

Office of Environment and Heritage
Use of water for the environment in New South Wales

Outcomes 2016-17



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Front cover: Wetland at sunset in the lower Murray catchment. Photo: John Spencer, OEH.

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Foreword

Rivers and wetlands across New South Wales finished the year brimming with new life after high rainfall and widespread flooding brought much-needed relief to a drying landscape.

The rainfall provided immediate benefits to a large number of rivers, creeks, swamps and flood runners. It was strategic, managed flows after the flood had passed, however, that allowed native birds, fish, plants and other animals to complete their breeding cycles and make the most of the change in conditions.

The start of the 2016–17 water year coincided with warmer ocean temperatures around northern and eastern Australia brought about by the breakdown of El Niño conditions in the Indian and Pacific oceans. Significant rains fell across much of south-eastern Australia in winter and spring. This was followed by drier than average conditions across much of the country influenced by higher than average pressure over the Great Australian Bight and the long-term trend in global air temperatures.

By the end of the 2016–17 water year, the Office of Environment and Heritage (OEH) had recorded its biggest ever year, managing a total of 54 deliveries of water for the environment. Almost 1,400,000 megalitres of water was delivered from state, Commonwealth and The Living Murray accounts, with a range of ecological benefits.

In the **Murray** and **Lower Darling** catchments, OEH managed the delivery of more than 680,000 megalitres. Native fish including golden perch and Murray cod took advantage of strategic environmental

flows to move from the Barwon–Darling and Menindee Lakes system into the Murray River during 2016–17. The management of water in the Lower Darling resulted in one of the biggest Murray cod spawning responses ever recorded. Water for the environment was used in the central Murray to provide refuge for native fish during a hypoxic blackwater event (low oxygen levels) that followed significant rainfall and natural flooding. Subsequent releases across the southern connected basin attracted native fish from the Lower Murray into the central river system.

In the **Murrumbidgee** catchment, a record 530,000 megalitres was delivered to rivers and wetlands to supplement natural flooding, improve habitat and support the breeding activities of native birds, fish and frogs. At one site, 6000 pelican nests were recorded.

Thousands of pelicans also commenced breeding in the **Lachlan** catchment during 2016–17. Scientists recorded 5500 nests at Lake Brewster. Water for the environment was used to maintain their chosen habitat and allow young pelicans to grow and take flight. Managed flows achieved multiple outcomes across the catchment including colonial waterbird breeding, fish breeding and movement and extended inundation to support the needs of birds, fish and other wildlife.



Dusk over the Booligal Wetlands, Lachlan catchment. Photo: Vince Bucello, Midstate Video Productions.

Foreword (continued)

In the **Macquarie–Castlereagh** catchment thousands of colonial nesting waterbirds built their nests and started to breed in late September 2016. At least 17 active waterbird colonies were observed across the Macquarie Marshes. A total of 16 colonial waterbird species were recorded nesting at these sites. The two largest colonies, with an estimated 35,000 nests, were dominated by straw-necked ibis with smaller numbers of Australian white ibis and glossy ibis. Water for the environment was used to maintain suitable conditions for the nesting waterbirds. OEH also managed a flow connecting the Macquarie and Barwon rivers, allowing for native fish movement between these river systems.

In the **Gwydir** catchment, water for the environment allowed a range of waterbirds to respond to natural flooding and complete their breeding cycles, as well as supporting improved vegetation and habitat health.

For the first time, OEH also facilitated the release of Chaffey Dam's Environmental Contingency Allowance with water held by the Commonwealth Environmental Water Office. The flow of 6190 megalitres aimed to restore the productivity of the Peel River for native fish populations and provide the opportunity for silver perch to move upstream into higher reaches of the Peel River.

Throughout the year, OEH staff have continued to demonstrate their incredible commitment to supporting the health and viability of inland river systems for the benefit of plants, animals and local communities.

Across the state, nine Commonwealth-funded Long Term Watering Plans are being developed in partnership with environmental water advisory groups, water managers, government agencies and scientists. These plans will guide the use of water for the environment in New South Wales to improve the health of our rivers and wetlands into the future, consistent with the Murray–Darling Basin Plan.

In 2016-17 OEH continued to engage with stakeholders and local communities, to strengthen partnerships and public understanding of the work being done to restore and sustain inland rivers. A series of events in the Murray and Lower Darling catchments brought agency staff and community members together to see water for the environment at work and to allow participants to share information directly. Plans are now underway for further engagement activities in other parts of the state to build awareness of this important work. OEH aims to provide clear information and opportunities to demonstrate the links between water for the environment and the values that people attach to their local rivers and wetlands.

Anthony Lean
Chief Executive
Office of Environment and Heritage

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Water for the environment

The NSW Office of Environment and Heritage (OEH) delivers water for the environment on behalf of the NSW Government for the people of New South Wales. Working in partnership with stakeholders including regional communities and other government agencies is an integral part of managing water to protect and improve the environmental, social and economic values of rivers, floodplains and wetlands.

OEH is responsible for ensuring that water is managed in accordance with relevant statutory plans, including water sharing plans established under the NSW Water Management Act 2000 and the Basin Plan established under the Commonwealth Water Act 2007.

This report provides an overview of the environmental watering actions undertaken by OEH during 2016-17 and the ecological outcomes achieved for New South Wales. This document reports on water:

- held on water access licences, by the NSW Government
- prescribed as allocations under water sharing plans
- provided by the Commonwealth Government
- available through programs such as The Living Murray (TLM).

This document does not report on environmental water that is released in accordance with water sharing plan rules and managed by the NSW Department of Industry – Crown Lands and Water Division.

Find out more about environmental water management planning.



Spoonbills and ibis gather in the Murrumbidgee catchment. Photo: Vince Bucello, Midstate Video Productions.

Water for the environment managed by OEH

'Adaptive' environmental water is delivered through a water access licence for a specific environmental purpose. Water access licences have been purchased from other water users on the open market or have been created by recovering water savings from infrastructure projects. Adaptive environmental water licensees receive the same water allocations as those that apply to other licensees of the same category.

There are currently five regional environmental water advisory groups (EWAGs) in New South Wales covering key areas of the Murray-Darling Basin. EWAGs bring a diversity of advice and local knowledge to decisions regarding OEH's management of water for the environment and typically include water managers, other water users, community members, landholders, environmental interest groups, Aboriginal groups, independent scientists, and relevant government agencies.

OEH produces annual environmental watering priority statements, required under the Basin Plan, on the basis of advice from EWAGs. The statements prioritise the

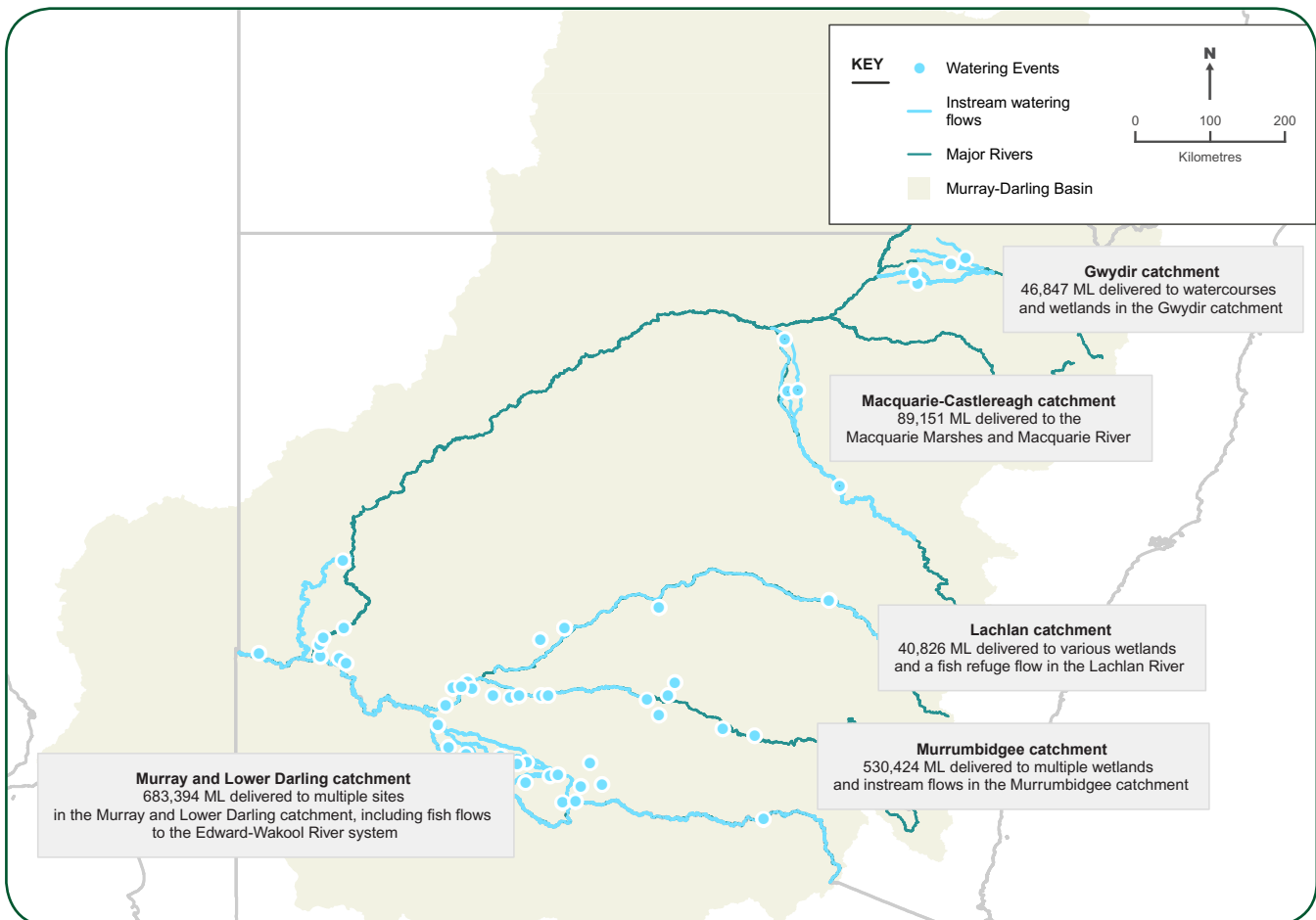
use of water for the environment over the coming water year in accordance with the Basin Plan. The priority statements are consistent with more detailed annual environmental watering plans developed for each catchment. Priorities are reassessed throughout the water year to account for variables such as weather conditions and water allocations to ensure the desired environmental outcomes are achieved.

OEH is also developing Long Term Watering Plans (LTWPs) for nine catchments that together make up the New South Wales section of the Murray-Darling Basin. These plans will contain objectives and targets for native fish, plants, waterbirds and river functions and their principal water requirements. The plans will be used to inform and guide environmental watering decisions that will help ensure our rivers and wetlands remain healthy for future generations.

NSW environmental watering event sites 2016-17

The map below illustrates the locations of the environmental watering events and the major instream flows for 2016-17 across the Murray-Darling Basin.

