Department of Planning and Environment

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Billabong Creek Environmental Water Regulators

State Significant Instructure Scoping Report

November 2022

Revision F Final

Acknowledgement of Country

The Department of Planning and Environment acknowledges that it stands on Aboriginal land. We acknowledge the Traditional Custodians of the land and we show our respect for Elders past, present and emerging through thoughtful and collaborative approaches to our work, seeking to demonstrate our ongoing commitment to providing places in which Aboriginal people are included socially, culturally and economically.

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Billabong Creek Environmental Water Regulators

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Glossary

Term	Description
Anabranch	A section of a river or stream that diverts from the main channel of the watercourse and rejoins downstream.
Commonwealth Environmental Water Holder	The Commonwealth Environmental Water Holder is a statutory position established under the *Water Act 2007* (Cth) responsible for managing the Commonwealth's environmental water holdings. These water holdings are used to protect or restore environmental assets of the Murray-Darling Basin.
Constraints	Anything that affects the delivery of environmental water. It can include physical aspects such as low-lying bridges, or river channel capacity, but can also include operational aspects such as river rules or operating practices that impact on when and how much water can be delivered.
Efficiency measure	Provide more water for the environment by making water delivery systems for irrigation more efficient. This can include replacing or upgrading on-farm irrigation, or lining channels to reduce water losses within an irrigation network.
Entitlement	The volume of water authorised to be taken and used by an irrigator or water authority; includes bulk entitlements, environmental entitlements, water rights, sales water and surface-water and groundwater licenses.
Environmental flow	Any river flow pattern provided with the intention of maintaining or improving river health.
Environmental water	Water used to achieve environmental outcomes, including benefits to ecosystem functions, biodiversity, water quality and water resource health.
Environmental water requirements	The amount of water needed to meet an ecological or environmental objective.
Fish passage	The ability of fish or other aquatic species to move through an aquatic system.
Fishway	Structures placed on or around constructed barriers (such as dams or weirs) to give fish the opportunity to move past the barrier.
Groundwater	Water occurring naturally below ground level (in an aquifer or otherwise).

Term	Description
Levee	An elongated embankment designed to contain the overland flow of water and prevent flooding.
Regulated	A water system in which water is stored or flow levels are controlled through the use of structures such as dams and weirs.
Regulator	A gated structure used to actively manage or control the amount of water that flows from one location to another.
Sustainable diversion limit	Defined by the Murray-Darling Basin Plan. The maximum long-term annual average quantities of water that can be taken, on a sustainable basis, from the Murray-Darling Basin's water resources as a whole, and the water resources, or particular parts of the water resources, of each water resource plan area.
Sustainable diversion limit adjustment mechanism	A mechanism under the Murray-Darling Basin Plan that allows the sustainable diversion limit to be adjusted under certain circumstances.
Water entitlement	See entitlement
Weir	A low barrier or dam that is built across a watercourse and is designed to store water, control or alter the flow of water in a creek.

Abbreviations

Abbreviations	Definitions
AHD	Australian height datum
BAM	Biodiversity Assessment Method
BDAR	Biodiversity Development Assessment Report
CEWO	Commonwealth Environmental Water Office
DPE	NSW Department of Planning and Environment
DPIE	NSW Department of Planning, Industry and Environment (now renamed as NSW Department of Planning and Environment)
EIS	Environmental impact statement
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
FM Act	*Fisheries Management Act 1994* (NSW)
GL	Gigalitre
km²	Square kilometres
LEP	Local environmental plan
LGA	Local government area
ML	Megalitre
the Regulation	*Environmental Planning and Assessment Regulation 2021* (NSW)
SDLAM	Sustainable diversion limit adjustment mechanism
SEARs	Secretary's environmental assessment requirements
SEPP	State environmental planning policy

Declaration

Project details	
Project name	Billabong Creek Environmental Water Regulators
Application number	-
Address of the land on which the infrastructure is to be carried out	Land at four locations along Billabong Creek in the localities of Hartwood, Conargo, Wanganella and Barratta.
Proponent details	
Proponent name	NSW Department of Planning and Environment – Water Infrastructure NSW
Proponent address	4 Parramatta Square, 12 Darcy Street, Parramatta NSW 2150
ABN	20 770 707 468
Details of the person by whom this EIS Scoping Report was prepared	
Name	3Rivers
Address	Level 15, 133 Castlereagh Street Sydney NSW 2000 Australia
Declaration	The undersigned declares that this EIS Scoping Report: • has been prepared to accompany the application for the SEARs for the project • has been prepared having regard for the SSI guidelines prepared by the Planning Secretary • contains a simple and easy to understand summary of the project as a whole, having regard to the economic, environmental and social impacts of the project and the principles of ecologically sustainable development.
Signature	 Tony Paull
Date	3 November 2022

Summary

This scoping report has been prepared on behalf of Water Infrastructure NSW for construction of four environmental water regulators along Billabong Creek, NSW. It seeks the Planning Secretary's environmental assessment requirements for the preparation of an environmental impact statement.

The key elements of the proposal are as follows:

- **Proposal summary:** The proposal involves replacing four existing weirs along Billabong Creek with four new environmental water regulators (the proposal). The weirs being replaced are Hartwood Weir, Piccaninny Weir, Wanganella Weir and Caroonboon Weir. Water Infrastructure NSW will determine a suitable name for the proposed environmental water regulator at Piccaninny Creek in consultation with the local community and First Nations people. The environmental regulators would be fully automated and remotely operable meaning river operators could control flow remotely which would increase the efficiency of flow control in Billabong Creek. The new environmental regulators would also feature fishways to support fish movement past the new structures. The proposal is part of a broader range of water savings projects under the Murray-Darling Basin Plan Sustainable Diversion Limit Adjustment Mechanism. Water Infrastructure NSW is the proponent for the proposal and WaterNSW will be the owner-operator of the Billabong Creek environmental water regulators.
- **Proposal vision and benefits:** The proposal is needed to improve the efficiency of water management in Billabong Creek by improving the ability of river operators to deliver the right amount of environmental and consumptive water to the right place at the right time and to improve the passage of fish through the system. The proposal would assist delivery of improved environmental outcomes compared to current conditions. It would also reduce the risk of additional adverse local socioeconomic outcomes resulting from additional water market purchases required to meet legislative water recovery targets of the Murray-Darling Basin Plan 2012.
- **Approval pathway:** The proposal, being development for the purpose of a water storage facility carried out by a public authority (Water Infrastructure NSW) on land zoned for primary production (Zone RU1), may be carried out without consent under section 2.159 of the *State Environment Planning Policy (Transport and Infrastructure) 2021*. The proposal is classified as State significant infrastructure under Part 5, Division 5.2 of the *NSW Environmental Planning and Assessment Act 1979* as it comprises a water storage facility with a capital investment cost estimate of more than $30 million carried out by a public authority. As such the proposal requires the approval of the Minister for Planning to proceed.
- **Stakeholder engagement:** Community engagement relating to the modernisation of the Yanco Creek system, where the Billabong Creek is located, has been extensive and has included engagement during early options assessment through to design. Community engagement has been guided by a community engagement plan developed in partnership with Yanco Creek and Tributaries Advisory Council Inc., and ongoing six-monthly stakeholder engagement plans, including specific First Nations activities. Community engagement activities have included

community information sessions, information products, and establishment of advisory groups with industry and local government representation. Key issues of concern include maintaining creek flow, collaboration, and topics for inclusion in the environmental impact statement.

- **Environmental issues for consideration:** This scoping report has found that detailed consideration will be needed for issues including biodiversity, water resources including hydrology, heritage, social and community. In addition, standard assessments will be required for land stability, rural environment and agriculture, amenity, air quality, access, and hazards and risks. Impacts are expected to be minimised by the proposal's design and operating rules as well as use of best practice in construction and operation.

