

State of the catchments 2010

Groundwater

Northern Rivers region

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

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.

ecological processes determined by groundwater (ARMCANZ & ANZECC 1996).

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 pollutants. Groundwater pollution can take many forms, ranging from saltwater intrusion and the release of such matrix elements as eg iron and arsenic from over-extraction, to contamination from pollution events (eg chemical spills, leakages, or contaminated run off 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 Northern Rivers region there are alluvial, fractured rock, coastal sands 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 GWMA in the Northern Rivers region

Alluvial GWMA	Coastal sands GWMA	Fractured rock GWMA	Porous rock GWMA
Macleay River Alluvium	Bellinger Coastal Sands	Alstonville Basalt	Clarence–Morton Basin
Richmond River Alluvium	Macleay Coastal Sands	New England Fold Belt	
Hastings River Alluvium	Stuarts Point Sandbeds	North Coast Fractured Rock	
Tweed River Alluvium	Tweed River Coastal Sands	Dorrigo Basalt	
Brunswick River Alluvium	Hastings Coastal Sands	Coffs Harbour Metasediments	
Clarence and Coffs Harbour Alluvium	Coffs Harbour Coastal Sands		
Bellinger River Alluvium	Richmond Coastal Sands		
Nambucca Alluvium	Brunswick Coastal Sands		
	Clarence Coastal Sands		
	Nambucca Coastal Sands		
	Manning Coastal Sands		

The objective of the water management plan for the Stuarts Point Sandbeds GWMA is to prevent groundwater extraction from causing intrusion of sea water into the freshwater aquifer, and protect GDEs and the quality of the aquifer system in the area.

While the groundwater systems in the Alstonville Basalt and Dorrigo Basalt GWMA also have water management plans, the estimated level of use is low. However, the groundwater systems are highly connected to the surface water and there are a number of ecosystems reliant on the availability of groundwater.

The unconsolidated alluvial aquifers that are not identified GWMA adjacent to unregulated water sources have been included as part of a single water sharing plan for the Bellinger River Area Unregulated and Alluvial and the Coffs Harbour Area Unregulated and Alluvial Water Sharing Plans. This enables the use of water from either of these unregulated streams and the adjacent unconsolidated alluvium to be managed as a single water source.

There is currently no metering of groundwater use in the Northern Rivers region. The level of groundwater use is estimated using the NSW Office of Water groundwater level monitoring network, which is targeted to monitor the impact of extraction on the aquifer systems. There are currently no significant impacts identified.

The New England Fold Belt GWMA has diverse characteristics as a result of the broad area that it covers. In the upper catchment, it contributes flows to streams and is the source of spring flows.

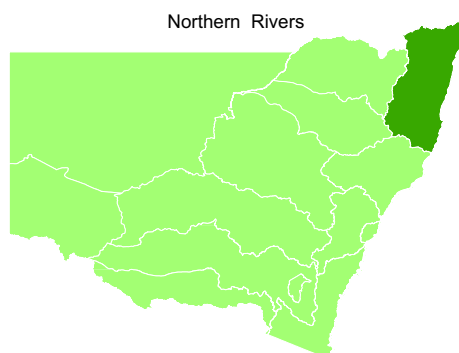
These systems support a diverse range of aquatic and terrestrial ecosystems, either directly or indirectly. They also ensure the availability of stock and domestic water for landholders.

The alluvial aquifers are highly connected to the river systems in the lower reaches. The level of connection in the mid to upper reaches is unknown. Water management plans for these aquifer systems are being developed and will also apply to surface water. The plans will apply to all surface water and groundwater licences in the associated alluvial aquifer systems. The intention of the plans is to manage the surface water and groundwater as one resource, due to the level of connectivity between the two systems.

The Clarence-Morton Basin GWMA is a porous rock aquifer system. There is currently limited use of the groundwater. It is generally saline and therefore has limited potential uses.

The coastal sand aquifers are important sources of town water for towns and villages in the region. These aquifer systems are predominantly located within national parks. There are a number of towns and villages that have established their bore fields within the national parks. To ensure that there are no adverse impacts on the GDEs within the national parks, stringent management plans are in place, which require the water authority to monitor the impact of the groundwater extraction.

