Adelaide Fold Belt	Western Murray
Lower Lachlan Alluvium		

There is minimal use of groundwater in the Lower Murray Darling region due to the high groundwater salinity. The only low salinity groundwater is in the Lower Darling Alluvium GWMA, which is a freshwater lens associated with the Darling River. It is used to supplement irrigation water from the Darling River during periods of low water allocation to irrigators.

The majority of groundwater used in the region is for stock and domestic purposes, mining operations and salt interception schemes.

Saline groundwater has naturally leaked into the River Murray. However, land-use change and river regulation have caused shallow groundwater levels on the River Murray floodplain. This has caused accessions of highly saline groundwater into the River Murray, and is impacting on floodplain ecosystems and GDEs.

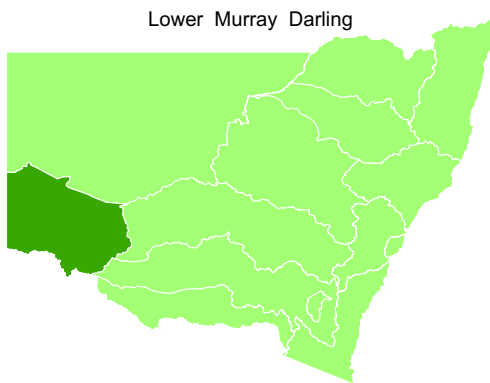
There are three salt interception schemes in the region preventing saline groundwater from entering the River Murray. The schemes are located at Mallee Cliffs, Buronga and Rufus River

near Lake Victoria. The schemes consist of a number of groundwater bores that extract the saline groundwater prior to it entering the river. The saline water is piped to evaporation basins.

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) has completed an assessment of the sustainability of the surface and groundwater systems at a catchment scale as part of the Murray–Darling Basin Sustainable Yields Project. The assessment was based on 18 regions representing the major tributaries of the Murray–Darling Basin including the Murray region. This report can be viewed at www.csiro.au/partnerships/MDBSY.html.

The saline groundwater systems in the region support a number of groundwater dependent ecosystems (GDEs), and are likely to support various terrestrial vegetation ecosystems. The identification and monitoring of GDE pressures and condition is in its infancy. A desktop study is currently identifying high priority GDEs across the state. No high priority sites have yet been identified in this region.

