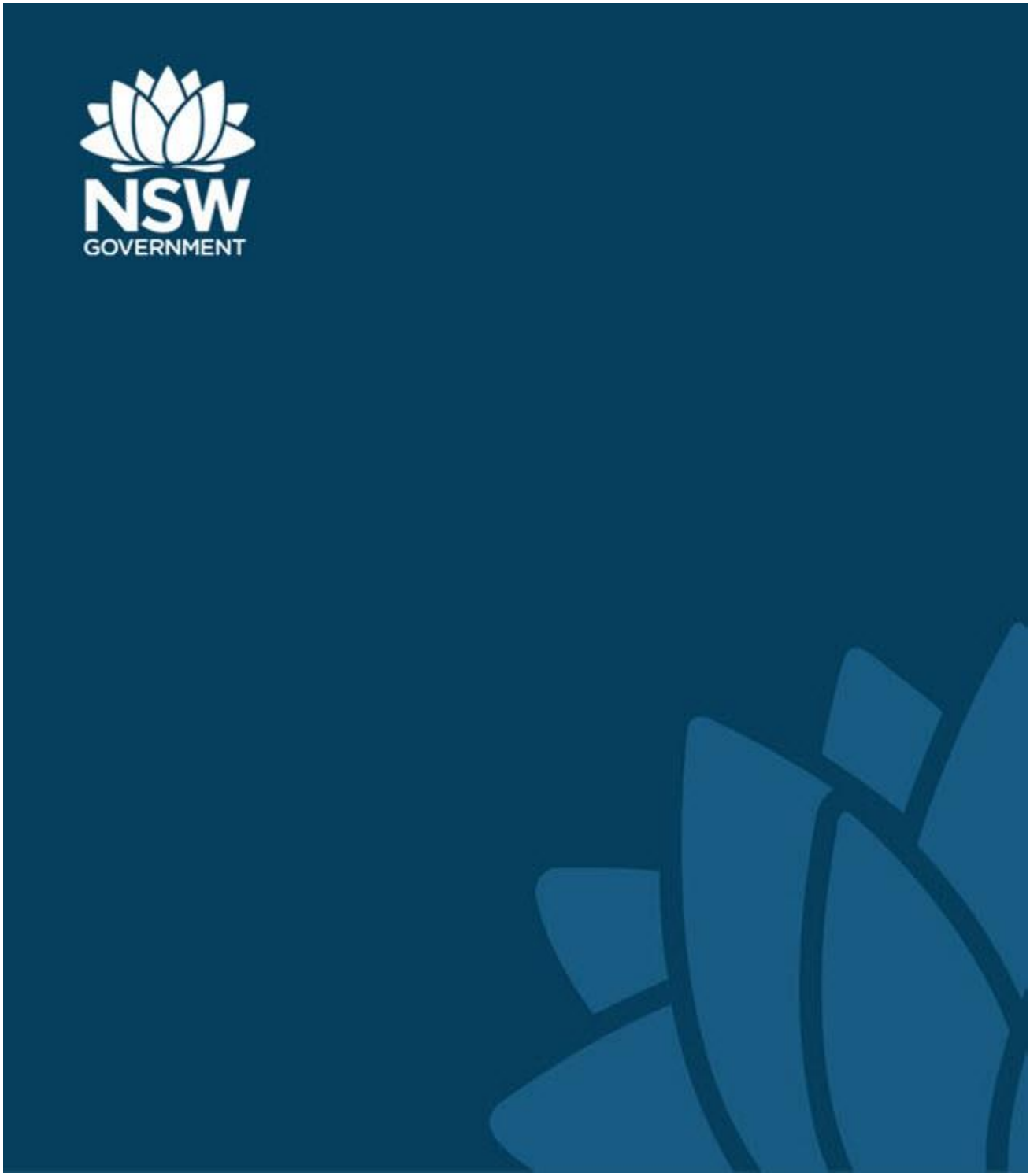

BASIN PLAN IMPLEMENTATION

Intersecting Streams Surface Water Resource Plan Area Description

Appendix A

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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 Intersecting Streams Surface Water Resource Plan covers the surface water sources of the Moonie, Narran, Culgoa, Warrego, Paroo and Yanda Creek catchments. The plan incorporates the water sharing plan for the Intersecting Streams Unregulated Water Sources. This report is a detailed description of the Intersecting Streams Water Resource Plan Area (SW13) to provide an understanding of the region and the resources covered by the Plan. The report describes the location and physical attributes, and provides information on the hydrology, environmental assets and water quality characteristics relevant to these water sources.

This report is intended to provide supplementary information to other components of the Intersecting Streams Water Resource Plan including the Intersecting Streams Risk Assessment, and the Water Quality Plan.

1.1 Overview of the Plan area

The Intersecting Streams Water Resource Plan Area (WRPA) is comprised of the NSW portions of the Moonie River Catchment (754 square kilometres), the Narran River Catchment (14,000 square kilometres), the Culgoa River Catchment (11,800 square kilometres), the Warrego River Catchment (11,375 square kilometres), and the Paroo River Catchment (40,450 square kilometres). The Yanda Creek Catchment (42,052 square kilometres) is also a part of the Plan area, which exists wholly inside NSW. The Plan is predominantly located along the Northern NSW / Queensland Border, with the southern catchment of Yanda Creek also included in the Plan area (Figure 1-1). The six surface water catchments of the Intersecting Streams cover an area of 120,431 square kilometres and represents a little over 11.4 per cent of the Murray-Darling Basin.

Localities within the Plan area include Lightning Ridge, Goodooga, Enngonia, Hungerford, Wanaaring, White Cliffs and Cobar. The Plan is bounded by the NSW / Queensland Border to the north, the Bulloo Overflow, Lake Bancannia, and Lower Murray-Darling Catchments to the west, the Barwon-Darling River and Bogan Catchment to the East, and the Barwon-Darling River, Lachlan and Lower Murray-Darling Catchments to the south.

Present information indicates that Aboriginal people have occupied NSW for more than 45,000 years. Prior to European settlement in the mid 1800's, the lands of the Intersecting Streams were home to a number Aboriginal tribal groups including Barkandji, Budjiti, Euahlayi, Gomeroi/Kamilaroi, Guwamu/Kooma, Kunja, Murrawarri, and Ngemba Nations. The Barkandji people were located in the outer western parts of NSW with most of the Darling River flowing through their lands. Barkandji country also includes the southern parts of the Intersecting Streams WRPA, as does the Ngemba Nation, which extends from Bourke to south of the Darling River. The Budjiti occupied the lands to the north of the Barkandji, along the banks of the Paroo, and the Kunja people occupied the area western banks of the Warrego. The people of Gomeroi/Kamilaroi, Guwamu/Kooma, Murrawarri and Euahlayi Nations lived within the lower Culgoa and Narran water sources.

Part of the Darling and Paroo Rivers in the Intersecting Streams WRPA are subject to a successful Native Title claim by the Barkandji and any future acts will need to be negotiated with them, mainly around the lower Darling and lower Paroo water sources.

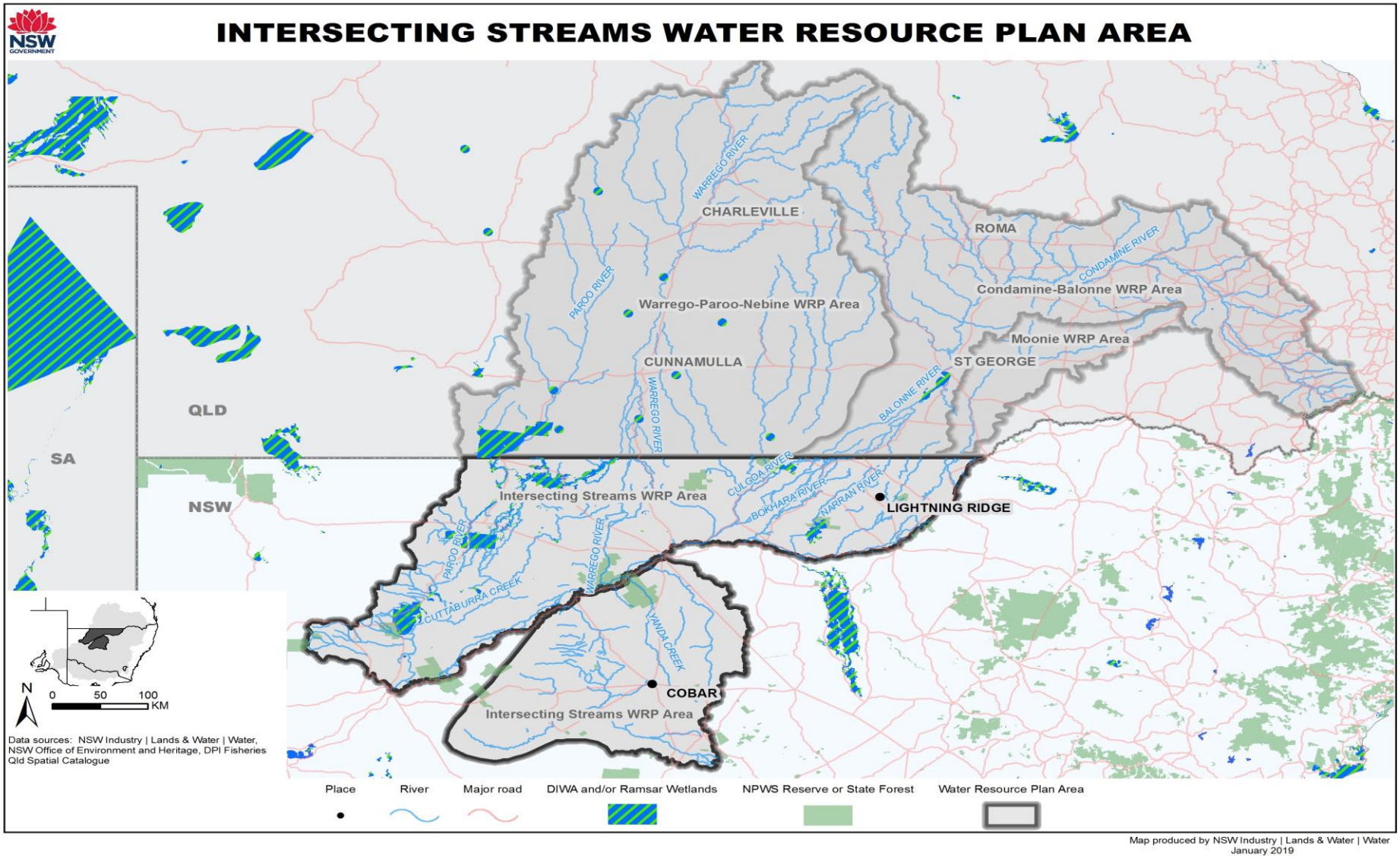


Figure 1-1: Intersecting Streams Water Resource Plan Area (SW13)

1.2 Water management units

The surface water of the Intersecting Streams WRPA is currently managed through the *Water Sharing Plan for the Intersecting Streams Unregulated and Alluvial Water Sources 2011.* This water sharing plan will be amended to the *Water Sharing Plan for the Intersecting Streams Unregulated River Water Sources 2011* before the water resource plan is accredited.

The Intersecting Streams Unregulated Water Sources comprises all the rivers in the 5 water sources which intersect the NSW / Queensland Border to the west of the Barwon River at Mungindi to the western edge of the Paroo water source and the Murray-Darling Basin, and 1 water source Yanda Creek which flows northward from its headwaters near Cobar, NSW (Figure 1-2Figure 1-2). The five water sources which intersect the NSW / Queensland Border are the Moonie River water source, the Narran River water source, the Culgoa River water source, the Warrego River water source and the Paroo River water source.

1.3 History of water management in the Intersecting Streams WRPA

1.3.1 Early wetland and water management

The former Department of Water Resources began mapping and studying wetlands of the Intersecting Streams in the early 1990s (Green 1992; Maher and Braithwaite 1992), focusing on the extensive wetland system of the Paroo and Cuttaburra Creek [291,000 ha] (Maher 1991; Maher and Braithwaite 1992; Kingsford et al., 1994), the 345,000 ha of floodplain / wetland habitat in the Warrego River (Green 1992), and the large terminal wetland of the Narran River, which consists of a large open basin (Lake Narran) and an area of largely lignum wetland known as Clear Lake (Wettin in Thoms et al., 1995; Baker et al., 1999). In 1999 the Narran Lake Nature Reserve was listed under the Ramsar Convention as a recognised site based on a natural or near-natural condition, its support of 40 migratory bird species and its provision of habitat for three wetland dependent threatened species listed under the Environment Protection and Biodiversity Act 1999 (OEH, 2017b). In 2007 the Paroo River Wetlands sites consisting of Nocoleche Nature Reserve (71,133 ha) near Wanaaring and the Peery lake section of Paroo-Darling National Park (67,171 ha) near White Cliffs; was also listed under the Ramsar convention as a recognised site. The Paroo wetlands are considered to be a near natural arid inland wetland system, several threatened species have been identified within their boundaries, they provide critical drought refuge in relation to waterbird breeding, they regularly support more than 20,000 waterbirds, and contain one of the most significant healthy golden perch communities in NSW (OEH, 2017c).

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 Cap on diversions (CAP)

The Murray Darling Basing Ministerial Council (MDBMC) established the Independent Audit Group (IAG) in the lead up to the adoption of an interim limit on diversions across the Murray Darling Basin in 1995. The IAG was established to audit the continuing increase of extraction from rivers across the Murray Darling Basin. The audit found a significant and unsustainable growth in diversions that was placing stress on environmental health and reliability of water supply (MDBMC 1995, MDBMC 1996). In view of the findings of the audit, the MDBMC introduced an interim cap on further increases in diversions in June 1995. The implementation of the interim cap was then reviewed by the IAG, which made recommendations regarding the implementation of the Final Cap. The IAG's recommendations were adopted by the MDBMC, and the Final Cap commenced 1 July 1997.

In NSW, the "Cap" was defined as the average yearly volume of water "*that would have been used with the infrastructure (pumps, dams, channels, areas developed for irrigation, management rules etc.) that existed in 1993/94…taking into account the climatic conditions that were experienced during the year under consideration*" (MDBC 2001, p13). Where diversions exceed the Cap by more than 20 percent (the Cap target exceedance trigger), NSW was required to conduct a special audit to determine whether a systematic growth in extraction had occurred. The audit would then be reviewed by the IAG and, if necessary, the MDBMC would require NSW to rectify the breach of Cap (MDBC 1998).