1. Introduction

1.1. Background to the proposal

Water Infrastructure NSW (WINSW) is proposing to replace four existing weirs along Billabong Creek with new environmental water regulators (the proposal). The four existing weirs to be fully or partially demolished are Hartwood Weir, Piccaninny Weir, Wanganella Weir and Caroonboon Weir. WINSW will determine a suitable name for the proposed environmental water regulator at Piccaninny Creek in consultation with the local community and First Nations people. These are situated on Billabong Creek within the Yanco Creek system in south-west NSW (refer Figure 1-1).

These weirs were built in the early 20th century and have been used to regulate flows through Billabong Creek, create weirs pools for irrigation and, in the case of Wanganella Weir, provide town water supply. The weirs are currently in states of declining condition and functionality, and are barriers to the movement of fish through the creek. Their condition limits their ability to regulate flows through the Yanco Creek system and leads to inefficiencies in how water is delivered to the environment and irrigators. The new environmental regulators would be fully automated and remotely operated meaning that operators could control the delivery of water more efficiently. The proposal is needed to improve the operator's ability to deliver the right amount of water to the right place at the right time. The new environmental regulators would also feature fishways to support fish movement past the new structures.

The objectives of the proposal are to:

- modernise ageing infrastructure
- provide service for water users
- improve fish passage
- improve delivery of environmental water.

The new environmental water regulators would be constructed downstream and in close proximity to the existing weirs and would be constructed using an in-stream method. The proposal has gone through a rigorous options selection process (refer to section 2.4) and has been informed by extensive stakeholder engagement (refer to section 5). Impacts are expected to be minimised by the proposal's design and operating rules as well as use of best practice in construction and operation.

The proposal location is shown in Figure 1-1 and details of the proposal are discussed in section 3.

1.2. Approval pathway

The proposal is subject to environmental and planning approvals in accordance with the *NSW Environmental Planning and Assessment Act 1979* (EP&A Act) and, potentially, the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The proposal is State significant infrastructure (SSI), and the Minister for Planning is the approval authority. An environmental impact statement (EIS) is required to accompany the application for approval of the proposal.

WINSW is the proponent for the proposal and WaterNSW will own and operate the new works once constructed.

This scoping report has been prepared on behalf of WINSW by 3Rivers to support the request for the Planning Secretary's environmental assessment requirements (SEARs) and based on which an EIS for the proposal will be prepared.

Figure 1.1 - Location of the proposal

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2. Background and strategic context

2.1. Description of existing conditions

2.1.1. Murray-Darling Basin

The Murray-Darling Basin (the Basin) is located in the interior of south-eastern Australia and encompasses the drainage basin of the tributaries of the Murray River and the Darling River. The Basin includes six of Australia's seven longest rivers and is one of the country's most significant agricultural areas. It drains in a south-westerly direction into the Great Australian Bight and spans most of the states of NSW and Victoria, the Australian Capital Territory, and parts of the states of Queensland (the lower third) and South Australia (the south-eastern corner). Figure 1-1 shows the location of the proposal in the context of the wider area and river system.

Two of the major rivers in the Basin are the Murrumbidgee and the Murray rivers. The Yanco Creek system is a complex system of waterways connecting the Murrumbidgee and Murray rivers. The Yanco Creek system generally flows south-west from the Murrumbidgee River downstream of Narrandera until it discharges into the Edward River (part of the Murray River basin) at Moulamein (Alluvium, 2013).

2.1.2. The Yanco Creek system

The Yanco Creek system contains multiple creeks including Billabong Creek. The headwaters of Billabong Creek are in the western slopes of the Great Dividing Range near Holbrook. The upper portions of Billabong Creek are unregulated (Alluvium, 2013). Billabong Creek is joined by Colombo Creek west of Urana and continues to flow in a westerly direction toward Jerilderie, before converging with Yanco Creek upstream of Conargo. The watercourse continues as Billabong Creek and flows west to join the Edward River at Moulamein. Billabong Creek drains a catchment of approximately 791 square kilometres (Cooling and Gippel, 2018).

Water can be diverted from the Murrumbidgee River through the Yanco Offtake into the Yanco Creek system. The Yanco Weir and Yanco Regulator allow the Murrumbidgee River to be raised at the Yanco Offtake to promote additional flow into Yanco Creek, including water contributed by the two major irrigation dams on the Murrumbidgee River. These dams are Burrinjuck on the Murrumbidgee River near Yass and Blowering on the Tumut River upstream of Tumut.

The Yanco Creek system is used to deliver environmental flows, along with consumptive water for irrigation and town supplies. The Yanco Creek system is used to service over 180 water licensees and provide town water supply to Morundah, Urana, Oaklands, Jerilderie, Conargo and Wanganella (NSW DPIE, 2019a). To fill water orders, flows into the Yanco Creek system are supplemented by flows diverted at the Yanco Creek Offtake. This has meant flows through the Yanco Creek system are maintained at artificially high levels during high demand periods.

The Yanco Creek system contains a number of environmental assets that are supported by the hydrological behaviour of the creek system. These include a wide range of floodplain wetlands such as the Wanganella Swamp, riparian and wetland vegetation communities and several large-bodied fish populations which are nationally threatened including Murray Cod and Trout Cod (NSW DPIE, 2019a). Fish movement in the Yanco Creek system is currently highly degraded and fragmented, with over 30 weirs in the system, only one of which has a fishway (refer Appendix E) (Stuart, 2022).

The structures that regulate the Yanco Creek system comprise of several weirs, inlet and outlet regulators, block banks and channels. Overall, the Yanco Creek system has been identified to contain 36 structures, many of which are in various states of degradation (Cooling and Gippel, 2018). The structures alter the distribution of water between the various creeks within the system and create weir pools that can be used to draw water. They also largely prevent the movement of fish along the system.

2.1.3. Billabong Creek

About Billabong Creek

Billabong Creek can be broadly divided into three reaches on the basis of hydrology, ecology and geomorphology (Alluvium, 2013; Cooling and Gippel, 2018). The proposal is located on the mid and lower Billabong Creek.

The upper Billabong Creek is the unregulated portion of the creek extending from its headwaters near Holbrook to its confluence with Colombo Creek. This reach of Billabong Creek also receives inflows from Cocketgedong Creek. The upper Billabong Creek flows the majority of the time due to catchment rainfall.

The mid Billabong Creek extends from the Colombo Creek confluence to the Yanco Creek confluence. Flow in this reach is supplemented by water from Colombo Creek and becomes part of a regulated water source receiving water from the major dams on the Murrumbidgee River. There are a number of weirs in this section of the creek below Jerilderie including Hartwood Weir. The mid Billabong Creek has a broad channel with deep pools separated by shallower runs and benches at a variety of elevations in the channel.

The lower Billabong Creek is from the Yanco Creek confluence to the Edward River confluence at Moulamein and is part of a regulated water source. There are several weirs along this stretch of creek including Piccaninny Weir, Wanganella Weir and Caroonboon Weir. The channel in the lower Billabong Creek is deep with steep one- to two-metre-high banks and has deep pools connected by shallow runs. Forest Creek is a notable anabranch of Billabong Creek. Forest Creek diverges from Billabong Creek upstream of the Yanco Creek confluence, near Hartwood Weir.

Table 2-1 lists the existing structures on Billabong Creek and some associated water bodies, that are located between Caroonboon Weir and Hartwood Weir. None of these structures have operational fishways.

Table 2-1 Structures on Billabong Creek within the proposal area

Barrier Name	Latitude	Longitude	Watercourse
Caroonboon Weir	-35.009	144.588	Billabong Creek
Wanganella Town Weir	-35.218	144.80	Billabong Creek
Old Wanganella Homestead Weir	-35.219	144.833	Billabong Creek
4 Mile Weir	-35.244	144.876	Billabong Creek
Chinamans Dam	-35.267	144.965	Billabong Creek
Traceys Dam	-35.283	145.021	Billabong Creek
Piccaninny Weir	-35.302	145.072	Billabong Creek
Boonoke Homestead Weir	-35.293	145.117	Billabong Creek
Hartwood Weir	-35.311	145.287	Billabong Creek

Flows from Billabong Creek can contribute to environmental watering of three key environmental assets in the Yanco Creek system: Wanganella Swamp, Rhyola Lake and Rhyola Swamp. Since May 2011, environmental water deliveries have targeted Wanganella Swamp and swamp health remains a key objective for environmental watering (CEWO, 2021).