Map of the catchment



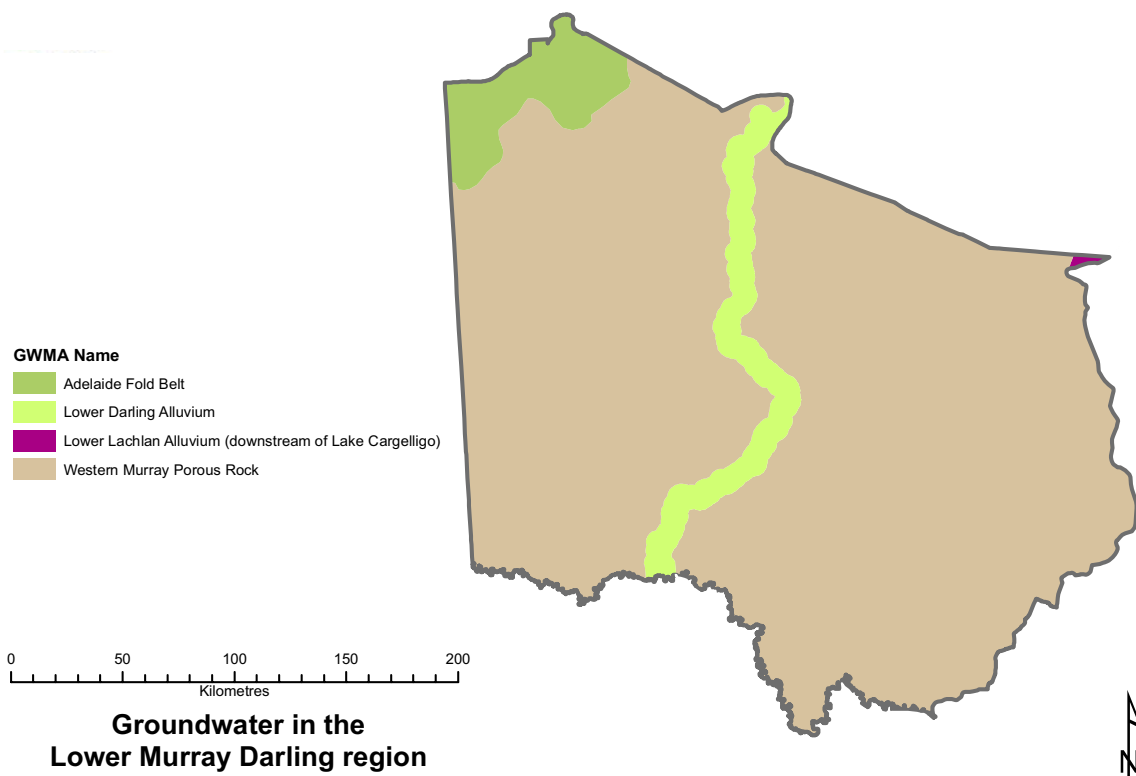


Figure 1 Lower Murray Darling region groundwater management areas

Assessment

The assessment of condition and pressure for the groundwater aquifers in the region has been based on the GWMA. The assessment focuses on the whole of each GWMA, including the areas extending beyond the Lower Murray Darling region.

In the Lower Murray Darling region, groundwater levels are monitored in irrigation areas, in the River Murray floodplain, in the vicinity of the salt interception schemes, and at Lake Victoria and Menindee Lakes. The objective is to monitor the groundwater behaviour in the vicinity of these assets.

The assessment of condition and pressure relative to the target has been based on both available information and expert opinion within the NSW Government. Seven indicators were used to assess both condition and pressure. Of those seven indicators, one was quantifiable for both condition and pressure using available information. The long-term annual average extraction limit (LTAEL) is the proportion of the long-term average annual recharge of water to the groundwater system available for extraction. The condition indicator quantified is the ratio of the amount of groundwater actually extracted and used in a given year compared with the LTAEL. The pressure indicator quantified is the ratio of the total annual entitlements for extraction held by licence holders compared with the LTAEL. Low ratios for these indicators would result in a ranking of 'very good' for condition and 'very low' for pressure.

The other six indicators used for assessing condition and pressure were determined using expert opinion, as current monitoring of aquifer systems in NSW does not provide sufficient data for more comprehensive analysis.

Condition

In addition to the quantifiable indicator of extraction vs LTAAEL, the six other indicators of condition used to assess each groundwater source within the Lower Murray Darling region are described in Table 2.

Table 2 Description of condition indicators

Indicator	Description
Extraction vs LTAAEL	The total annual usage compared with the LTAAEL available for extraction
GDE condition	The condition of GDEs in the region, in terms of their access to the amount and quality of groundwater they require
Landscape condition	The condition of the wider landscape in terms of potential changes caused by land-use to groundwater quality and the volume of water available for recharging the aquifer: Increased recharge causes groundwater levels to rise, which can have an impact on the productivity of agriculture and the condition of urban infrastructure. Taken together, these measures can be used to make an assessment of landscape condition
Regional groundwater levels	Change in regional groundwater levels from the influence of extraction: Where groundwater levels are not monitored, changes in the duration of pumping time that groundwater is available for basic landholder access and for licensed users can be used as a surrogate
Local groundwater levels	Change in local groundwater levels from the influence of extraction
Groundwater quality	Groundwater quality, as measured by the following: <ul style="list-style-type: none"> • groundwater acidity • groundwater salinity • nutrient concentrations • contamination from heavy metals and hydrocarbons • changes in beneficial use category (resulting from groundwater quality changes) • freshwater/saltwater interface (indicated by electrical conductivity)
Aquifer integrity	The integrity of the aquifer matrix, which can be affected by dewatering and compaction with consequent ground subsidence or upsidence, or by various land-use activities