Map of the catchment



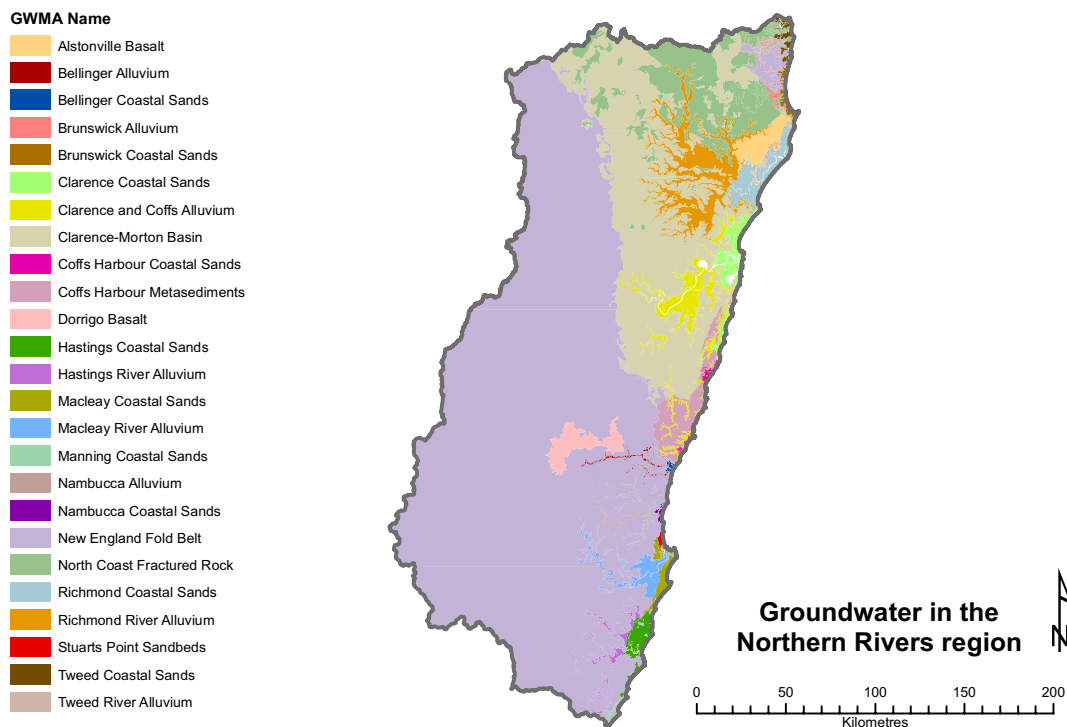


Figure 1 Northern Rivers region groundwater management areas

Assessment

The assessment of condition and pressure for the groundwater aquifers in the region has been based on the GWMA's. The assessment focuses on the whole of each GWMA, including the areas extending beyond the Northern Rivers region.

Monitoring focuses on groundwater levels in areas where there is a concentration of groundwater use for irrigation, mining and urban water supply, and areas where there is a close interaction between groundwater and surface water systems.

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 (LTAAEL) is the proportion of the long-term average annual recharge of water to the groundwater system that is 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 LTAAEL. The pressure indicator quantified is the ratio of the total annual entitlements for extraction held by licence holders compared with the LTAAEL. 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 Northern Rivers 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 other 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: • 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 groundwater aquifer systems in the Northern Rivers region are generally in good to very good condition (Table 3). There is assumed to be a low level of use of groundwater except for town water supply. Monitoring by the water supply authorities ensures that this use does not place any adverse pressure on the aquifer systems and their condition.

The level of confidence in the information is generally low to moderate due to the number of groundwater level monitoring sites in the region, and the limited available information on

groundwater use, quality and GDEs.

There is limited information on the condition of GDEs in the region. A desktop assessment by the former Department of Water and Energy (DWE 2008) identified high priority GDEs in the region, as shown in Figure 2. The desktop assessment methodology includes a limited assessment of terrestrial ecosystems.

The locations of the high priority GDEs and GDEs identified in water sharing plan (WSP) areas are shown in Figure 2. A diagram of the GDEs in the Stuarts Point Sandbeds WSP area is shown in Figure 3.

The following is an indication of the type of work occurring on GDEs within the region.

Alstonville Plateau

Objective: The identification of GDEs using a conceptual model of the groundwater flow systems, aerial photography, and vegetation and ecological information (Brodie & Green 2002)

Description of work: The development of a spatial layer identifying the GDEs on the Alstonville Plateau (see Figure 4)

Outcomes: The spatial mapping enabled the identification of GDEs for the WSP, and the appropriate buffer distances around GDEs excluding water extraction were included in the plan to ensure their protection.