Figure 1: NSW environmental watering event locations for 2016-17



A year in the Gwydir catchment

The Gwydir catchment covers 26,596 square kilometres and contains a diverse range of water dependent ecological communities. Smaller eastern upland creeks mainly flow into the Gwydir River upstream of Copeton Dam. Downstream on the western floodplain, the Gwydir River splits into its main distributaries, the Mehi River (south), Carole Creek (north) and Lower Gwydir (or Big Leather) and Gingham (central) watercourses.

The Gingham and Lower Gwydir watercourses include four areas listed under the Convention on Wetlands of International Importance (the Ramsar Convention). Three sites are on privately owned land within the Gingham system and one is in the Gwydir Wetlands State Conservation Area within the Lower Gwydir.

Gwydir wetlands support floodplain vegetation including river red gum, coolibah and belah woodlands, and aquatic species such as spike rush and water couch. The Lower Gwydir watercourse supports the state's largest stand of marsh club rush, a critically endangered ecological community listed in the NSW Biodiversity Conservation Act 2016. Many Gwydir wetlands provide feeding and breeding habitat for waterbirds, including broilgas, black-necked storks, ibises, spoonbills, and migratory species such as painted snipe, terns and sandpipers, listed under international agreements.

Wetlands associated with Mallowa Creek have historically supported significant bird breeding events. Improved environmental water availability since 2012 now allows the supply of targeted flows to this area.

The Mehi River and Carole Creek are regulated streams where water for the environment is delivered specifically to benefit native fish and the aquatic ecological community. Many native fish found in the Gwydir system are listed as threatened or vulnerable.

The Kamilaroi (Gomeri) people are the traditional owners of the Gwydir catchment, with more than 160 cultural heritage sites recorded in and around the wetlands. The area's wetlands, floodplains and rivers are considered special places to the local Aboriginal people, who place great importance on maintaining the ecological health of the rivers, streams and wetlands.

The Gwydir EWAG provides advice, ensuring that community, industry, scientific and government expertise guides the effective management of water for the environment in the Gwydir catchment.



Water flows down the Gingham Channel, downstream of Gingham Bridge, toward Boyanga Waterhole and western wetlands. Photo: David Preston, OEH.

A year in the Gwydir catchment (continued)

Catchment conditions in 2016-17

Early season water planning was for extended dry conditions; however, conditions in late August and September 2016 quickly turned wetter than forecast.

During August and September, heavy rainfalls generated large flows downstream of Copeton Dam, creating moderate flooding in the downstream Gwydir Wetlands. The connected systems of the Mehi River, Moomin and Carole creeks also benefited from these early season flows.

By October 2016 river flow levels had mostly receded and by early December a general dry to very dry period ensued for the rest of the summer period. These early season river flows had however, greatly assisted in priming the wetlands and floodplain areas for the season ahead.

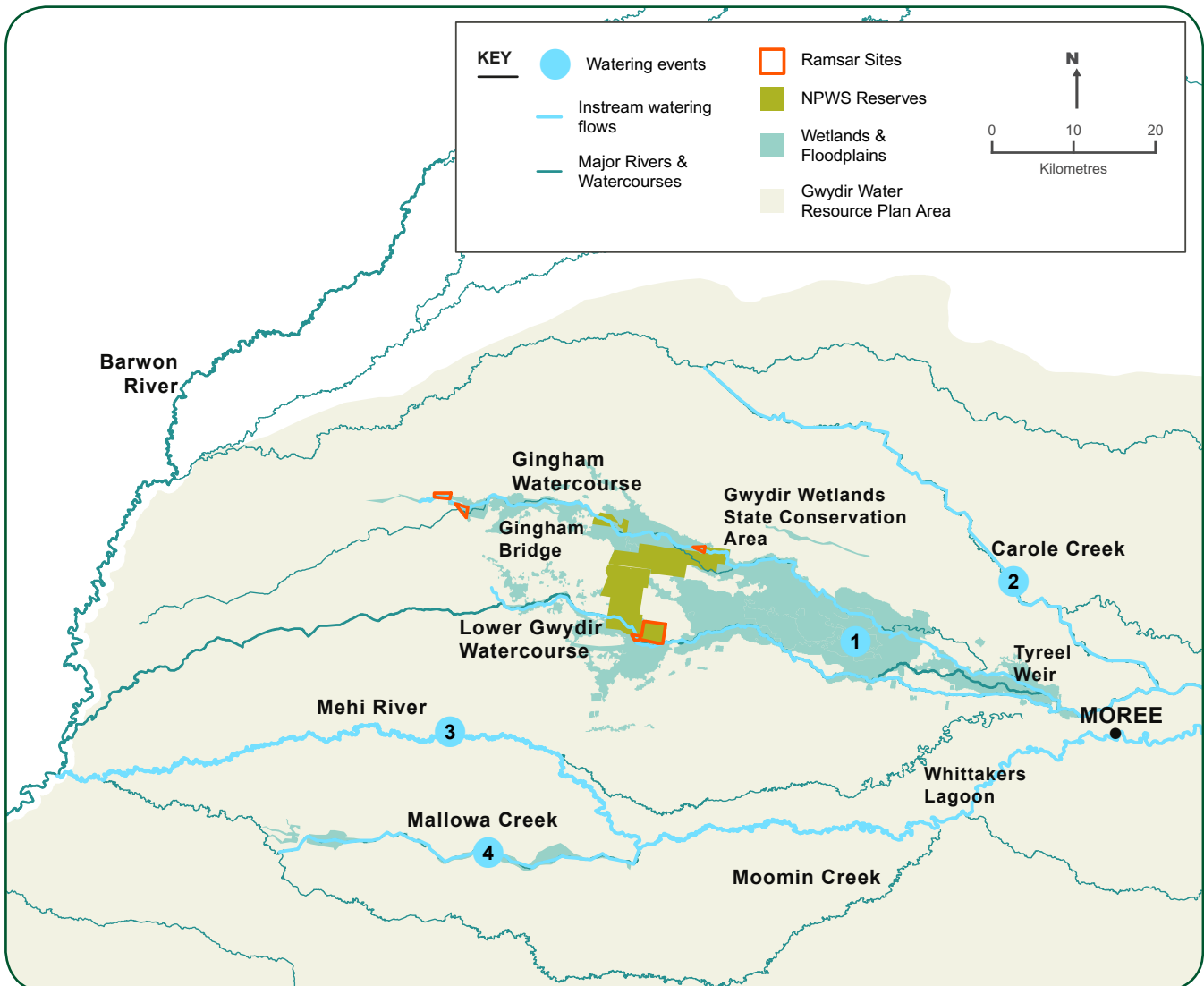
Watering aims

The Gwydir EWAG has developed a three-year rolling plan to guide water delivery. Following wet conditions in 2015-16 the EWAG recommended environmental water should be used in response to naturally occurring triggers during the 2016-17 water year, allowing for water carry-over in 2017-18.

This reactive approach ensures water is available to provide conditions that support vegetation growth, waterbirds to complete nesting and native fish to move and reproduce.

Significant rainfall triggered waterbird breeding in the Gwydir wetlands, water managers then delivered sufficient water to complete the breeding cycle. Further rainfall triggered supplementary events allowing environmental water delivery to the Mallowa system to

Figure 2: Environmental watering events in the Gwydir Water Resource Plan area, 2016-17. Event numbers correspond to those in Table 1.



provide foraging habitat for waterbirds and to retain water in the Mehi River and Carole Creek to benefit native fish habitat.

Gwydir environmental watering events for 2016–17

The Gwydir Water Resource Plan area (Figure 2) as defined in the Basin Plan, includes unregulated and regulated rivers and creeks. Environmental watering events for 2016–17 are shown in Figure 2.

Water delivery

A total of 46,847 megalitres of water for the environment was delivered to wetland and instream targets, mainly between December 2016 and February 2017 (Table 1). A drying period in summer followed the high river and wetland inflows during early spring as a result of early season heavy rainfall. Environmental water deliveries achieved daily flow variability and good inundation throughout the Gingham and Lower Gwydir watercourses. Deliveries were made by the Commonwealth Environmental Water Office to the Mallowa Creek and wetlands, and the Mehi River and Carole Creek systems.

Table 1: Environmental water delivered in the Gwydir catchment during the 2016–17 watering year

Location	Start date	Finish date	Megalitres of water delivered			
			NSW	CEW	EWA	Total
1 Gwydir Wetlands	24 Jul 2016 25 Dec 2016	7 Aug 2016 28 Feb 2017	3,000	9,000	3,000 18,000	33,000
2 Carole Creek	15 Sep 2016	21 Sep 2016		1,351*		1,351
3 Mehi River	17 Sep 2016	21 Sep 2016		5,000*		5,000
4 Mallowa Creek and watercourse	13 Jan 2017	3 Apr 2017		7,496*		7,496
TOTAL			3,000	22,847	21,000	46,847

Note: Location numbers in the table relate to watering events marked on the map in Figure 2.

NSW = NSW licensed environmental water

CEW = Commonwealth licensed environmental water

EWA = Environmental water allowance established under the *Water Sharing Plan for the Gwydir Regulated River Water Source 2016*

* These events were managed by the Commonwealth Environmental Water Office (CEWO) with support from the regional OEH office, and delivered through CEW licences.

A year in the Gwydir catchment (continued)

Ecological outcomes

Large natural inflows, mainly in September, resulted in widespread inundation across the Gingham and the Lower Gwydir. Smaller natural flows were experienced for the remainder of the water year with environmental water deliveries made in late December 2016 to late February 2017. Together with the three previous years of reasonable inflows, most wetland areas were in good to intermediate condition (floristic structure and groundcover, low percentage of exotic/terrestrial species). Woodland sites had intermediate canopy cover and good understorey condition. Western or higher areas, which received a shorter period of inundation, were in a poorer condition (lower level of groundcover and moderate levels of exotic/terrestrial cover).

The Mallowa system did not receive the benefit of the early season natural flows. Inflows to the system were mainly deliveries of water for the environment with limited extent and duration of inundation. Eastern and lower wetlands to the west were in good to intermediate condition. Areas without inundation over the last two seasons are now in a poorer and extremely dry state.

Ten species of frogs, including large numbers of barking marsh frogs were recorded at Gingham, Lower Gwydir, Mallowa and Mehi sites. The highest species diversity was at Boyanga Waterhole with the greatest number of frogs recorded at Little Lagoon and Munwonga, being sites along the Gingham Watercourse.

Inundation from the September inflows, in the central Gingham area, stimulated waterbird breeding with large numbers of young observed across the catchment including a small breeding colony of egrets, ibis and spoonbills. Ground surveys recorded more than 142 bird species; 51 of these were waterbird species, including two listed as endangered, three as vulnerable and six species listed on international migratory bird agreements. The overall waterbird abundance was considered moderate when compared with recent very wet years (i.e. 2011 and 2012).

Commonwealth Long Term Intervention Monitoring (LTIM) surveys by NSW DPI Fisheries recorded several species of native fish including western carp gudgeon, spangled perch, bony bream, eel-tailed catfish, fly-speckled hardyhead, and olive perchlet. Deliveries of water for the environment over the hotter, drier period of December to March supported native fish populations.



Little Lagoon Gingham Wetlands, Australasian grebe nest. Photo: David Preston, OEH.

