Gwydir Water Resource Plan

Surface water resource description
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*Gwydir Water Resource Plan: Surface water resource description*

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**More information**


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Cover images: Gwydir River at Yagobe Crossing; Murray cod; Aquatic plants; Tyreel Regulator
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**NSW DPI Water**

**NSW Office of Environment and Heritage Atlas of NSW Wildlife data**

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1. Introduction
The NSW Government is developing water resource plans as part of implementing the Basin Plan 2012 (the Basin Plan). Water resource plans will align Basin-wide and state-based water resource management in each water resource plan area. The plans will recognise and build on the existing water planning and management framework that has been established in NSW.

The Gwydir Water Resource Plan covers the surface water sources of the Gwydir catchment. The plan incorporates two surface water resources, the Gwydir Regulated River Water Source and the Gwydir Unregulated Water Sources. This report is a detailed description of the Gwydir Water Resource Plan Area (SW15) to provide an understanding of the region and the resources covered by the Plan. It describes the location and physical attributes, and provides information on the hydrology, environmental assets and water quality characteristics relevant to these water sources.


1.1 Overview of the Plan area
The Gwydir Water Resource Plan Area (WRPA) is located within the Gwydir catchment, which forms part of the Murray-Darling Basin in northern NSW. It is bounded by the Namoi catchment to the south, the Barwon River to the west, the slopes of the Great Dividing Range to the east and the Border Rivers region to the north (Figure 1). The Gwydir catchment covers more than 26,000 km² and represents about 2.7 per cent of the Murray-Darling Basin.

The Gwydir River originates on the New England Tablelands near Uralla. From here the river and its tributaries flow north-west through undulating and steep sided valleys before descending onto wide, flat floodplains near Gravesend. This broad alluvial floodplain characterises the lower half of the valley and continues west to the Barwon River at Collaranebri.

Watercourses draining from the tablelands include Rocky Creek, Laura Creek, Georges Creek, Moredun Creek, Copes Creek, Gwydir River and the Horton River, the last being a major contributor of unregulated flows (MDBA 2012a). Downstream of Moree, the Gwydir River splits into two major streams: the Gingham Watercourse forms the northern arm and the Lower Gwydir Watercourse (also known as the Big Leather Watercourse) forms the southern arm. These watercourses also contain the Gwydir Wetlands which are one of the most extensive and significant semi-permanent terminal wetlands in north-west NSW.

The Gwydir River is regulated by a number of dams and weirs. The valley’s major water storage is Copeton Dam which is situated on the Gwydir River about 35 km south-west of Inverell. The dam supplies water to users along the Gwydir River and effluent streams of Carole Creek, Moomin Creek and Mehi River (MDBA 2012a).

The Gomeroi/Kamilaroi people are the traditional custodians of the Gwydir catchment. Their land extends from Singleton in the Hunter Valley through to the Warrumbungles in the west, and up through the Namoi and Gwydir catchments to just over the Queensland border. The land and waters of the Gwydir catchment contain places of deep significance to Aboriginal people and are central to their spiritual beliefs. They are celebrated in ritual, ceremony, story, dance and art work.

The Gwydir catchment supports around 25,000 people with the majority of these living in the Moree Plains Local Government Area. The town of Moree is the major regional centre and has a population of around 10,000 people (ABS 2011). There are a number of smaller towns supporting 1,000-2,000 people. These are Uralla, Guyra, Bingara and Warialda. Other small
villages within the Plan area include Bundarra, Delungra, Pallamallawa and Tingha which have populations of 300-700 people.
1.2 Water management units
The surface water of the Gwydir WRPA is currently managed through two water sharing plans:

- Water Sharing Plan for the Gwydir Regulated River Water Sources 2016
- Water Sharing Plan for the Gwydir Unregulated and Alluvial Water Sources 2012

The **Gwydir Regulated River Water Source** comprises water between the banks of all rivers, from Copeton Dam water storage downstream to the junction of the Gwydir River and its effluent rivers with the Barwon River. It is represented by the blue line in Figure 1 and Figure 2.

The **Gwydir Unregulated Water Sources** comprise all of the streams upstream of Copeton Dam, and all of the tributaries entering the Gwydir River downstream of Copeton Dam. They are categorised into 28 water sources as shown in Error! Reference source not found.

1.3 History of water management in the Gwydir WRPA

1.3.1 Early wetland and water management
The former Department of Water Resources began mapping and studying the floodplain wetlands of the Gwydir catchment in the early 1990s (Green and Bennett 1991; Bennett and Green 1993) leading to the preparation of a *Lower Gwydir Wetland Plan of Management* (Keyte 1994). During this time the University of New England also contributed significant knowledge around the ecological values and management of the wetlands with the preparation of a management plan for the Gingham Watercourse (McCosker and Duggin 1993). Further work by McCosker in the late 1990s assessed the ecological responses to various flood events (McCosker 1996, 1999a, 1999b, 2001) providing a foundation for early water management within the Gwydir Wetlands.

1.3.2 NSW water reforms
In February 1994 the Council of Australian Governments (COAG) endorsed a strategic framework for the efficient and sustainable reform of the Australian water industry. Following this, the NSW Government released a discussion paper in mid-1994 outlining changes to the management of the state’s rivers and waterways. Early reforms included the development of water quality and river flow objectives, embargoes on new licences on regulated and unregulated rivers in the Murray-Darling Basin to meet an agreed cap on water extractions from the Basin, and a commitment to deliver water to key wetlands.

In 1997 the Government introduced its current program of rural water reforms that aimed to achieve a better balance in water use by more explicit and careful sharing of water between the environment and water uses. This program led to the development of the current legislative framework that defines how water is shared and managed under the *Water Management Act* 2000.

1.3.3 Water sharing in the Gwydir Regulated River
The Gwydir Regulated River Management Committee was formed in 1997 to develop environmental flow rules that would optimise the allocation of water for environmental values in the Gwydir catchment. The committee included representatives from water users, interest groups, and government agencies involved in water management in the Gwydir catchment. The committee reached consensus on environmental flow rules for the Gwydir River in 1998.

In 2001 the Minister for Land and Water Conservation asked the committee to recommend water sharing rules to form a statutory water sharing plan. A draft water sharing plan, including revised environmental flow rules was prepared by the committee and placed on public exhibition in mid-2002. The statutory plan was approved by the Minister in February 2003 and commenced on 1 July 2004. The Plan was based on the recommendations of the Committee, submissions
Figure 2: Location of regulated and unregulated water sources in the Gwydir WRPA
received from the community following the public exhibition period, and agreed Government policy at the time.

The water sharing plan for the Gwydir Regulated River was amongst the first plans to be implemented in NSW. All of the 31 plans that commenced in 2004 were subject to a formal review towards the end of their ten year period of operation. Through this review and associated consultation, some amendments were made to the Plan in 2014 to provide greater flexibility for some of the environmental rules, and flexibility in annual usage limits for water users.

In 2016 the Water Sharing Plan for the Gwydir Regulated River was formally replaced. The Plan will continue operating to ensure continuity of rights to water while the water resource plan is being developed. No changes to water sharing rules were made in the replacement Plan and all issues that were raised by stakeholders during the review process will be considered in the development of the water resource plan.

1.3.4 Water sharing in the Gwydir unregulated rivers

The Gwydir Unregulated River Management Committee was appointed by the NSW Government to make recommendations on a water sharing plan by December 2001. At this time water sharing plans were being prepared for catchments or sub-catchments with the highest level of hydrologic stress. A draft Water Sharing Plan for the Rocky Creek, Cobbadah, Upper Horton and Lower Horton Water Source was prepared by the committee and placed on public exhibition in 2002. The final Plan was approved by the Minister for Land and Water Conservation in 2003 and the Plan commenced on 1 July 2004. The Plan was based on the recommendations of the committee, public submissions received following the exhibition period and the government policy at the time.