The creek and surrounding area have significant cultural values for the Aboriginal community. Aboriginal culture is connected to Country, including waterways, animals, plants and landscape features. Physical evidence of Aboriginal occupation and history can be seen across the landscape. Aboriginal cultural heritage sites around Yanco, Forest, Colombo and Billabong creeks include scarred trees, earth mounds, isolated finds and open camp sites. Recorded Aboriginal sites are located along the creek frontages and in undisturbed areas, there is a high potential for unrecorded sites to be present along Billabong Creek.

European settlement of the Yanco Creek system began in the 1840s. From 1885, work began to connect the Murrumbidgee with the Yanco Creek. The Yanco Weir was completed in 1928 (Beal et al., 2004). Irrigated agriculture continued to spread in the Yanco Creek system after the Yanco Weir was completed and provided high flows through the system. Due to the long history of agriculture in the system, there a number of heritage listed items both in towns and at significant agricultural locations. Some listed items, such as the Old Coree Homestead and farm buildings, are associated with the families that helped develop agriculture in the area.

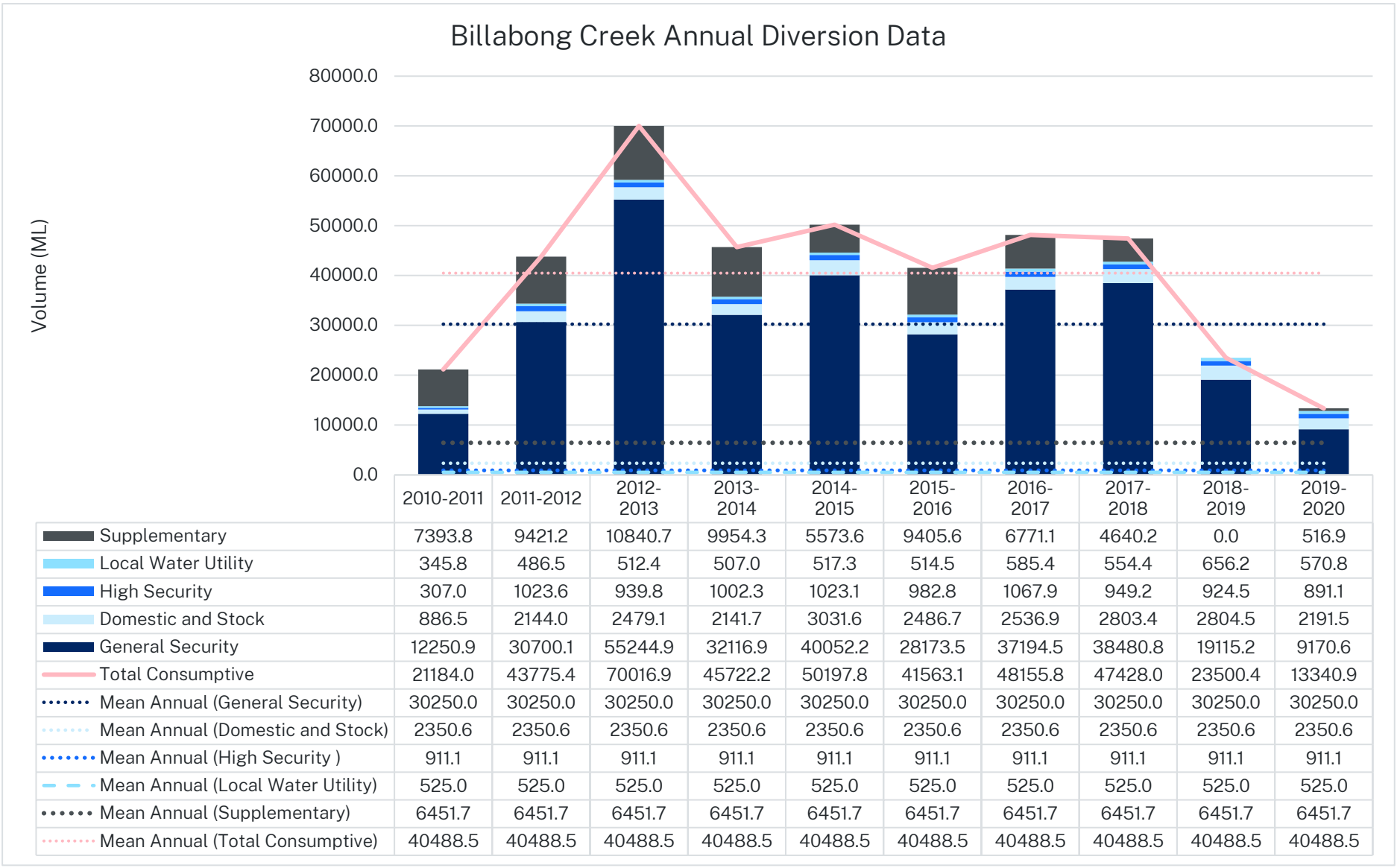
Billabong Creek also provides an important local and regional recreational and tourism resource. The creek is an attraction for creek-based activities including walking, biking, kayaking, camping, bird watching and fishing. Recreation reserves, such as the Wanganella Camping Reserve, utilise the weir pool created by the existing structure in the creek for water-based activities. Local businesses offer creek front accommodation in Wanganella village.

Water use in Billabong Creek

Billabong Creek is an important source of water for the surrounding areas. The majority of land adjacent to the water course is used for dryland grazing and cropping. The majority of irrigation water licences in the Yanco Creek system are general security, stock and domestic, and supplementary licences used for seasonal crops. Billabong Creek also provides water supply for local water utility, and in the case Wanganella Weir, town water supply (DPE, 2022a).

Average annual diversions of consumptive water from Billabong Creek are shown in Figure 2-1. The figure indicates the proportion of volume for each type of licence including supplementary and total consumptive licences. The data shows that agriculture and irrigation (General and High Security licences) use the most consumptive water from Billabong Creek.

Water from Yanco Creek system has also been used for environmental watering. There have been at least eight environmental watering events in the Yanco Creek system since 2010 (OEH, 2011b, 2012a, 2012b, 2014, 2015, 2017, 2018; DPE, 2020, 2022b, 2022c). These events include waterings of Wanganella Swamp in 2016-17 (9,300 ML) and 2019-20 (2,250 ML) (OEH, 2018; DPE, 2022b).



	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020
Supplementary	7393.8	9421.2	10840.7	9954.3	5573.6	9405.6	6771.1	4640.2	0.0	516.9
Local Water Utility	345.8	486.5	512.4	507.0	517.3	514.5	585.4	554.4	656.2	570.8
High Security	307.0	1023.6	939.8	1002.3	1023.1	982.8	1067.9	949.2	924.5	891.1
Domestic and Stock	886.5	2144.0	2479.1	2141.7	3031.6	2486.7	2536.9	2803.4	2804.5	2191.5
General Security	12250.9	30700.1	55244.9	32116.9	40052.2	28173.5	37194.5	38480.8	19115.2	9170.6
Total Consumptive	21184.0	43775.4	70016.9	45722.2	50197.8	41563.1	48155.8	47428.0	23500.4	13340.9
Mean Annual (General Security)	30250.0	30250.0	30250.0	30250.0	30250.0	30250.0	30250.0	30250.0	30250.0	30250.0
Mean Annual (Domestic and Stock)	2350.6	2350.6	2350.6	2350.6	2350.6	2350.6	2350.6	2350.6	2350.6	2350.6
Mean Annual (High Security)	911.1	911.1	911.1	911.1	911.1	911.1	911.1	911.1	911.1	911.1
Mean Annual (Local Water Utility)	525.0	525.0	525.0	525.0	525.0	525.0	525.0	525.0	525.0	525.0
Mean Annual (Supplementary)	6451.7	6451.7	6451.7	6451.7	6451.7	6451.7	6451.7	6451.7	6451.7	6451.7
Mean Annual (Total Consumptive)	40488.5	40488.5	40488.5	40488.5	40488.5	40488.5	40488.5	40488.5	40488.5	40488.5

Figure 2-1 Historical water use in Billabong Creek

The average annual flow volume from the unregulated portion of Billabong Creek for the last decade is shown in Figure 2-2.