The reporting of Cap management through the Water Audit Monitoring Report series finished in the 2011-2012 water year. Cap management is being be replaced by a system of Sustainable Diversion Limits (SDLs) established in the Basin Plan 2012. The SDLs shall take effect in 2019. During the transition period between 2012 and 2019, the use of Basin water resources is reported in Transition Period Water Take Reports prepared by the Murray Darling Basin Authority.[1]

1.3.4 Water sharing in the Intersecting Streams unregulated rivers

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 Intersecting Streams Interagency Regional Panel was established to guide the development of a 'macro plan' for the Intersecting Streams water sources. 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 early 2010 and were placed on public exhibition in December 2010. The *Water Sharing Plan for the Intersecting Streams Unregulated and Alluvial Water Sources* commenced on 14th November 2011.

Water sharing rules in the plan include:

- environmental water rules – the share of water reserved for the environment
- long-term average annual extraction limits – a growth-in-use assessment and management tool
- access rules – which determine when extraction is allowed (for example above a set river flow rate)
- dealing rules – which govern the trade of water, both the transfer of share components of an access licence and assignment of water allocations between water accounts, as well as changing the location for water extraction

The health of the Intersecting Streams water sources depends on floods (very high flows), freshes (high flows) and dry spells (very low flows). The environmental flow rules are designed to protect the full range of flows that are critical to river health. The plan establishes two flow classes - very low flows and 'A' class flows - in order to protect the range of flows. All water licences in the unregulated river water sources are subject to cease to take rules that are based on these flow

[1] A the time of the publication of this report, the transition take reports were still in preparation, MDBA pers. comms.

classes. The rules contained in the *Water Sharing Plan for the Intersecting Streams Unregulated and Water Sources* were reviewed during the development of the Intersecting Streams Water Resource Plan.

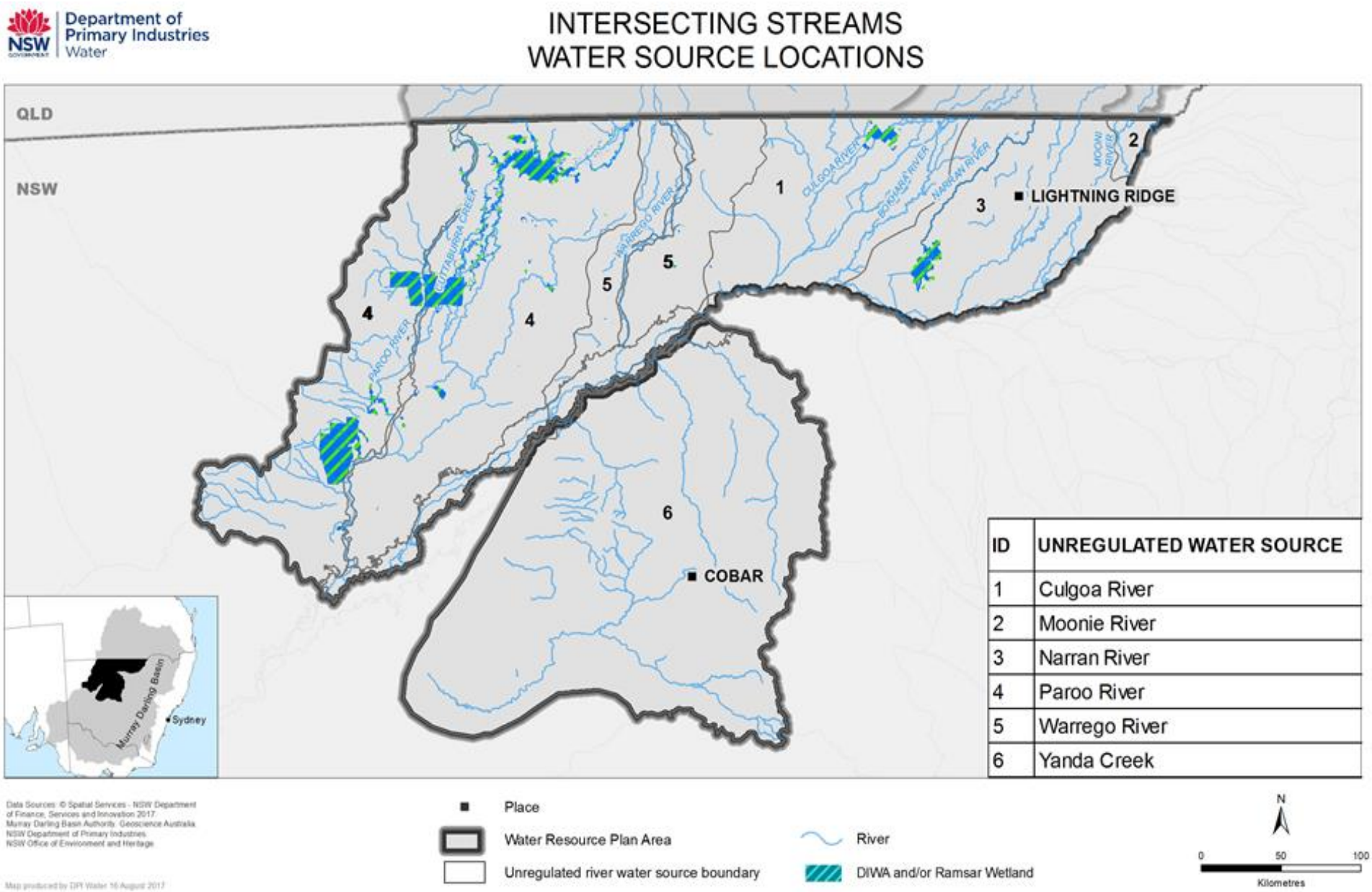


Figure 1-2: Location of unregulated water sources in the Intersecting Streams WRPA

2. Regional Setting

2.1 Climate

Rainfall

Rainfall throughout the Intersecting Streams water sources ranges from 500 mm in the eastern and southern catchments down to 200 mm in the western catchments (Figure 2-1). There is an increase in rainfall in the summer months, although predominantly the monthly averages are within 20 mm of each other throughout the year in the central and western catchments. Mean annual rainfall at Lightning Ridge in the Culgoa catchment is 467 mm whilst at Enngonia mean annual rainfall is 357 mm (Figure 2-2).

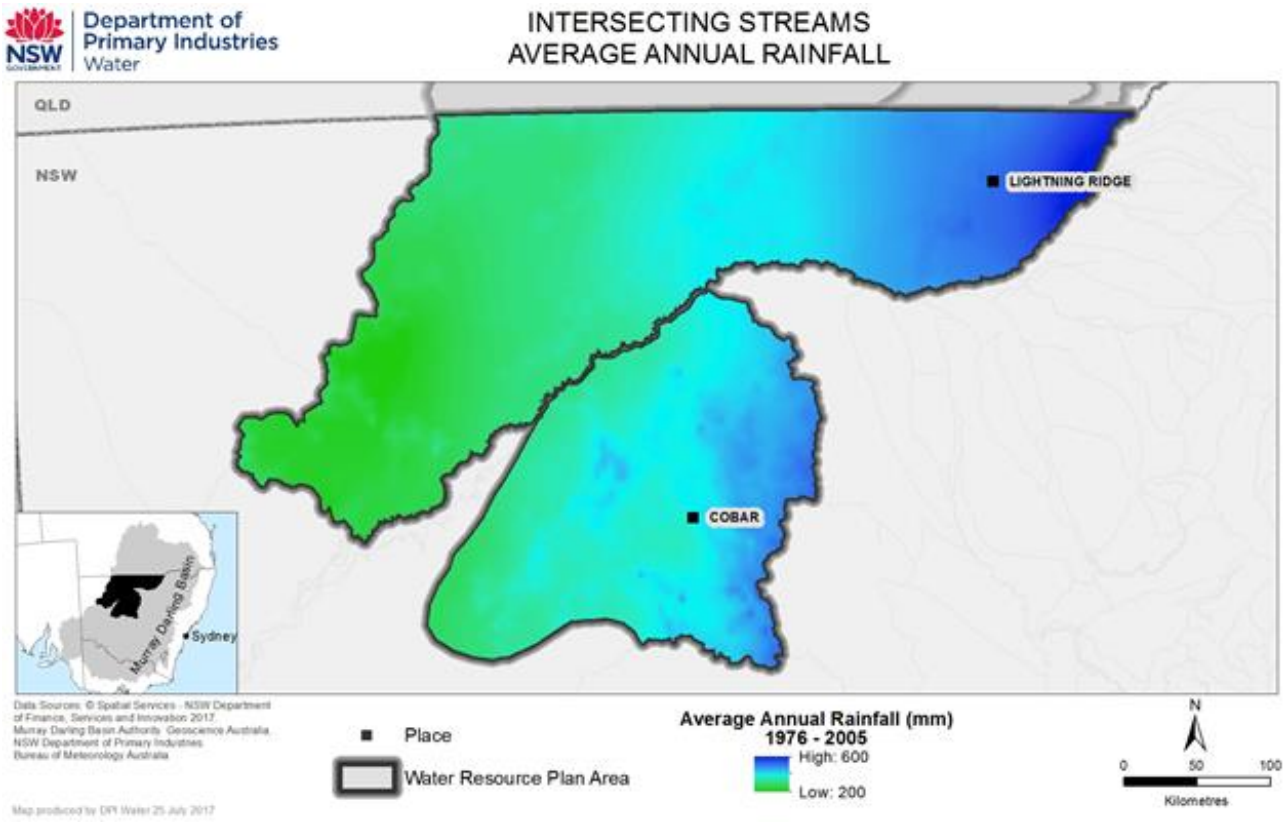


Figure 2-1: Average annual rainfall in the Intersecting Streams water sources

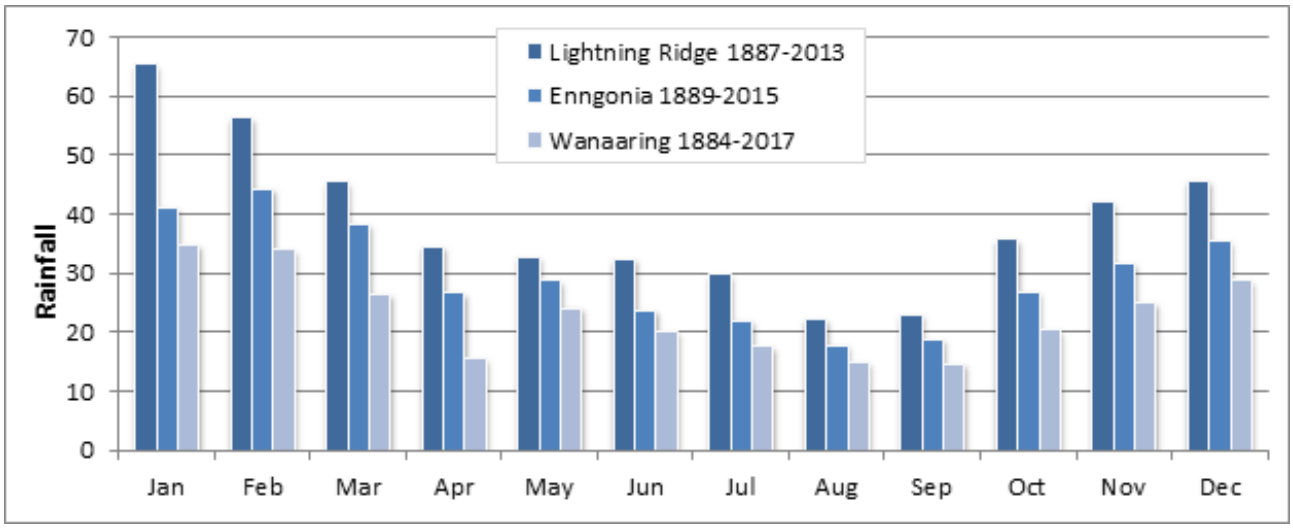


Figure 2-2: Average monthly rainfall for selected stations in the Intersecting

Rain is generally summer dominant with the heaviest rainfall occurring from November to March. This pattern is reflected in the monthly rainfall totals at Lightning Ridge in the Culgoa catchment, Enngonia (99 km north of Bourke) in the Warrego catchment, and Wanaaring in the Paroo catchment (Figure 2-2). January has the highest rainfall ranging from 66 mm at Lightning Ridge in the east to 35 mm at Wanaaring in the west. Localised summer storms may cause flash flooding and erosion, and winter flooding may also occur if soils remain saturated after summer rains. Autumn and winter rainfall generally varies between 25 to 35 mm per month at Lightning Ridge, and 20 to 25 mm across the rest of the catchments (Figure 2-2).

Climate change modelling for the Far West Region (OEH 2014) predicts that spring 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 Intersecting Streams catchments has a mild east-west gradient (Figure 2-3). Yearly evaporation varies from around 2,275 mm in the east (Goodooga) to over 2,350 mm in the west (Wanaaring). Evaporation significantly exceeds average monthly rainfall throughout the year. The greatest exceedance occurs during the summer months of December and January when over 300 mm of evaporation occurs per month at Goodooga compared to around 42 mm and 61 mm of rainfall respectively (Figure 2-3).