After the first round of water sharing plans commenced in 2004 the government realised that a broader approach was required to implement water sharing in the remaining unregulated water sources. The Gwydir Interagency Regional Panel was established to guide the development of a ‘macro plan’ for the remainder of the Gwydir unregulated catchment. The Plan was based on current government policy for defining water access with refinement of rules based on the local knowledge and expertise of the panel members. The draft water sharing rules were discussed with various specific interest groups in 2010 and were placed on public exhibition in September 2011. The Water Sharing Plan for the Gwydir Unregulated and Alluvial Water Sources commenced on 3 August 2012.

In 2016 the Gwydir Unregulated plan was amended to incorporate the water source previously managed through the Water Sharing Plan for the Rocky Creek, Cobbadah, Upper Horton and Lower Horton Water Source (2003) which had reached the end of its term. The Gwydir Interagency Regional Panel guided these amendments and consultation with stakeholders was undertaken to ensure the amendments did not have any unintended impacts. The merging of the Rocky Creek, Cobbadah and Upper and Lower Horton water source into the Gwydir unregulated plan now allows all water in the catchment to be managed through one plan and brings consistency in management across the Plan area.

The rules contained in the Water Sharing Plan for the Gwydir Unregulated and Alluvial Water Sources will be reviewed during the development of the Gwydir Water Resource Plan.
2. Regional setting

2.1 Climate

Rainfall

The Gwydir catchment is characterised by a temperate to sub-tropical climate, with a considerable gradient from east (cooler and wetter) to west (hotter and drier). Average rainfall ranges from 1000 mm per year in the east to around 500 mm in the west. Annual rainfall at Moree totals around 600 mm (Figure 3).

Figure 3: Average annual rainfall in the Gwydir catchment

Rain is generally summer dominant with the heaviest rainfall occurring from October to March. This pattern is reflected in the monthly rainfall totals at Bundarra in the upper catchment, Pallamallawa (23 km upstream of Moree), and Collarenebri at the end of the catchment (Figure 4). January has the highest rainfall ranging from 100 mm at Bundarra in the east to 68 mm at Collarenebri in the west. Summer storms may cause severe flooding and erosion, and winter...
flooding may also occur if soils remain saturated after summer rains. Autumn and winter rainfall generally varies between 40 to 50 mm per month at Bundarra, and 25 to 40 mm across the rest of the catchment (Figure 4).

Climate change modelling for the New England North West Region (OEH 2014) predicts that winter rainfall will decrease over the next 50 years while autumn and summer rainfall is projected to increase across the region over this timeframe (OEH 2014).

Evaporation

Evaporation (Class A pan evaporation) in the Gwydir catchment has a strong east-west gradient (Figure 5). Yearly evaporation varies from around 1,500 mm in the south-east to over 2,000 mm in the west. Evaporation significantly exceeds average monthly rainfall throughout the year. The greatest exceedance occurs during summer when nearly 300 mm of evaporation occurs per month at Moree compared to around 80 mm of rainfall (Figure 6).

Figure 5: Average annual evaporation for the Gwydir WRPA

![Average Annual Evaporation](image)

Figure 6: Average monthly evaporation at Moree 1900–2016

![Average Monthly Evaporation](image)
Temperature
The temperature extremes across the catchment can range from -8°C in the winter to 48°C in the summer. The average maximum temperature is 26°C and the average minimum is 11°C.

Long-term temperature records indicate that temperatures in the New England North West region have been increasing since the 1960s. Climate change modelling for the region predicts that this warming will continue over the next 50 years, with mean temperatures increasing by an average of 0.7°C in the near future (2030) and 2.2°C in the far future (2070). Spring will experience the greatest changes in maximum temperatures increasing by 2.5°C by 2070 (OEH 2014).

The number of hot days (>35°C) is projected to increase, while the number of cold nights will decrease. The greatest increase in hot days is projected for the north-west plains where 10–20 additional hot days per year are predicted by 2030, and more than 40 additional hot days per year by 2070 (OEH 2014).

2.2 Land use
European settlement of the catchment was encouraged by the discovery of gold at Bingara in the 1850s and later diamonds. However since the 1900s land use within the catchment has been largely agricultural and today agriculture is responsible for more than twice as much employment as any other sector in the local economy.

The most extensive land uses across the Gwydir WRPA are livestock grazing and dryland agriculture which together account for around 86 per cent of land use (Table 1, Figure 7). Lucerne and pasture are grown on the narrow alluvial floodplains of the Gwydir and Mehi rivers, and dryland crops are grown on the western floodplain. In terms of livestock, over 60 per cent of farms raise beef cattle and around 30 per cent raise sheep (ABS 2001).

Irrigation is concentrated around Moree and the floodplains west of Moree and accounts for 4 per cent of land use. The Gwydir catchment is the largest cotton-growing region in Australia, with over 100 growers producing an average of 460,000 bales between 2000 and 2008 (EBC Consortium 2011). Up to nine cotton gins were operating in the Moree region in 2010 (Roth 2010). The number of cotton growers and the amount sown and harvested varies each year in response to crop prices and water availability.

Other irrigated crops include wheat, lucerne, oil seeds and fodder as well as pastures for sheep and cattle. Perennial horticulture including pecans and olives and to a lesser extent annual vegetable crops are produced on some farms, primarily with high security water. Forestry, conservation reserves and other remnant native landscapes account for around 8 per cent of land use, and are concentrated in the mid to upper catchment.

Table 1: Land use in the Gwydir WRPA

<table>
<thead>
<tr>
<th>Land use</th>
<th>Area (sq km)</th>
<th>Area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dryland cropping and horticulture</td>
<td>8,841</td>
<td>30%</td>
</tr>
<tr>
<td>Grazing</td>
<td>16,432</td>
<td>56%</td>
</tr>
<tr>
<td>Irrigation</td>
<td>1,235</td>
<td>4%</td>
</tr>
<tr>
<td>Mining</td>
<td>2</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Forestry, conservation reserve and native vegetation</td>
<td>2,424</td>
<td>8%</td>
</tr>
<tr>
<td>Residential</td>
<td>55</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Urban intensive uses</td>
<td>72</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Water</td>
<td>127</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

Source: Australian Bureau of Agricultural and Resource Economics and Sciences, National scale land use 2010-11
Figure 7: Land use map of the Gwydir WRPA

Source: Australian Bureau of Agricultural and Resource Economics and Sciences, National scale land use 2010-11
2.3 Topographic description

The Gwydir catchment begins in the tablelands around Guyra and Uralla, at elevations of up to 1,200 m above sea level. From here the river and its tributaries flow through steep sided valleys before entering the plains near Gravesend. West of Pallamallawa the valley widens into an almost completely flat floodplain, where the elevation is generally less than 200 m.

The following description of the Gwydir WRPA is divided into three main regions – upland, midland and lowland – based on the topography and flow characteristics of the water sources (Figure 8). Analysis undertaken as part of the Risk Assessment and Water Quality Plan are based on these topographic zones.

Figure 8: Topographic areas of the Gwydir WRPA

2.3.1 Upland (upstream of Copeton Dam)

The headwaters of the Gwydir River begin between Uralla and Guyra in the New England tablelands. The main tributaries of the river above Copeton Dam are: Copes Creek, Moredun Creek, Georges Creek, Laura Creek, and Bakers Creek. A number of large upland wetlands occur in the top of the catchment near Guyra and Uralla. Copeton Dam is located approximately 90 km downstream of the headwaters of the Gwydir River.

Water sources located in the upland section of the WRPA are: Roumallia Creek, Rocky River, Boorolong Creek, Upper Gwydir River, Laura Creek, Bakers Creek, Georges River, Moredun Creek and Copeton Dam.

Photo 1 shows a pool in the Upper Gwydir River at Yarrowyck, around 35 km west of Armidale.
2.3.2 Midland (Copeton Dam to Moree)

Between Copeton Dam and Gravesend (west of Warialda), the Gwydir River flows westward linking a number of catchments including Keera Creek, Halls Creek, Myall Creek, and Warialda Creek. The Horton River, the major tributary of the Gwydir, rises in the south from the Nandewar Ranges and enters the river between Bingara and Gravesend.