A year in the Macquarie–Castlereagh catchment

The Macquarie–Castlereagh catchment covers 90,000 square kilometres and extends north-west from the Blue Mountains to the Barwon River Plains. The Macquarie River’s major tributaries include the Cudgegong, Talbragar and Bell rivers.

The Macquarie and Castlereagh catchments are home to the well-known Macquarie Marshes – one of the largest remaining semi-permanent wetland systems in inland Australia – which have hosted some of the largest-scale waterbird breeding events recorded on this continent.

The Marshes include a network of smaller wetlands and streams which support areas of semi-permanent vegetation such as reed beds and water couch, as well as the largest river red gum woodlands in the north of the Murray–Darling Basin. The catchment connects with the Barwon River, providing an important source of both water and nutrients that support the aquatic food web downstream.

The Macquarie River and Macquarie Marshes, parts of which are Ramsar-listed, provide important support for business and social networks in the local community, with approximately 90% of the Marshes supporting primary production. The river and associated wetlands are also intrinsic to the culture and wellbeing of traditional Aboriginal communities. The Wayilwan people of the mid and lower Macquarie River have had more than 500 Aboriginal cultural heritage sites recorded in the wider marshes area, including carved trees, ceremonial and burial sites, oven mounds and stone artefacts.

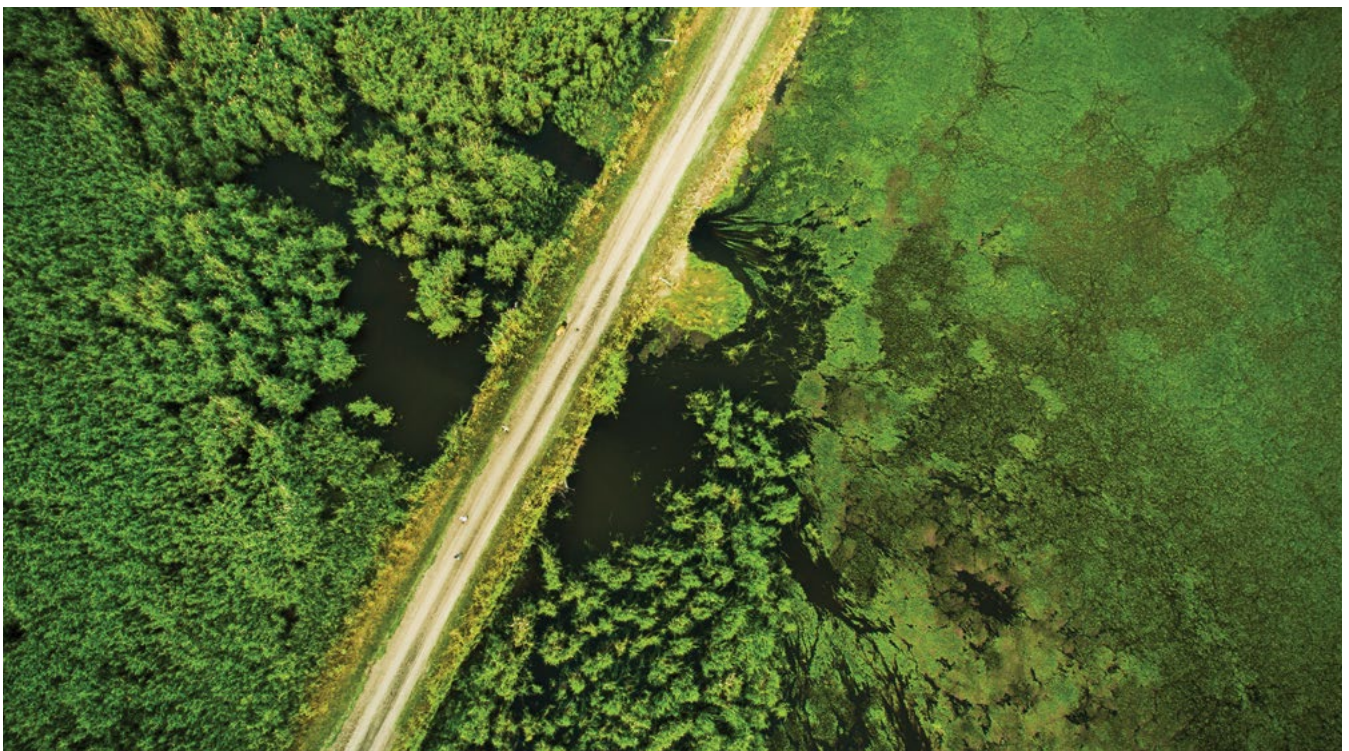
The Macquarie Cudgegong EWAG is chaired by NSW Local Land Services (LLS), and includes representatives from communities, environmental interests, water users, the irrigation industry and Commonwealth and NSW government agencies. The group meets regularly and provides advice on environmental water priorities and management within the catchment.

Catchment condition in 2016–17

The Macquarie–Castlereagh catchment remained dry through early 2016, with inflows to Burrendong Dam remaining below the 80th percentile, according to historic records.

After the 2012 Burrendong Dam spill, the Macquarie Cudgegong EWAG developed a three-year watering plan, setting aside a specific volume for delivery each year up to 2015–16. Being the end of year three, with persistent low catchment inflow, the environmental water account balances in early 2016 were very low.

From early June 2016, widespread, drought-breaking rainfall provided relief to the entire catchment.



Inundation of the Macquarie Marshes. Photo: John Spencer, OEH.

A year in the Macquarie–Castlereagh catchment (continued)

Watering aims

Early season planning in May 2016 forecast a ‘very dry’ resource availability scenario. The primary aims of environmental watering in 2016–17 were to:

- capitalise upon a suitably-sized tributary flow event in spring 2016 or autumn 2017 to inundate approximately 4000 hectares of the Macquarie Marshes to avoid damage to permanent and semi-permanent wetland vegetation in some locations
- carry over water for the environment into 2017–18 (if no suitable tributary flows arose) to support fish refugia in the mid-Macquarie River channel.

However, in August 2016, the EWAG revised its annual delivery strategy in response to ‘medium’ resource availability conditions at that time. By early September 2016, water entering Burrendong Dam had reached the flood mitigation zone (FMZ) level. A delivery pattern

to draw down the FMZ in the dam supported the successful completion of large-scale colonial waterbird breeding in the Macquarie Marshes in response to flood conditions.

Due to the changing conditions, the August 2016 plans were modified, with the Macquarie and Barwon rivers fish connection flow subsequently undertaken during autumn 2017.

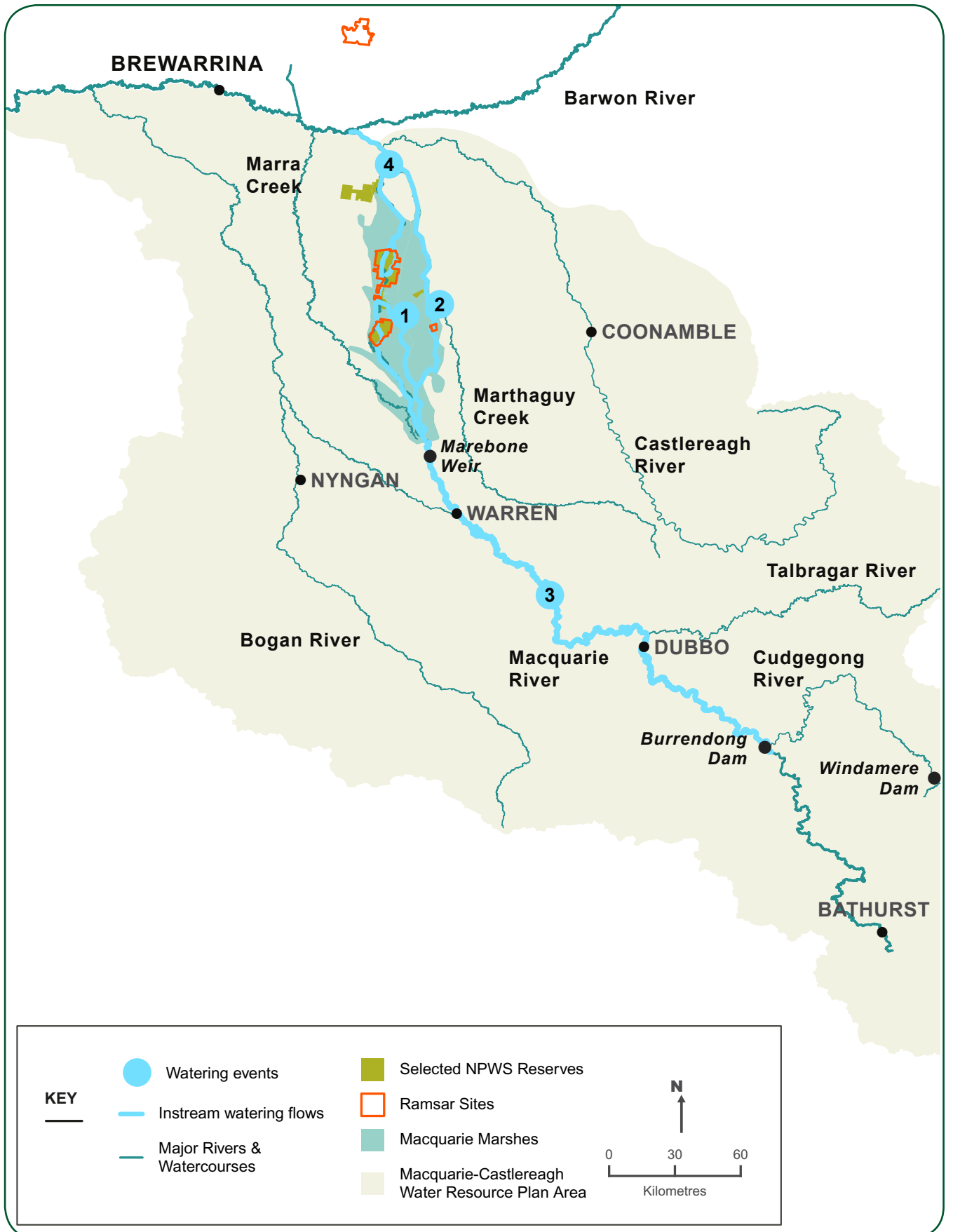
Macquarie–Castlereagh environmental watering events for 2016–17

The Macquarie–Castlereagh Water Resource Plan area is defined in the Basin Plan and includes the Macquarie, Castlereagh and Bogan river catchments (Figure 3). Environmental watering events for 2016–17 are shown in Figure 3.



OEH staff monitoring an Ibis and Royal Spoonbill colony in the Macquarie Marshes. Photo: John Spencer, OEH.

Figure 3: Environmental watering events in the Macquarie–Castlereagh Water Resource Plan area, 2016–17. Event numbers correspond to those in Table 2.



A year in the Macquarie–Castlereagh catchment (continued)

Water delivery

A total of 89,151 megalitres of water for the environment was delivered to wetland and instream targets between July 2016 and May 2017 (Table 2).

Strategic environmental watering supplemented natural flooding events as detailed in Table 2.