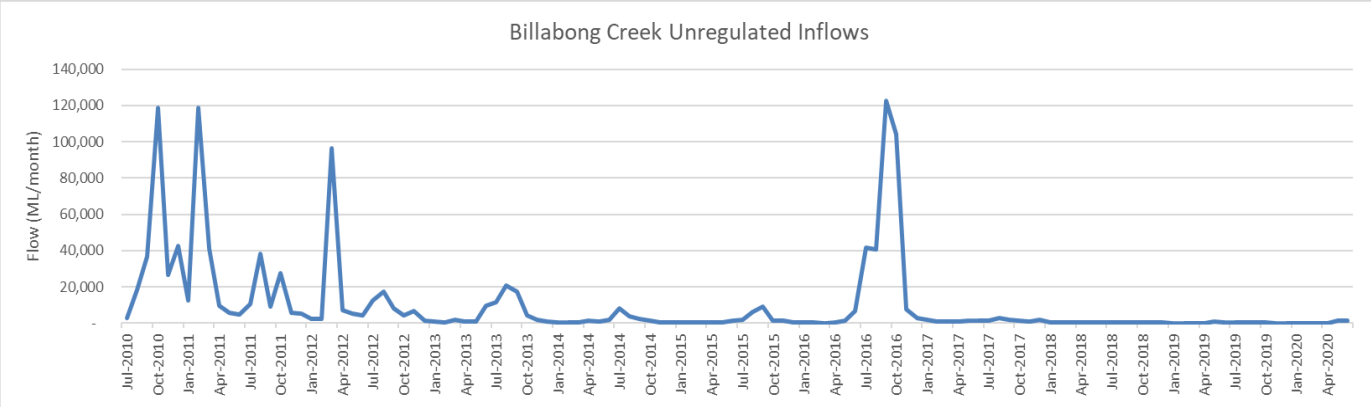


Figure 2-2 Average annual unregulated inflows to Billabong Creek

Existing weirs on Billabong Creek

Four of the existing weirs on Billabong Creek are proposed to be replaced as part of the proposal.

Hartwood Weir, is located on Billabong Creek, 10 kilometres east of Conargo and 42 kilometres west of Jerilderie, shown in Figure 2-3. It is owned and operated by WaterNSW and was completed in 1916. It is located on land owned by WaterNSW. The surrounding land is Crown land on the west bank and private land on the east bank. Hartwood Weir is downstream of the Billabong Creek and Forest Creek junction and can share the regulated flows between the two creeks by creating a weir pool to supply water to Forest Creek (Alluvium, 2013). Hartwood Weir, shown in Figure 2-4, now largely operates as a fixed crest weir with a concrete apron and abutments. The weir contains manual drop boards that would have been used historically to regulate flows past the weir and are now only removed in high flows. The extent of the weir pool at full supply level upstream of the structure is around 16.5 kilometres.

Existing weir
Access track
Preliminary work area
Crown land
Land use
RU1, Primary Production
Water bodies

N

GDA2020 MGA Zone 55
A4 Scale: 1:14,000

0 0.3
Kilometres

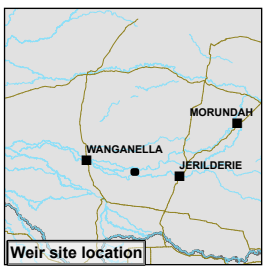


Figure 2.3 Hartwood Weir Zoning and Land Ownership

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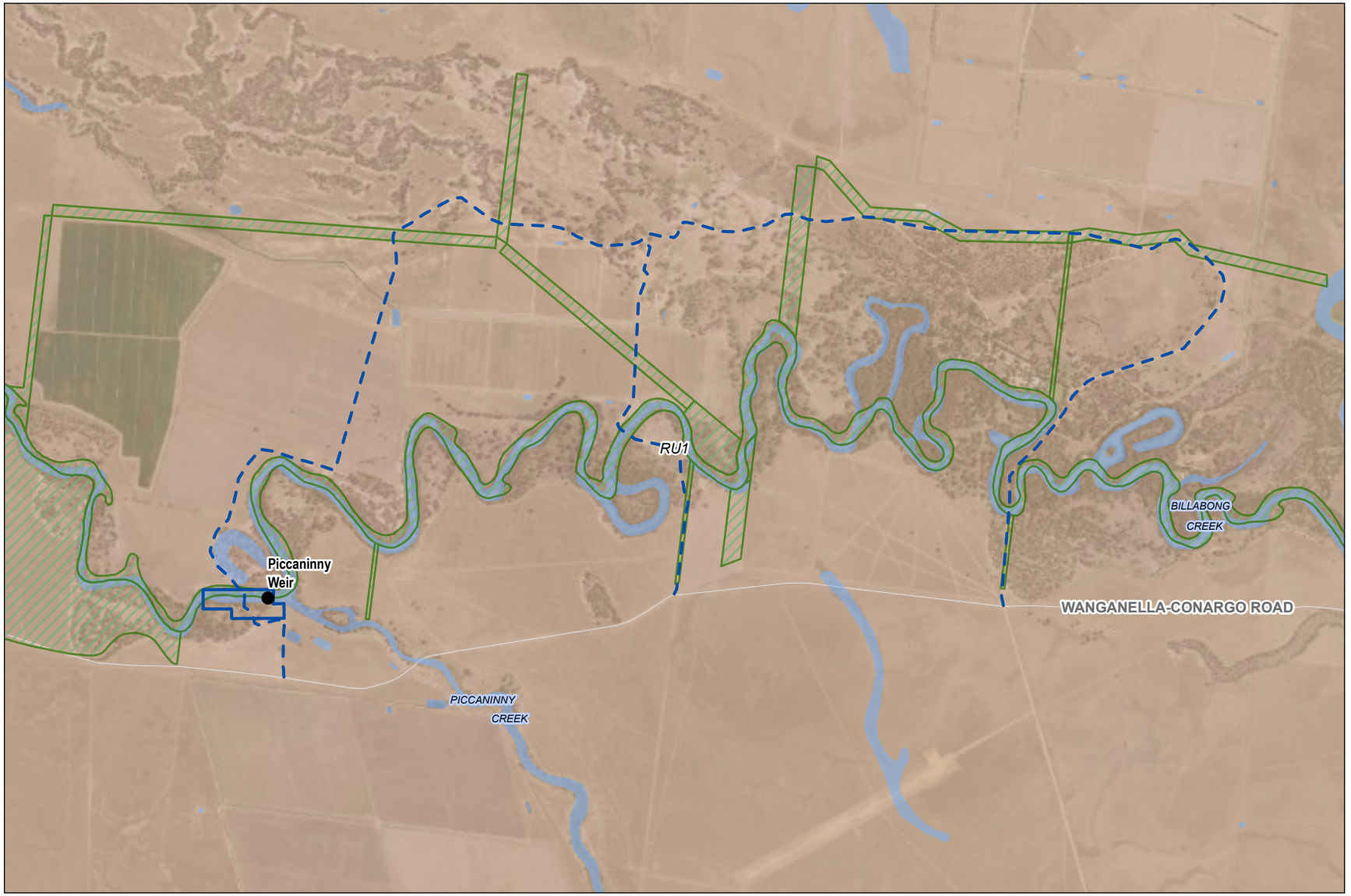
Figure 2-4 Hartwood Weir

Piccaninny Weir, is a privately owned structure, located on Billabong Creek, about 9.5 kilometres west of Conargo. The surrounding land is mostly private, with some Crown Land existing downstream of the existing structure, shown in Figure 2-5. Upstream of the weir, at the junction of Billabong and Piccaninny creeks, is the Peppinella property. The Piccaninny Weir is about 100 metres from the confluence of Piccaninny Creek and Billabong Creek. Piccaninny Weir, shown in Figure 2-6, provides a weir pool that is used for irrigation supply. The extent of the weir pool at full supply level upstream of the structure is around 10 kilometres.