Beyond Gravesend the floodplain begins to widen and the Gwydir River becomes a slow moving river with a complex pattern of effluents, anabranches, and tributaries. Almost the entire runoff for the Gwydir catchment is generated above Pallamallawa, with the western floodplains contributing almost no runoff due to low slopes, absorbent soils and high evaporation. At Pallamallawa a flood channel known as the Biniguy Break conveys floodwaters from the Gwydir River through to the Mehi River. The riverine vegetation in this reach consists of a narrow band of river red gums, and there are a number of lagoons adjacent to the river, associated with small creeks and flood channels (Green and Bennett 1991).

A unique feature of the Gwydir River is the Gwydir Raft, a large log-jam which extends for over 15 km along the river downstream of Moree (Pietsch 2006). The Raft is an accumulation of timber, debris and sediment which has been deposited in the former channel of the Gwydir River over many decades. Water pooled behind this blockage breaks out of the Gwydir channel northwards into the Gingham Watercourse and south into the Tyreel Anabranch.

Water sources located in the midland section of the WRPA are: Keera Creek, Mackenzies Flat, Myall Creek, Halls Creek, Warialda Creek, Slaughterhouse Creek, Mosquito Creek, Moree and the Cobbadah, Rocky Creek and Horton water source (which includes management zones for Cobbadah, Lower Horton, Upper Horton and Rocky Creek).
2.3.3 Lowland (Moree to Barwon River)

Downstream of Moree the Gwydir River spreads out over the floodplain in an alluvial fan that covers around 20,000 ha. Water sources in this lowland section of the river are: Mehi River, Tycannah Creek, Gurley Creek, Gwydir, Gingham Watercourse, Carole Creek, Gil Gil Creek, Millie Creek and Thalaba Creek.

Mehi River and Moomin Creek

The Mehi River takes the majority of the flow from the Gwydir River 30 km upstream of Moree. Diversions to the Mehi River are regulated by Tareelaroi Weir. For most of its length the Mehi River supports a narrow band of riverine woodland dominated by river red gum, coolibah, river cooba and lignum (Photo 2). Small lagoons and depressions occur adjacent to the river channel, some natural and others the result of river straightening. A small number are used as off-river storages, however most are only filled during large floods (Green and Bennett 1991).

Moomin Creek is an anabranch which leaves the Mehi River about 20 km downstream of Moree and rejoins it just before the Mehi River enters the Barwon River. Like the Mehi River there are many small lagoons and depressions adjacent to the channel that are filled during high flows. Land adjacent to Moomin Creek is highly cultivated although it does support a narrow strip of riparian vegetation including coolibah woodland, lignum, river cooba and water couch (DECCW 2011).

Gurley Creek and Tycannah Creek are the major tributaries to the Mehi system, with both contributing significant flows during major flood events (DECCW 2010). Tycannah Creek enters the Mehi River just upstream of the Mehi-Moomin Creek confluence, while Gurley Creek enters Moomin Creek around 15 km downstream of the confluence.

Photo 2: The end of the Mehi River at the Gwydir Highway near Collarenebri

DEPI Water
Lower Gwydir and Gingham Watercourses

The lower Gwydir catchment below Moree forms an inland terminal delta resulting in an alluvial fan of 20,000 ha. This region is referred to as the Lower Gwydir Wetlands and consists of two main channels – the Gingham Watercourse and the Lower Gwydir Watercourse, which is also known locally as the Big Leather Watercourse (Photo 3). The wetlands absorb much of the river’s flow during normal conditions, resulting in little water reaching the Barwon River. During flood events however, the floodplain becomes inundated and water flows into the Barwon River at a number of locations.

Inflows to the Lower Gwydir Wetlands are measured at the Gwydir River gauge at Yarraman Bridge. Flooding in these wetlands starts to occur at flows between 5,000 and 10,000 ML/d at Yarraman Bridge, depending on the amount of extraction occurring and the antecedent conditions in the channels and wetlands (Powell et al. 2008).

The Gingham Watercourse supports a small core of semi-permanent wetland vegetation (3,700 ha in 2008) as well as extensive areas of floodplain vegetation (Bowen and Simpson 2010). The main channel contains deep open water lagoons such as Gingham Waterhole, Pear Paddock Lagoon and Boyanga Waterhole which provide significant waterbird breeding habitat. Towards the lower end of the Gingham Channel water spreads out over the floodplain forming extensive areas of water couch pasture with rushes and some lignum. During shallow flooding these pastures become valuable feeding grounds for waterbirds such as spoonbills and ibis.

The Lower Gwydir Watercourse supports similar habitats to those in the Gingham Watercourse. The Lower Gwydir is characterised by poorly defined channels and extremely flat country with a gradient of less than one per cent which leads to widespread flooding. In 2008 the core of the Lower Gwydir Watercourse supported 3,076 ha of semi-permanent wetlands including water couch, marsh club rush, cumbungi and common reed (Bowen and Simpson 2010). Wandoona Waterhole is one of the last waterholes in the Lower Gwydir Watercourse to dry out and provides a valuable refuge for waterbirds and other wetland-dependent animals (DECCW 2011).
Carole and Gil Gil Creeks
Carole Creek is an effluent channel that breaks away from the Gwydir River upstream of Moree. At its upstream end the channel is well-defined with steep banks but further downstream the creek becomes shallower. Coolibah and river coobas form a narrow band of riverine woodland along each bank (Photo 4).

Gil Gil Creek has its own catchment area which begins on the plains north of Warralda. Carole Creek merges with Gil Gil Creek about 60 km downstream of its offtake from the Gwydir River. After joining with Carole Creek, Gil Gil Creek becomes a wide shallow channel which supports extensive areas of lignum and river cooba (Green and Bennett 1991). Carole Creek and the lower section of Gil Gil Creek are regulated via Boolooroo Weir which diverts water into the creek system from the Gwydir River.

Thalaba Creek
Thalaba Creek flows west into the Barwon River, however during flood events water flows overland and into Moomin Creek (DECCW 2010).

Photo 4: Carole Creek at Garah looking downstream from the gauging station

DPI Water
2.4 Streamflow characteristics

The Gwydir River is regulated by Copeton Dam which provides water for town water supplies, irrigation, stock and domestic use, industry, and environmental flows along the Gwydir River and its effluent channels. The flow regime of the Gwydir River has been substantially altered by the construction of Copeton Dam and the weirs and regulators that divert water along distributary channels such as the Mehi River, Moomin Creek and Carole Creek. Regulation of the river system has caused significant reduction in moderate to high flows in the lower Gwydir. It has also contributed to an increase in the average period between large flows, and a reduction in the average volume of large flows (CSIRO 2007).

The Gwydir River reaches it maximum capacity at Pallamallawa upstream of Moree where the mean daily flow is 2,053 ML per day. After this the main channel of the Gwydir River begins to lose its flow to the many anabranches and effluent channels that characterise the lower part of the catchment. The channel capacity at Pallamallawa is greater than the combined capacity of the four major distributary streams (the Gwydir River, Mehi River, Moomin Creek and Carole Creek) and so even small rises at Pallamallawa can cause overbank flooding downstream (Pietsch 2006). All of the effluents leaving the river are regulated and have an average flow of 200-300 ML per day.

Flows have been recorded in the upper Gwydir River at Bundarra since 1937 and provide a good long term record of natural streamflow patterns in the Gwydir catchment. Bundarra is in the upper catchment where the flows are not regulated by Copeton Dam. Here the long term average annual flow is 327,000 ML (Figure 9).

Years of extreme low flows have occurred on average a few years each decade, the most recent being in 2002 and 2009. The driest year on record was 1994 when just 3,400 ML of water was recorded at Bundarra. Extended drought periods have occurred in 1937-1949 and 1999-2009 when all annual flows were below the long term average. Annual flows have again been below average since 2012, with 2014 having the second lowest annual flow since records began.