Table 2: Environmental water delivered in the Macquarie–Castlereagh catchment during the 2016–17 water year

Location	Start date	Finish date	Megalitres of water delivered			
			NSW	CEW	EWA	Total
1 Macquarie Marshes and mid-Macquarie River	13 Jul 2016	20 Dec 2016	1,426	7,251		8,677
2 Macquarie Marshes (colonial waterbirds) and mid-Macquarie River	24 Jan 2017	18 Feb 2017	6,384	17,038	22,988	46,410
3 Macquarie Marshes and mid-Macquarie River fish return flow	4 Apr 2017	12 Apr 2017	448	2,648	3,385	6,481
4 Macquarie and Barwon river fish connection flow	16 Apr 2017	15 May 2017		27,583		27,583
TOTAL			8,258	54,520	26,373	89,151

Note: Location numbers in the table relate to watering events marked on the map in Figure 3.

NSW = NSW licensed environmental water (general security and supplementary licences)

CEW = Commonwealth licensed environmental water

EWA = Environmental water allowance established under the *Water Sharing Plan for the Macquarie and Cudgegong Regulated Rivers Water Source 2016*



A dusky moorhen nest in the Macquarie Marshes. Photo: John Spencer, OEH.

Ecological outcomes

The significant flows of 2016–17 resulted in extensive inundation on the lower Macquarie floodplain, with September 2016 having the highest recorded rainfall across the entire Murray–Darling Basin. In total, the Macquarie Marshes recorded 1,010,000 megalitres of gauged inflows during the water year.

The early season natural flows primed the Macquarie Marshes system, inundating about 75,000 hectares by mid-September, allowing a high diversity of waterbird species including non-colonial ducks, swans, waterhens, bitterns and magpie geese to start breeding.

From October 2016 to February 2017 about 155,000 hectares of the Macquarie Marshes were inundated. Ground and aerial surveys confirmed 16 colonial waterbird species nested across 17 individual colonies in the Marshes during this period. The two largest colonies, which in total supported an estimated 35,000 nests, were dominated by straw-necked ibis, with smaller numbers of nesting Australian white ibis, glossy ibis and royal spoonbills. There were also two large egret colonies that supported intermediate egrets, eastern great egrets, little egrets, cattle egrets and nankeen night herons, along with nesting pairs of pied herons, a species more typically seen in northern Australia.

Deliveries of water for the environment were made from late January to mid-February 2017 to extend the duration of inundation in colonial waterbird breeding and feeding habitats. This water delivery allowed for the successful completion of the major egret colonies and supported late-nesting royal spoonbills

in some locations. The flows also extended the availability of feeding habitat to promote the survival of recently-fledged juvenile non-colonial and colonial waterbird species.

OEH and the Commonwealth Environmental Water Office (CEWO) co-delivered a 10-day connection flow between the lower Macquarie and the Barwon rivers during 2016–17. High flows in the Barwon River following tropical cyclone Debbie allowed OEH and the CEWO to provide a flow that allowed for the movement of juvenile golden perch between the two river systems.

Monitoring by NSW DPI Fisheries detected golden perch, carp gudgeon, bony bream and Hyrtl's catfish (the first time this fish has been recorded in the Macquarie, according to the NSW Freshwater Fish Database). Following the connection flow, monitoring detected an increase in juvenile golden perch numbers with evidence of both golden perch and spangled perch migrating upstream.

Overall, the flow itself gave an insight into the cues needed to encourage fish movement between rivers, as well as determining the most appropriate flow design and potential future flow management options. The connection flow was the first deliberate attempt by managers of water for the environment to provide a connection flow encouraging fish movement between the Macquarie and the Barwon. It highlighted the potential of future flows in the northern connected basin to achieve environmental outcomes at the Basin scale.



A pair of crested grebes on a private wetland within the Macquarie Marshes. Photo: Sue Brookhouse, OEH.

A year in the Lachlan catchment

The Lachlan catchment covers an area of 90,000 square kilometres. The Lachlan River experiences highly variable flows. The river originates near Gunning and winds its way across the landscape for 1400 kilometres, terminating at the Great Cumbung Swamp. The catchment supports many wetlands of high ecological value. These include the Booligal Wetlands, Great Cumbung Swamp and Lachlan Swamp, all of which are listed in the Directory of Important Wetlands in Australia.

The Booligal Wetlands support lignum, river red gum, black box and river cooba communities, providing habitat for many colonial waterbirds, including the great egret, glossy ibis and sharp-tailed sandpiper. The Lachlan Swamp provides habitat for many vulnerable bird species, including the brown treecreeper, grey-crowned babbler and magpie goose, as well as the vulnerable Mossgiel daisy and Menindee nightshade. Both of these major wetlands provide breeding grounds for the Australasian bittern, blue-billed duck and freckled duck, which are listed under the Biodiversity Conservation Act. The southern bell frog has also been recently rediscovered in the lower Lachlan following the delivery of water for the environment in 2012 and thereafter. It had not been detected for more than 30 years.

The Great Cumbung Swamp acts as a drought refuge, and contains one of the largest areas of common reed and river red gum in New South Wales. Several waterbirds listed in international bilateral agreements frequent the swamp, including the great egret, glossy ibis, common greenshank, Latham's snipe, white-bellied sea-eagle and sharp-tailed sandpiper.

Since 2006, water for the environment has been delivered to the mid-Lachlan anabranches (section of a stream that diverts from the main channel and

re-joins downstream) and large wetland complexes in the lower Lachlan. These wetland sites are highly valued by the community, and are vital for maintaining river and floodplain health. The wetlands, rivers and creeks in the Lachlan catchment also have important Aboriginal cultural heritage values. They include significant sites found throughout the catchment, such as scarred trees, earthen mounds and artefacts.

The Lachlan EWAG is chaired by the Central Tablelands LLS. It consists of community and agency representatives, including Aboriginal traditional owners, local landholders, water user groups and Commonwealth and NSW government agencies with a role in water management. The EWAG meets quarterly to plan annual watering actions and review outcomes of environmental watering.

Catchment condition in 2016–17

In 2016–17 the Lachlan catchment experienced above-average rainfall. The lower catchment experienced particularly good rainfalls in winter, leading to localised flooding in some areas prior to the later arrival of floodwater moving down the Lachlan River, although below-average to very dry conditions were experienced from spring throughout



Aerial view of the Merrimajeel Creek during the 2016 floods. Photo: Vince Bucello, Midstate Video Productions.

the rest of the water year. The upper Lachlan catchment experienced wet to very wet conditions until November, with flood inflows above Wyangala Dam and into the major below-dam tributaries followed by widespread flooding.

All major semi-permanent water bodies were filled including the Lake Cowal system, with significant floodplain wetting occurring from natural events. Flows in the Lachlan River, below Lake Brewster, were continuously high and filled the Lower Lachlan Swamp and the Great Cumbung Swamp for a period of five and a half months. Following the peak winter/spring inflow period conditions in the catchment were generally dry throughout the summer and autumn months.

Watering aims

When planning for the water year, catchment conditions were dry and surface water availability was low, with reduced inflows expected and the possibility of continuing drying conditions. The resource availability scenario was therefore determined to be dry. The EWAG consequently recommended that the management outcomes should ensure environmental assets maintain their basic functions and resilience through:

- support for the survival and viability of threatened species and communities
- maintenance of environmental assets and ecosystem functions, including by allowing drying to occur consistent with natural wetting–drying cycles
- maintaining refuges.

Subsequent rainfall and widespread flooding changed conditions from dry to very wet and, as a result, the focus of watering aims shifted to improving the health and resilience of water-dependent ecosystems by:

- enabling growth, reproduction and large-scale recruitment for a diverse range of flora and fauna
- promoting higher floodplain–river connectivity
- supporting high-flow river and floodplain functions.

Lachlan environmental watering events for 2016–17

The Lachlan Water Resource Plan area is defined in the Basin Plan and incorporates all distributaries located in the lower Lachlan (Figure 4). Environmental watering events for 2016–17 are shown in Figure 4.

Water delivery

A total of 40,826 megalitres of managed water for the environment was delivered to wetland and river targets across the Lachlan catchment (Table 3). Heavy rainfall in the catchment over winter triggered flooding and high flows into spring. Water for the environment was used to extend the duration of flows in Merrimajeel Creek to Murrumbidgee Swamp improving early stage recovery of river red gum woodland, providing higher water quality refuge flows for fish during a blackwater event in the Lachlan River, supporting successful conclusion of an ibis nesting colony on the Merrimajeel Creek near Booligal and supporting a large pelican breeding event in Lake Brewster (Table 3).



A new generation of cormorants at home in the Lachlan catchment. Photo: Vince Bucello, Midstate Video Productions.

A year in the Lachlan catchment (continued)

Figure 4: Environmental watering events in the Lachlan Water Resource Plan area, 2016–17. Event numbers correspond to those in Table 3.

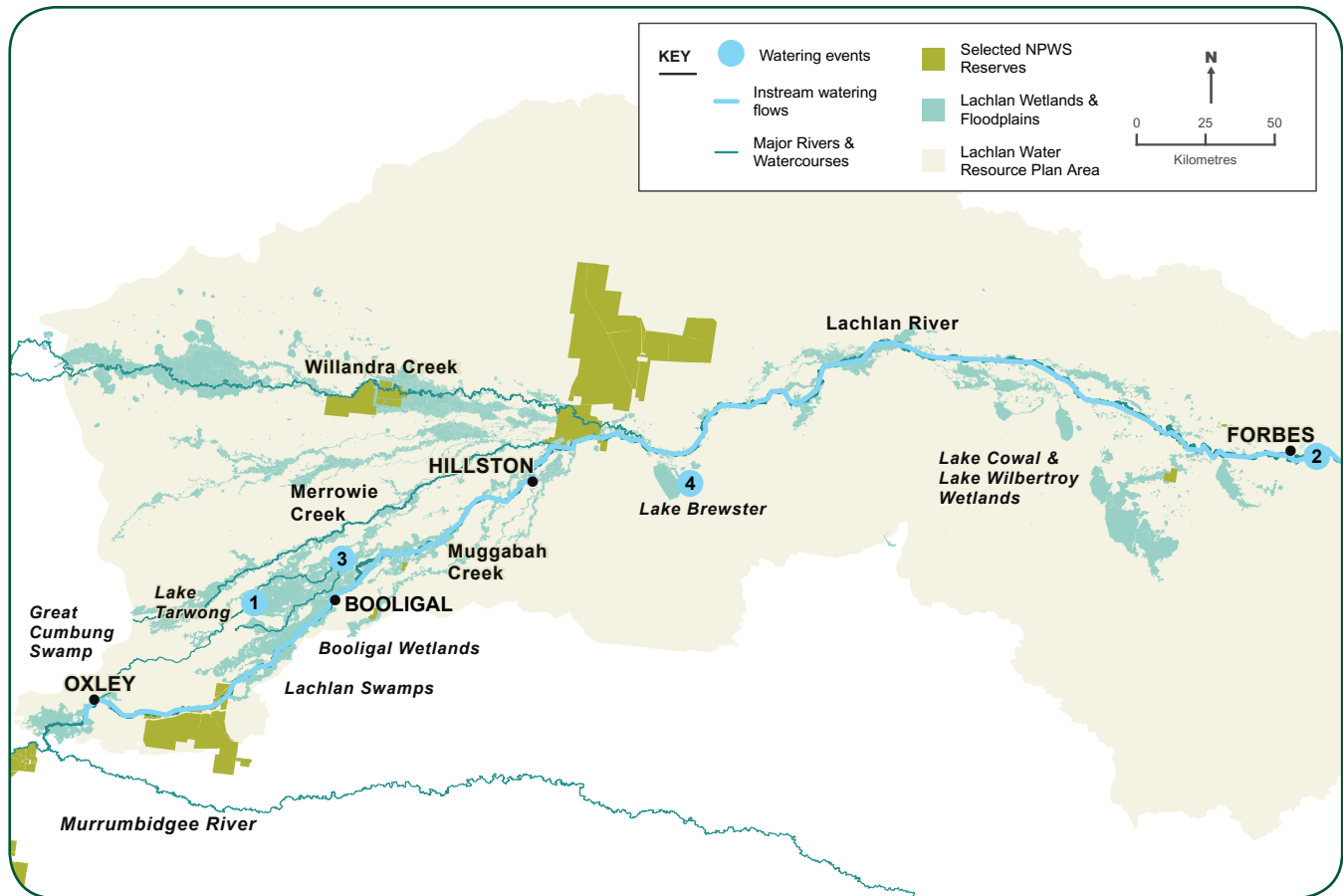


Table 3: Environmental water delivered in the Lachlan catchment during the 2016–17 watering year