Dorrigo Basalt

Objective: The identification of GDEs for the WSP for the Dorriggo Plateau surface water source and the Dorriggo Basalt groundwater source

Description of work: A report on the water habitats in the region was prepared by Graham (2001) for the National Parks and Wildlife Service. Based on this report, various GDEs were identified for the WSP area

Outcomes: A map of the identified GDEs within the WSP area.

Table 3 Groundwater source condition summary

|--|

Condition

Trend

Data confidence



Very good

Good

Fair

Poor

Very poor

No data

↑

↔

↓

?

Improving

No change

Declining

Unknown

H

M

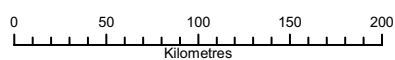
L

High

Medium

Low

Northern Rivers region high priority groundwater dependent ecosystems



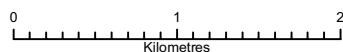
- TOWNS
- MAJOR ROADS
- GDES in WSPs**
 - ▲ WETLAND
 - SEE ALSTONVILLE PLATEAU, DORRIGO PLATEAU & STUARTS POINT & FISHERMANS BEND NATURE RESERVE CASE STUDIES
- GDES not in WSPs**
 - ▲ WETLAND
 - KARST
 - SPRING
 - SEE MARIA RIVER NATIONAL PARK CASE STUDY



Figure 2 High priority and water sharing plan (WSP) identified GDEs

Legend

- Fishermans Bend NR
- Stuarts Point WSP
- SEPP14 Wetlands
- Terrestrial and Wetland GDEs**
 - Scrubby dry sclerophyll forest
 - Swamp sclerophyll forest (banksia and leptospermum)
 - Swamp sclerophyll forest (paperbark)
 - Seagrass
 - Saltmarsh
 - Mangrove



Groundwater dependent ecosystems within the locality of Stuarts Point and Fishermans Bend Nature Reserve