Figure 9: Annual flows in the Gwydir River at Bundarra 1937–2015
Figure 10: Daily flow in the Gwydir River at Bundarra

Daily streamflows provide an indication of the variability of flow patterns and the peak height of flood events. The largest flood in the Gwydir River at Bundarra was recorded in August 1949 reaching a peak volume of 276,329 ML (Figure 10). Medium to large floods of up to 100,000 ML/d occur in the upper Gwydir three to four times per decade. The last significant flood event at Bundarra was in November 2011 when flows peaked at 186,214 ML/d.

Daily and seasonal streamflow patterns in the unregulated streams vary across the catchment. Figure 11 shows the seasonal variation in daily flows for three streams in the upland, midland and lowland parts of the Gwydir WRPA. High flows (indicated by the 20th percentile flow) are strongly seasonal, occurring mostly from August through to December in the upper and middle parts of the catchment, and from August to October in the lowland streams. The upper Gwydir catchment and the midland tributaries (such as the Horton River) display similar seasonal trends in flow. In these streams the median daily flow (50th percentile flow) is again highest from August to December but a reasonably constant flow is maintained throughout the remainder of the year. This more reliable flow allows water users regular access to water throughout the year. The total volume of water in the Gwydir River at Bundarra is much higher however, with a median daily flow of 200-500 ML/d during spring, compared to 100-120 ML/d in the Horton River at the same time. Partly this is accounted for by the larger catchment area (the catchment at Bundarra is around twice the area of the Horton River) however it is also due to the higher rainfall over the tablelands where the Gwydir River begins.

In the unregulated streams and effluents of the lower catchment (such as Tycannah Creek) persistent flow is very low and the streams often cease to flow. The median daily flow (50th percentile) in Tycannah Creek is less than 3 ML/d in August and is often 1 ML/d or less. Water users along these streams are reliant on accessing the larger flood events.
Figure 11: High, median and low daily flows in the Gwydir catchment

Gwydir River at Bundarra (Upper Gwydir catchment)

Horton River at Rider (Mid-Gwydir catchment)

Tycannah Creek at Horseshoe Lagoon (Lower Gwydir catchment)
3. Environmental assets

3.1 Parks and reserves
There is approximately 607 km$^2$ of land conserved within national parks and nature reserves within the Gwydir catchment. The majority of this area lies within the middle and upper parts of the catchment. The largest conservation area is Mount Kaputar National Park, part of the Nandewar Ranges which divide the Gwydir from the Namoi catchment to the south. The park covers 386 km$^2$ and protects a wide variety of plant communities, including semi-arid woodlands, wet eucalypt forests and sub-alpine heaths.

The Gwydir Wetlands State Conservation Area was created in February 2011 following the acquisition of ‘Old Dromana’, a former grazing property. It protects 76 km$^2$ of Ramsar listed wetland habitat in the core of the Gwydir wetlands.

3.2 Wetlands
The Gwydir Wetlands cover an area of over 1,000 km$^2$ on the lower Gwydir floodplain west of Moree. The most extensive wetland areas are located along the Gingham and Lower Gwydir watercourses, where flat overland grades result in extensive shallow flooding over large areas. Water flows through a series of natural and constructed channels and swamps. The core of the wetland supports some of the most extensive areas of water couch pasture remaining in NSW, as well as significant stands of critically endangered marsh club rush (*Bolboschoenus fluviatilis*) ecological community which occurs in three frequently flooded areas of the Gingham and Gwydir watercourses (Photo 4).

The floodplain wetlands provide habitat for 13 migratory birds listed under international agreements with Japan, China and the Republic of Korea (JAMBA, CAMBA and ROKAMBA). Four parcels of land (including the new Gwydir Wetlands State Conservation Area) are recognised internationally as a wetland site under the Ramsar Convention. The wetlands provide breeding and feeding grounds for colonial waterbirds and habitat for many threatened species. Over 235 species of birds have been observed in the wetlands, of which 165 species have been recorded as breeding (Dept. Environment and Energy 2016).

Photo 4: Marsh clubrush in the core of the Lower Gwydir wetlands
*MDBA, Arthur Mostead*
### 3.3 High ecological value aquatic ecosystems

Key aquatic ecological assets in the Gwydir WRPA include:

- 102,120 ha of significant wetlands on the floodplains (Gwydir Wetlands) including Ramsar listed migratory bird breeding sites
- River reaches with high fish diversity
- Threatened fish species including silver perch, Murray cod and purple spotted gudgeon
- Habitat for threatened species such as Sloane’s froglet, Booroolong frog, yellow-spotted tree frog, greater broad-nosed bat, river snail and Bell’s turtle; and threatened endangered populations including eel-tailed catfish and tusked frog
- Endangered ecological communities (EECs) including marsh club-rush sedgeland, carex sedgeland, coolibah-black box woodlands, carbeen open forest, upland wetlands of the New England Tableland bioregion and the Lowland Darling River aquatic EEC
- Off-river lagoons and wetlands that are located throughout the catchment
- In-stream pools and low flow refuges that support local and migratory species.

The value of the aquatic ecosystems in the Gwydir WRPA has been assessed using the High Ecological Value Aquatic Ecosystem (HEVAE) framework which consists of five key criteria (diversity, distinctiveness, naturalness, vital habitat and representativeness) that can be used at a range of scales to map and prioritise aquatic assets for water management (Aquatic Ecosystems Task Group 2012). The HEVAE framework was applied by DPI Water to assign an ecological value to instream assets across NSW using four of the five criteria (the representativeness criteria was not used due to insufficient data) (Healey et al. draft).

Most of the regulated section of the Gwydir River was assessed as having high to very high instream values (Figure 11). These included high fish diversity, the presence of threatened fish species, and large tracts of riparian vegetation and relatively undisturbed river reaches that provide habitat and contribute to primary production. Eel-tailed catfish and Murray cod are widespread in the regulated river sites, while silver perch is found only in the Mehi River (Figure 12). There is also the presence of endangered ecological communities, the most widespread of these being the Lowland Darling River Aquatic EEC and the Coolabah-Black box Woodland EEC (Figure 13).

Unregulated rivers in the following water sources also have high or very high ecological values (Figure 12):

- Gwydir water source (the unregulated sections of the lower Gwydir River) contains the Ramsar listed Gwydir Wetlands, as well as endangered ecological communities.
- Halls Creek water source has very high diversity of fish and macroinvertebrates and high naturalness values.
- In the upper catchment above Copeton Dam, Georges Creek and Moredun Creek water sources are of high value due to threatened fish species and endangered ecological communities.
- Lower Horton, Upper Horton and Myall Creek water sources have threatened fish species and high diversity, and are major tributaries to the regulated sections of the Gwydir River.
- Gil Gil Creek, Gingham Watercourse and Mehi River water sources have high ecological values due to endangered ecological communities and high naturalness and distinctiveness. In their lower reaches, Thalaba Creek, Tycannah Creek and Millie Creek
water sources all contain high values due to threatened fish and endangered ecological communities.

All of the above ecological values have been considered as part of the Gwydir Risk Assessment for the Gwydir Water Resource Plan.

Figure 12: Instream values for the Gwydir WRPA

Figure 13: Distribution of threatened fish species within the Gwydir WRPA
3.4 Hydrologic Indicator Sites

The hydrologic indicator site approach uses detailed eco-hydrological assessment of environmental water requirements for a subset of key environmental assets and key ecosystems functions across the Basin (MDBA, 2012a). The environmental assets of the Gwydir Wetlands are one of the key hydrologic indicator sites where a detailed assessment was undertaken. Through assessment of the environmental water requirements, the MDBA has determined the “Environmental Sustainable Level of Take” (ESTL) for the Gwydir Wetlands (MDBA, 2012a). The ESTL is a representation of the Sustainable Diversion Limit (SDL); which is the maximum long-term annual average volumes of environmentally sustainable surface water that can be taken from the Basin for consumptive use.