Location	Start date	Finish date	Megalitres of water delivered			
			NSW	CEW	EWA	Total
1 Merrimajeel Creek to Murrumbidgee Swamp	7 Jul 2016	26 Jul 2016	1,000			1,000
2 Lachlan River – fish refuge flow	4 Nov 2016	2 Jan 2017	5,250	28,168		33,418
3 Booligal – ibis breeding (Block Bank)	9 Jan 2017	17 Mar 2017		1,324	3,571	4,895
4 Lake Brewster – pelican breeding	16 Feb 2017	30 Jun 2017			1,513	1,513
TOTAL			6,250	29,492	5,084	40,826

Note: Location numbers in the table relate to watering events marked on the map in Figure 4.

NSW = NSW licensed environmental water

CEW = Commonwealth licensed environmental water

EWA = Environmental water allowance established under the *Water Sharing Plan for the Lachlan Regulated River Water Source 2016*

Ecological outcomes

Very wet conditions early in the water year, resulting in widespread inundation, saw some significant ecological outcomes in the Lachlan system.

An ibis colony of over 100,000 nests established on Merrimajeel Creek in the Booligal Wetlands. The ibis began congregating during the passage of a small environmental flow event. Nest construction and breeding began in earnest with the arrival of translucent releases allowing a portion of dam inflows to pass down the river to mimic natural flow conditions. This breeding event reached its natural conclusion as the flood flows in the lower Lachlan system receded in summer. This was the largest ibis breeding event in the Booligal area in more than 20 years.

Translucent dam releases following flood flows down the Lachlan River channel to the Lower Lachlan Swamp, Booligal Wetlands and Great Cumbung Swamp, saw extended surface and groundwater connectivity, including flows connecting the Lachlan River system with the Murrumbidgee River for a period in excess of four months.

Floodwater returning from the floodplain areas back to the Lachlan River and anabranche creeks, contained hypoxic water – low in oxygen – that can stress and kill fish. A total of 48,000 megalitres of water for the environment was released to enable fish in the river to find refuge areas of better quality oxygenated water. No widespread fish kills were observed in the Lachlan system at the end of the flooding period.

Water for the environment was delivered into Merrimajeel Creek to support and maintain a late season breeding event of more than 8000 nests of straw-necked ibis, glossy ibis, white ibis, spoonbills and rufous night herons. Further water for the environment was used to support a significant pelican breeding event at Lake Brewster. The final wave of breeding, between March and May 2017, saw 1500 juvenile pelicans successfully fledge.



Scientists observe a pelican colony at Lake Brewster in the Lachlan catchment. Photo: Paul Packard, OEH.

A year in the Murrumbidgee catchment

The Murrumbidgee is one of Australia's most regulated river systems. The catchment covers 81,527 square kilometres. This includes a 1690 kilometre stretch of river that supports many floodplain wetlands (some of which are listed under the Ramsar Convention).

The Murrumbidgee catchment includes a number of national parks, nature reserves and conservation areas with important wetland values. These wetland systems provide habitat and breeding opportunities for native flora and fauna, as well as refuge areas during times of low flows.

Wetlands throughout the Murrumbidgee support threatened species listed under the Commonwealth Environment Protection and Biodiversity Conservation Act and NSW Biodiversity Conservation Act. These include the Australian painted snipe, regent honeyeater, regent parrot, superb parrot, austral pipewort, Australasian bittern, southern bell frog, chariot wheels, and Menindee nightshade.

The mid-Murrumbidgee wetlands, listed under the Directory of Important Wetlands in Australia, support a variety of wetland-dependent vegetation, including river red gum, spike rush and water

lilies. The Lowbidgee floodplain incorporates the Nimmie-Caira and Redbank floodplains. Vegetation supported by these wetlands includes river red gum, black box, lignum, common reed, cumbungi, river cooba, nitre goosefoot and cane grassland.

Cultural heritage sites in the Murrumbidgee catchment include Tuckerbil Swamp, which contains an ancestral burial ground significant to the Wiradjuri people. The Narrungadera Wiradjuri community have strong connections to both Fivebough and Tuckerbil swamps, which are listed under the Ramsar Convention.

The Murrumbidgee EWAG is chaired by the LLS and consists of community and agency representatives, including Aboriginal people, local landholders, water user groups, environmental groups and Commonwealth and NSW government stakeholders. The group provides strategic advice on managing environmental water in the Murrumbidgee catchment.



Inundation of Tori Swamp near Redbank Weir in the Murrumbidgee catchment. Photo: Vince Bucello, Midstate Video Productions.

Catchment condition in 2016–17

The Murrumbidgee catchment condition in 2016–17 varied considerably; however, it is generally accepted that the condition of the Murrumbidgee River floodplain has improved following natural flooding.

The 2016–17 water year saw 100% general security allocation, providing 237,000 megalitres of environmental water. This allocation combined with wet climate conditions meant the year could best be described as ‘very wet’. Environmental watering actions undertaken during 2016–17 resulted in good responses from wetland vegetation, waterbirds and frogs.

Watering aims

Under a moderate resource availability scenario, the delivery of water for the environment in the Murrumbidgee catchment for 2016–17 focused on the primary aim of achieving a ‘stand-alone’ wetland reconnection flow.

The aim was to simulate, to some extent, a natural high flow event or ‘fresh’ which would inundate hundreds of low-lying Murrumbidgee and Yanco Creek wetlands. Releases of water for the environment were to be made outside of the peak irrigation season so as to avoid channel and resource constraints.

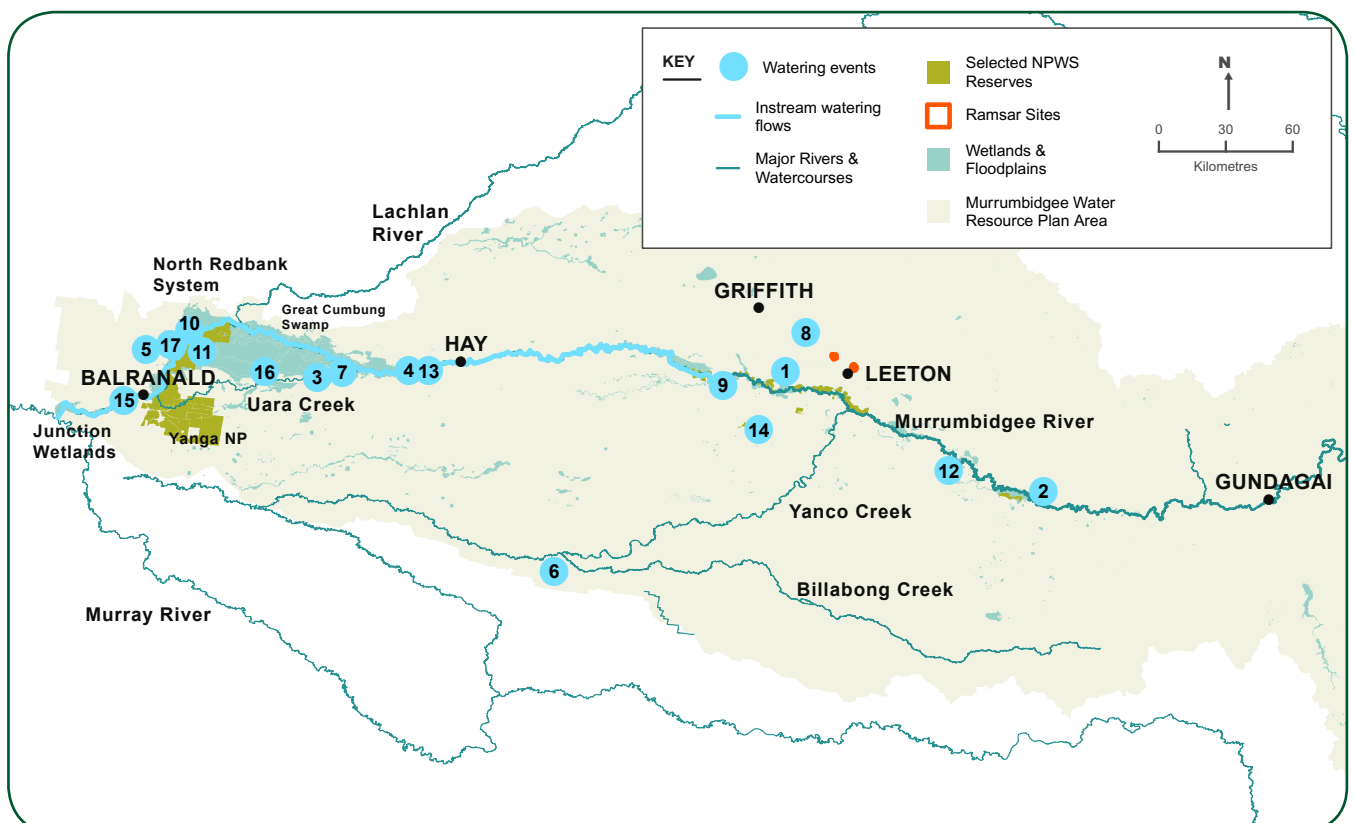
A well-timed flow of reasonable duration and peaking at ~20,000 megalitres/day at Wagga Wagga, can inundate hundreds of targeted low level wetlands. The Junction Wetlands at the end of the Murrumbidgee River should also benefit from this type of flow as it continues to the Murray River.

However, significant natural flooding in the Murrumbidgee catchment reset watering priorities. The primary objective became to minimise and manage adverse impacts that highly fluctuating flow rates may have on biotic functioning, such as naturally triggered breeding, in particular for colonial nesting waterbirds and native fish populations.