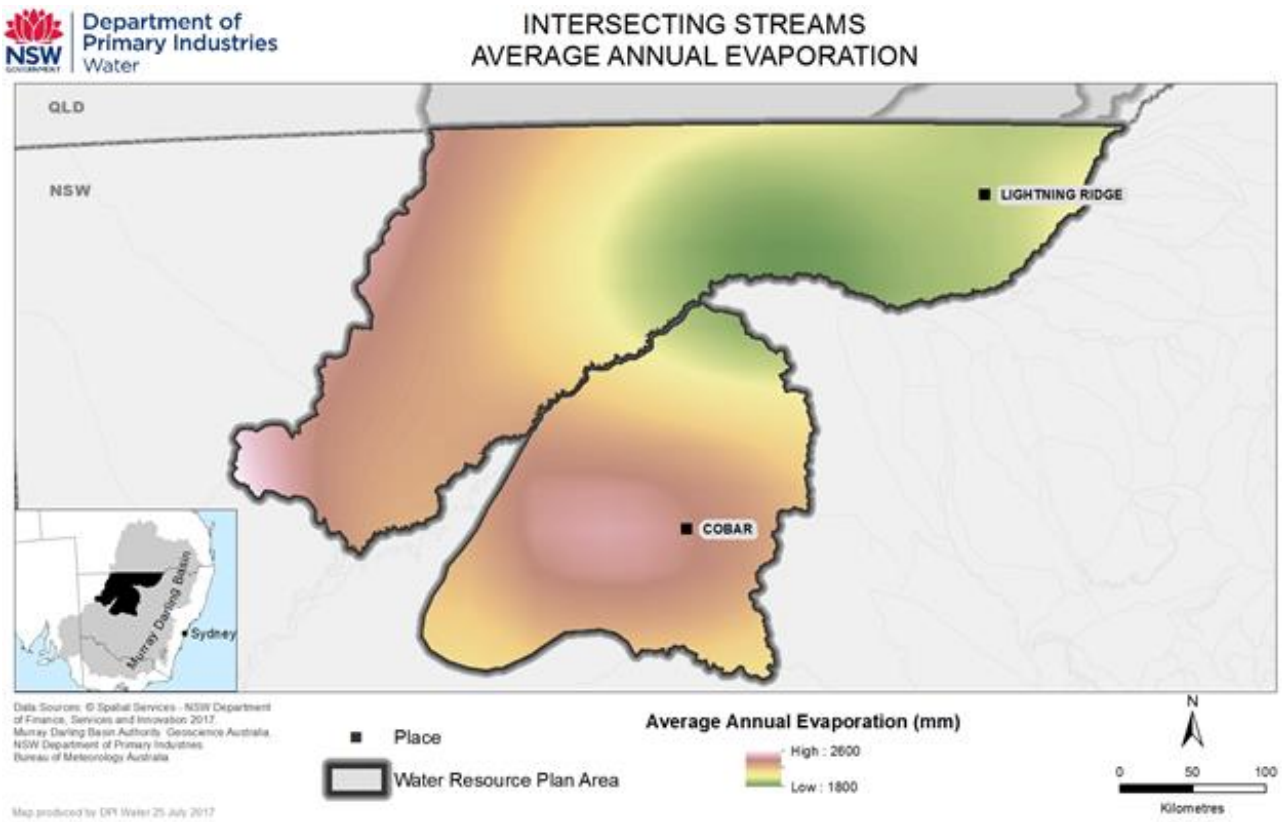


Figure 2-3: Average annual evaporation for the Intersecting Streams WRPA

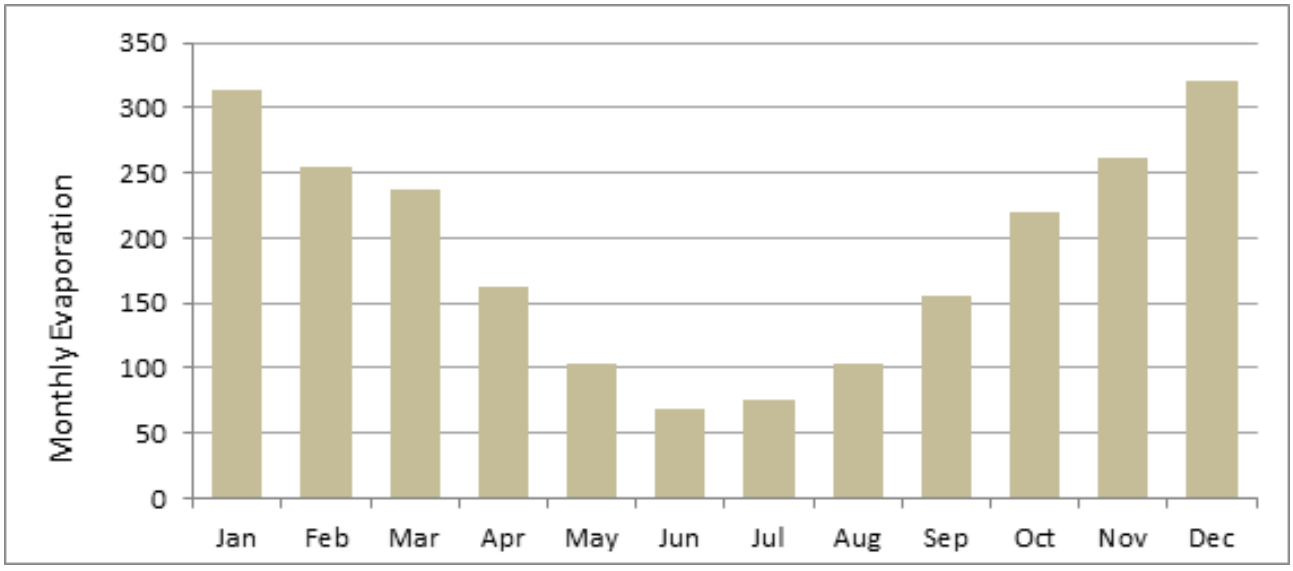


Figure 2-4: Average monthly evaporation at Goodooga (Culgoa water source) 1889–2017

Temperature

The Intersecting Streams water sources of NSW experience a semi-arid climate characterised by hot dry summers and mild dry winters. Temperatures exceed 40°C for short periods during December to February. Frosts are frequent during the winter months. The mean annual temperature for the Plan area is 15-20°C. Minimum average monthly temperature is 1.6-4.9°C, whilst the maximum average monthly temperature is 30.8-35.4°C.

Long-term temperature records indicate that temperatures in the Intersecting Streams region have been increasing since the 1950s. Climate change modelling for the region predicts that this warming will continue over the next 50 years, with temperatures increasing by an average of 0.7°C in the near future (2039), and increasing by an average of 2.1°C in the far future (2079). The

number of high temperature days is projected to increase, with fewer potential frost risk nights anticipated. Maximum temperatures in the far future are expected to exceed current mean conditions by 2.7°C by 2079 (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 2039, and more than 40 additional hot days per year by 2079. Consequently, it is forecast that the Intersecting Streams region will have 10–20 fewer nights where the temperature drops below 2°C by 2079 (OEH, 2014).

2.2 Land use

Heavy grazing throughout much of the Intersecting Streams water sources has resulted in vast areas being covered by a dense regrowth of woody shrubs. This shrub layer is for the most part unpalatable to stock, and the encroachment and proliferation of these species is a major problem throughout the semi-arid rangelands of NSW.

European settlement of the Intersecting Streams began in the late 1860s, when pioneering pastoralists arrived and occupied these landscapes for grazing and agriculture, displacing the original indigenous inhabitants. The early European settlers were seeking landscapes for grazing sheep and cattle and for other forms of agriculture. Large stations became established in the area, and the introduction of riverboats increased the number of people moving to the area. Indigenous people were employed as stockmen, farmhands, or domestic help on stations and also as timber cutters for pastoral progress and to fuel fires on steamboats which were beginning to ply their trade up and down the Darling River.

Today the area is made up of large pastoral stations, which occupy all the leasehold land within the plan area aside from, the scattering of localities, and national parks or nature reserves. There are areas within the plan area that remain under native vegetation and some of these are protected as national park or nature reserves. In particular, the Paroo River water source is protected through an inter-governmental agreement between NSW and Queensland, similarly, the terminal Narran Lake, at the end of the Narran River system is a RAMSAR protected wetland.

The most extensive land uses across the Intersecting Streams WRPA are livestock grazing and dryland agriculture which together account for over 72 per cent of land use (Table 2-1, Figure 2-5). Some dryland cropping is carried out on the alluvial floodplains in the eastern catchments whilst forestry, conservation reserves and other remnant native landscapes account for around 8 per cent of land use.

Table 2-1: Land use in the Intersecting Streams WRPA

Land use	Area (sq km)	Area (%)
Dryland cropping and horticulture	1,826	1.5%
Grazing	85,870	72.1%
Irrigation	226	<1%
Mining	9	<1%
Forestry, conservation reserve and native vegetation	9,156	7.7%
Lakes, rivers, dams	19,532	16.4%
Residential	5	<1%
Urban intensive uses	15	<1%
Wetland	2,440	2%

Photo 1: Aerial view of the wetlands at Narran Lake Nature Reserve
ABC

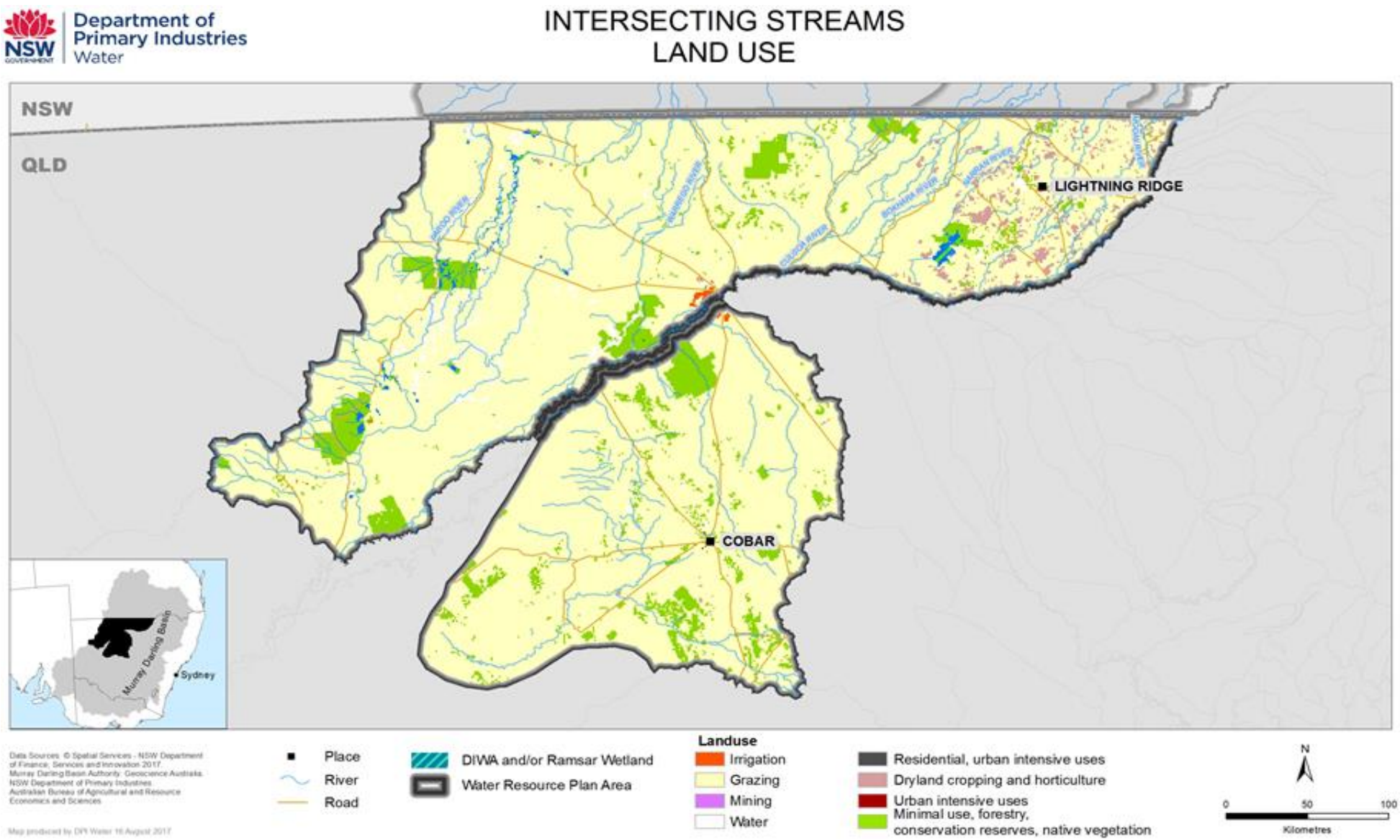


Figure 2-5: Land use map of the Intersecting Streams WRPA

Source: Australian Bureau of Agricultural and Resource Economics and Sciences, National scale land use 2016-17

2.3 Topographic and stream description

The Plan area is characterised by low relief with elevations ranging from 300 m above sea level, through to 100 m. The character of the contemporary river channel system and its physical structure is largely influenced by evolution of the drainage networks across the Intersecting Streams catchments.

Geologically, the Intersecting Streams form the northern edge of a large intercratonic Cainzoic basin which has in-filled with mainly continentally derived alluvial sediments. There are numerous bedrock areas within the catchments; these are Ordovician to Cretaceous metamorphic, granite, and sandstone, which form a heavily dissected landscape around the marginal areas of the catchments.

The topography of the Intersecting streams falls within three defined bioregions (OEH, 2017a):

- The Moonie, Narran and Culgoa water sources are located within the 'Darling Riverine Plains' Bioregion;
- The Warrego and Paroo water sources are located within the 'Mulga Lands' Bioregion; and
- Yanda Creek water source is located in the 'Cobar Peneplain' Bioregion.

River valley patterns characterise an inland drainage system associated with a depositional area. Flattening of the landscape, characteristic of the Intersecting Streams catchments was primarily through infilling of a prior landscape by younger Cainzoic sediments. Drainage networks in these catchments comprise distributary, anabranching and meandering systems typical of flat riverine plains with some bordering alluvial fans. The southern drainage direction of the Intersecting Streams Border Catchments (Moonie, Narran, Culgoa, Warrego and Paroo) can be traced back to the rifting in the late Cretaceous – early Tertiary (80-60 Million years ago), associated with the formation of the Tasman, and which resulted in the Great Divide and Canobolas Dividing Ranges. The up-warping of the eastern margins of Australia provided an impetus for a flow reversal in the greater Barwon-Darling River System, from a north-east, to a south-west flowing drainage system. It has been suggested that further up-warping of the Great Divide at the northern most extremities of the Barwon-Darling Catchment resulted in the drainage network development of the Paroo, Warrego, Culgoa, Narran and Moonie systems (NOW 2011). As such, the Paroo, Warrego, Culgoa, and Narran Rivers are probably the youngest drainage systems in the greater Barwon-Darling River Catchment.

2.3.1 Western Catchments (Paroo & Warrego)

The Paroo and Warrego Catchments - The Paroo and Warrego catchments are located in the 'Mulga Lands' bioregion and cover around 14% of the Murray Darling Basin with large areas within QLD (NOW 2011). Both systems are tributaries of the Darling River, however the lack of flows often leave them disconnected.

Paroo River

The Paroo River is one of the last truly unregulated free-flowing rivers in the Murray Darling Basin, however, the ephemeral nature and the 640km extent of arid to semi-arid landscape restricts it to flowing mainly when there is heavy rainfall in the northern catchment (Kingsford and Roff 2008).