The MDBA used the Wetlands Geographic Information Systems of the Murray-Darling Basin series 2.0 dataset as well as data from ‘A directory of important wetlands in Australia’ (MDBA, 2012a) to determine the boundaries of the Gwydir Wetlands hydrologic indicator site. The site includes the Gwydir River, the Gingham Watercourses, the confluence of the Gwydir and Gingham Rivers, and the wetlands along Mallowa Creek (MDBA, 2012a). The Gwydir Wetlands met all five criteria used by the MDBA for determining a key environmental asset in the Basin. The wetlands are formally recognised in international agreements; they are natural or near-natural; they provide essential ecosystem habitat; they support state and national threatened species communities; and they are capable of supporting significant biodiversity (MDBA, 2012a).

“Detailed environmental water requirements led to the specification of site-specific flow indicators to achieve site-specific ecological targets” (MDBA 2012c, p.2). The site specific flow indicators are referenced to a “hydrologic indicator” site or sites. The hydrologic indicator sites, and flows describe at those sites, are intended to represent the broader environmental flow needs of river valleys or reaches (MDBA 2012c). The MDBA identifies five “ecologically
significant components of the flow regime”. These components are “cease to flow periods”, “base flows (low flows)”, “freshes”, “full bank flows”, and “overbank flows” (MDBA 2012c, p.21). Freshes are considered as flows that exceed the upper limit of based flows yet below “bank full flows”. Overbank flows are flows that exceed bank full flows. The assessment for unregulated catchments attended primarily to base flow requirements (low flows) “reflecting the prioritisation of efforts on parts of the flow regime that are most sensitive to the determination of [environmental sustainable levels of take and sustainable diversion limits]” (MDBA 2012c, p.39).
4. Water quality

4.1 Background

Degradation of water quality can put stress on a range of aquatic organisms, impact on Aboriginal cultural and spiritual uses of water, increase the cost of drinking water treatment, contribute to public health risks, and decrease the suitability of water for irrigation (DPI Water 2016a).

Water quality in the Gwydir WRPA varies from poor to excellent. The water quality status map (Figure 15) provides an overview of water quality within the Plan area. Water quality condition index scores are an integrated indicator of total nitrogen, total phosphorus, pH, turbidity and dissolved oxygen at main monitoring locations in the Plan area. The scores were calculated using the frequency and amplitude of exceedance of water quality targets listed in the Basin Plan between the years 2010-11 and 2014-15. Specific indices were also included for thermal pollution, harmful algal blooms, and salinity for irrigation water.

Water quality problems occurring within the catchment are mostly caused by a combination of alteration to natural flow regimes and land use change (DPI Water 2016a). The following sections provide a summary of the status, issues and likely causes of water quality degradation in the different regions of the plan area.

Figure 15: Water quality condition of the Gwydir WRPA
WaQI Scores: Blue = Excellent (100-95), Green = Good (94-80), Orange = Fair (79-60), Red = Poor (59-1).
4.2 Upland region

**Condition: Poor to Good**

Dissolved oxygen concentrations were within the targeted range for much of the period of analysis. During periods of low or no flow dissolved oxygen levels became unpredictable and fluctuated from very high to very low possibly due to algal production or stagnation. The pH was generally elevated due to high levels of aquatic plant and algal growth. Salinity in the upland was mostly low and negatively related to discharge i.e. the highest salinities occur during low flow periods (DPI Water 2016a).

Nutrients such as nitrogen and phosphorus were high in the upland water sources. This can occur through the combination of naturally occurring high concentrations of nitrogen and phosphorus in soils and erosion. Soil erosion may be exacerbated by historical conversion of forested to cleared land, degradation of stream banks and some land use issues. Turbidity and suspended sediment were low, but like nutrients, can increase during high flows in those reaches where bank and riparian condition is poor (DPI Water 2016a).

Algal blooms were a regular occurrence in Copeton Dam within the analysis period. Blooms occurred frequently during the warmer months when temperatures and light are high and mixing is low. The blooms may be exacerbated by high levels of bioavailable nutrients that will stimulate growth of algae and plants (DPI Water 2016a).

4.3 Midland region

**Condition: Poor to Good**

Thermal pollution from Copeton Dam results in water temperatures below natural during the summer months and above natural during the winter months. This is because the dam infrastructure only allows water to be released from the deeper layers. Temperature has a wide range of influences on biological processes. The release of cold water can interrupt important biological cues such as fish spawning and other fauna, and can reduce the growth rate of fish, and increase mortality (Lugg and Copeland 2014).

The extent of cold water pollution from Copeton Dam is estimated to extend over 200 km downstream of the dam wall (Lugg 1999). Cold water pollution has the potential to impact on the recovery potential of fish (as a result of increased environmental water) in the Gwydir catchment (DPI Water 2016a).

Copeton Dam has a major disruptive effect on water quality immediately downstream of the dam. It causes reduced primary productivity and leads to an increase in nutrient concentrations (Westhorpe et al. 2015). Further down the river nutrient concentrations were mostly influenced by rainfall and discharge and generally do not exceed target levels. Land use within the midland region is dominated by grazing, which can be associated with high nutrient concentrations. Turbidity and suspended sediment were high in the midland water sources, particularly in the Horton River. Peak concentrations of turbidity occurred during high flows and were a result of high levels of erosion from poor bank and riparian condition (DPI Water 2016a).

Dissolved oxygen was generally within target ranges. However, like the upland, it can become unpredictable during low and cease-to-flow periods. In Myall Creek, the evidence suggests that eutrophication caused dissolved oxygen concentrations to exceed target ranges (DPI Water 2016a). Salinity levels were low for the majority of the midland section of the catchment, though there were localised areas in some tributaries with naturally high salinity. The highest salinities occurred during low and no flow periods (DPI Water 2016a). Algal blooms are generally rare in the midland area, though there are occasional blooms of non-harmful species (DPI Water 2016a).
4.4 Lowland region

Condition: Fair

In the lowland part of the catchment, dissolved oxygen was frequently recorded at concentrations outside of the target ranges. This occurs when organic carbon concentrations, nutrient concentrations and temperature are high, resulting in increased microbial respiration.

Turbidity and suspended sediment were high throughout most of the lowland including the Gwydir Wetlands. High levels of turbidity can be a result of a number of factors including land use, bank and riparian condition, and the presence of invasive carp. Clay dominated soils have an increased susceptibility to re-suspension within the water column (DPI Water 2016a).

Nutrient concentrations were mostly at medium to high levels in the lowland. Upstream of the wetlands, nutrients were generally associated with runoff and erosion during rainfall events. However, this relationship was not as strong downstream of the wetlands. ‘Improved’ soils associated with cropping and irrigation are a potential source of excess nutrients in the lowland, as well as nutrients associated with suspended sediment. Algal blooms are rare in the lowland, though there are occasional blooms of non-harmful species. Isolated algae blooms occurred in the wetlands.

Salinity in the lowland was generally excellent for irrigation purposes with specific adsorption ratios being low at all times. Historically pesticides have been a major pollutant in the lower Gwydir catchment however, pesticide levels were reducing until the mid-2000s when monitoring ceased. Although spray drift and bioaccumulation of historical contamination have been reported in the wetlands, limited information on the current status of pesticide or toxicant pollution is available (DPI Water 2016a).
5. Riparian condition

Riparian vegetation is a key attribute connecting rivers and terrestrial ecosystems. It is important for controlling river bank stability, mitigating runoff, influencing instream processes and providing habitat for a range of biota (Lovett and Price 2007). Leaf litter derived from riparian vegetation is a key contributor of allochthonous energy sources into rivers, driving primary production and stimulating the development of food chains (Robertson et al. 1999; Westhorpe et al. 2010). Native riparian vegetation cover greater than 60 per cent and a riparian buffer zone width of up to 30 m are considered to be important for influencing good riparian condition (Jansen et al. 2003). An increase in the presence of large woody debris within rivers has been correlated with an increase in riparian tree cover, reaching a maximum when tree cover reaches 60 per cent (Matheson and Thoms in prep). Large woody debris derived from the riparian zone was associated with primary control on geomorphic stability and habitat heterogeneity in rivers (Brooks & Brierley 2002; Treadwell et al. 2007).