Existing weir
Access track
Preliminary work area
Crown land
Land use
RU1, Primary Production
Water bodies
Main road

N

GDA2020 MGA Zone 55
A4 Scale: 1:32,000

0 0.7
Kilometres

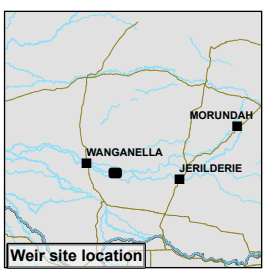


Figure 2.5 Piccaninny Weir Zoning and Land Ownership

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Figure 2-6 Piccaninny Weir

Wanganella Weir is located on lower Billabong Creek, one kilometre southwest of Wanganella village. The surrounding land use zoning is shown in Figure 2-7. The weir is an Edward River Council structure, constructed for the Wanganella town water supply. It now operates as a fixed crest weir with a concrete apron and abutments. The weir, shown in Figure 2-8, contains ten drop board bays to regulate flows, however the drop boards are no longer in place, apparently removed in the 1980s. The area surrounding Wanganella Weir is part of the Wanganella Recreation Reserve (camping reserve) which includes a recreation area next to the weir and along the creek, camping areas, Wanganella Tip (about 600 metres north of the weir) and the Wanganella Cemetery (about 1.5 kilometres north-west). The reserve also contains two off creek lagoons and numerous vehicle tracks. To the south of Wanganella Weir are agricultural areas. The extent of the weir pool at full supply level upstream of the structure is around 13 kilometres.

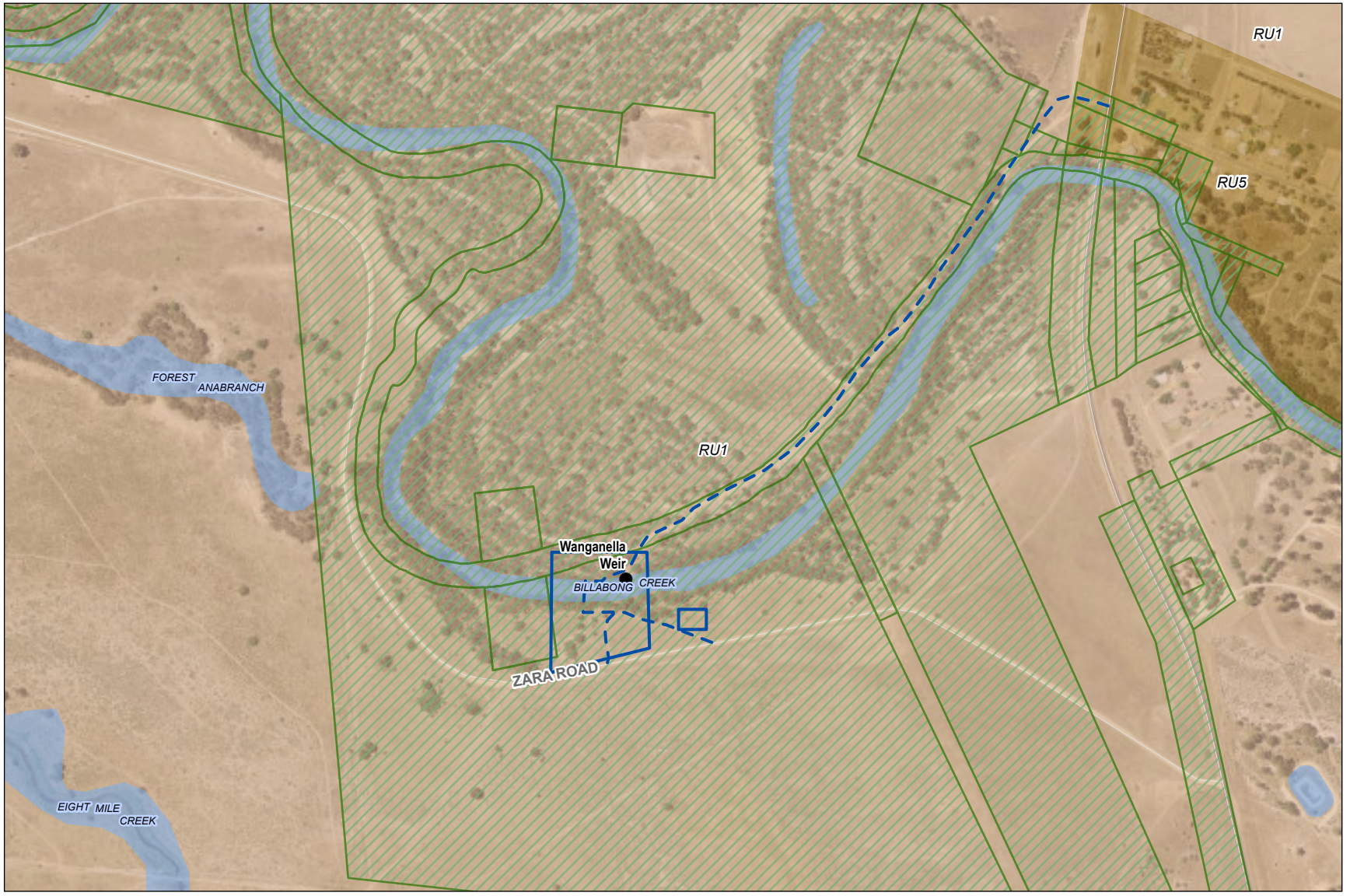

Figure 2.7 Wanganella Weir Zoning and Land Ownership

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Figure 2-8 Wanganella Weir

Caroonboon Weir is located on lower Billabong Creek, about 24 kilometres north-west of Wanganella village. The weir is located on private land used for agriculture. The weir is privately owned and effectively operates as a fixed crest weir with a concrete apron and abutments. Surrounding land use zoning is shown on Figure 2-9. The weir, shown in Figure 2-10, has piers that would be used to contain drop boards to allow the raising of the weir pool level. The extent of the weir pool at full supply level upstream of the structure is around 18 kilometres.