The GWMA in the Lower Murray Darling region are generally in good to very good condition (see Table 3) but with significant variability. Some of the GWMA are ranked very poor for the GDE condition indicator and poor for the landscape condition indicator. The factors influencing these indicators are river regulation and land-use change. River regulation has reduced the frequency of flood inundation and altered the natural flow of groundwater in the area. The reduction in the frequency of flood inundation prevents the groundwater systems on the floodplain being recharged with low salinity water. Floodplain vegetation is therefore exposed to highly saline groundwater for longer periods of time as well as the accumulated salts within floodplain soils. The

weirs have created fresh groundwater lenses adjacent to the Murray River, which is preventing the natural flow of groundwater in the area, causing shallow saline groundwater levels on the floodplain as the watertable rises. This is further enhanced through additional recharge to the groundwater system caused by the clearing of native vegetation and irrigation.

Groundwater resources in the region are generally not overused. The highest use of fresh groundwater is occurring in the Lower Darling Alluvium GWMA. The level of groundwater use in the region is shown in Figure 2.

Table 3 Groundwater source condition summary

GWMA no. and name	GDE Condition			Landscape Condition			Regional Groundwater Levels			Local Groundwater Levels			Groundwater Quality			Aquifer Integrity			Percentage Use to the LTAEL			GWMA Condition Index
	Condition	Data Confidence	Trend	Condition	Data Confidence	Trend	Condition	Data Confidence	Trend	Condition	Data Confidence	Trend	Condition	Data Confidence	Trend	Condition	Data Confidence	Trend	Condition	Data Confidence	Trend	
012 Lower Lachlan Alluvium	Good	H	?	Fair	M	↑	Good	H	↑	Poor	M	↑	Good	M	?	Good	M	↔	Poor	H	↑	Good
045 Lower Darling Alluvium	Very poor	L	?	Poor	M	↔	Good	H	↔	Good	M	↔	Good	L	?	Good	H	↔	Good	M	↓	Good
612 Western Murray Porous Rock	Very poor	L	?	Poor	M	↔	Good	H	↔	Good	M	↔	Good	L	?	Good	H	↔	Good	M	↓	Good
818 Adelaide Fold Belt Darling	Very poor	L	?	Very poor	M	↔	Good	H	↔	Good	M	↔	Good	L	?	Good	H	?	Good	M	↓	Good

Condition		Trend		Data confidence	
	Very good	↑	Improving	H	High
	Good	↔	No change	M	Medium
	Fair	↓	Declining	L	Low
	Poor	?	Unknown		
	Very poor				
	No data				

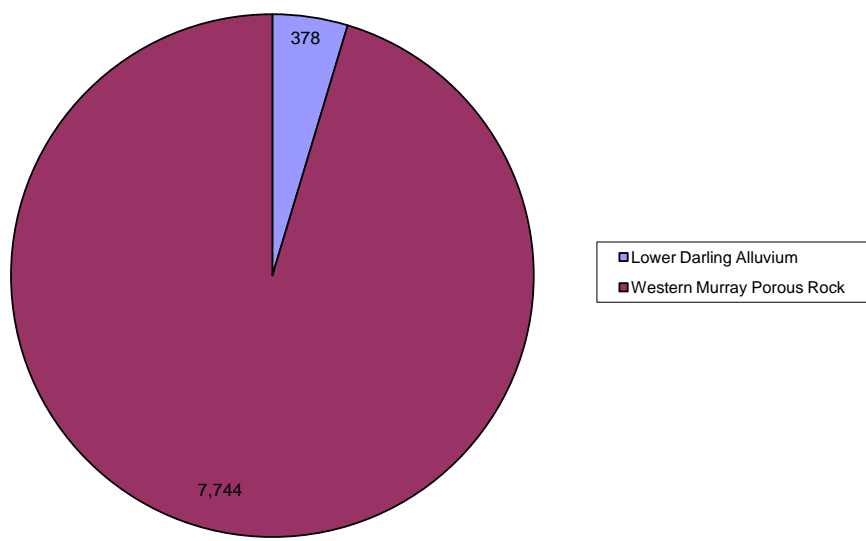


Figure 2 2007-08 metered groundwater use in the Lower Murray Darling region (megalitres)

The two salt interception schemes in the Western Murray porous rock groundwater source at Mallee Cliffs and Buronga reduce the accession of saline groundwater into the River Murray. The volume of water and tonnes of salt intercepted by the Mallee Cliffs and Buronga salt interception schemes are shown in Table 4.