Murrumbidgee environmental watering events for 2016–17

The Murrumbidgee Water Resource Plan area is defined in the Basin Plan and includes significant environmental water assets such as the mid-Murrumbidgee wetlands, the Lowbidgee wetlands, Junction Wetlands, Western Lakes, Yanco–Billabong Creek system and the Murrumbidgee River channel (Figure 5). Environmental watering events for 2016–17 are shown in Figure 5.

Figure 5: Environmental watering events in the Murrumbidgee Water Resource Plan area, 2016–17. Event numbers correspond to those in Table 4.



A year in the Murrumbidgee catchment (continued)

Water delivery

A total of 530,424 megalitres of managed environmental water was delivered to wetland and river targets across the Murrumbidgee catchment (Table 4). This is the largest delivery of water for the environment in the Murrumbidgee catchment to date.

Sources of water for the environment included New South Wales, Commonwealth and TLM licences and the environmental water allowance made available under the *Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016* (Table 4).

Table 4: Environmental water delivered in the Murrumbidgee catchment during the 2016–17 watering year

Location	Start date	Finish date	Megalitres of water delivered				Total
			NSW	CEW	EWA	TLM	
1 Gooragool	1 Jul 2016	N/A (transfer)	4,365				4,365
2 Currawannana Lagoon	1 Jul 2016	30 Jun 2017	40				40
3 Nimmie-Caira to South Yanga	4 Aug 2016	3 Sep 2016		15,507			15,507
4 Lowbidgee fresh	29 Oct 2016	5 Jan 2017		150,978	134,861	85,000	370,839
5 Western Lakes	11 Nov 2016	30 Jun 2017	13,300	5,060			18,360
6 Yanco-Wanganella	16 Nov 2016	4 Jan 2017		5,000	4,300		9,300
7 Nimmie-Caira Rookeries	24 Nov 2016	20 Mar 2017	2,196	13,375	6,630		22,201
8 Murrumbidgee Irrigation Area	1 Dec 2016	28 May 2017			1,000		1,000
9 Tombullen perch pulse	16 Dec 2016	20 Dec 2016			1,205		1,205
10 North Redbank - Lake Merimley	27 Jan 2017	13 Feb 2017	1,350	844	596		2,790
11 Yanga NP rookeries	29 Jan 2017	7 Feb 2017		2,155			2,155
12 Sandy Creek	5 Mar 2017	26 Mar 2017	300				300
13 Toogimbie	18 Mar 2017	24 Jun 2017		998			998
14 CIA - Coleambally	27 Mar 2017	30 May 2017			5,000		5,000
15 Lower Murrumbidgee connectivity	1 Apr 2017	20 Apr 2017	1,039	47,548			48,587
16 Nimmie-Caira wetland refuge flows	24 May 2017	18 Jun 2017	15,104		5,000		20,104
17 Redbank refuge flows	30 May 2017	30 Jun 2017	7,673				7,673
TOTAL			45,367	241,465	158,592	85,000	530,424

Note: Location numbers in the table relate to watering events marked on the map in Figure 5.

NSW = NSW licensed environmental water

CEW = Commonwealth licensed environmental water

EWA = Environmental water allowance established under the *Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016*

TLM = The Living Murray

Ecological outcomes

During spring and early summer, inundation occurred across the mid-Murrumbidgee and Lowbidgee floodplains. While the peak flood level at Wagga Wagga was not as high as the 2010 and 2012 flood events, the significant duration of the flood resulted in very extensive inundation of the lower Murrumbidgee floodplain. An outcome of this flooding was a severe hypoxic blackwater event (low oxygen levels) which affected the lower Murrumbidgee River (below Maude). The blackwater event was most extreme below Balranald Weir where the Lowbidgee floodplain drainage returns to the river channel.

The declining water quality prompted the delivery of native fish recovery flows, which utilised 371,000 megalitres of environmental water to successfully recover dissolved oxygen levels in the lower river reaches and maximise native fish passage.

Dozens of significant waterbird rookeries established across the lower Murrumbidgee floodplain, primarily in response to the floods. A total of 25,000 megalitres of environmental water was used to maintain suitable water levels in numerous Lowbidgee bird rookeries including the first significant pelican rookery documented in the area, consisting of ~6000 nests.

Southern bell frogs continued to be widespread throughout the Nimmie-Caira, with adults and tadpoles recorded at LTIM sites and more than 100 adult frogs recorded at Nap Nap Swamp.

In 2016–17, widespread natural flooding and multiple watering actions supported a high diversity of waterbird species across the Murrumbidgee, including 39 species in mid-Murrumbidgee wetlands and reserves, 52 species in the Lowbidgee floodplain (including Yanga) and 60 species at Fivebough-Tuckerbil. Watering actions were focused on bird nesting areas in the Lowbidgee floodplain including 50,000 ibis nests and a large pelican breeding event (6000 nests) at Kieeta Lake in the Nimmie-Caira zone.

Some of these wetlands that received water for the environment in the Lowbidgee floodplain supported species of conservation significance such as the threatened Australasian bittern and vulnerable blue-billed duck, freckled duck and magpie goose. Species listed under international migratory agreements were also identified including the marsh piper, sharp-tailed sandpiper, eastern great egret and cattle egret.



Pelicans nesting in the Murrumbidgee catchment. Photo: Vince Bucello, Midstate Video Productions.

A year in the Murray and Lower Darling catchments

The iconic Murray and Lower Darling catchments are home to a diverse range of wetland plants, animals and ecosystems. These interconnected waterways are the lifeblood of countless inland communities.

The floodplains of the Murray and Lower Darling rivers cover a combined 98,300 square kilometres, and include a mosaic of wetland types ranging from ephemeral wetlands and creeks to permanently wet lagoons and rivers. The Murray and Lower Darling catchments support important habitat for critically endangered, endangered, threatened and vulnerable fauna listed under Commonwealth and state legislation. This includes the southern pygmy perch, silver perch, trout cod, Murray cod, southern bell frog, superb parrot, colonial nesting birds and migratory bird species.

The Millewa Forest makes up more than half of the Barmah–Millewa Forest icon site under The Living Murray program, and contains the largest river red gum forest in Australia.

Several sites in the region support the southern bell frog and bush stone curlew, as well as many other fauna and flora species listed in the Fisheries Management Act or Biodiversity Conservation Act.

The Murray catchment has records of more than 968 cultural heritage sites. Most of these are within the Millewa Forest (Yorta Yorta and Cummeragunja Nations), Werai Forest (Wamba Wamba/Wemba Wemba and Barapa Barapa/Perrepa Perrepa Nations) and the eastern portion of Koondrook Forest (Barapa Barapa/Perrepa Perrepa and Yorta Yorta, Cummeragunja and Perrepa Perrepa Nations).

OEH is working with local communities to improve the health of wetlands, rivers and floodplains in the Murray and Lower Darling catchments. The Murray Lower Darling EWAG, chaired by LLS, consists of community and agency representatives, recreational fishers, Aboriginal representatives, local landholders, water user groups and scientists. The group provides advice to OEH on managing water for the environment within the valleys.

Non-government organisations have provided invaluable cooperative support to OEH in the delivery of water for the environment. These include Murray Irrigation, landholders (using privately owned infrastructure at several sites), and the Murray–Darling Wetlands Working Group.



An ibis nest among the reeds in the Murray catchment. Photo: Vince Bucello, Midstate Video Productions.

Catchment condition in 2016–17

It was the wettest May to September on record, with heavy rain during winter and early spring causing widespread and prolonged flooding across much of inland NSW. These wet conditions led to greatly improved connections between rivers and floodplains, providing much-needed flows to water-dependent ecosystems throughout the Murray and Lower Darling river systems.

The change from dry to very wet conditions in 2016 demonstrated how quickly above-average rainfall can change environmental watering opportunities.

Watering aims

Pre-season planning with the EWAG determined a moderate to dry resource availability scenario in the Murray and Lower Darling catchments for 2016–17. Water management was aimed at maintaining ecological health by:

- supporting the survival and viability of threatened species and aquatic communities

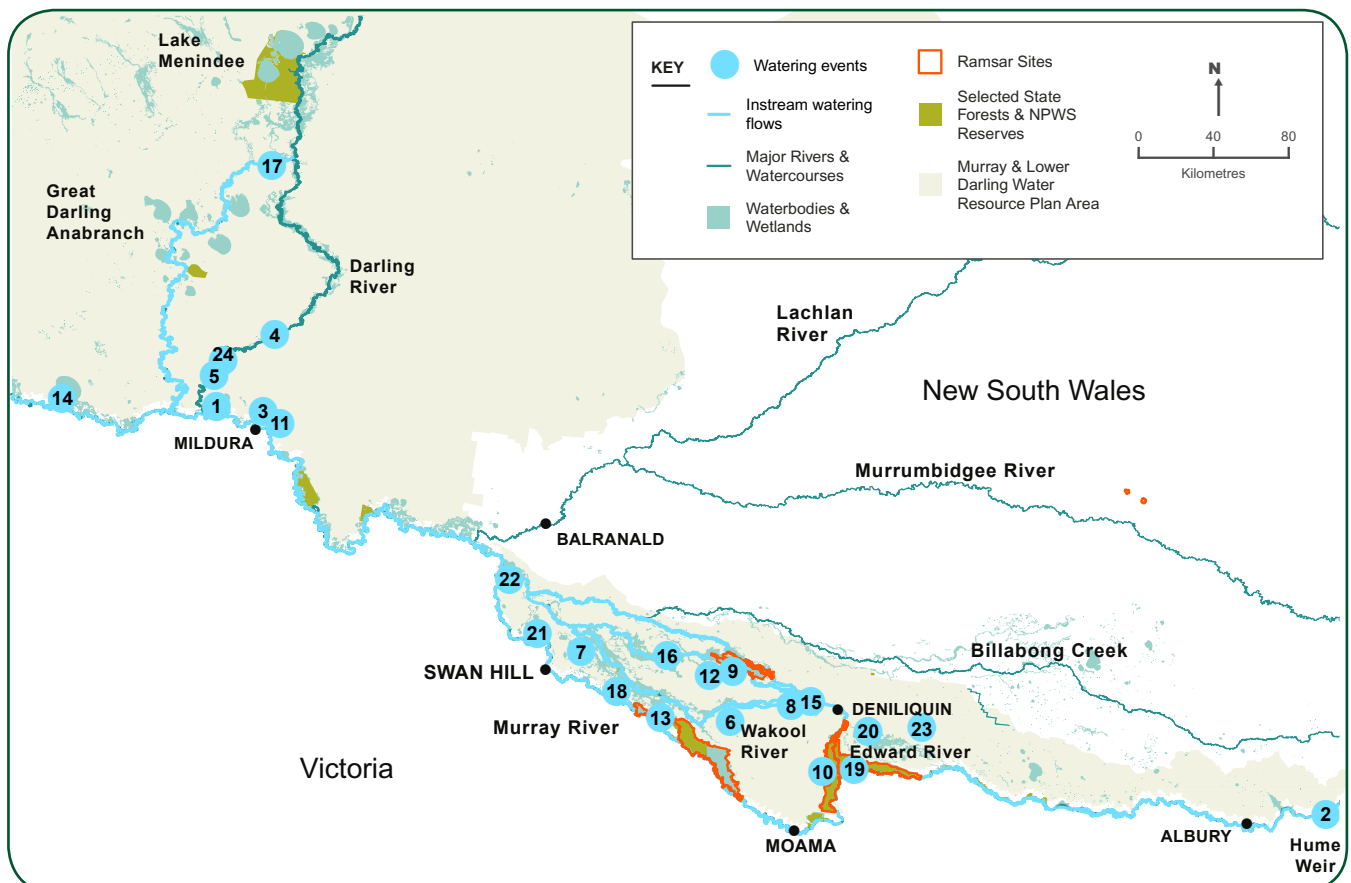
- maintaining environmental values and ecosystem functions, including allowing drying to occur consistent with natural wetting–drying cycles, and
- maintaining refuges.