The Paroo River is often represented as a series of waterholes, connected as a running stream to the Darling River just upstream of Wilcannia during wet periods. The headwaters of the Paroo catchment begin in south-west Queensland near Mariala National Park. The main tributaries contributing to the river within NSW are Cuttaburra and Kulkyne Creeks which join the river south of Wanaaring where the flood plain widens into a network of wetlands, lakes and channels which form the Paroo Overflow. It is only during major flood events that flows are sufficient enough to reach the Darling River (Kingsford and Lee 2010). More often, flows terminate in the floodplains and wetlands south of Wanaaring (NOW *et al* 2011).

The unique character and significance of the Paroo catchment is recognised in the *Intergovernmental Agreement for the Paroo River between New South Wales and Queensland,*

2003 which highlights the need for sustainable management of the water resources in the system to maintain its ecological and cultural value.

Warrego River

The Warrego River is located east of the Paroo River and is connected to the Paroo catchment during large floods through Cuttaburra Creek, an effluent of the Warrego River south of Cunnamulla in QLD.

The Warrego River rises in the most northerly point of the Murray-Darling Basin from below Mount Ka Ka Mundi in the Carnarvon Range (near Tambo), where it flows south for over 800 km and into the Darling River, downstream from Bourke (MDBA 2010). The Warrego has 37 tributaries, including the Nive and Langlo Rivers. In Queensland, the River flows south, forming a series of anabranches and wetlands south of Wyandra, then crosses the NSW border at Barringun. During wetter years, a series of creeks and channels can form to connect the Warrego to the Paroo River, specifically through Cuttaburra Creek, which can carry up to 40% of the Warrego's flow during floods (Green and King 1993). During drier periods which dominate this climatic zone, the Warrego River terminates in a series of large swamps and storages near Louth and waterholes along the Warrego River and Cuttaburra systems provide refuge for fish and waterbird populations (Holtz et al. 2008).

The ephemeral nature of this river is similar to the Paroo, with flow only reaching the Darling River during wet years. Average annual discharge is around 10,000 ML/year with flows above the 75th percentile represented by 0 ML/day (gauge 423002). Unlike the Paroo, the Warrego River has six impoundments downstream of Wyandra including: Cunnamulla Weir (QLD), Boera, Lower Lila, Booka, Keernie and Dicks Dams with the latter four dams small and not permanent (Green and King 1993). These in-channel dams create weir pools which have become important refugia for freshwater-dependent species when flow ceases (Capon 2009)

The Toorale property in the Warrego River water source was purchased by the NSW Government in 2008. The resulting Toorale National Park and State Conservation Areas were created and the water entitlement linked to the property is to be returned to the Warrego River along with the decommissioning of the associated in-channel dams (Capon 2009). The resulting changes to in-channel structures will likely improve connectivity to the adjacent floodplains and the Darling River system (CEWO 2014).

Both the Paroo and Warrego catchments are sparsely populated with less than 7,000 inhabitants (400 in the Paroo catchment) with a significant interconnection between the river systems and the Aboriginal people of this area for over 25,000 years (NOW 2011).

Photo 2: Warrego River

DPI Water

Photo 3: Nocoleche Nature Reserve, Paroo River

OEH

2.3.2 Eastern Catchments (Culgoa, Narran and Moonie)

Culgoa, Narran and Moonie Catchments - These water sources all flow into the Barwon River and are located in the Darling Riverine Plains Bioregion to the north-east of the Water Resource Plan area.

Culgoa and Narran Rivers

The Condamine River begins at Warwick in south-eastern Queensland, flowing north-west until it becomes the Balonne River. Approximately 70 km downstream form the town of St George (near Dirranbandi), the Balonne River splits into five channels. The two main channels are the Culgoa and Narran Rivers, comprising 35% and 28% of the long-term mean annual flow at St George respectively. The remaining Bokhara and Ballandool Rivers and Birrie Creek flow only during higher discharge periods (Thoms et al. 2007), where the Bokara River forms a confluence with Cato Creek, an anabranch of the Barwon River. These rivers all form the Condamine-Culgoa catchment which covers approximately 26,060 km of the NSW portion. The Narran River terminates in a series of floodplain lakes, namely Narran Lake, a Ramsar-listed wetland (MDBA 2012a). The lakes in the Narran system have an average inundation frequency of two years, making it a more frequent waterbird habitat than other inland wetlands in NSW (Magrath 1991). Unlike the Narran, the Bokhara and Culgoa Rivers flow into the Barwon-Darling River downstream of Brewarrina during wetter periods. The majority of the catchment is flat landscape and extensive floodplains with low elevations (100-150 m).

There are no major storages in the NSW catchment however in Queensland, the Balonne River is impounded by E. J. Beardmore Dam with a capacity of 81,800 ML. Cubbie Station, a significant irrigator in the Murray Darling Basin, is located at Dirranbandi, between the Culgoa and Narran River on the Queensland side of the border. Cubbie Station can extract up to 537,000 ML of water, comprising about 30% of the total average diversions in the Lower Balonne in Queensland (CS Agriculture 2013).

Moonie River

The Moonie River rises south-west of Dalby Queensland and is joined by 13 minor tributaries (including the Teelba and Toombilla Creeks) in its 540 km length, before reaching the Barwon River near Mogi Mogi in NSW. There are two weirs on the Moonie River; the Nindigully and Thallon Weir. Only a small length of the Moonie River flows through NSW.

2.3.3 Southern Catchment (Yanda Creek)

Yanda Creek water source is the only system in the Intersecting Streams with its catchment wholly within NSW. Comprised mainly of ephemeral streams, this system flows north-west through the arid landscapes of the Cobar Peneplain Bioregion to its confluence with the Darling River. This is the least significant water source within the Intersecting Streams WRP with more than 90% of the flow record represented by flows of less than 1 ML/day (gauge 425016).

Photo 4: Nebine Creek, Culgoa National Park
NSW Government

Photo 5: Narran River flowing into Lake Narran Nature Reserve
MDFRC

2.4 Streamflow characteristics

The river systems within the Intersecting Streams WRP area are unique, with some of the largest natural free flowing systems in the Murray-Darling Basin. All rivers within the Intersecting Streams are categorised as unregulated systems, although some water capture does occur in Queensland storages (e.g. E.J. Beardmore Dam). Variability in stream flows occurs between seasons and across the catchments with sporadic flooding associated with cyclonic rain depressions in the Queensland portions of the water sources (NOW 2011). The wetter months and subsequent higher flows occur in summer-autumn, with the drier periods during late winter-spring. The wetlands of the Paroo, Warrego, Narran and other rivers in the Intersecting Streams water source are primarily towards the end of each system.

The Condamine-Culgoa Rivers, which includes the Narran and Bokhara River, contributes 20% of flow to the long term average flow in the Darling River at Menindee. Water resource development in Queensland has resulted in a reduction in volume in the NSW downstream section of the Intersecting Streams. Since 1993-1994, the mean annual volume of water diverted from the unregulated section of the Condamine-Culgoa catchment (downstream of St George) has increased by 339%. These systems have experienced the greatest flow alteration, with the average cross border flows into NSW halving since 1993 and compared to natural conditions. As there are no accurate water take records for unregulated water across licences, it is difficult to estimate actual volumes used from year to year (SMEC 2010).

Flows have been recorded in the Moonie River at Gundablouie since 1945 (2-6 and Figure 2-7); in the Culgoa River at Brenda since 1960 (Figure 2-8 and Figure 2-9); and in the Warrego River at Fords Bridge since 1921 (Figure 2-10 and Figure 2-11), and provide good long term records of natural streamflow patterns in the Intersecting Streams.

Years of extreme low flows have occurred on average a few years each decade, the most recent being in 2002 and 2009.

The average annual discharge has been approximated at: 100,000 mega litres per year (ML/year) for the Moonie River, 460,000 ML/year for the Culgoa and Narran Rivers, 10,000 ML/year for the Warrego River and 1,000 ML/year for the Paroo River. There is no reliable data for discharge of Yanda Creek.