Changes to riparian vegetation can reduce the geomorphic condition of rivers (Brierley and Fryirs 2005). Reduction in geomorphic condition from good to moderate can be linked to reductions in macrophyte and macroinvertebrate assemblages (Chessman et. al 2006a), and freshwater mussel abundance declined in river reaches where geomorphic condition was reduced (Jones and Byrne 2010).

River Styles® recovery potential is related to geomorphic condition. It gives an indication of the capacity of a stream to return to good condition or to a realistic rehabilitated condition (Brierley and Fryirs 2005). Streams rated as having conservation or rapid recovery potential are likely to be the most stable and in a good condition, whereas streams with low recovery potential may never recover to a natural condition or may continue to decline quickly without intervention (Cook and Schneider 2006).

Figure 16 and Figure 17 provide a general overview of riparian and geomorphic condition for the Gwydir WRPA. The percentage of native riparian vegetation in the Plan area is highest in the middle region of the catchment (Figure 16). For river recovery potential (Figure 17), river reaches identified as being ‘strategic’ can be in good, moderate or poor geomorphic condition. These reaches are often undergoing rapid change and should be a focus for action to control degradation. Overall, the recovery potential is good with only a small proportion of the Gwydir catchment classed as having low recovery potential.
Figure 16: Percent cover of native woody riparian vegetation in the Gwydir WRPA

Figure 17: Geomorphic recovery potential in streams in the Gwydir WRPA
6. River operations and management

Alteration of the natural flow patterns of the Gwydir River began in the early 1900s as the early landholders set about modifying and diverting various channels to their benefit. Some examples include reducing the height of the Mehi River offtake to significantly increase flows down this channel, the cutting of a high level channel between the Gwydir River and Carole Creek (previously not directly connected) and modification of the offtake of Moomin Creek to increase flows (Pitsch 2006). Major development of surface water resources however did not occur until the construction of Copeton Dam.

6.1 Storages and regulating structures

Located on the Gwydir River 35 km south west of Inverell, Copeton Dam is the major irrigation storage within the Gwydir catchment. It provides water for town water supplies, irrigation, stock and domestic requirements, industry and environmental flows along the Gwydir River and its effluent channels. The storage has a total capacity of 1,364,000 ML which it draws from a catchment area of over 5,300 km². The dam has been full to capacity four times since its completion in 1973 (Figure 18). Inflows to Copeton Dam have been well below average in recent years, with 2014-15 being the third consecutive year with significantly lower than average inflows (Burrell et al. 2016).

AGL Southern Hydro operates a 21 megawatt hydro power station at Copeton Dam which generates enough power to supply an average of 10,000 people each year. Water is available for power generation only when releases are made for water users, the environment and during flood operations. Copeton Dam also provides significant recreational opportunities for the community in the form of boating, swimming, fishing and camping.

A series of weirs and regulators assist in the diversion of water to the various watercourses of the lower Gwydir catchment. The first of these is Tareelaroi Weir about 30 km upstream of Moree, which controls diversions to the Mehi River. Other major structures include Boolooroo Weir, Tyreel Weir, Combadello Weir, Gundare Regulator and Mallowa Regulator. The location and function of these weirs is shown in Figure 19 and Table 2.

Figure 18: Copeton Dam daily volumes since construction (1972-2016)
Figure 19: Location of major weirs and regulators in the Gwydir WRPA

![Map of Gwydir WRPA showing major weirs and regulators](image)

Table 2: Major weirs in the Gwydir catchment

<table>
<thead>
<tr>
<th>Weir</th>
<th>Approximate location</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tareelaroi Weir</td>
<td>Gwydir River 30km upstream of Moree</td>
<td>Diversions to the Mehi River</td>
</tr>
<tr>
<td>Boolooroo Weir</td>
<td>Gwydir River downstream of Moree</td>
<td>Diversions to Carole Creek</td>
</tr>
<tr>
<td>Tyreel Regulator</td>
<td>Gwydir River downstream of Moree</td>
<td>Diversions to Tyreel Anabranch and then to the Lower Gwydir Watercourse</td>
</tr>
<tr>
<td>Combadello Weir</td>
<td>Mehi River 20km southwest of Moree</td>
<td>Diversions to Moomin Creek</td>
</tr>
<tr>
<td>Gundare Regulator</td>
<td>Mehi River 50km southwest of Moree</td>
<td>Diversions to Mallowa Creek</td>
</tr>
<tr>
<td>Mallowa Creek Regulator</td>
<td>Mallowa Creek 50km southwest of Moree</td>
<td>Control of stock and domestic flows along Mallowa Creek</td>
</tr>
</tbody>
</table>
6.2 Licensed water use

The Gwydir catchment uses around 3.5 per cent of all surface water diverted in the Murray-Darling Basin (CSIRO 2007). The Gwydir River system is regulated to meet the needs of water users and the environment from Copeton Dam to its junction with the Barwon-Darling River near Collarenebri. Where possible the tributary inflows from the Keera Creek, Halls Creek, Myall Creek, Horton River, and Warialda Creek are used before dam releases are made.

6.2.1 Regulated river entitlement and usage

There is nearly 718,000 ML of regulated entitlement within the Gwydir Regulated Water Source (Table 3). Licences occur along the length of the river below Copeton Dam, however the major volumes of entitlement are attached to the lower Gwydir River and the Mehi River/Moomin Creek system.

The major water users in the Gwydir River are general security irrigators with an annual entitlement of 509,665 ML (Table 3). The needs of general security irrigators are met through a continuous accounting system where each irrigator operates their own individual water account. Irrigators are allowed to maintain up to 150 per cent of their entitlement within their account at any one time and may use up to 100 per cent of their entitlement within a water year.

Under the continuous accounting system the NSW Government maintains a reserve plus a working account (to cover transmission and operation losses) within Copeton Dam to ensure the security of water users. The reserve is used to meet the essential commitments of the system, including town water supply, high security irrigation, stock and domestic needs, and environmental flows. An environmental contingency allowance of 25,000 ML is also available in Copeton Dam.

General security water is less reliable and is affected by storage levels. Available water determination announcements are used to determine the proportion of entitlement that is allocated to general security water users. Long term modelling indicates that general security water users in the Gwydir catchment receive 100 per cent of their allocation or more at the start of a water year in 28 per cent of years. However by the end of the water year 100 per cent of allocation or more is achieved in 47 per cent of years (Figure 21).
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Table 3: Surface water share components for the regulated Gwydir catchment 2015-16

<table>
<thead>
<tr>
<th>Access licence category</th>
<th>Total share component (ML)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic and Stock</td>
<td>2,506</td>
</tr>
<tr>
<td>Domestic and Stock (Domestic)</td>
<td>88</td>
</tr>
<tr>
<td>Domestic and Stock (Stock)</td>
<td>230</td>
</tr>
<tr>
<td>Local Water Utility</td>
<td>3,836</td>
</tr>
<tr>
<td>Regulated River (general security)</td>
<td>509,665</td>
</tr>
<tr>
<td>Regulated River (high security)</td>
<td>20,200</td>
</tr>
<tr>
<td>Regulated River (high security –research)</td>
<td>60</td>
</tr>
<tr>
<td>Supplementary water</td>
<td>181,398</td>
</tr>
</tbody>
</table>
Figure 20: Distribution of regulated entitlement in the Gwydir WRPA
Figure 21: Long term simulated water availability for the Gwydir Regulated River

Water availability at the start of a water year

At the commencement of a water year General Security users receive 100% of their share component or more in 28% of years.