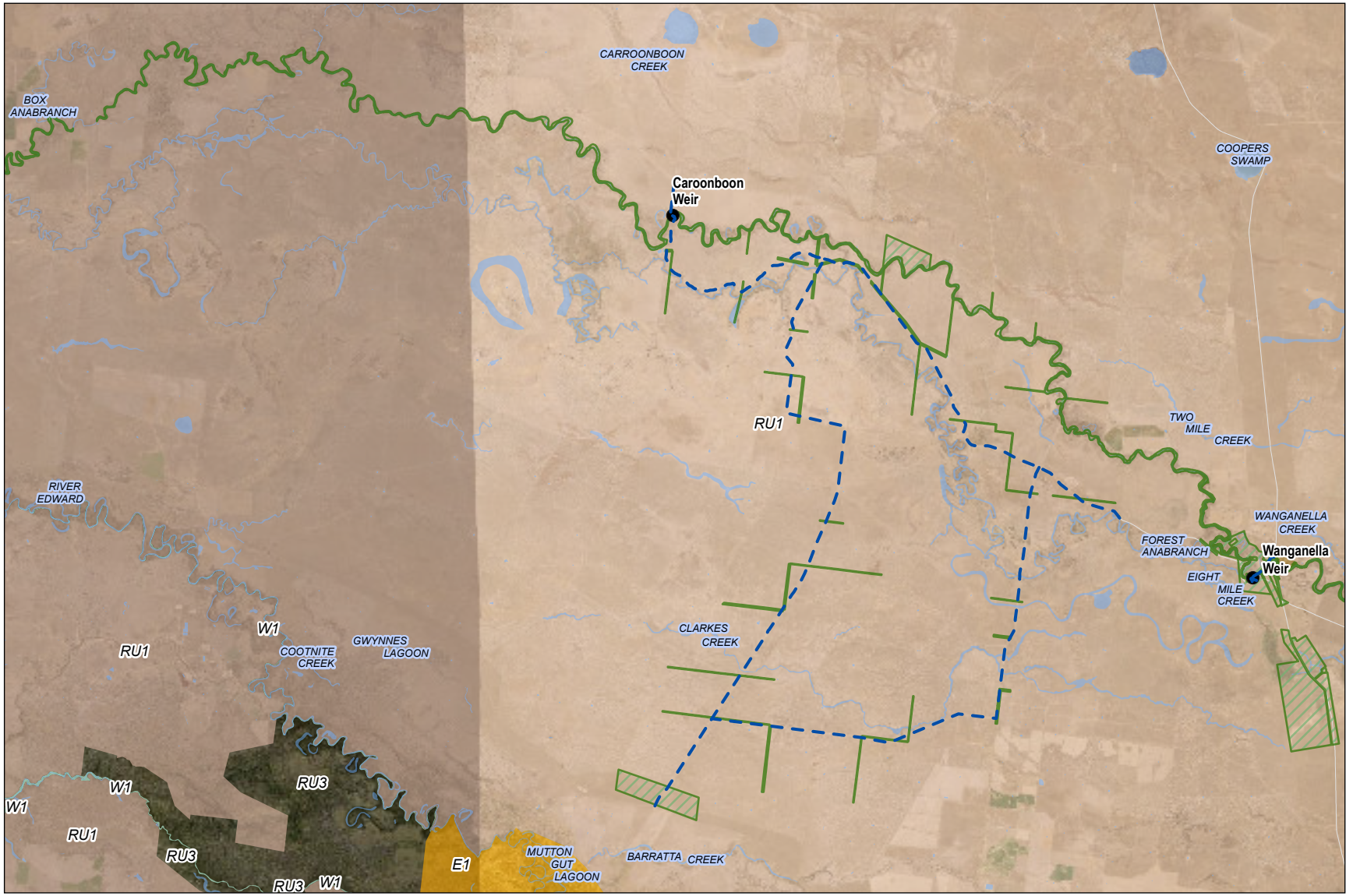

Figure 2.9 Caroonboon Weir Zoning and Land Ownership

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Figure 2-10 Caroonboon Weir

The location of the existing weirs are shown in Figure 3-1 to Figure 3-4. Table 2-2 provides a list of reference property lots for the existing weirs, for the parcels of land on which the weirs are located or, where weirs are located on Crown land, the adjoining land.

Table 2-2 Lot and DP for the existing weirs.

Weir	Reference lot and DP	Land zone
Hartwood	1 / DP1144789 2 / DP1144789 3 / DP181995	RU1 Conargo Local Environmental Plan 2013
Piccaninny	31 / DP756268 17 / DP756247	RU1 Conargo Local Environmental Plan 2013
Wanganella	7015 / DP1053753 7006 / DP1055647	RU1 Conargo Local Environmental Plan 2013
Caroonboon	34 / DP756248 6 / DP756263	RU1 Conargo Local Environmental Plan 2013

2.2. Strategic context

2.2.1. The Murray-Darling Basin Plan

The Federation drought between 1895 and 1902 provided a catalyst to bring the states together to agree on the management of the Murray River. The River Murray Waters Agreement commenced in 1915 involving the governments of NSW, Victoria, South Australia and the Australian Government. The formation of the River Murray Commission followed in 1917.

In 1987, the first Murray-Darling Basin Agreement was reached, which established the Murray-Darling Basin Commission. The millennium drought from the late 1990s to 2010 in much of the Basin increased understanding of environmental management constraints and water management requirements, highlighted the limits and weaknesses of how water in the Basin was managed, and highlighted the need for continuing reform. In response, the *Water Act 2007* (Cth) (the Water Act) was enacted.

As a requirement of the Water Act, the Murray-Darling Basin Authority was set up and was required to develop a plan to manage how much water could be used by industries and communities in the Basin. The Murray-Darling Basin Plan (the Basin Plan) was adopted in November 2012. The aim of the Basin Plan is to bring the Basin back to a healthier and sustainable level, while continuing to support farming and other industries for the benefit of the Australian community. The plan sets the amount of water that can be taken from the Basin each year.

There are several key components of water management in the Basin, which work as an integrated package:

- water entitlements – a permanent share/allocation of water within a catchment
- water trade – the ability to sell water entitlements and/or allocations
- water resource plans – management plans that define how water in a catchment can be used sustainably
- sustainable diversion limits – how much water can be used in the Basin while leaving enough water for the environment (see section 2.2.2)
- monitoring and accounting
- compliance.

2.2.2. Sustainable Diversion Limits and the Adjustment Mechanism

The Basin Plan sets sustainable diversion limits for each catchment or group of catchments. The existing sustainable diversion limits were lower than the amount of water that was being used at the time. As a consequence, water has to be recovered from the Basin's already allocated water to meet the limit. Across the Basin, the additional amount of water needed to meet the diversion limits and improve river and wetland health is an average of 2,750 GL per year. It is estimated that 2,107 GL of water had been recovered by September 2021.

To provide flexibility, the Basin Plan includes a mechanism to adjust sustainable diversion limits to achieve equivalent social, economic and environmental outcomes with less water recovery. The Sustainable Diversion Limit Adjustment Mechanism (SDLAM) allows the sustainable diversion limits to be adjusted within defined limits to offset the remaining gap between extractions and the desired 2,750 GL water saving. The ability to do this, and make additional water available for communities, is subject to implementing a range of projects, which include:

- supply projects – improving the efficiency of how water is delivered to the environment
- efficiency projects – projects or activities that change water use practices and save water for the environment
- constraints projects – projects that aim to overcome some of the physical barriers and river management practices that impact the ability to move environmental water around the Basin.

2.2.3. Yanco Creek modernisation

WINSW's Yanco Creek modernisation program is progressing the upgrade of infrastructure to enable smarter use of water in the Yanco Creek system, including Yanco, Billabong, Colombo and Forest creeks. It encompasses a series of initiatives aiming to improve water management as part of commitments within the SDLAM program.

The modernisation of Yanco Creek aims to:

- create a community and government partnership to maintain and improve flows
- keep the Yanco, Billabong, Forest and Colombo creeks flowing
- be smart in the use of available water
- modernise ageing infrastructure
- ensure project benefits for irrigators, town water supplies, native fish, water birds, culture and heritage, and recreational use.

The modernisation focuses on delivering equivalent and/ or improved environment outcomes through infrastructure and smarter use of water. Some of the expected benefits in the Yanco, Billabong, Forest, Colombo creeks and Murrumbidgee River system include:

- more efficient delivery of environmental water
- improved fish passage (e.g. new fish passage)
- improved knowledge and understanding of First Nations cultural heritage
- improved connection to Country
- an economic, training and employment boost for local communities
- improved levels of service for water users (e.g. more flexible irrigation scheduling)
- a reduced risk of further non-strategic water market purchases from the southern-connected Basin to meet Basin Plan commitments.

The Yanco Creek modernisation is also progressing the construction of fish passage to restore fish passage between water bodies to enable native fish to safely bypass obstacles such as weirs and other fish barriers.

2.3. Proposal need and justification

2.3.1. Overview

The proposal is needed to improve the efficiency of water management in Billabong Creek by improving the ability to deliver the right amount of environmental and consumptive (town and irrigation) water to the right place at the right time and to improve the passage of fish through the system.

The proposal would assist delivery of improved environmental outcomes compared to current conditions and reduce the risk of additional adverse socioeconomic outcomes in the local area from additional water market purchases to meet legislative water recovery targets required by the Basin Plan.

The NSW Government is committed to delivering the water saving project under the SDLAM program. As noted in section 2.2.2, NSW signed a funding agreement with the Australian Government to undertake detailed planning for a number of SDLAM projects. In accordance with these agreements, NSW and other Basin states are responsible for implementing the SDLAM projects. The proposal is needed to enable the NSW Government to meet its commitments under the SDLAM program.