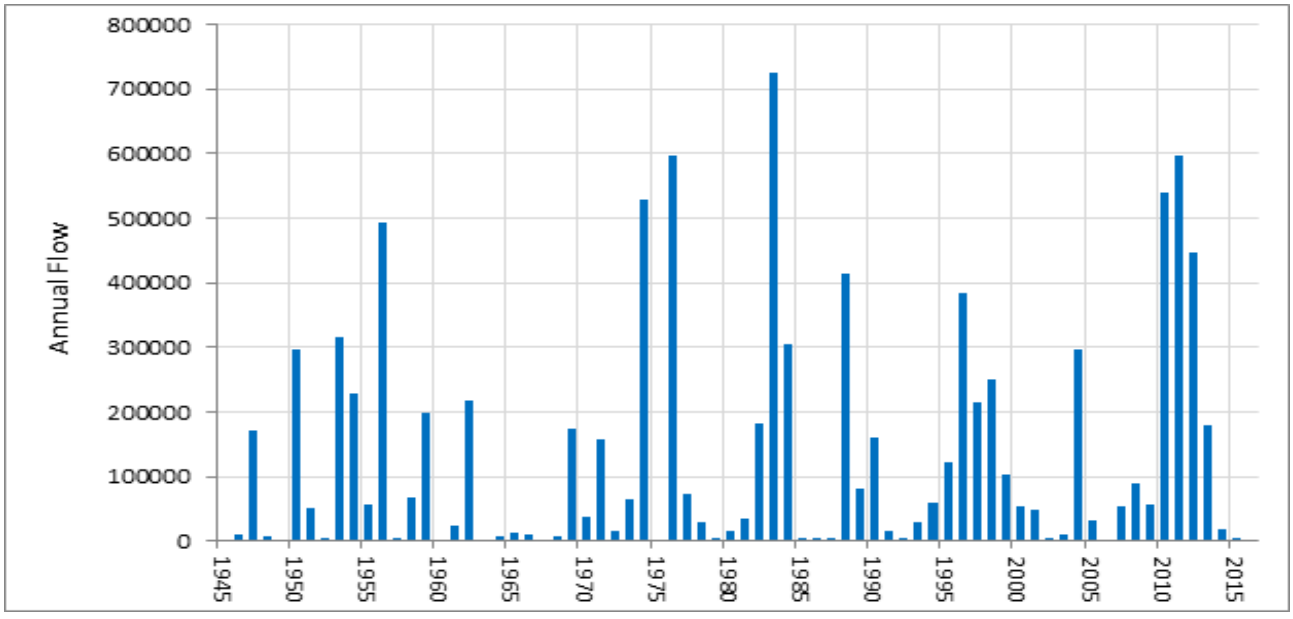


Figure 2-6: Annual flows in the Moonie River at Gundablouie 1945–2017

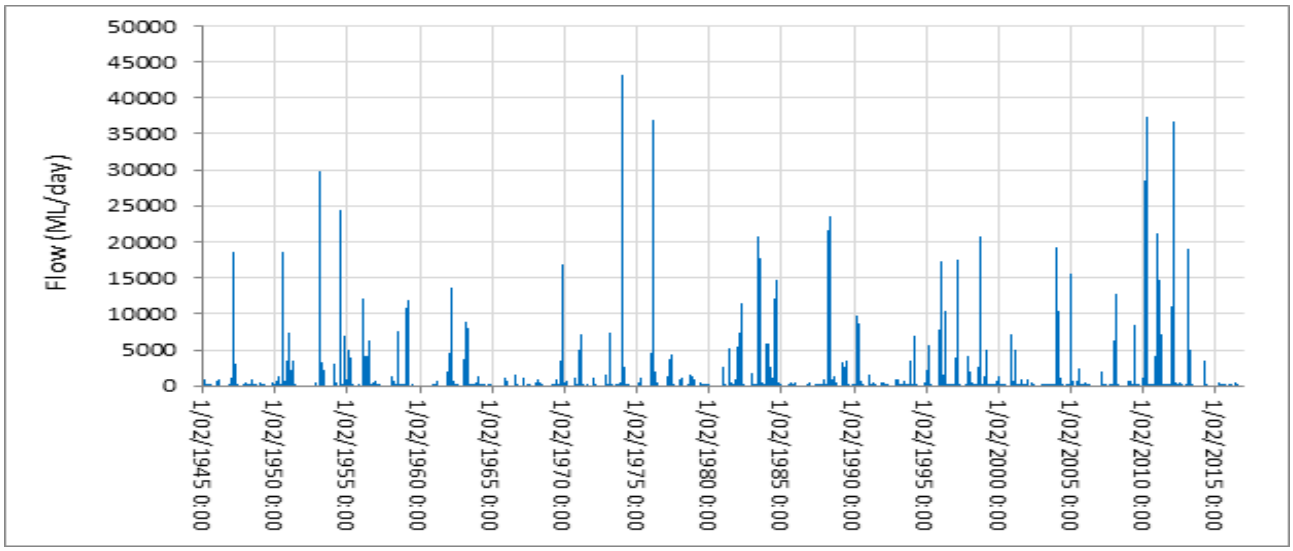


Figure 2-7: Daily flow in the Moonie River at Gundablouie 1945-2017

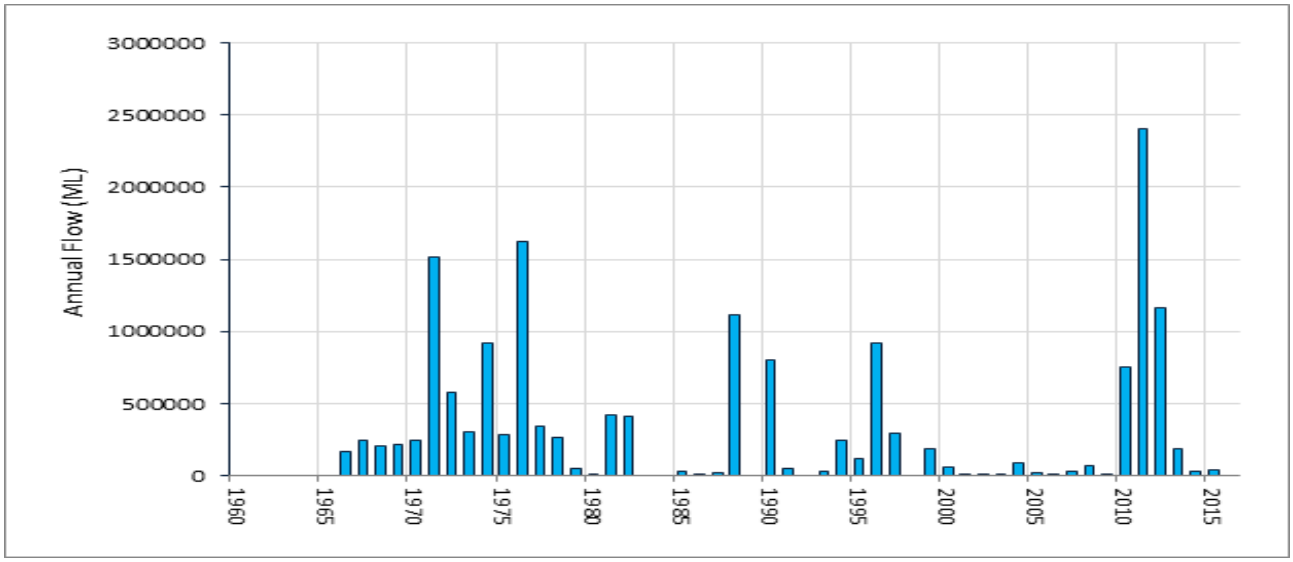


Figure 2-8: Annual flows in the Culgoa River at Brenda 1960-2017

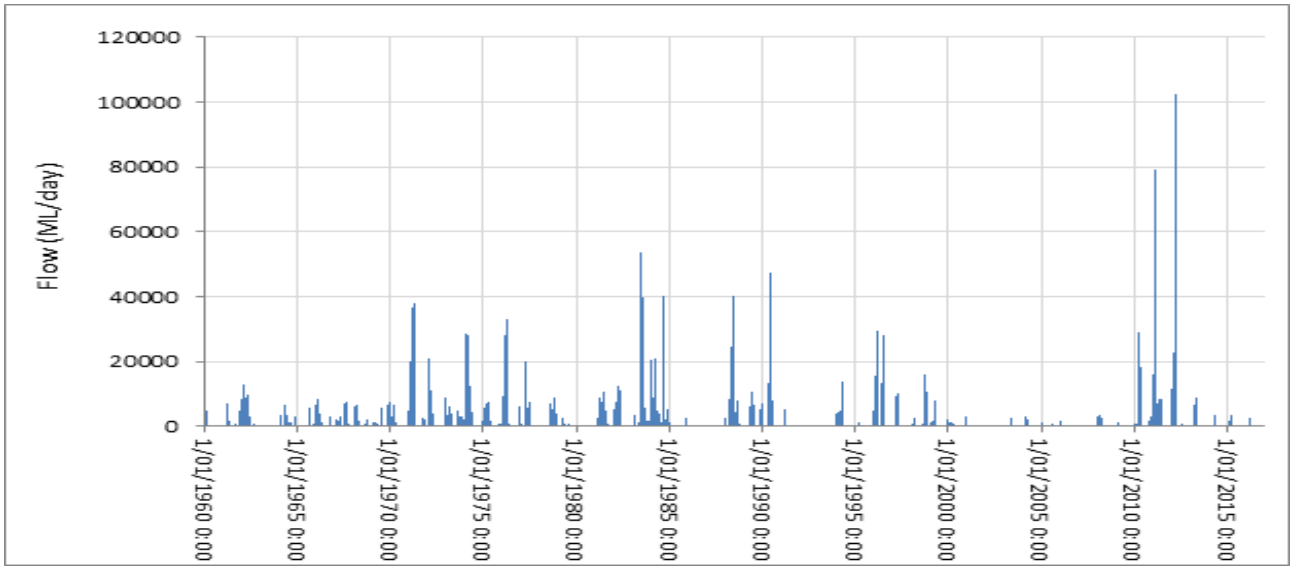


Figure 2-9: Daily flow in the Culgoa River at Brenda 1960-2017

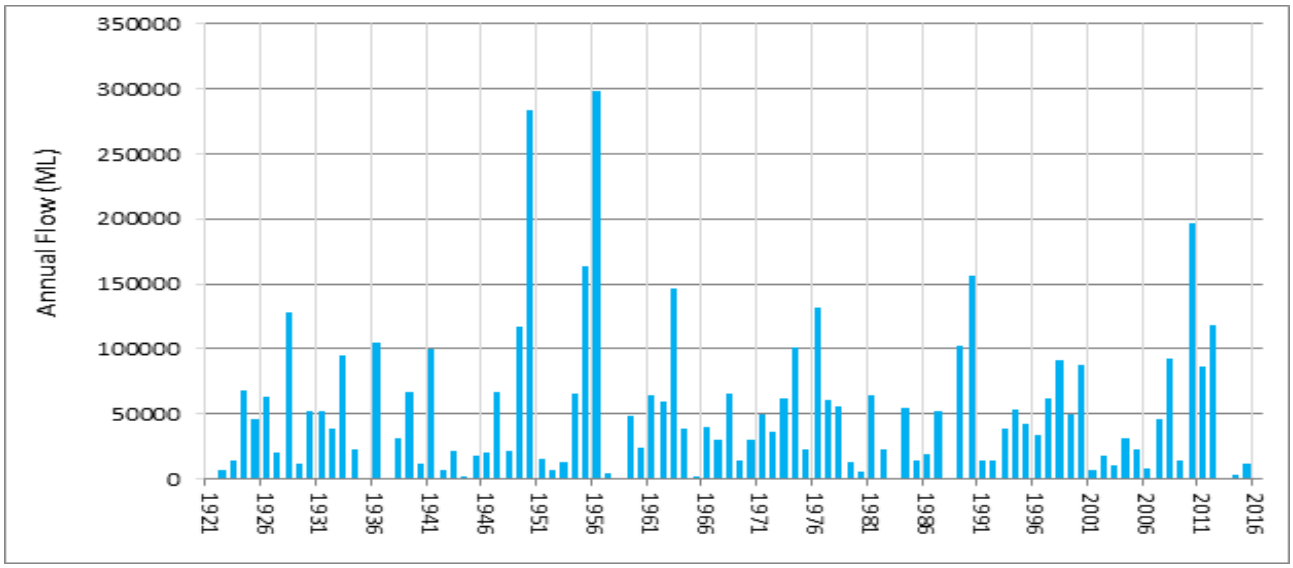


Figure 2-10: Annual flows in the Warrego River at Fords Bridge 1921-2017

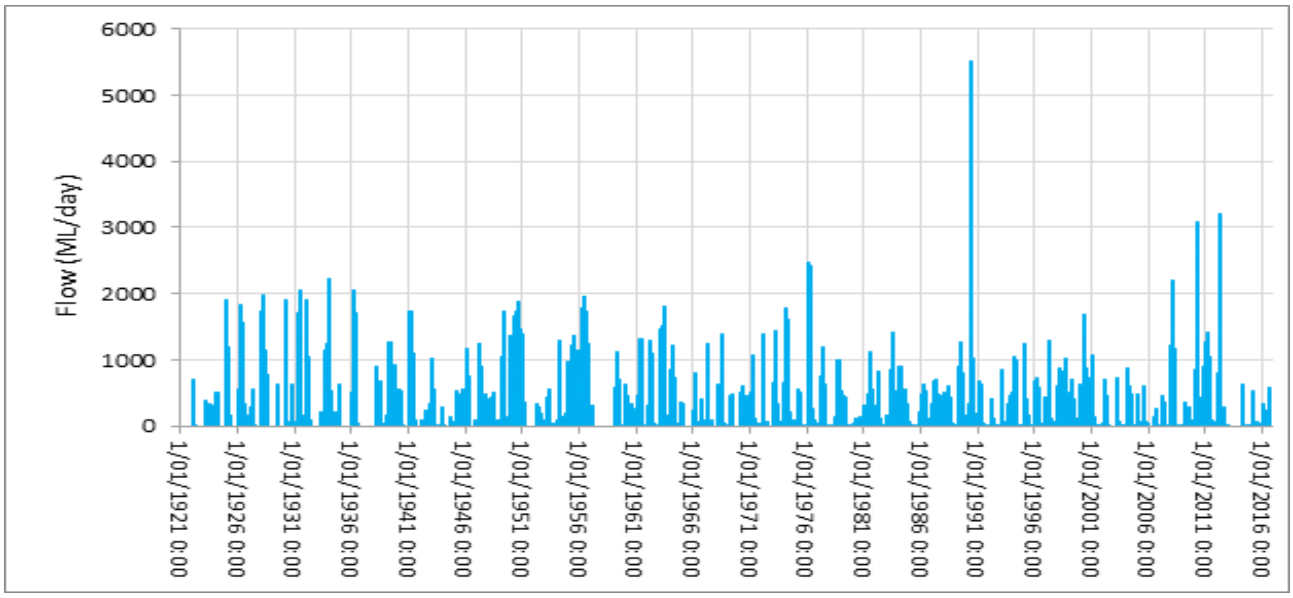


Figure 2-11: Daily flow in the Warrego River at Fords Bridge 1921-2017

Streamflow is currently measured at 15 gauging stations within the Intersecting Streams water sources as listed in Table 2-2. Records from both the current (listed below) and discontinued gauging stations provide a history of stream flows throughout the plan area and have been used in the development of the plan.

Table 2-2: Stream gauging stations in the Intersecting Streams WRPA

Station Name	Water Source	Station No.	Period of record	
			Start	Finish
Moonie River at Gundablouie	Moonie River	417001	24/08/1944	Ongoing
Narran River at Wilby Wilby	Narran River	422016	02/11/1964	Ongoing
Narran River at Narran Park	Narran River	422029	14/02/2002	Ongoing
Narran River at Angledool 2	Narran River	422030	11/04/2002	Ongoing
Narran River at Bundah	Narran River	422031	31/03/2008	Ongoing

Narran River at Back Lake	Narran River	422034	10/12/2009	Ongoing
Bokhara River at Bokhara	Culgoa River	422005	06/09/1944	Ongoing
Bokhara River upstream of Weir	Culgoa River	422032	09/12/2009	Ongoing
Culgoa River upstream of Collerina	Culgoa River	422011	27/10/1964	Ongoing
Culgoa River at Brenda	Culgoa River	422015	01/01/1926	Ongoing
Warrego River at Ford's Bridge	Warrego River	423001	29/11/1921	Ongoing
Warrego River at Ford's Bywash	Warrego River	423002	29/11/1921	Ongoing
Warrego River at Barringun 2	Warrego River	423004	30/05/1993	Ongoing
Cuttaburra River at Turra	Warrego River	423005	31/05/1993	Ongoing
Paroo River at Willara Crossing	Paroo River	424002	23/11/1975	Ongoing

3. Environmental Assets

3.1 Parks and reserves

There is approximately 6,030 km^2 of land conserved within national parks and nature reserves within the Intersecting Streams water sources. Table 2-1 shows the main parks and reserves and their size:

Table 3-1: Parks and Reserves in the Intersecting Streams WRPA

Name	Water Source	Park / Reserve	Area (sq.km)
Balowra	Yanda Creek	State Conservation Area	17.3
Culgoa	Culgoa	National Park	378.6
Gundabooka	Yanda Creek	National Park	640.3
Gundabooka	Yanda Creek	State Conservation Area	253.9
Ledknapper	Warrego & Culgoa Rivers	Nature Reserve	479.0
Mount Grenfell	Yanda Creek	Historic Site	13.7
Mutawintji	Paroo River	Nature Reserve	67.2
Narran Lake	Narran River	Nature Reserve	268.3
Nocoleche	Paroo River	Nature Reserve	711.1
Paddington	Yanda Creek	Nature Reserve	48.7
Paroo-Darling	Paroo River	National Park	1,771.8
Paroo-Darling	Paroo River	State Conservation Area	415.5
Toorale	Warrego River	National Park	306.5
Toorale	Warrego River	State Conservation Area	536.6
Warrambool	Narran River	State Conservation Area	121.2

The majority of the parks and reserves are located along watercourses, with the greatest concentration around the confluence of the Warrego River and Yanda Creek with the Darling River near Bourke.

On the northern side of the Darling River near the confluence of the Warrego River, Toorale National Park and Toorale State Conservation Area occupy 306.5 and 536.6 square kilometres respectively. The former pastoral property is located at the junction of the Darling and Warrego rivers and conserves vast areas of floodplain and wetland habitat. The property was purchased by the NSW Government in 2008 and includes significant aboriginal and pastoral heritage sites.

On the southern side of the Darling River near the confluence of Yanda Creek, Gundabooka National Park and Gundabooka State Conservation Area occupy 640.3 and 253.9 square kilometres respectively. Gundabooka National Park takes in the rugged Gundabooka Range and includes frontage to the Darling River. The mountain range is a significant place for the Ngemba and Barkandji Aboriginal people of western New South Wales and includes important ceremonial sites and rock art. The park conserves a variety of open woodland communities including mulga, poplar box, red box, ironwood, cypress pine, belah and leopardwood.

Paroo-Darling National Park is the largest conservation reserve within and adjacent to the WRPA, covering an area of 1,781 km^2. It occurs at the junction of the Darling and Paroo rivers, including frontage to the north and south sides of the Darling River upstream of Wilcannia. Fifty-five bird species have been identified in the park and more than 60,000 waterbirds have been observed

during surveys on some of the large lakes within the park. Threatened species found within the park include the pink cockatoo, red-tailed black-cockatoo, brolga, freckled duck and slender Darling pea (NPWS 2012).

3.2 Wetlands

Forty-six percent of inland wetlands in NSW are situated in the north-west of the state; in the water sources of the Paroo, Warrego and Condamine-Culgoa River catchments. (Kingsford *et al* 2003). Over 90% of these are floodplain wetlands and cover 5% of the land surface. In the Paroo, Warrego and Condamine-Culgoa water sources, wetlands cover 16%, 13% and 28% of the NSW components respectively (Kingsford *et al* 2003).

The Narran Lake Nature Reserve is one of the most important areas for birds in NSW, ranked among the highest for species richness, number of breeding species and total abundance (MDBA 2012a).

The Narran wetlands, also known as the Narran Lakes are contained within the Narran Lakes Nature Reserve and comprise series of protected ephemeral lakes and swamps fed by the terminal system of the Narran River. The Reserve is 26,480 hectares, of which 8,447 hectares is protected under the Ramsar convention. The wetland is important because of its rarity and naturalness; and its significance as a waterbird breeding habitat and drought refuge (OEH 2012). The complex wetland system supports extensive and dense stands of lignum and over-storey river red gums, which constitutes the substrate on which breeding waterbirds depend (NSW National Parks & Wildlife Service, 2000). The wetlands are significant refugia for at least 65 species of waterbirds, five which are listed as threatened in NSW and a further nine are noted of conservation concern within western NSW (Thoms *et al* 2007).