With conditions changing to very wet early in the water year, outcomes from the natural flooding event were supported by strategic delivery of environmental flows to enhance waterbird, native fish and plant responses.

Murray and Lower Darling environmental watering events for 2016–17

The Murray and Lower Darling Water Resource Plan area is defined in the Basin Plan (Figure 6). This area supports hydrologically and ecologically complex freshwater habitats, as well as productive agricultural industries. Environmental watering events for 2016–17 are shown in Figure 6.

Figure 6: Environmental watering events in the Murray and Lower Darling Water Resource Plan area, 2016–17. Event numbers correspond to those in Table 5.



A year in the Murray and Lower Darling catchments (continued)

Water delivery

A total of 683,394 megalitres of managed environmental water was delivered in 2016–17 to wetland and river targets across the Murray and Lower Darling catchments (Table 5). The aim of environmental

water deliveries was to strategically support widespread catchment flooding to enhance waterbird, native fish and plant responses.

Table 5: Environmental water delivered in the Murray and Lower Darling catchments during the 2016–17 watering year.

Location	Start date	Finish date	Megalitres of water delivered					Total
			NSW	CEW	EWA	TLM	RMIF	
1 Thegoa Lagoon	1 Jul 2016	14 Aug 2016	1,440					1,440
2 Multisite	1 Aug 2016	30 Jun 2017		107,481	84,032	40,700	50,000	282,213
3 Bottle Bend Reserve	18 Aug 2016	26 Aug 2016	2,133					2,133
4 Lower Darling	17 Sep 2016	30 Jun 2017		35,268		47,980		83,248
5 Andruco Lagoon	6 Oct 2016	13 Oct 2016	115					115
6 MIL Private Property Wetland Watering Program	12 Oct 2016	30 Jan 2017	277					277
7 Brechin	20 Oct 2016	15 Dec 2016	295					295
8 Edward–Wakool native fish refuge flows	24 Oct 2016	26 Dec 2016	2,578	107,370				109,948
9 Cockrans Creek	6 Nov 2016	17 Jan 2017	615					615
10 Reed beds (Millewa)	7 Nov 2016	31 Jan 2017	4,488					4,488
11 Lake Gol Gol	17 Nov 2016	13 Dec 2016	5,792					5,792
12 Cockrans & Jimaringle creeks	27 Nov 2016	26 Dec 2016	1,840					1,840
13 The Pollack (Koondrook)	9 Dec 2016	28 Feb 2017	1,000			224		1,224
14 Lake Victoria	17 Dec 2016	31 Dec 2016				29,570		29,570
15 Yallakool–Wakool fish flows	1 Jan 2017	30 Jun 2017		30,351				30,351
16 Colligen Creek (Niemur River)	1 Jan 2017	30 Jun 2017		21,542				21,542
17 Darling Anabranch	17 Feb 2017	30 Jun 2017	10,850	89,204				100,054
18 Merran Creek	19 Feb 2017	30 Mar 2017		1,107				1,107
19 Pinchgut (Multisite Millewa)	1 Mar 2017	15 Jun 2017				2,033		2,033
20 Mary Ada (Millewa)	1 Mar 2017	15 Jun 2017				2,439		2,439
21 Speewa Creek	18 Mar 2017	12 Apr 2017	500					500
22 Rosenhoe Swamp	24 Mar 2017	14 Apr 2017	250					250
23 Tuppal Creek	30 Mar 2017	5 May 2017	500	1,320				1,820
24 Andruco #2	14 Jun 2017	21 Jun 2017	100					100
TOTAL			32,773	393,643	84,032	122,946	50,000	683,394

Note: Location numbers in the table relate to watering events marked on the map in Figure 6.

NSW = NSW licensed environmental water

CEW = Commonwealth licensed environmental water

EWA = Environmental water allowance established under the *Water Sharing Plan for the NSW Murray and Lower Darling Regulated Rivers Water Sources 2016*

TLM = The Living Murray

RMIF = River Murray Increased Flows

Ecological outcomes

Flora and fauna responded positively across the Murray and Lower Darling sites that received water for the environment in 2016–17.

Murray cod spawning in the Lower Darling was reported to be the best observed for approximately 20 years. Significant flows down the Darling Anabranch and releases from Weir 32 assisted the dispersal of tens of thousands of juvenile golden perch from the Menindee Lakes system into the River Murray system.

Due to significant rainfall, high flows during July to October 2016 resulted in the establishment of a significant colonial waterbird rookery within the Gulpa Creek wetland complex. This event also provided habitat for the Australasian bittern and the Australian little bittern, with breeding considered likely based on recorded calling behaviour. Water for the environment was used to successfully maintain nesting and foraging habitat for waterbirds in the Gulpa Creek wetland complex between December 2016 and January 2017. There was a positive response from vegetation including recruitment of threatened swamp wallaby grass and Moira grass.

The Gol Gol wetlands, which includes Gol Gol Swamp and Lake Gol Gol, attracted tens of thousands of waterbirds comprised of at least 27 species including glossy ibis (which may have bred) and two threatened species – the blue-billed duck and the freckled duck.

During the spring watering events the endangered southern bell frog was detected at seven private mid-Murray wetlands and multiple locations along the Jimaringle, Cockran and Gwynnes creeks. The number of male southern bell frogs calling at each location ranged from five to 30. This was the first record of the species for some wetlands.

The Edward–Wakool system had its biggest flood since 1992 resulting in large amounts of carbon and nutrients entering rivers and creeks from the floodplain. A hypoxic event (low oxygen levels) occurred. In response, a trial using water for the environment to create small areas of refuge habitat for native fish was undertaken in the system. The trial event used 13 Murray Irrigation escapes that delivered non-flood affected water that was highly oxygenated.



Water from Murray Irrigation Limited escape mixing with hypoxic (low levels of oxygen) water in the Wakool River to provide refuge pockets for native fish. Photo: Robyn Watts, Charles Sturt University.

Working with communities

Where there are fish, there are fishers!

Our stakeholders are many and varied but not always obvious. Recreational fishers have a strong interest in the future of their fishery – but not many of them know how water for the environment can help native fish.

Providing information in a setting where stakeholders feel comfortable to ask questions can be a challenge.

Our recent work to engage with recreational fishers has allowed us to reach an important stakeholder base that is passionate about the health of native fish and the rivers they call home.

Earlier this year, more than a dozen recreational fishers took part in two bus trips in southern and western New South Wales. One tour focused on prime cod habitat in the Millewa Forest on the Murray and the second on environmental flows through the Lower Darling Anabranch, Murray and Lower Darling rivers, to support dispersal of golden perch from Menindee Lakes.

Hosted by OEH, recreational fishers met with water managers, fish experts, water holders and members of the local community.

They inspected wetland sites, river regulators and fishways and heard about the role of water for the environment in providing healthy aquatic habitat, fish-friendly flows and food for fish.

The trips have allowed us to share information about the work we do and answer questions from these important stakeholders. It was also an opportunity to hear directly from anglers who were concerned about hypoxic blackwater (low oxygen levels), barriers to fish movement and natural recruitment of native fish stocks.

The trips have also provided the impetus to develop site-specific communication materials that enable participants to understand more fully the importance of local rivers on a broader landscape scale.

Participants have, in turn, been actively sharing their learnings with their broader fishing networks.

These trips have led to further formal information sessions about 'water for fish' being hosted in Renmark, Albury and Wagga.

More bus trips are now planned for the Murrumbidgee, Macquarie and Gwydir catchments.

The trips have highlighted the value of choosing a setting where participants feel at ease and comfortable to ask questions. As well as site visits and informal presentations, the trip itself provides an opportunity for participants to speak with each other one-to-one.

Outcomes have included invitations to attend fish-related community events, contribute to river restoration projects and a growing network of stakeholders who understand our work and want to take action to improve the health of their rivers for the future of native fish.



Participants in the Murray and Lower Darling field trip being shown a fishway, which enables native fish to move past the weir at Lock 10 at Wentworth on the River Murray. Photo: Terry Korodaj, OEH.

NSW environmental water holdings

Table 6 summarises current NSW licensed water for the environment. It should be noted that this does not include 'planned' water for the environment which is allocated under water sharing plans.

Table 6: Environmental water holdings to 30 June 2017 (megalitres)

Valley	High security	General security	Supplementary	Unregulated	Total
Gwydir	1,249	17,092	3,141	-	21,482
Macquarie	-	48,419	1,452	2,916	52,787
Lachlan	1,795	36,569	-	-	38,364
Murrumbidgee	-	28,508	153,767	6,162	188,437
Murray	2,027	30,000*	-	-	32,027
Barwon-Darling	-	-	-	1,539	1,539
Subtotal OEH only	5,071	160,588	158,360	10,617	334,636
The Living Murray	5,624	187,938	350,000	12,965	556,527
Total	10,695	348,526	508,360	23,582	891,163

* Conveyance

Note: These figures have been rounded up, and OEH considers them to be accurate at the time of printing.

Find out more about environmental water holdings.

NSW environmental water trade

OEH's environmental water business model allows for the periodic trading of water allocation in the accounts of OEH water access licences to pay for some of the costs of managing these licences. Funds may also be used to purchase allocation or implement small-scale projects that improve environmental watering outcomes.

In 2016-17, OEH sold 960 megalitres in the Gwydir and 5000 megalitres of carryover space in the Murrumbidgee. A carryover agreement in the Murray for 2243 megalitres was made in June 2016 which enabled watering to continue into July 2016. Later in 2016, 1494 megalitres was transferred back. An agreement was reached with water users

to protect identified high priority wetlands in the mid-Murrumbidgee reach which involved the transfer of 1365 megalitres. In addition, OEH purchased 19,028 megalitres of Murrumbidgee allocation and received a donation of 972 megalitres, enabling an additional 20,000 megalitres to be delivered for core wetland watering in the Nimmie-Caira and North Redbank systems and pre-watering key waterbird rookery areas including known sites for Australasian bitterns. The additional allocation was over 70% of the total water delivered for these events.

Trade will continue to occur in future years to manage the portfolio for maximum environmental benefit.

Environmental water monitoring

OEH monitoring, evaluation and reporting program

The OEH environmental water monitoring, evaluation and reporting (MER) program is designed to meet OEH’s commitment to Open Government principles; including transparency, easy access to information, and improved collaboration and participation. The program also guides the adaptive management of environmental water and informs our progress towards meeting both Basin Plan and NSW environmental watering objectives.