2.3.2. Sustainable Diversion Limits and the Adjustment Mechanism supply projects

Within NSW, Billabong Creek environmental water regulators are part of a SDLAM supply project.

The SDLAM supply projects provide the opportunity to efficiently deliver water for the environment, balancing environmental water requirements with the needs of other water users. Supply projects must deliver equivalent or better environmental outcomes compared to those achieved under current Basin Plan settings, using less water. The water can then remain in the river for consumptive uses.

Supply projects are able to offset a quantity of water, which would otherwise need to be recovered from the Basin, to a maximum volume of 605 GL. The projects seek to provide equivalent environmental outcomes with a reduced volume of water and reduce the amount of water that needs to be recovered to meet the sustainable diversion limits. Project examples include environmental works, building or improving river or water management structures, changes in river operations, and works to reduce evaporation losses. Preliminary modelling of the supply projects indicated that implementing them would save up to 605 GL of water. This estimated saving has been incorporated into an amendment of the Basin Plan.

In early 2019, NSW signed a funding agreement with the Australian Government to undertake detailed planning for a number of projects under the SDLAM Program. Under these agreements, NSW and other Basin states are responsible for implementing the agreed measures.

The NSW Government has brought forward five of its remaining SDLAM projects through the NSW SDLAM Acceleration Program (the Acceleration Program). This program will remove barriers and streamline construction funding to demonstrate significant progress of these projects by June 2024.

The Acceleration Program will deliver up to 45 GL of the outstanding amount needed to reach the 605 GL target required by the Basin Plan each year, delivering strong ecological outcomes for the Murray-Darling Basin.

Yanco Creek Modernisation, primarily from the proposal, is estimated to provide about 7.5 GL, with a possible range from 7 GL to 16 GL (INDEC, 2021). This would account for about 16.7 per cent of the Acceleration Program and 1.2 per cent of the overall target required by the Basin Plan.

2.3.3. Modernising ageing infrastructure

The four existing Billabong Creek weirs that comprise the proposal are unable to meet contemporary demands for water supply and efficient delivery of water. They also largely prevent the movement of fish through the system. Only Hartwood Weir is actively managed and maintained. All four weirs are ageing and are in different states of deteriorating condition, as shown in Figure 2-11, Figure 2-12, Figure 2-13 and Figure 2-14.

Figure 2-11 Examples of deterioration at the existing Hartwood Weir

Figure 2-12 Examples of deterioration and missing drop boards at the existing Piccaninny Weir


Figure 2-13 Examples of deterioration and missing drop boards at the existing Wanganella Weir


Figure 2-14 Examples of deterioration and missing drop boards at the existing Caroonboon Weir

2.3.4. Improving service for water users

There are currently long ordering periods for water, of up to 26 days to the lower Billabong Creek, between releases from the headwater dams and final delivery of water to licensees (Cooling and Gippel, 2018; WaterNSW, 2015). It takes about 15 days from the Yanco Creek offtake on the Murrumbidgee River to Hartwood Weir. The long delivery times for water in the creek make it difficult to implement effective order management or control (WaterNSW, 2015).

As a result, WaterNSW maintains high levels of flow in the Yanco Creek system throughout the season to avoid risks of non-supply (WaterNSW, 2015). The outcome is that flows within the system are greater than would be required to meet actual irrigation demand and so end of system flows at Darlot are generally higher than the target set in the *Murrumbidgee Regulated River Water Sharing Plan* (WaterNSW, 2015).

2.3.5. Improving fish passage

The Yanco Creek system, which includes Billabong Creek, along with the connected mid Murrumbidgee River, encompasses the range of 15 native fish species including Murray Cod (*Maccullochella peelii*). The native fish community is highly degraded and fragmented with over 30 weirs and barriers, only one of which has a fishway in the Yanco Creek system (refer Appendix E) (Stuart, 2022). Hence, fish passage throughout the system is extremely limited and this explains the high degree of spatial fragmentation evident for native fish.

2.3.6. Improved delivery of environmental water

Wanganella and Rhyola swamps are important habitat and breeding sites for bird species. These areas receive water via Forest Creek and Forest Anabranch, respectively, from flow diverted or pumped from Billabong Creek. Environmental water deliveries have targeted both swamps to ensure their health (CEWO, 2021).

Long delivery times and losses during delivery of environmental water reduces the effectiveness of the environmental water allocations generally and for efficient watering of these wetland areas.

2.3.7. Benefits of the proposal

The proposal would contribute to:

- the SDLAM water savings target
- improve environmental water managers' ability to achieve ecological outcomes in the Yanco Creek system
- improve fish passage within Billabong Creek
- improve water delivery levels of service to both irrigators and the environment.

It is recognised that the proposal also has the potential to present a range of environmental, cultural and community impacts and risks.

Minimising the potential risks and impacts has been the focus of the work undertaken over the last six or so years to refine and develop the infrastructure and operating rules required to implement the proposal. Further information is provided in the following section.

The key potential risks and issues, which will require assessment in the EIS, are described in section 6.

2.4. How the proposal has developed to date

2.4.1. Development of the proposal

The Yanco Creek system has been a focus of regulation works since the 1880s (Beal et al., 2004). The four existing weirs included in this proposal were built in the early 20th century and have a limited ability to manipulate flow in the system. The potential to improve regulation of water in the Yanco Creek system has been investigated for many years.

Extensive investigations have been undertaken to identify opportunities for improving water management in the Yanco Creek system since 2015. The first investigation was the *2015 Business case for modernising supply systems for effluent creeks – Murrumbidgee River* (WaterNSW, 2015) (available at: *https://www.industry.nsw.gov.au/__data/assets/pdf_file/0018/165132/Modernising-Supply-Systems-for-Effluent-Creeks-Murrumbidgee-River-Business-case.pdf*). This identified that there was potential to modernise the supply arrangement for diversions in the Yanco Creek system to create water savings.

The Yanco Creek system was identified as a potential site to improve water efficiency partly because there are few operational controls in the Yanco Creek system and very long order periods for water, meaning WaterNSW must maintain high levels of flow through the irrigation season to avoid risk of non-supply. This means flows throughout the system are greater than would be required to meet actual irrigation demand.

The 2015 Business Case suggested a range of modernisation options. These options and others were then refined and developed through consultation with the Yanco Stakeholder Advisory Group and the Yanco Technical Advisory Group.

The modernisation options were evaluated in accordance with the NSW SDLAM options evaluation framework (Alluvium, 2020). This evaluation identified a shortlist of options:

- Part 1: Environmental water efficiency
- Part 2: Billabong Creek environmental water regulators
- Part 3: Yanco Creek / Mundoora / Wilson Anabranch reconfiguration
- Part 4: Forest Creek return flows via Piccaninny Creek
- Part 5: Flow measurement
- Part 6: Review of irrigation escape flows
- Part 7: Improved use of technology
- Part 8: Improved riparian management.

2.4.2. Analysis of alternatives

This proposal relates to Part 2: Billabong Creek environmental water regulators. The proposal and its design have been further developed in partnership with the Yanco Stakeholder Advisory Group and the Yanco Technical Advisory Group. This partnership will continue during further detailed design in parallel with, and beyond the EIS.

As part of concept design, refinements have been investigated to enhance the positive outcomes of the proposal and minimise impacts. These refinements in the following areas will be further detailed within the EIS:

- location of the environmental regulators within the creek system
- core structures
- types of fish passage
- source and alignment of power supply
- construction methodology.

Modelling of the Yanco Creek system

The Yanco Creek system model was implemented using the eWater Source modelling framework (version 5.10.0.11841). eWater Source is a hydrological modelling tool that is designed to support integrated water resources planning, policy and management. The choice of eWater Source was dictated by the need to integrate with the larger Murrumbidgee River system model being developed by the DPE-Water modelling team, and eWater Source's unique framework for representing water sharing arrangements in the Basin.