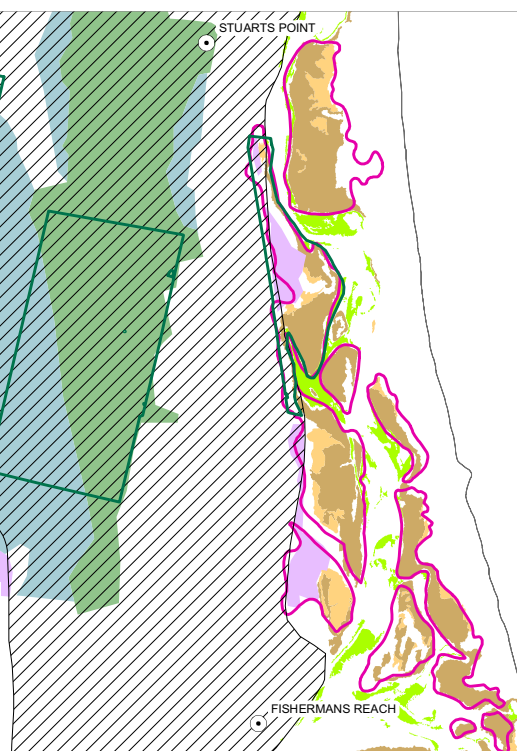


Figure 3 Identified GDEs at Stuarts Point

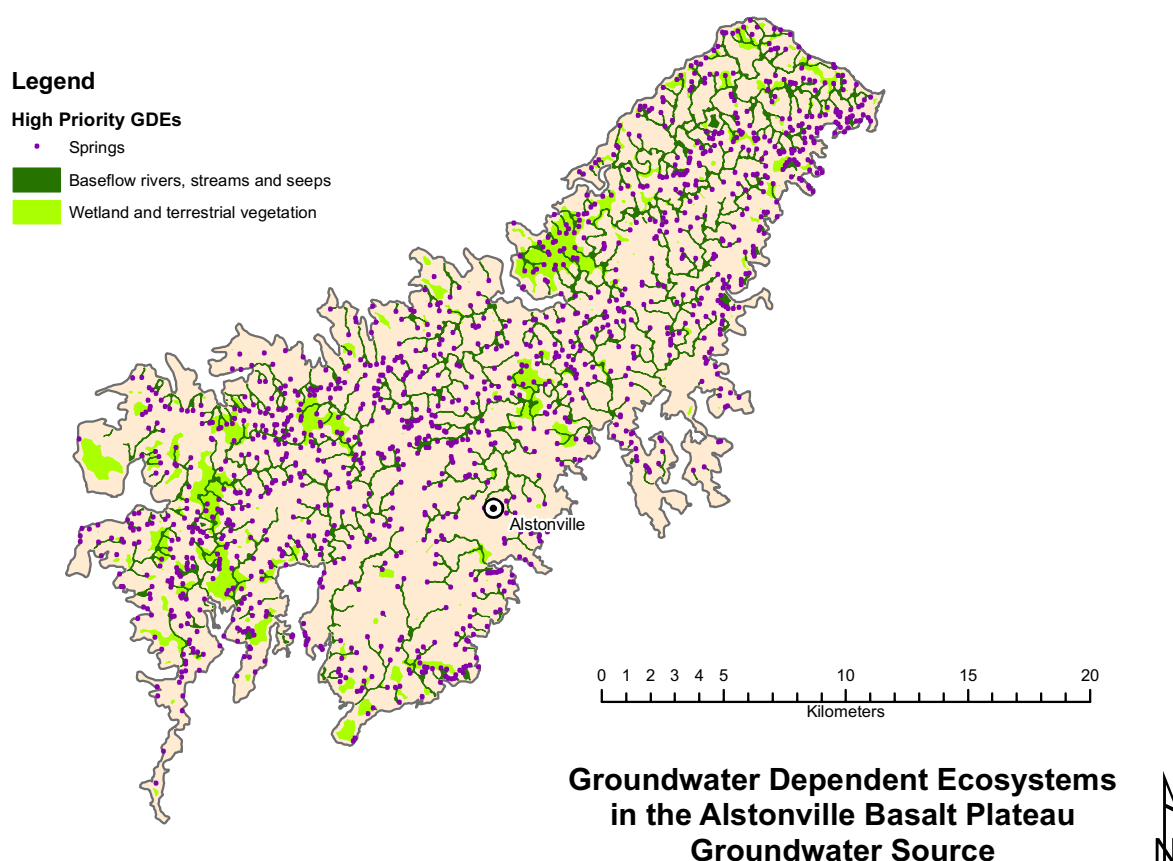


Figure 4 Identified GDEs at Alstonville Basalt

Pressures

'Pressures' in this report refers to the potential impacts of human activity on the groundwater system. (NB: This is different from 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 Northern Rivers region are described in Table 4.

Table 4 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: • 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 groundwater aquifer systems are generally experiencing very low to moderate pressure (see Table 5). It is believed that there is a low level of use of groundwater except for town water supply. The very high pressure rankings for the groundwater quality indicator are associated with the following:

- Stuarts Point Sandbeds – the arsenic concentrations in the groundwater are above drinking water guideline standards. It is uncertain if these concentrations are naturally occurring or caused by human influences. The town water sourced from the area is treated to ensure that the arsenic levels are within drinking water guideline standards
- Tweed River Coastal Sands – previous mineral sand mining and current sand mining have the potential to release naturally occurring heavy minerals
- Coffs Harbour Coastal Sands – there is a potential impact on the groundwater from the use of agricultural chemicals and fertilisers.

The level of confidence in the information is generally low to moderate due to the number of groundwater level monitoring sites in the region, and the limited information available on groundwater use, quality and GDEs.