The MER program supports environmental water managers, other stakeholders and collaborators by providing immediate access to the best available data and knowledge. This information is then used to guide

management decisions and report on outcomes from environmental watering actions. The major themes of environmental water MER are floodplain-dependent vegetation, fish, waterbirds and hydrology.

Monitoring is undertaken whenever environmental water is delivered to measure hydrological and ecological outcomes, and to ensure that any lessons gained from these deliveries are captured to improve future management.

Following is an example of how environmental water monitoring has been used in 2016–17 to support successful native fish breeding in the Lower Darling.



Monitoring of wildlife responses in the Macquarie Marshes. Photo: John Spencer, OEH.

Case study: Lower Darling fish flows

Murray cod and many other native fish are in decline, particularly in the Murray–Darling Basin. To counter this decline, managers of water for the environment are looking to enhance breeding and recruitment opportunities to help restore native fish populations.

The science to restore these populations is already well advanced and is improving our confidence in ways we can increase native fish abundance across large areas of the Murray–Darling Basin.

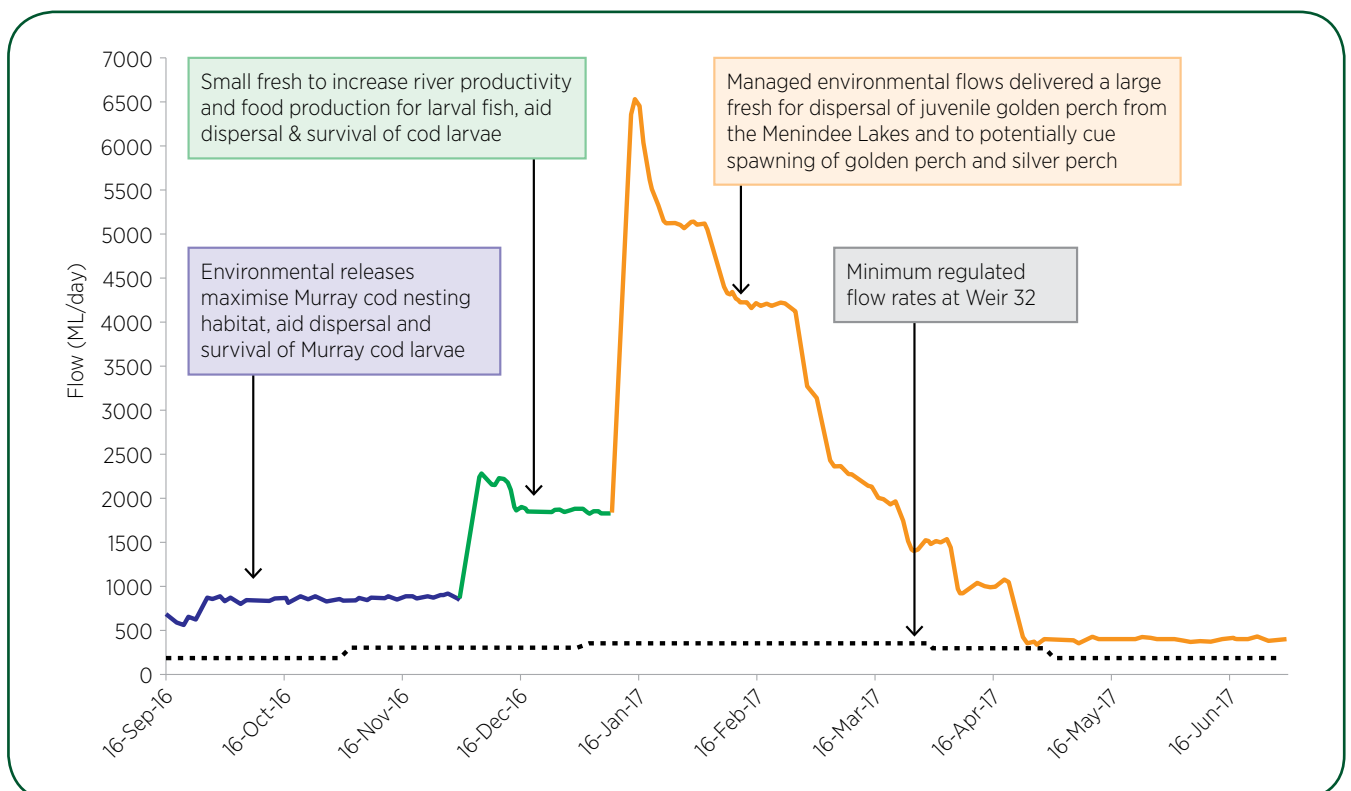
After a natural flow event in late 2016, plans were approved for a further release of water for the environment from Menindee Lakes to support Murray cod and other native fish breeding and dispersal opportunities.

The managed watering event was designed to increase available fish habitat by inundating more snags, providing more nesting sites, improving dissolved oxygen levels and increasing riverine productivity. This increase in habitat improved breeding and recruitment opportunities for native fish populations.

The provision of water for the environment from mid-September 2016 through to June 2017 was shown to maximise opportunities for native fish spawning, recruitment and dispersal. The stabilised flow rates, especially during October to December 2016, facilitated native fish spawning and prevented Murray cod nest abandonment. Monitoring found a significant positive breeding response, with the greatest number of juvenile Murray cod recorded for one specific event in over 20 years. Substantial dispersal of golden perch was also noted. The flow also contributed to improving water quality and reduced salt readings.

The hydrograph below demonstrates how the flow was delivered to achieve positive outcomes for native fish.

Figure 7: Strategy for delivery of up to 50,000 megalitres of environmental water within the Lower Darling River from September 2016 to June 2017 to benefit native fish (Credit: NSW DPI Fisheries)



Complementary planning instruments

A range of planning instruments are used by OEH to guide environmental water use in New South Wales. These instruments include a variety of New South Wales and Commonwealth government statutory and non-statutory documents.

- **The Basin Plan** is a statutory instrument under the Commonwealth Water Act 2007 that aims to ensure that water is shared between all users, including the environment, in a sustainable way. This is done by managing the basin as one system that traverses a number of states and a territory.
- **Water sharing plans** relevant to each catchment establish rules for sharing water between different types of water use, under the NSW Water Management Act 2000.
- **Basin Environmental Watering Outlook** is prepared annually by the MDBA identifying environmental watering priorities for the Murray–Darling Basin to guide basin-wide environmental watering outcomes.
- **Annual environmental watering plans** are prepared by OEH for each valley referencing a variety of statutory and non-statutory instruments to provide details about environmental watering for each water year.
- **Statements of annual environmental watering priorities** are prepared by OEH for each catchment in accordance with Chapter 8 of the Basin Plan, the Basin Environmental Watering Outlook, Basin-Wide Environmental Watering Strategy 2014, and the regional valley Annual Environmental Watering plans. These plans are prepared at the beginning of the water year to help guide and prioritise water planning.
- **Commonwealth portfolio management plans** are prepared each year for each catchment by CEWO to support the management and use of the Commonwealth environmental water portfolio.
- **Other valley specific documents** are used by OEH to inform specific areas and land management issues of environmental water management.



Pink eared ducks at wetlands in Lachlan catchment. Photo: Vince Bucello, Midstate Video Productions.

Our partners

Management and delivery of water for the environment by OEH relies on cooperation with a number of NSW agencies, the Australian Government and other partners. OEH would like to acknowledge the contribution of the following partners:

Environmental Water Advisory Groups provide invaluable expertise, including local knowledge and experience, when advising OEH on managing water for the environment.

Private and public landholders provide advice and on-ground support to OEH during watering events, as well as access to their properties in many cases.

The **Commonwealth Environmental Water Holder**, supported by the **Commonwealth Environmental Water Office (CEWO)**, makes decisions on the use and management of water holdings of the Australian Government. Commonwealth water for the environment is allocated to NSW events undertaken by OEH and its partners. The NSW and Australian governments work cooperatively to ensure the best possible outcomes from managing water for the environment. The CEWO also administers the Ramsar wetland and migratory bird conventions (Australia is a signatory), with many sites being high priority targets for environmental water use.

The **NSW Department of Industry – Crown Lands and Water Division** is responsible for implementing

the Water Act 1912 and Water Management Act. It determines water availability, manages flow events in unregulated and regulated rivers, monitors water use, and implements and monitors the outcomes of rules-based planned environmental water under water sharing plans.

The **NSW Department of Primary Industries – DPI Fisheries** provides specialist technical and policy advice on fisheries management in water recovery and environmental water-use projects and plans.

WaterNSW manages river operations and water delivery in regulated river systems across New South Wales under licence to the NSW Government.

Local Land Services or **LLS** work with regional communities to respond to key natural resource management issues facing their catchments. They also participate on EWAGs in New South Wales.

The **Murray–Darling Basin Authority (MDBA)** is the Australian Government agency responsible for managing the water resources within the Basin, including preparing a Basin Plan and coordinating the management of water recovered for TLM icon sites.



Young egret on nest in Murray catchment. Photo: Vince Bucello, Midstate Video Productions.

Our partners (continued)

River Murray Operations are part of the MDBA and have been crucial in the success of environmental water projects by providing information and cooperation in flow management, as well as coordination and facilitation for various operational advisory groups throughout the Murray Valley.

Irrigation companies, including Murray Irrigation, Murrumbidgee Irrigation and Coleambally Irrigation, help deliver environmental water projects by using their infrastructure.

Universities and other organisations that support OEH in monitoring and research include:

- Charles Sturt University
- University of New England
- University of New South Wales
- University of Technology, Sydney
- Macquarie University
- Murray–Darling Freshwater Research Centre.

The **Murray Lower Darling Rivers Indigenous Nations (MLDRIN)** was formed in 1998 and is a confederation of Indigenous Nations or traditional owners in the lower southern part of the Murray–Darling Basin, representing 24 nations. MLDRIN is an expression of the way the Indigenous Nations have always done business – by caring for Country and talking to their traditional neighbours upstream and downstream on

the Murray and its sister rivers, creeks, lakes, billabongs and waterways. MLDRIN also provides advice as a member of the Murray Lower Darling Environmental Water Advisory Group, when delivering water for the environment.

Northern Basin Aboriginal Nations (NBAN) is an organisation that represents 22 Sovereign First Nations in the Northern Murray–Darling Basin in natural resource and water management. NBAN is only the second organisation to successfully bring Sovereign First Nations together under one common cause. Within the Murray–Darling Basin there are 46 Sovereign First Nations represented by both NBAN and MLDRIN. NBAN has recently attended the Gwydir EWAG as an observer.

The **Southern Connected Basin Environmental Watering Committee** was established by the Murray–Darling Basin Ministerial Council in October 2014 and has been meeting regularly since February 2015. The current committee membership consists of state and Commonwealth environmental water holders and managers of planned environmental water, key river operators and waterway managers.

This committee coordinates the efficient and effective delivery of all water for the environment in the Southern Connected Basin and makes decisions on the planning and use of the TLM portfolio, River Murray Increased Flows and River Murray Unregulated Flows.



OEH staff viewing wetlands in the central Murray region. Photo: Vince Bucello, Midstate Video Productions.

Find out more:

www.environment.nsw.gov.au/environmentalwater