Table 4 Salt interception schemes – salt interception 2007–2008

Salt interception scheme	Volume pumped (megalitres)	Salt load diverted (tonnes)	Average salinity ($\mu\text{S}/\text{cm}$)
Mallee Cliffs	2620	88,870	53,000
Buronga	2830	84,148	46,460

There is limited information on the condition of GDEs in the Lower Murray Darling region. A desktop assessment by the former Department of Water and Energy (DWE 2008) identified no high priority GDEs in the region. The desktop assessment methodology does not currently include terrestrial ecosystems.

There are significant knowledge gaps in relation to groundwater quality and the location and condition of GDEs, especially terrestrial, wetland and base flow GDEs. The major influences on the condition of GDEs in the region are shallow saline groundwater levels from rising watertables and overuse of the freshwater lens in the Lower Darling Alluvium.

Pressures

'Pressures' in this report refers to the potential impacts of human activity on the groundwater system. (NB: This is different for the 'pressure' term as used in the discipline of hydrogeology.)

In addition to the quantifiable indicator of entitlements vs LTAAEL, the six other indicators of pressure used to assess each groundwater source within the Lower Murray Darling region are described in Table 5.

Table 5 Description of pressure indicators

Indicator	Description
Entitlements vs LTAAEL	The total annual entitlements compared with the LTAAEL available for extraction
GDE groundwater availability	The pressure on GDEs from long-term and seasonal changes in groundwater levels, including the influence of changes in groundwater levels in highly connected systems
Land-use pressures	The pressure of land-use on aquifer systems: The indicator also identifies the pressure that shallow groundwater levels place on productive land or urban areas (eg the creation of salinity issues), and combines both these measures into a single indicator






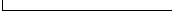
Regional impacts	The extent to which current groundwater extraction could potentially affect regional groundwater levels
Localised impacts	The extent to which current groundwater extraction could potentially affect localised groundwater levels
Groundwater quality impacts	Potential contamination of groundwater from: <ul style="list-style-type: none"> • various discrete or dispersed sources • migration of water of a lower quality • acidification from exposure of acid sulfate soils through the lowering of groundwater levels • changes to seawater and groundwater interfaces from extraction in coastal sand aquifers
Aquifer structure pressures	The effect on groundwater flow systems from compaction, or changes to aquifer material through groundwater extraction and from the removal of aquifers in mining or quarrying activities

The high and very high rankings in Table 6 are associated with land-use change, such as river regulation, irrigation and vegetation clearing. River regulation has reduced the frequency of flooding events that flush salts from the floodplains. Groundwater levels have also risen due to the regulated river systems holding back the groundwater.

The piping of open channels is reducing the impact of irrigation and a measurable change has been observed in groundwater levels. In the Lower Darling Alluvium GWMA, there is the potential that groundwater use may cause a reduction in the size of the freshwater lens surrounding the Darling River. This is managed by monitoring the groundwater levels and salinity in the area, and limiting groundwater extraction to a total of the licence holder’s surface water entitlement.

Table 6 Groundwater source pressure summary

GWMA no. and name	GDE Groundwater Availability			Land-use Pressures			Regional Impacts			Localised Impacts			Groundwater Quality Impacts			Aquifer Structure Pressures			Entitlement/Share Component to the LTADEL			GWMA Pressure Index
	Data Confidence	Trend		Data Confidence	Trend		Data Confidence	Trend		Data Confidence	Trend		Data Confidence	Trend		Data Confidence	Trend		Data Confidence	Trend		
012 Lower Lachlan Alluvium				H	↑		H	↑		H	↔	L	?		M	?		H	↔			
045 Lower Darling Alluvium	L	?		M	↓		M	↔		M	↔	L	?		H	?		H	↔			
612 Western Murray Porous Rock	L	?		H	↓		M	↔		H	↔	L	?		H	?		H	↔			
818 Adelaide Fold Belt Darling				H	↔		M	↔		H	↔	I	?		H	?		H	↔			