The Warrego River supports a variety of wetland habitats in NSW; including water holes in the river and creek channels, densely vegetated swamps, floodplain woodlands, lakes, expansive overflow areas, claypans and permanent open water. In the northern areas of the water source Coolibah woodlands dominate the landscape with extensive lignum stands and emu bush predominant in the understorey (Green & King 1993). Further south towards the Darling, Black Box and to a lesser extent River Cooba can be found interspersed with Coolibah, and spike rushes, grasses and budda pea can be found growing in the channels. Significant wetlands along the Warrego include: Waterholes in Irrara and Kerribree Creeks; Pirrillie, Denman and Coonany Lakes; and Willeroo and Yandaroo Lakes. There are at least four threatened species of birds; the great egret, brolga, pink cockatoo and freckled duck which are frequently found in these wetlands (Green & King, 1993).

There are a range of wetland types in the Paroo catchment, including claypans, canegrass swamps, river channels and water holes, black box swampls, *Eleocharis* swamps, lignum swamps and overflow plains, freshwater lakes, salt lakes and mound springs (Kingsford & Lee 2010). The two Paroo River wetlands listed under the Ramsar Convention are unique examples of near natural, arid inland wetland systems. The natural pattern of flow is maintained as there are no major diversions, dams or weirs. They provide a significant refuge for biological diversity including newly identified plants and macroinvertebrates and a separate breeding population of golden perch (*Macquaria ambigua*) (Keenan et al. 1996 & 1998). Over 63 species of water bird use the Paroo wetlands as well as over 200 other bird species. Over 350 plant species have been recorded around the wetlands, as well as 67 species of reptile, 11 fish species and more than 25 species of mammals (Kingsford & Lee 2010). Some of the plants found in the Paroo Wetlands are endemic to the area, including large stands of yapunyah (*Euclayptus ochrophloia*) which mainly grown in floodplain areas around the Nocoleche Nature Reserve. River Red Gum, River cooba, and black box communities are common the length of the catchment and are commonly found with lignum and sedge understorey species.

3.3 Hydrologic indicator sites

The Murray-Darling Basin Authority has assessed the environmental water requirements for the Lower Balonne Floodplain which covers the northern and central components of the Culgoa and Narran water sources (MDBA 2012c). The assessment was undertaken to determine the

"Environmentally Sustainable Level of Take" for the Lower Balonne Floodplain [which encompasses the upper Culgoa and Narran River water sources]. The assessment of environmental water requirements led to the "specification of site-specific flow indicators to achieve site-specific ecological targets" (MDBA 2012c, p.2).

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 2012b). 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 2012b, 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 2012b, p.39).

For the NSW component of the Lower Balonne River Floodplain System (approximately 1,391,600 ha), key ecological communities include water dependent ecosystems and their vital habitat through the retention of wetlands and the surrounding vegetation (MDBA 2012c). This includes the protection of Coolibah –Black Box woodlands and other associated upper storey species including; River Red Gum, and River Cooba. Dense understoreys of lignum, sedges and spike-rushes as well as other grassy understorey communities provide important ecosystem functions which support fish, birds and invertebrates through habitat maintenance, energy transfer and the facilitation of connections between rivers and floodplains (MDBA 2012c). The Lower Balonne has high ecological and hydrological connectivity with the Ramsar-listed Narran Lakes Nature Reserve which is an important site for colonial waterbird breeding.

The Authority conducted a detailed eco-hydrological assessment of the environmental water requirements for this environmental asset (MDBA 2012a,). Along with the flow requirements of other hydrologic indicator sites, these water requirements were integrated within the hydrological models used to determine the Environmentally Sustainable Level of Take (the ESLT) for the Basin Plan.

3.4 High ecological value aquatic ecosystems

Key aquatic ecological assets in the Intersecting Streams WRPA include:

- Significant Ramsar and Directory of Important Wetlands in Australia (DIWA) listed wetlands. Ramsar sites are located in the Paroo and Narran River water sources;
    - Nocoleche Nature Reserve (71,000 Ha)
    - Paroo-Darling National Park (61,171 Ha)
    - Narran Lake Nature Reserve (8,447 Ha)
- Habitat for threatened and endangered bird species including the Australasian Bittern (*Botaurus poiciloptilus*), Australian Painted Snipe (*Rostratula australis*)*, Black-necked Stork (Ephippiorhynchus asiaticus), Black-tailed Godwit (Limosa limosa), Brolga (Grus rubicunda), Blue-billed Duck (Oxyura australis), Freckled Duck (Stictonetta naevosa) and the Curlew Sandpiper (Calidris ferruginea).*
- Threatened plant species including: Shrub Sida (*Sida rohlenae*), Winged Peppercress (*Lepidium monoplocoides*) and the endangered aquatic plants *Aponogeton queenslandicus*, *Nocoleche goodenia* and *Nitella partita.*
- Native fish species (Figure 3-2) [2] including Murray Cod (*Maccullochella peelii peelii*), Bony Bream (*Nematolosa erebi*), Golden Perch (*Macquaria ambigua*) and Silver Perch (*Bidyanus bidyanus*).

[2] A threatened species is a species listed as endangered, critically endangered, or vulnerable under the NSW *Threatened Species Conservation Act 1995*.

- A number of endangered ecological communities (EEC) (Figure 3-3)[3] including:
    - The critically endangered Artesian Springs Ecological Community;
    - Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregion; and
    - Lowland Darling River EEC.

The value of the aquatic ecosystems in the Intersecting Streams 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.* in prep).

Unregulated rivers in the following water sources also have high or very high ecological values (Figure 3-1):

- The Moonie River water source has a Murray cod presence in the system and contains the endangered Coolibah Black Box Woodland ecological communities.
- The Narran River water source has the Ramsar listed Lake Narran Reserve wetland complex which is a crucial waterbird breeding habitat and contains the endangered Coolibah Black Box Woodland ecological community. The Narran also returns a very high ecological value for fish and macroinvertebrate diversity, and threatened bird species.
- The Culgoa River water source had a very high consequence from the presence of the Coolibah Black Box Woodland and very high naturalness.
- The Warrego River water source contains the threatened Silver perch, and has remnant stands of the endangered Coolibah Black Box Woodland ecological community.
- The Paroo River water source contains the threatened Silver perch and has two Ramsar listed wetlands at Nocoleche and in the Paroo Darling National Park. Stands of endemic tree species like yapunyah and the endangered Coolibah Black Box Woodland also afforded a high ecological value. The wetlands are important habitats for threatened bird species as well as important breeding habitats for waterbird species. Macroinvertebrate and fish diversity was also high in this water source.

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

[3]Endangered ecological communities are ecological communities (an assemblage of species occupying a particular area) listed as endangered under the NSW *Threatened Species Conservation Act 1995*.

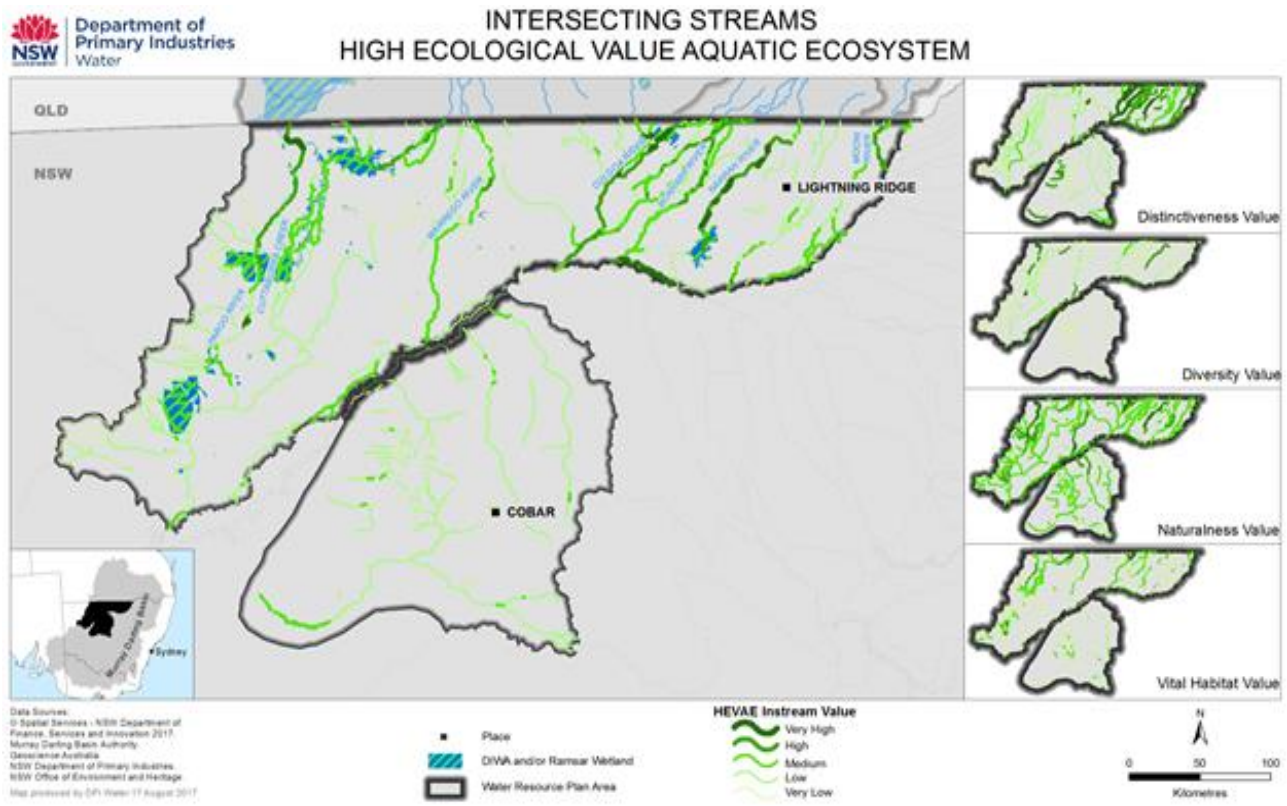


Figure 3-1: Instream values for the Intersecting Streams WRPA

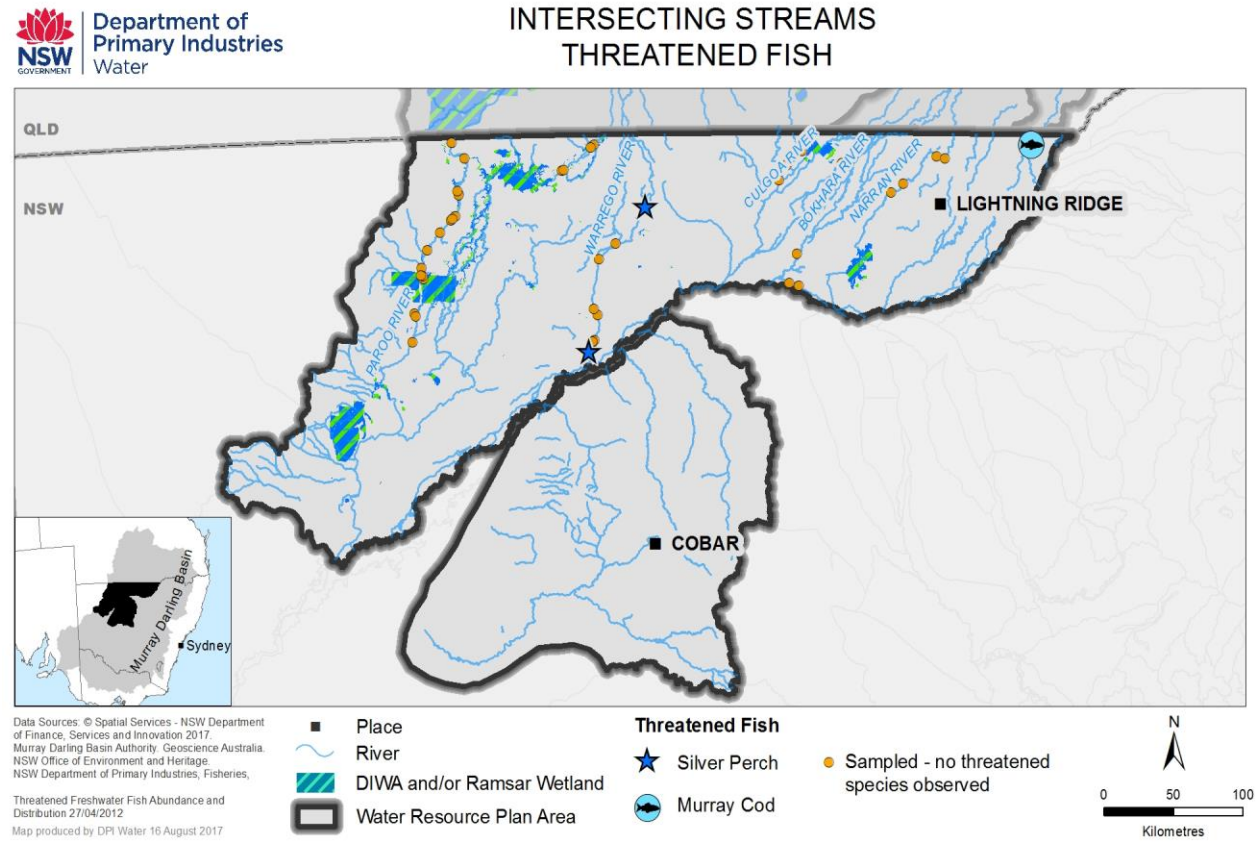


Figure 3-2: Distribution of threatened fish species within the Intersecting Streams WRPA