Water availability at the end of a water year

By the end of a water year General Security holders receive 100% or more of their share component in 47% of years.
Figure 22 shows the water availability, as a proportion of entitlement since the water sharing plan commenced in 2004-5. The actual water usage varies from year to year depending on rainfall and account water availability (Figure 23). Water usage in the early part of the water sharing plan (2004-2009) was heavily influenced by the millennium drought when low levels of water was available to general security water users. Similarly the low water availability in 2014-15 and 2015-16 resulted in reduced areas of plantings, and reduced water use (Burrell et al. 2016).

Figure 22: General Security water availability in the regulated Gwydir River

![Graph showing water availability over years]

Figure 23: Total water usage in the regulated Gwydir River (excludes supplementary water)

![Graph showing water usage over years]

About 20,260 ML of high security entitlement exists within the valley for irrigation and research purposes (Table 3). The availability of high security water is guaranteed (unless exceptional drought conditions occur) and must be provided for prior to allocating water to other users.

There is 3,836 ML of water allocated to local water utilities which also receive priority over general security water users. Moree Plains, Gwydir and Inverell Shire councils extract water from the Gwydir Regulated River to supply the towns of Bingara, Gravesend, Weemelah and Inverell (Table 4).
Table 4: Local water utilities using surface water within the Gwydir WRPA

<table>
<thead>
<tr>
<th>Council</th>
<th>Town</th>
<th>Water Source</th>
<th>Share component (ML)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gwydir Shire Council</td>
<td>Bingara</td>
<td>Gwydir Regulated River</td>
<td>660</td>
</tr>
<tr>
<td></td>
<td>Gravesend</td>
<td>Gwydir Regulated River</td>
<td>85</td>
</tr>
<tr>
<td>Moree Plains Shire Council</td>
<td>Weemelah</td>
<td>Gwydir Regulated River</td>
<td>37</td>
</tr>
<tr>
<td>Inverell Shire Council</td>
<td>Inverell</td>
<td>Gwydir Regulated River</td>
<td>3054</td>
</tr>
<tr>
<td>Uralla Shire Council</td>
<td>Uralla</td>
<td>Rocky River Water Source</td>
<td>621</td>
</tr>
<tr>
<td></td>
<td>Bundarra</td>
<td>Moredun Creek Water Source</td>
<td>93</td>
</tr>
<tr>
<td>Moree Plains Shire Council</td>
<td>Garah</td>
<td>Gil Gil Creek Water Source</td>
<td>43</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td><strong>4,593</strong></td>
</tr>
</tbody>
</table>

Supplementary water, formerly known as off-allocation water, is surplus flow that cannot be captured into storages during high flow events. As soon as these conditions are identified, a period of supplementary access is announced and details of the river reaches and time periods for supplementary access are published. Supplementary Water Access Licence holders can only pump water against these licences during these announced periods.

Due to the large volume of on-farm storage capacity within the Gwydir catchment rules for the sharing of surplus water were introduced in 1998. Flow thresholds protect low flows and determine the access available to this water. For each flow event, irrigators may access 50 per cent of the supplementary flow volume with the other 50 per cent remaining in the river for environmental use.

Supplementary water entitlements in the Gwydir River total 181,398 ML (Table 3). The highest use of supplementary water to date has been during the wetter years between 2010 and 2012 (Figure 24).

Figure 24: Total supplementary account usage in the Gwydir River
6.2.2 Unregulated river entitlement

Water users located on the various unregulated tributaries of the Gwydir catchment are entitled to extract water with an unregulated water licence. These licences are subject to a range of access conditions, including cease to pump triggers that protect the health of the rivers and watercourses. There is currently around 47,950 ML of unregulated entitlement within the Gwydir WRPA (Table 5). The main licensed use of water is for irrigation.
Figure 25 shows the distribution of unregulated river entitlement by water source. There is 757 ML of water for town water supply purposes that is extracted from unregulated rivers through domestic and stock access licences. These licences are held by Moree Plains and Uralla Shire councils to supply the villages of Uralla, Bundarra, and Garah (Table 4).

Table 5: Unregulated share components for the Gwydir WRPA 2015-16

<table>
<thead>
<tr>
<th>Access licence category</th>
<th>Total share component (ML)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic and Stock</td>
<td>192</td>
</tr>
<tr>
<td>Domestic and Stock (Domestic)</td>
<td>4</td>
</tr>
<tr>
<td>Domestic and Stock (Stock)</td>
<td>107</td>
</tr>
<tr>
<td>Domestic and Stock (Town Water Supplies)</td>
<td>757</td>
</tr>
<tr>
<td>Unregulated River Access</td>
<td>46,890</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>47,950</strong></td>
</tr>
</tbody>
</table>
Figure 25: Distribution of water entitlement for the Gwydir unregulated water sources
6.3 Water trading

In 1983-84 the temporary transfer of water licences (allocation trade) was introduced in regulated systems to facilitate business flexibility and optimise the benefits of water use to the NSW economy. Additionally, in 1989 permanent trades (entitlement trade) in regulated systems were provided for, and the NSW water market commenced to rapidly grow.

The implementation of water sharing planning has removed barriers to the efficient operation of these water markets, facilitating more efficient and better informed trades. This has been achieved through the inclusion of clear rules for trading in water sharing plans, the separation of the water licence from the land title in 2004, and the establishment of public registers in 2004, showing the volume and price paid for access licences.

Permanent trades include both share assignments and the sale of the licence entitlement. Temporary trades are temporary assignments of shares where water in a licence holder’s account is sold, but ownership of the licence is retained. Figure 26 and Figure 27 show permanent and temporary water licence trades from 1 July 2005 to 30 June 2016 within the Gwydir Regulated River water source. Variations between years are mostly related to climatic conditions and the volume of water made available to different licence categories.

Figure 26: Permanent trades for environmental and commercial use from 2005-06 to 2015-16

Figure 27: Temporary trades for environmental and commercial use from 2004-05 to 2015-16
6.4 Environmental water

Water sharing plans allow for two types of environmental water. Held environmental water is an entitlement that is held by a licence-holder for environmental watering purposes. Planned environmental water is water that is prescribed under the rules of a water sharing plan.

6.4.1 Held environmental water

The volume of held environmental water in the Gwydir WRPA has gradually increased since the first shares were acquired in 2007-08. They currently total 135,965 ML (Figure 28) which is comprised of 106,617 ML of general security water, 5,757 ML of high security water and 23,591 ML of supplementary water.

The main entitlement holders of held environmental water are the Commonwealth Environmental Water Holder and the NSW Office of Environment and Heritage. Held environmental water was first used in the Gwydir catchment in 2010-11 with the highest use to date being in 2014-15 (Figure 28). During that year environmental watering provided 5-6 months of continuous watering of the Gingham and Lower Gwydir wetland systems to build wetland resistance after a dry 2013-14 season, environmental water to wetlands along Mallowa Creek, and environmental watering of the Mehi River and Carole Creek systems to benefit native fish and instream ecology (OEH 2015).

Figure 28: Held environmental water share component in the Gwydir WRPA

6.4.2 Planned environmental water

Planned environmental water is rule-based water which is defined in the water sharing plan. The Gwydir catchment has an environmental water allowance which provides for up to 90,000 ML to be set aside for the environment. Releases may be made for a wide range of purposes related to wetland or river health or for the direct benefit of birds, fish or other fauna. There is also a three tributaries rule that provides up to 500 ML/day of combined flow from the Horton River, Myall Creek and Halls Creek to be passed to the Gwydir wetlands.

Figure 29 shows the usage of environmental water allowances in the Gwydir WRPA. A volume of 88,260 ML was available through the environmental water allowance in 2014-15 and of this 29,895 ML was used. This was the highest use of the environmental water allowance since commencement of the water sharing plan (Burrell et al. 2016).