Pressure	Trend	Data confidence
 Very low	↑ Increasing	H High
 Low	↔ No change	M Medium
 Moderate	↓ Decreasing	L Low
 High	? Unknown	
 Very high		
 No data		

Management activity

Regional initiatives

The State Plan natural resource management targets are being addressed through state, regional and local partnerships. The catchment action plans (CAPs) and the investment programs that support the CAPs are the key documents that coordinate targeted projects for the improvement of natural resources across NSW. The CAPs describe the whole-of-Government approach, and specify regional targets and activities that contribute to the achievement of the state-wide targets. The Lower Murray Darling CAP can be found at www.lmd.cma.nsw.gov.au/catchment_plan/index.shtml.

Land-use planning in the region is primarily achieved through local environmental plans (LEPs). All LEPs in the state are currently being reviewed by local governments in consultation with NSW Government agencies and the local community. The plans aim to ensure that appropriate development occurs in the landscape with consideration of future population demands, economic issues and the protection of natural resources and environmental assets in the area. LEPs are statutory controls against which development proposals are assessed. With respect to groundwater, LEPs ensure that development is prevented or restricted in locations where there is a high likelihood of groundwater contamination or the potential for development to increase salinity within the landscape.

Land-use pressures

Groundwater systems in the Lower Murray Darling region are strongly influenced by land-use activities such as the regulation of the Lower Darling River and the River Murray, irrigation and land clearing. This has caused shallow saline groundwater levels on the floodplains and in lower areas of the landscape such as billabongs and playa lakes.

Management activities in the region include:

- salt interception schemes at Mallee Cliffs and Buronga
- the inundation of wetlands with environmental flows to flush out the saline groundwater and protect the remnant vegetation
- the piping of irrigation channels within the Western Murray irrigation area and other irrigation areas
- the use of efficient irrigation methods to reduce water loss past the root zone
- investigation by the Lower Murray Darling Catchment Management Authority into the establishment of a dewatering bore field at Lake Gol Gol to lower levels of saline groundwater for the protection of the remnant wetland and riparian vegetation
- an aerial electromagnetic survey of the River Murray floodplain to identify areas of salt stores and accessions of saline groundwater into the river system.

Groundwater use and entitlement

The groundwater target is being addressed at the state level through water sharing plans (WSPs) for groundwater sources where there is over-allocation of entitlements or a need to protect high value ecosystems. The implementation of WSPs, which are plans to ensure the equitable and sustainable sharing of water, will ensure long-term water management for GDEs and other beneficial uses. However, some groundwater systems in NSW will remain under stress until current processes to reduce use to sustainable levels are complete. Key initiatives to meet this challenge include:

- continuing the implementation of current WSPs
- completing the remaining WSPs in the Murray–Darling Basin by 2011 and elsewhere before 2013
- expanding the existing groundwater level monitoring network through capital funding by the NSW Government
- adjusting future WSPs where necessary to account for climate change impacts
- effectively implementing the monitoring, evaluation and reporting strategy.

There are a number of activities being implemented to better understand groundwater systems, including:

- the expansion of the existing groundwater level monitoring network
- the implementation of telemetered time series groundwater level monitoring sites in the inland alluvial water sharing plan areas.

Groundwater dependent ecosystems

There are a number of activities being implemented around NSW to better understand GDEs, including:

- a trial remote sensing project to identify terrestrial GDEs in the Lower Macquarie GWMA
- staged spatial mapping of potential GDEs across NSW.

Further reading

ARMCANZ & ANZECC 1996, *National Principles for the Provision of Water for Ecosystems*, Occasional Paper SWR No 3, Sustainable Land and Water Resource Management Committee, Subcommittee on Water Resources, Canberra.

CSIRO 2008, *Water availability in the Murray: A report to the Australian Government from the CSIRO Murray–Darling Basin Sustainable Yields Project*, Commonwealth Scientific and Industrial Research Organisation, Australia.

DWE 2008, *Process to Identify Potential and Known High Priority Groundwater Dependent Ecosystems*, Department of Water and Energy, Armidale, unpublished.

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