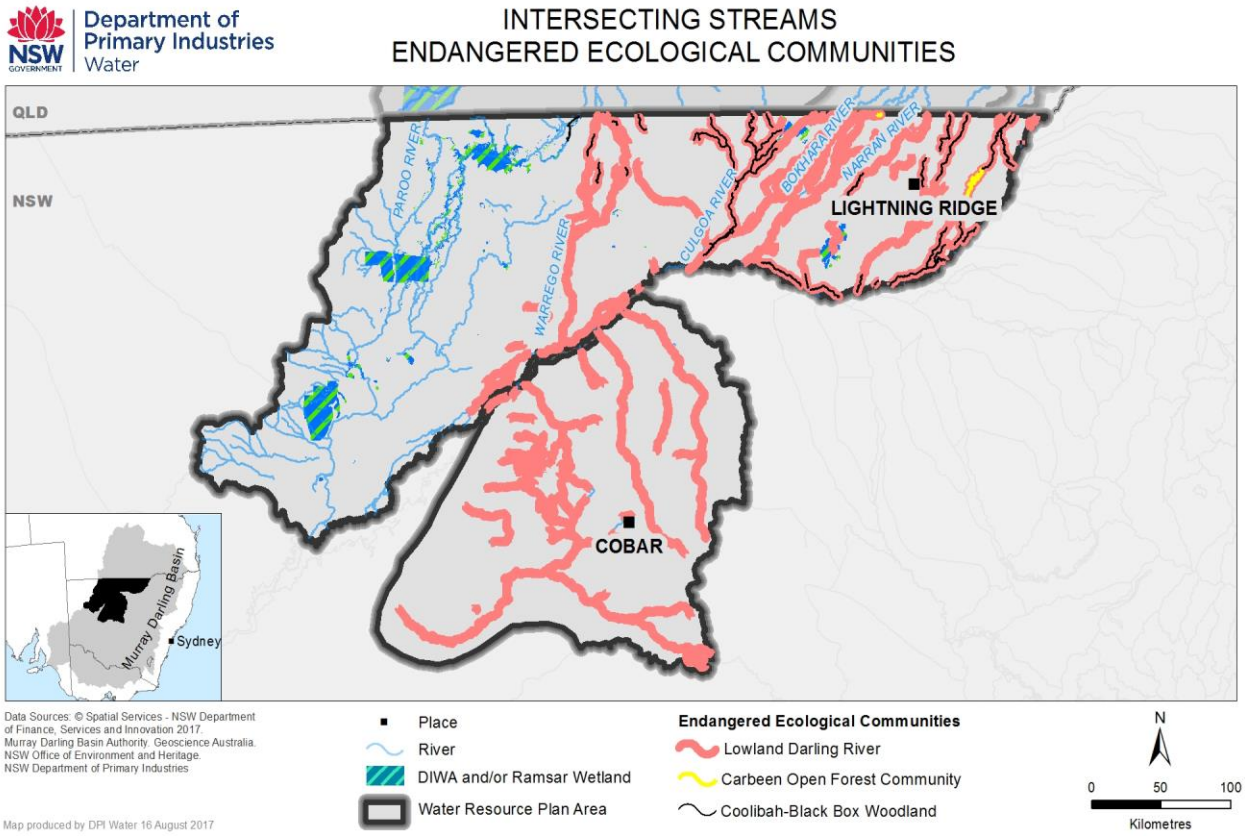


Figure 3-3: Endangered ecological communities in the Intersecting Streams WRPA

Photo 6: Straw-necked Ibis at Narran Lake Nature Reserve
Australian Geographic: Josh Smith

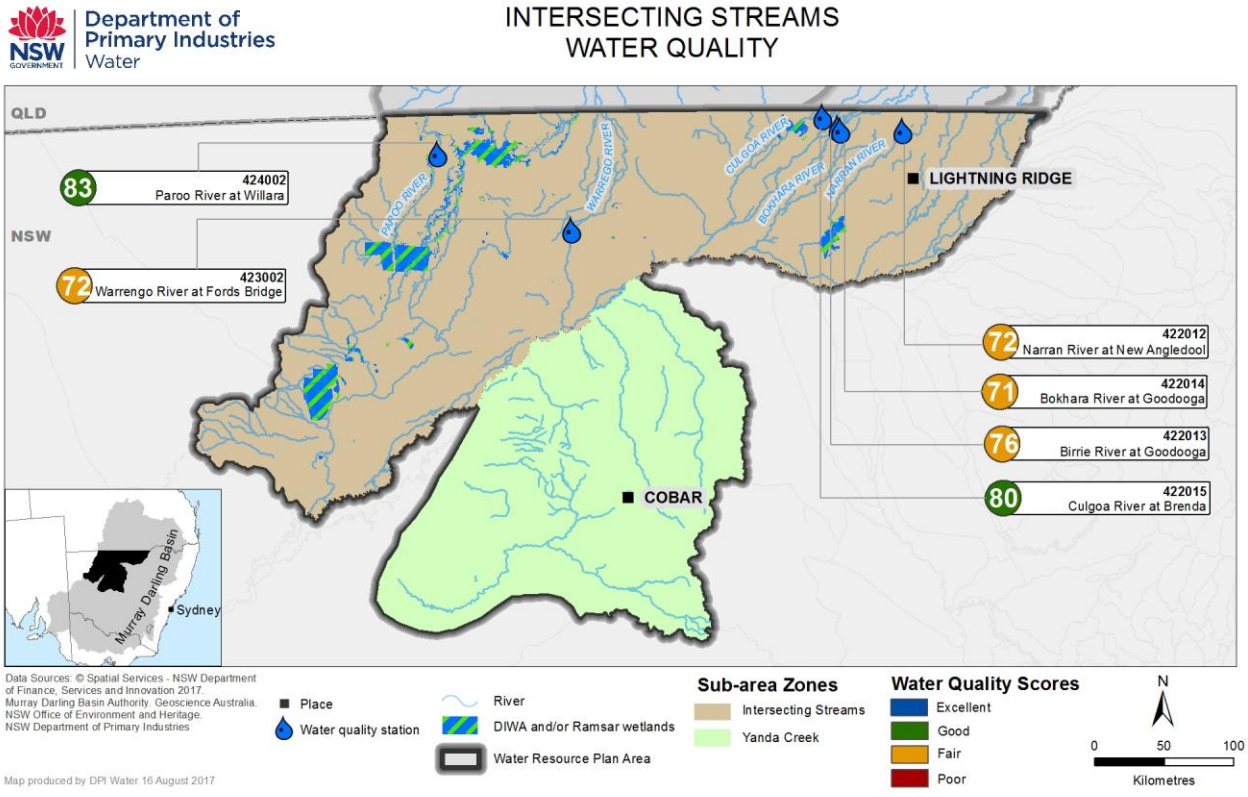
4 Water Quality

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 2017).

Water quality in the Intersecting Streams WRPA varies from fair to good. The water quality status map (Figure 4-1) 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 2017). Table 4-1 provides a summary of the status of water quality in the different water sources in the plan area. There are not enough reliable flows in Yanda Creek to calculate water quality parameters.



WaQI Scores: Blue = Excellent (100-95), Green = Good (94-80), Orange = Fair (79-60), Red = Poor (59-1).

Figure 4-1: Water quality condition of the Intersecting Streams WRPA

Table 4-1: Summary of water quality assessment in the NSW Intersecting Streams WRPA

	Yanda Creek	Intersecting Streams
Dissolved oxygen	Unknown	Unpredictable during low flows. Can be elevated due to algal growth.
pH	Unknown	Frequently above the upper pH target limit. May be elevated by algal growth.
Salinity	Unknown	Generally low.
Nutrients (nitrogen and phosphorus)	Unknown	High throughout the zone due to nutrient inputs from upper catchments. Increased during high flows.
Suspended sediments and turbidity	Unknown	High throughout the zone due to inputs from upper catchments and fine clay particles remaining in suspension. Increased during high flows.
	Turbidity is elevated due to a number of factors including the widespread conversion of land for cropping, river bank and riparian condition, presence of carp and grazing practices. Fine clay particles remaining in suspension in the water column, even during low flows, maintains elevated turbidity levels.	
Harmful algal blooms	Unknown	Algal blooms can occur anywhere in this zone during warmer months. More commonly found in weir pools, such as Narran River at New Angledool and Bokhara River at Goodooga. Caused by low flows, clear, warm water and high level of nutrients.
Thermal pollution	Nil	Nil

Photo 7: Narran Lake Ramsar site

DPI Water

5 Riparian and geomorphic 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* 2006), 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 5-1 and Figure 5-2 provide a general overview of riparian and geomorphic condition for the Intersecting Streams WRPA. The percentage of native riparian vegetation in the Plan area is highest in the middle region of the catchment (Figure 5-1). For river recovery potential (Figure 5-2), 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 western edge of the Paroo water source classed as having low recovery potential.

Photo 8: Paroo River, Paroo-Darling National Park

Neal Foster (NOW)

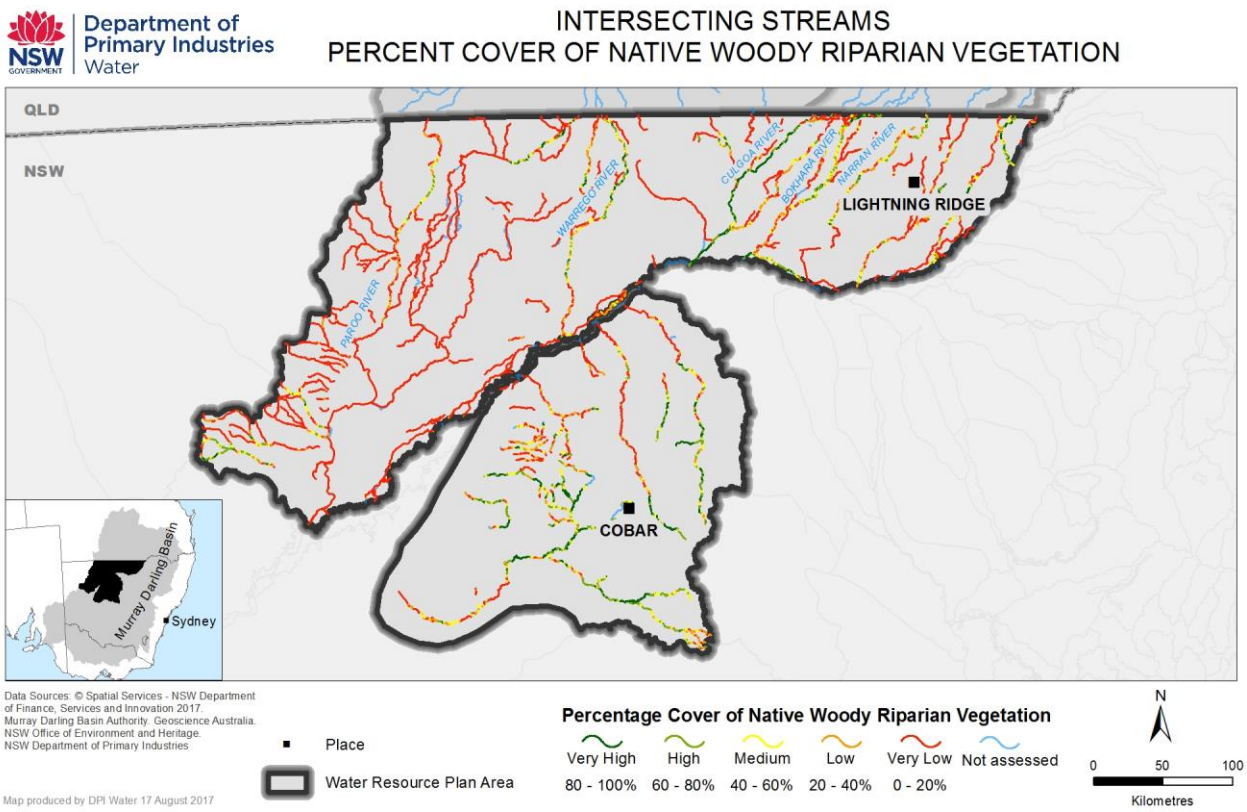


Figure 5-1: Percent cover of native woody riparian vegetation in the Intersecting Streams WRPA

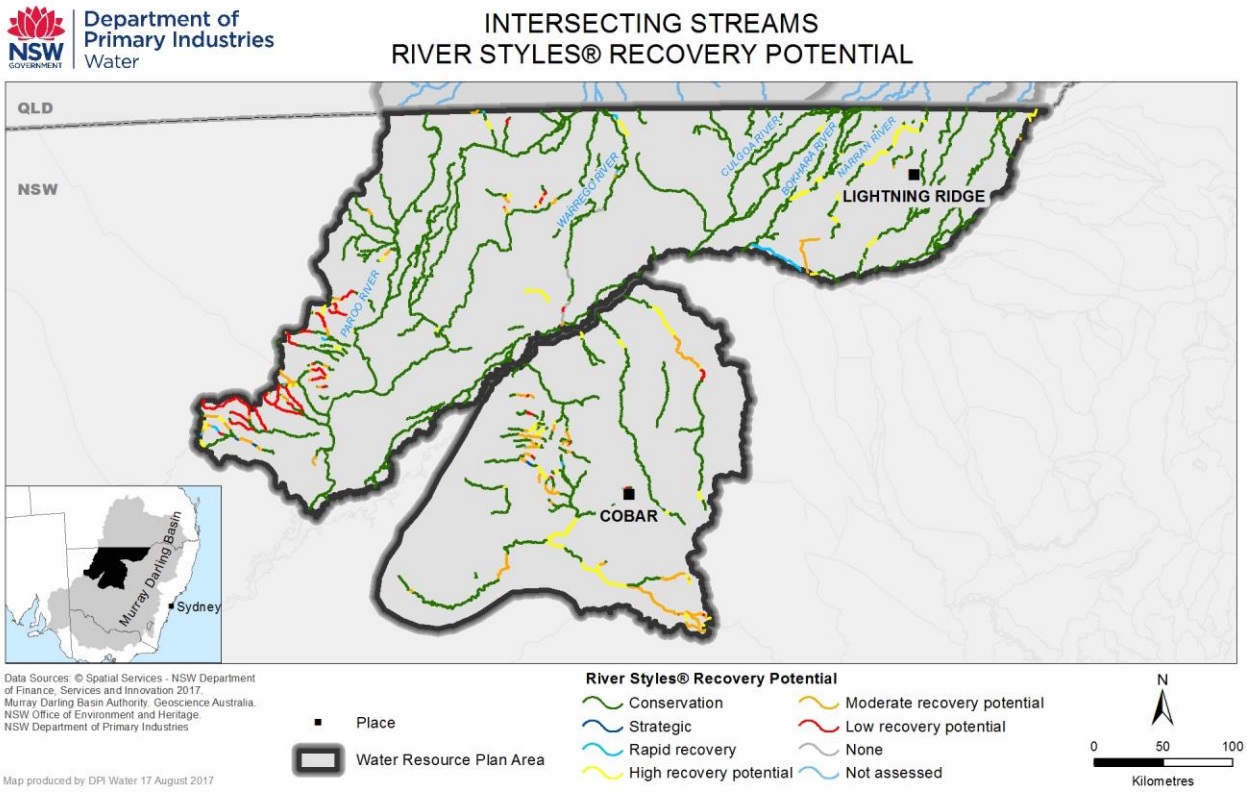


Figure 5-2: Geomorphic recovery potential in streams in the Intersecting Streams WRPA

6 River operations and management

6.2 Storages and regulating structures

There are a number of weirs and regulating structures in the Intersecting Streams which assist in the diversion of water for various uses. Two of these weirs; Culgoa and Goodooga provide water for the localities of Collerina and Goodooga respectively. The main weirs are listed in Table 6-1.