The water sharing plan also provides for the environment through sharing arrangements in supplementary events where no more than 50 per cent of supplementary water event volume can be taken under supplementary water access licences.
It should also be noted that all water above the Plan extraction limit is regarded as planned environmental water. This means that on a long-term average basis, approximately 56 per cent of yearly flows in the river are protected for the maintenance of environmental health.

Figure 29: Environmental Water Allowance availability and usage in the Gwydir WRPA
## Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aquatic ecosystems</strong></td>
<td>Ecosystems that are dependent on flows, or periodic or sustained inundation/waterlogging for their ecological integrity. Examples include wetlands, rivers, karst and other groundwater-dependent ecosystems, saltmarshes, estuaries and areas of marine water not exceeding 6 m deep at low tide.</td>
</tr>
<tr>
<td><strong>Allocation</strong></td>
<td>The volume of water assigned to water allocation accounts in a given season, defined according to rules in the relevant water plan.</td>
</tr>
<tr>
<td><strong>Allocation assignment</strong></td>
<td>The transfer of water between licence holder allocation accounts as a result of a trade agreement. The assignment becomes part of the receiver’s allocation account water for the current water year.</td>
</tr>
<tr>
<td><strong>Available water determination (AWD)</strong></td>
<td>A determination referred to in section 59 of the <em>Water Management Act 2000</em> that defines the proportion of the share component that will be available for extraction under each category of water access licence.</td>
</tr>
<tr>
<td><strong>Basic Landholder Rights</strong></td>
<td>Means domestic and stock rights, harvestable rights or native title rights.</td>
</tr>
<tr>
<td><strong>Cold water pollution</strong></td>
<td>An artificial decrease in the temperature of water in a natural river.</td>
</tr>
<tr>
<td><strong>Dissolved oxygen</strong></td>
<td>Measured concentration of oxygen dissolved in water.</td>
</tr>
<tr>
<td><strong>Domestic consumption</strong></td>
<td>Consumption of water for normal household purposes in domestic premises on the land.</td>
</tr>
<tr>
<td><strong>Ecological value</strong></td>
<td>The perceived importance of an ecosystem which is underpinned by the biotic and/or abiotic components and processes that characterise that ecosystem.</td>
</tr>
<tr>
<td><strong>Ecosystem</strong></td>
<td>A specific composition of animals and plants that interact with one another and their environment.</td>
</tr>
<tr>
<td><strong>Ecosystem functions</strong></td>
<td>The processes that occur between organisms and within and between populations and communities. They include interactions with the nonliving environment that result in existing ecosystems and bring about dynamism through changes in ecosystems over time.</td>
</tr>
<tr>
<td><strong>Effluent</strong></td>
<td>An effluent stream is one which leaves the main river and does not return.</td>
</tr>
<tr>
<td><strong>Endangered ecological community</strong></td>
<td>Ecological communities as listed in Schedule 1 of the <em>Threatened Species Conservation Act 1995</em> or Schedule 4 of the <em>Fisheries Management Act 1994</em>.</td>
</tr>
<tr>
<td><strong>Eutrophication</strong></td>
<td>The process where an accumulation of nutrients in water bodies leads to rapid growth of aquatic plants.</td>
</tr>
<tr>
<td><strong>Farm dams</strong></td>
<td>Private dams that are used to intercept catchment runoff that would otherwise contributed to streamflow or recharge of aquifers. Primarily located on hillsides (does not include floodplain harvesting dams).</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<td>-------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>General security licence</td>
<td>A category of water access licence implemented under the Water Management Act 2000. Forms the bulk of the water access licence entitlement volume in NSW and is a low priority entitlement i.e. only receives water once essential and high security entitlements are met in the available water determination process.</td>
</tr>
<tr>
<td>Groundwater</td>
<td>Water that occurs beneath the ground surface in the saturated zone.</td>
</tr>
<tr>
<td>Groundwater dependent ecosystems</td>
<td>¹Ecosystems that require access to groundwater to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services.</td>
</tr>
<tr>
<td>Harmful algal bloom</td>
<td>An algal bloom that causes negative impacts to other organisms through the production of natural toxins, mechanical damage, or other means.</td>
</tr>
<tr>
<td>High flows</td>
<td>Also called bankfull events, these reshape the channel, creating habitats such as pools, bars and benches.</td>
</tr>
<tr>
<td>High security licence</td>
<td>A category of licence water access licence implemented under the Water Management Act 2000. Receives a higher priority than general security licences but less priority than essential requirements in the available water determination process.</td>
</tr>
<tr>
<td>Instream value</td>
<td>Ecological condition value of river reaches based upon High Ecological Value Aquatic Ecosystems (HEVAE). In NSW HEVAE was calculated using four criteria: distinctiveness, diversity, naturalness and vital habitat.</td>
</tr>
<tr>
<td>Low flows</td>
<td>Flows that are confined to the lower part of the channel; also often called base flows. These flows are between pools and riffle areas between pools. Generally defined as the 80th percentile flow.</td>
</tr>
<tr>
<td>Nitrogen and phosphorous</td>
<td>Chemical nutrients essential for growth and added to many fertilisers.</td>
</tr>
<tr>
<td>Overbank flows</td>
<td>High flows that connect the river to floodplain and wetlands allowing the exchange of nutrients and sediment to these areas.</td>
</tr>
<tr>
<td>Regulated river</td>
<td>Gazetted under the NSW Water Management Act 2000 and is a river where downstream flows are regulated by a major state-owned storage. Downstream licence holders can order water against a held entitlement.</td>
</tr>
<tr>
<td>Replenishment flows</td>
<td>Flows provided along effluent systems to supply water for household, town use and stock.</td>
</tr>
<tr>
<td>Riparian</td>
<td>Relating to or living or located on the bank of a natural watercourse, such as a river stream.</td>
</tr>
<tr>
<td>Salinity</td>
<td>The concentration of sodium chloride or other dissolved minerals in water, usually expressed in EC units or milligrams of total dissolved solids per litre. Conversion factor is 0.64 mg/l TDS = 1000 μS/cm = 1 dS/m.</td>
</tr>
<tr>
<td>Seasonality</td>
<td>The timing of flooding and low flow events.</td>
</tr>
</tbody>
</table>

¹Kuginis L., Dabovic, J., Byrne, G., Raine, A., and Hemakumara, H. 2016, Methods for the identification of high probability groundwater dependent vegetation ecosystems. DPI Water, Sydney, NSW.
Share component  An entitlement to water specified on the access licence, expressed as a unit share or in the case of specific purpose licences, a volume in megalitres (eg. local water utility, major water utility and domestic and stock).

Stock watering  The watering of stock animals being raised on the land but does not include the raising of stock animals on an intensive commercial basis that are housed or kept in feedlots or buildings for all (or a substantial period) during which the stock animals are being raised.

Stratification  The formation of separate water layers.

Supplementary water  Formerly known as off-allocation water, this is surplus flow resulting from storm events that cannot be captured in storages or weirs. When the water is not needed to meet current demands or commitments, then it is considered surplus to requirements and a period of Supplementary Access is announced. Supplementary Water Access Licence holders can only pump water against these licences during these announced periods. Other categories of licence holders may also pump water during these periods.

Water access entitlement  A water product (licence) issued under the Water Management Act 2000.

Water resource plan  A plan made under the Commonwealth Water Act 2007 that outlines how a particular area of the Murray–Darling Basin’s water resources will be managed to be consistent with the Murray–Darling Basin Plan. These plans set out the water sharing rules and arrangements relating to issues such as annual limits on water take, environmental water, managing water during extreme events and strategies to achieve water quality standards and manage risks.

Water sharing plan  A plan made under the Water Management Act 2000 which sets out the rules for sharing water between the environment and water users within whole or part of a water management area or water source.

Water source  The whole or any part of:

- one or more rivers, lakes or estuaries, or
- one or more places where water occurs naturally on or below the surface of the ground

and includes the coastal waters of the State.

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3 As defined in the Water Management Act 2000
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