Table 5 Groundwater source pressure summary

	Groundwater Availability																					
	Data Confidence		Trend		Land-use Pressures		Data Confidence		Trend		Regional Impacts		Data Confidence		Trend		Localised Impacts		Data Confidence		Trend	
	Groundwater Quality Impacts		Data Confidence		Trend		Aquifer Structure Pressures		Data Confidence		Trend		Entitlement/Share Component to the LTAAEL		Data Confidence		Trend		GWMA Pressure Index			
GWMA no. and name																						
025 Bellinger Coastal Sands						H ↔		M ↔		M ↔			M ↔			M ↔			M ↔			
028 Macleay River Alluvium						M ↔		L ↔		M ↔			L ?			M ?			H ↔			
029 Richmond River Alluvium						M ↔		M ↔		M ↔			L ?			M ?			H ↔			
031 Hastings River Alluvium						M ↔		M ↔		M ↔			L ?			M ?			H ↔			
032 Stuarts Point Sandbeds		M ?				H ↔		M ↔		M ↔			M ↔			M ↔			H ↔			
035 Macleay Coastal Sands						H ↔		M ↔		M ↔			M ↔			M ↔			H ↔			
036 Tweed River Coastal Sands						H ↔		M ↔		M ↔			M ↔			M ↔			H ↔			
040 Hastings Coastal Sands						H ↔		M ↔		L ↔			M ↔			M ↔			H ↔			
047 Coffs Harbour Coastal Sands						H ↔		M ↔		L ↔			M ↔			M ↔			H ↔			
030 Richmond Coastal Sands						H ↔		M ↔		M ↔			M ↔			M ↔			H ↔			
048 Brunswick Coastal Sands						H ↔		M ↔		M ↔			M ↔			M ↔			H ↔			
049 Tweed River Alluvium						M ↔		M ↔		M ↔			L ?			M ?			H ↔			
051 Clarence Coastal Sands						H ↔		M ↔		M ↔			M ↔			M ↔			H ↔			
052 Nambucca Coastal Sands						H ↔		M ↔		M ↔			M ↔			M ↔			H ↔			
057 Brunswick Coastal Sands						M ↔		M ↔		M ↔			L ?			M ?			H ↔			
058 Clarence and Coffs Harbour Alluvium						M ↔		M ↔		M ↔			L ?			M ?			H ↔			
059 Bellinger River Alluvium						M ↔		M ↔		M ↔			L ?			M ?			H ↔			
060 Nambucca Alluvium						M ↔		M ↔		M ↔			L ?			M ?			H ↔			
062 Manning Coastal Sands						H ↔		M ↔		M ↔			M ↔			M ↔			H ↔			
602 Clarence–Morton Basin						L ↔		L ↔		L ↔			L ?			L ↔			H ↔			
804 Alstonville Basalt		H ↔				L ↔		M ↔		H ↔			M ?			H ↔			H ↔			
805 New England Fold Belt–Coast		L ?				L ?		M ?		M ?			L ?			H ↔			H ↔			
807 North Coast Fractured Rock						L ↔		L ↔		L ↔			M ?			H ↔			H ↔			
808 Dorrig Basalt						L ↔		M ↔		L ↔			M ?			H ↔			H ↔			
812 Coffs Harbour Metasediments						L ↔		L ↔		L ↔			L ?			H ↔			H ↔			

Pressure	Trend	Data confidence
	↑ Increasing	H High
	↔ No change	M Medium
	↓ Decreasing	L Low
	?	
		
		

Management activity

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

Northern Rivers CAP can be found at www.northern.cma.nsw.gov.au/region_catchment_action_plan.php.

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.

Groundwater use and entitlement

The groundwater target is being addressed at the state level through WSPs for groundwater sources where there is over-allocation of entitlements or a need to protect high value ecosystems. In the Northern Rivers region, the groundwater resources are not over-allocated but there is a need at a local level to protect the GDEs. There are currently three groundwater and two unregulated and alluvial WSPs in the region.

The implementation of WSPs, which are plans to ensure the equitable and sustainable sharing of water, for the remaining GWMA in the region will ensure long-term water level 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 being undertaken to meet this challenge include:

- 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:

- expansion of the existing groundwater level monitoring network
- implementation of telemetered time series groundwater level monitoring sites in the inland alluvial WSP 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
- National Water Initiative projects being run by the NSW Office of Water, Geoscience Australia and project partners that are investigating GDEs in coastal sand dunes and estuaries.

The Northern Rivers Catchment Management Authority is undertaking the following activities in relation to the groundwater target:

- 10 water use efficiency projects

- restoring critical aquatic habitats for the eastern cod and pygmy perch by advocating environmental flows from connected groundwater systems to rivers
- gazetting three macro WSPs in 2008–09 (which have some connectivity to groundwater).

There are a number of other groups undertaking significant work in the region that is contributing to better outcomes for groundwater systems including Waterwise delivery via Industry & Investment NSW to Landcare.

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.

Brodie SR & Green R 2002, *A Hydrogeological Assessment of the Fractured Basalt Aquifers on the Alstonville Plateau, NSW*, Bureau of Rural Sciences, Canberra.

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

Graham M 2001, *Water Habitats of the Clarence, Coffs Coastal and Bellinger Catchments*, NSW North Coast Water Habitats Study, Report 2, prepared for the Upper North Coast Water Management Committee, NSW National Parks and Wildlife Service, Northern Directorate.

Published by: Department of Environment, Climate Change and Water NSW, 59–61 Goulburn Street, PO Box A290, Sydney South 1232.

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DECCW 2010/423 ISBN 978 1 74232 736 5 November 2010

Cover photo: J Turbill/DECCW – 'windmill in vivid red sunset'