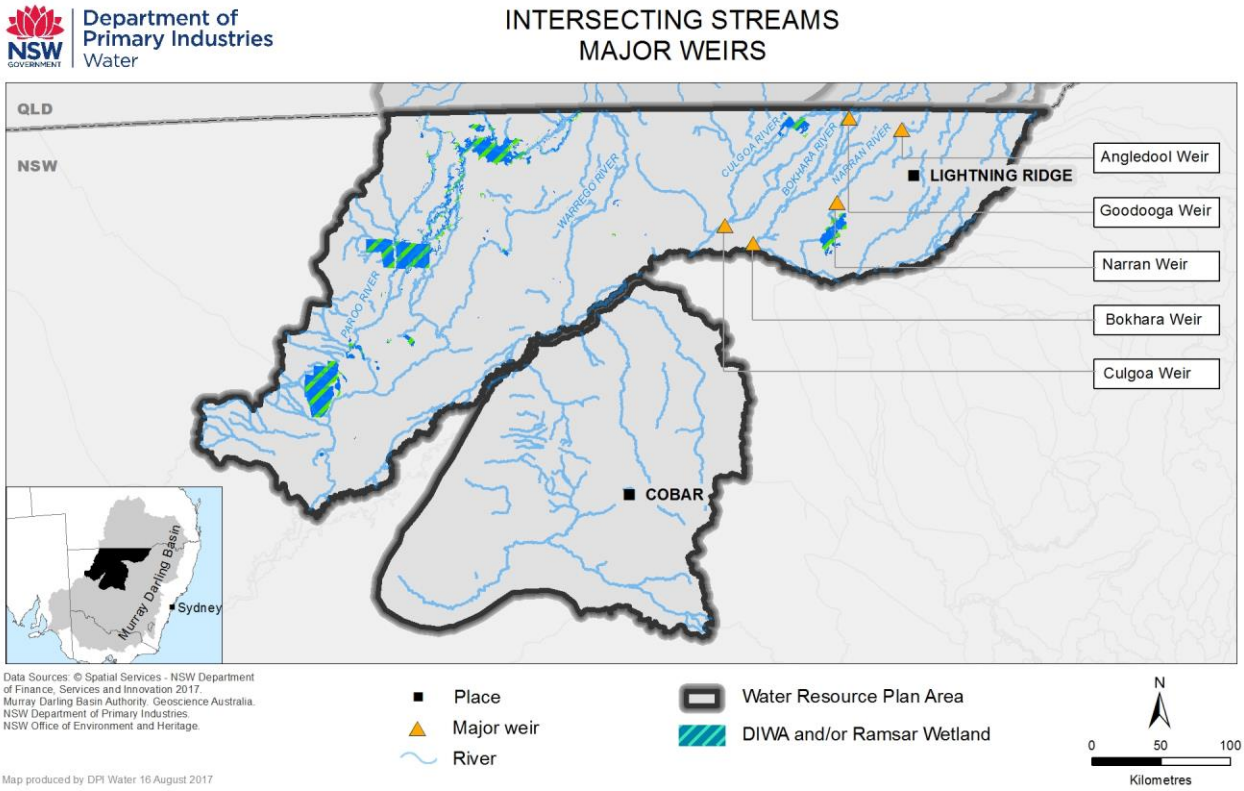


Figure 6-1: Location of major weirs in the Intersecting Streams WRPA

Weir	Approximate location	
	Longitude	Latitude
Angledool Weir	147.86	-29.19
Narran Weir	147.41	-29.61
Goodooga Weir	147.45	-29.10
Bokhara Weir	146.72	-29.87
Culgoa Weir	146.53	-29.68

6.2 Licenced water use

The Intersecting Streams catchments use about 0.1 per cent of all the surface water diverted in the Murray-Darling Basin (CSIRO 2007). There is 312 ML of water allocated to local water utilities in the Intersecting Streams water sources. Brewarrina Shire, Central Darling Shire Councils and the

Wanaaring & District Progress Association extract water from the Bokhara and Paroo Rivers respectively (Table 6-1).

Table 6-1: Local water utilities using surface water in the Intersecting Streams WRPA

Council	River	Water Source	Share component (ML)
Brewarrina Shire Council	Bokhara	Culgoa River	91
Wanaaring & Districts Progress Association	Paroo	Paroo River	25
Central Darling Shire	Paroo	Paroo River	196
TOTAL			**312**

6.2.1 Unregulated river entitlements

Water users located on the various unregulated tributaries of the Intersecting Streams catchments 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 24,152 ML of unregulated entitlement within the Intersecting Streams WRPA (Table 6-2). The main licensed use of water is for irrigation.

Figure 6-2 shows the distribution of unregulated river entitlement by type and water source.

Table 6-2: Unregulated share components for the Intersecting Streams WRPA 2015-16

Access licence category	Total share component (ML)
Domestic and Stock	244
Local Water Utility (Town Water Supply)	312
Unregulated River Access	23,596
Unregulated River Access (special additional high flow)	0
TOTAL	**24,152**

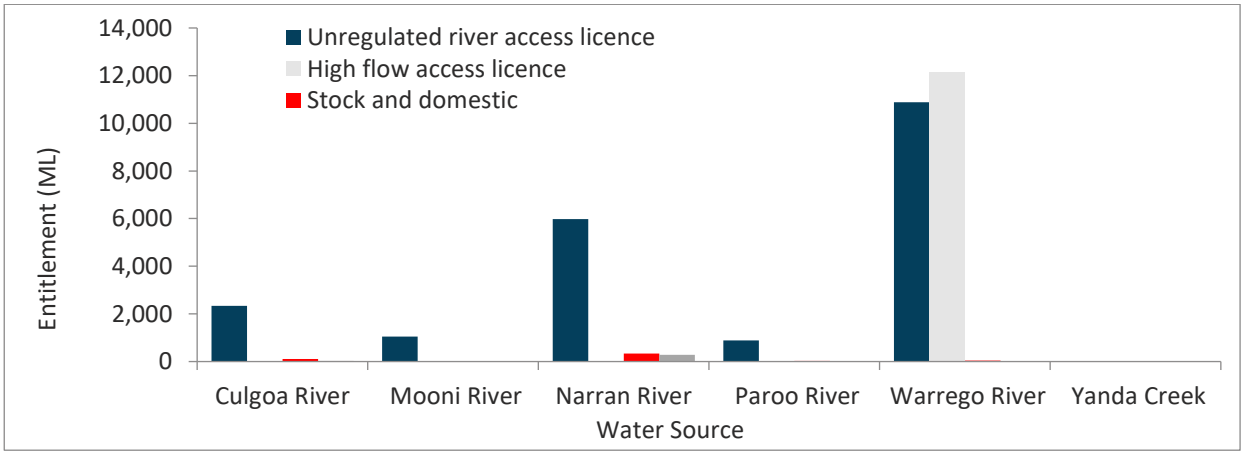
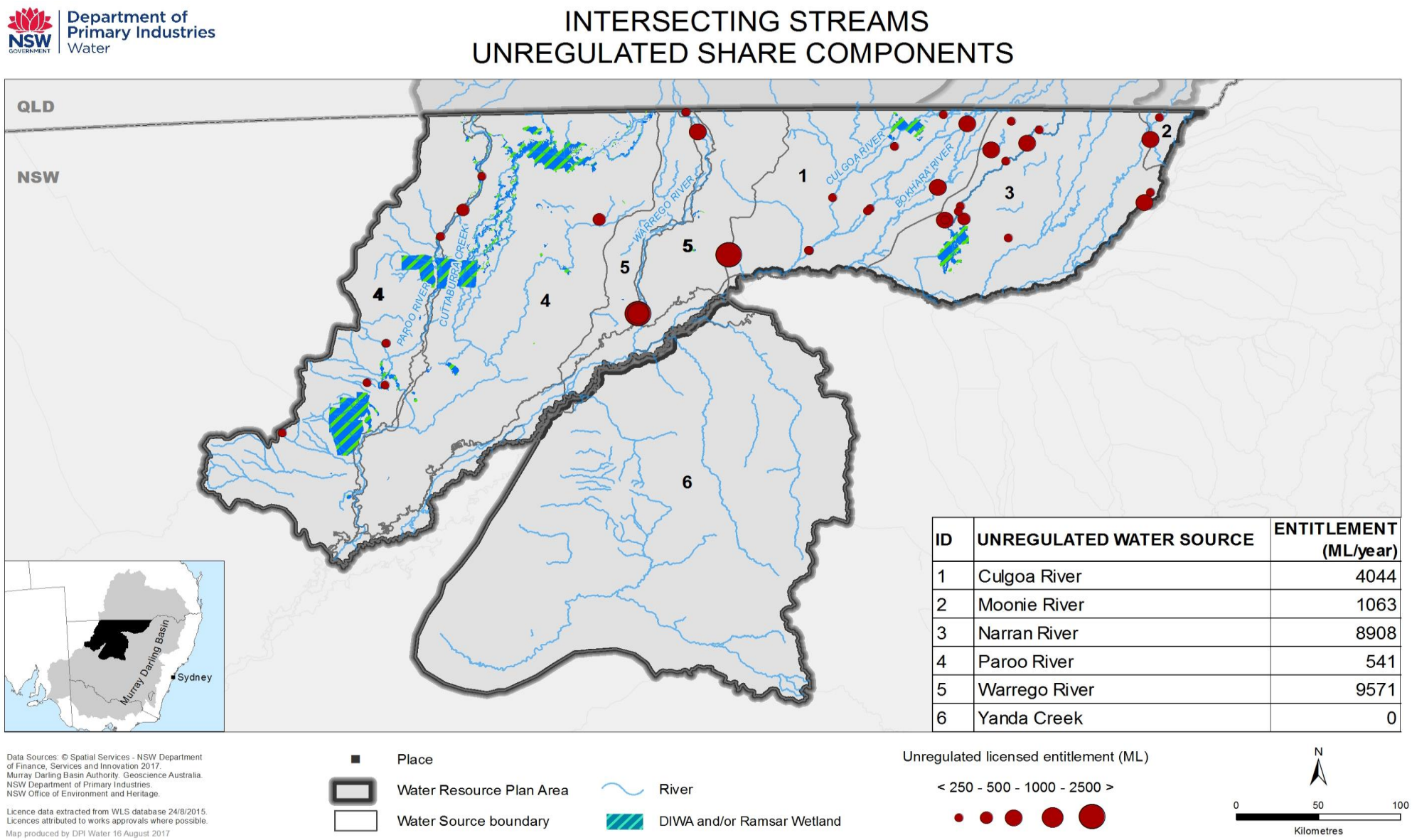


Figure 6-2: 2016 water entitlement type for unregulated water access licences in the Intersecting Streams



ID	UNREGULATED WATER SOURCE	ENTITLEMENT (ML/year)
1	Culgoa River	4044
2	Moonie River	1063
3	Narran River	8908
4	Paroo River	541
5	Warrego River	9571
6	Yanda Creek	0

Figure 6-3: Distribution of water entitlements for the Intersecting Streams unregulated water sources

6.3 Water trading

Permanent trades refer to the trade of share components between licences, while temporary trade refers to the trade of water allocation. 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.

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

There is 16,854 ML volume of held environmental water in the Intersecting Streams WRPA. The main entitlement holders of held environmental water are the Commonwealth Environmental Water Holder and the NSW Office of Environment and Heritage.

6.4.2 Planned environmental water

Planned environmental water is rule-based water which is defined in the water sharing plan. It should also be noted that all water above the Plan extraction limit is regarded as planned environmental water.

Photo 9: Toorale National Park

M. Hull (OEH)

Glossary

Aquatic ecosystems	Ecosystems that is 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.
Allocation	The volume of water assigned to water allocation accounts in a given season, defined according to rules in the relevant water plan.
Allocation assignment	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.
Available water determination (AWD)	A determination referred to in section 59 of the *Water Management Act 2000* that defines the proportion of the share component that will be available for extraction under each category of water access licence.
Basic Landholder Rights	Means domestic and stock rights, harvestable rights or native title rights.
Cold water pollution	An artificial decrease in the temperature of water in a natural river.
Dissolved oxygen	Measured concentration of oxygen dissolved in water.
Domestic consumption	Consumption of water for normal household purposes in domestic premises on the land.
Ecological value	The perceived importance of an ecosystem which is underpinned by the biotic and/or abiotic components and processes that characterise that ecosystem.
Ecosystem	A specific composition of animals and plants that interact with one another and their environment.
Ecosystem functions	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.
Effluent	An effluent stream is one which leaves the main river and does not return.
Endangered ecological community	Ecological communities as listed in Schedule 1 of the *Threatened Species Conservation Act 1995* or Schedule 4 of the *Fisheries Management Act 1994*.
Eutrophication	The process where an accumulation of nutrients in water bodies leads to rapid growth of aquatic plants.
Farm dams	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).

General security licence	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.
Groundwater	Water that occurs beneath the ground surface in the saturated zone.
Groundwater dependent ecosystems	[4]Ecosystems 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.
Harmful algal bloom	An algal bloom that causes negative impacts to other organisms through the production of natural toxins, mechanical damage, or other means.
High flows	Also called bankfull events, these reshape the channel, creating habitats such as pools, bars and benches.
High security licence	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.
Instream value	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.
Low flows	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.
Nitrogen and phosphorous	Chemical nutrients essential for growth and added to many fertilisers.
Overbank flows	High flows that connect the river to floodplain and wetlands allowing the exchange of nutrients and sediment to these areas.
Regulated river	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.
Replenishment flows	Flows provided along effluent systems to supply water for household, town use and stock.
Riparian	Relating to or living or located on the bank of a natural watercourse, such as a river stream.
Salinity	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.
Seasonality	The timing of flooding and low flow events.

[4] Kuginis 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	[5]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	[6]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.

[5] https://www.mdba.gov.au/basin-plan-roll-out/water-resource-plans

[6] As defined in the *Water Management Act 2000*

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