The model calibration period is primarily dictated by the availability of streamflow and water demand data. For the purposes of calibrating flow routing (lags and attenuation), instream fluxes, and offtake relationships, the nominal calibration period is 1/07/1982 to 30/06/2018. However, the calibration period at many locations is shorter due to limited streamflow data availability. The quality of the available demand data improves from 1/07/2004 onwards and, for this reason, the calibration of operational behaviour considers the period from 1/07/2004 to 30/06/2018. Some changes to river operations have been implemented in recent years and these changes are difficult to verify based on the observed data alone due to the relatively short record. For these aspects of the system operations, the model configuration relies heavily on advice from WaterNSW, the river operator.

The model extends from the Murrumbidgee River at Narrandera to the Billabong Creek at Darlot and Forest Creek at Warriston Weir. For water accounting purposes, diversions downstream of Darlot (between Darlot and Moulamein) are included in the model.

Model outputs include daily time series from the long-term model run (1/07/1895 – 30/06/2020) at flow gauging sites and other points of interest in the Yanco Creek system. The model simulates the following processes:

- diversions for irrigation and town water supply
- environmental water demands
- flow routing (i.e. the lag and attenuation of flows as they move through the river system)
- rainfall-runoff processes
- net evaporation from water surfaces
- volumetric losses
- weir and irrigation escape operations
- resource allocation.

The model has been used throughout the alternatives investigation process to estimate the amount of water savings likely to be achieved and to compare the relative performance of various alternatives considered.

2.5. Potential cumulative impacts

The EP&A Act plays a key role in the NSW Government's statutory framework for managing cumulative impacts across NSW. An assessment of cumulative impacts is a key component of a proposal's environment impact assessment. The 'cumulative environmental effect with other existing or likely future activities' must be taken into account when considering the likely effect of an activity on the environment under Part 5 Division 5.2 of the EP&A Act.

The potential for cumulative impacts will be included as part of relevant technical assessments of the EIS. This would consider the *Cumulative Impact Assessment Guidelines for State Significant Projects* (DPIE, November 2021).

3. The proposal

3.1. Overview

The proposal involves partially or fully demolishing four existing weirs along Billabong Creek and replacing them with new environmental regulators. The weirs being replaced and included in the proposal are Hartwood Weir, Piccaninny Weir, Wanganella Weir and Caroonboon Weir. WINSW will determine a suitable name for the proposed environmental water regulator at Piccaninny Creek, which would replace the existing Piccaninny Weir. The new name will be developed in consultation with the local community and First Nations people.

The regulators would be fully automated and remotely operated meaning operators could control river flow remotely which would increase the efficiency of water delivery in Billabong Creek. The new regulators would also feature fishways to support fish movement past the new structures.

In addition, an existing block bank on Forest Creek near its confluence with Billabong Creek would be upgraded to a spillway style structure raising the height of the existing block bank by less than half a metre. The Forest Creek block bank prevents water from bypassing the nearby Forest Creek Regulator. The existing block bank will be designed to avoid overtopping under normal operating conditions after the installation of the new Hartwood Environmental Water Regulator.

Operating rules for the proposed environmental regulators have been developed by WINSW and are being further refined. Operating rules have been developed to manage the impacts of the proposal on biodiversity, bank stability and flooding.

The proposed infrastructure and its operation have been identified as an outcome of numerous studies, investigations and extensive stakeholder consultation that have been undertaken over the last six years. A summary of how the proposal has developed, including the current options assessment process, is provided in section 2.4.

The proposal is currently being finalised based on the results of an extensive options selection process and continuing consultation with key stakeholders.

An overview of the infrastructure comprising the preferred option and the proposal for which approval is sought is provided in the following sections.

The location of the proposed infrastructure, and the indicative disturbance footprints, are shown on Figure 3-1 to Figure 3-4. Table 3-4 lists the lot details for the land on which the new environmental water regulators are located and the lots on either side of the creek adjacent to the structures. Those portions of the structures within the creek banks will be on Crown land.

Table 3-1 Lot and DP for the environmental water regulators

Environmental water regulators	Lot and DP	Land zone
Hartwood Environmental Water Regulator	1 / DP707463 28 / DP756330	RU1 Conargo Local Environmental Plan 2013
The environmental water regulator at Piccaninny Creek	30 / DP756268 17 / DP756247	RU1 Conargo Local Environmental Plan 2013
Wanganella Environmental Water Regulator	7006 / DP1055647 7015 / DP1053753 7005 / DP1024202 7004 / DP1024203	RU1 Conargo Local Environmental Plan 2013
Caroonboon Environmental Water Regulator	34 / DP756248 6 / DP756263	RU1 Conargo Local Environmental Plan 2013

3.2. Proposed infrastructure

3.2.1. Core structures

The core structure of the four environmental regulators is similar and would include:

- concrete piers with maintenance bulkhead slots
- fixed concrete crests on either side of the central gates
- automated layflat gates across the crest of the structure to assist with flow management and downstream fish passage
- access from a trafficable deck for maintenance
- control house
- sheet pile cut-off walls beneath the structure
- SCADA control system
- a low turbulence 'keyhole' type vertical slot fishway with allowances for variable headwater to provide upstream fish passage. This design is intended to allow passage for fish from 30 – 100 millimetres long.

The upgraded Forest Creek block bank, associated with the Hartwood environmental regulator, would involve a spillway structure with potentially a reinforced concrete deck. Further consideration is also being given to whether works may be required at the Forest Creek regulator that controls diversions of water to Forest Creek.

Table 3-2 provides a comparison between the existing weir and the new environmental water regulators heights and water supply levels.

Table 3-2. Comparison of weir pool height between existing weirs and proposed new regulators

Heights of existing weir and new regulator features	Hartwood	Piccaninny	Wanganella	Caroonboon
Up stream creek bed level (metres above AHD)	92.70	87.80	80.20	74.00
Existing weir sill (metres above AHD)	95.28	89.58	80.75	75.94
Existing weir median water level (metres AHD)	95.44	89.79	80.99	76.12
New regulator full supply level (metres above AHD)	95.74	90.09	81.50	76.52
New regulator top of structure (metres above AHD)	97.10	92.10	85.30	80.50
New regulator structure height (height between creek bed to top of structure in metres)	4.40	4.30	5.10	6.50
Existing weir pool depth (depth between existing weir median water level and creek bed in metres)	2.74	1.99	0.79	2.12
New weir pool depth (depth between new regulator full supply level and creek bed in metres)	3.04	2.29	1.30	2.52

The predicted maximum additional storage volume relating to each new environmental water regulator is outlined in Table 3-3. This table presents the predicted additional volumes of water for general operations of the new regulator and the further additional volume for periodic operations. The additional volumes are calculated from the existing weir sill levels or, for Hartwood Weir, the level when drop boards are utilised. Together these two volumes indicate the total additional full supply level of the new environmental water regulators.

Table 3-3 Additional storage volumes for the proposed new regulators

Volume of water supply (ML)	Hartwood	Piccaninny	Wanganella	Caroonboon
Additional volume for general operations	79	104	55	81
Additional volume for periodic operations	185	183	174	220
Total additional storage volume	264	287	229	301

3.2.2. Ancillary facilities and mitigation works

Ancillary facilities, which will not form a permanent part of the proposal, would be required to construct the environmental regulators. These include site compounds, erosion control measures, sedimentation basins, temporary lay down areas and stockpile sites. In addition, there will be a need for spoil and materials handling areas, worker facilities and vehicle parking. These facilities will be located as close as possible to work areas and avoiding sensitive environmental locations. The location and size of ancillary facilities will be identified in the EIS and confirmed as the design and construction planning progresses.

It is also expected that some road works would be needed to provide reliable access for construction. This could include road upgrades to provide all weather traffic, tree trimming or clearing to provide adequate clearance and new access roads.

Mitigation works would include scour protection to reduce potential erosion impacts from operation of the proposal. Construction would also implement environmental protection measures such as installation of silt curtains and jute matting to reduce sediment mobilisation.

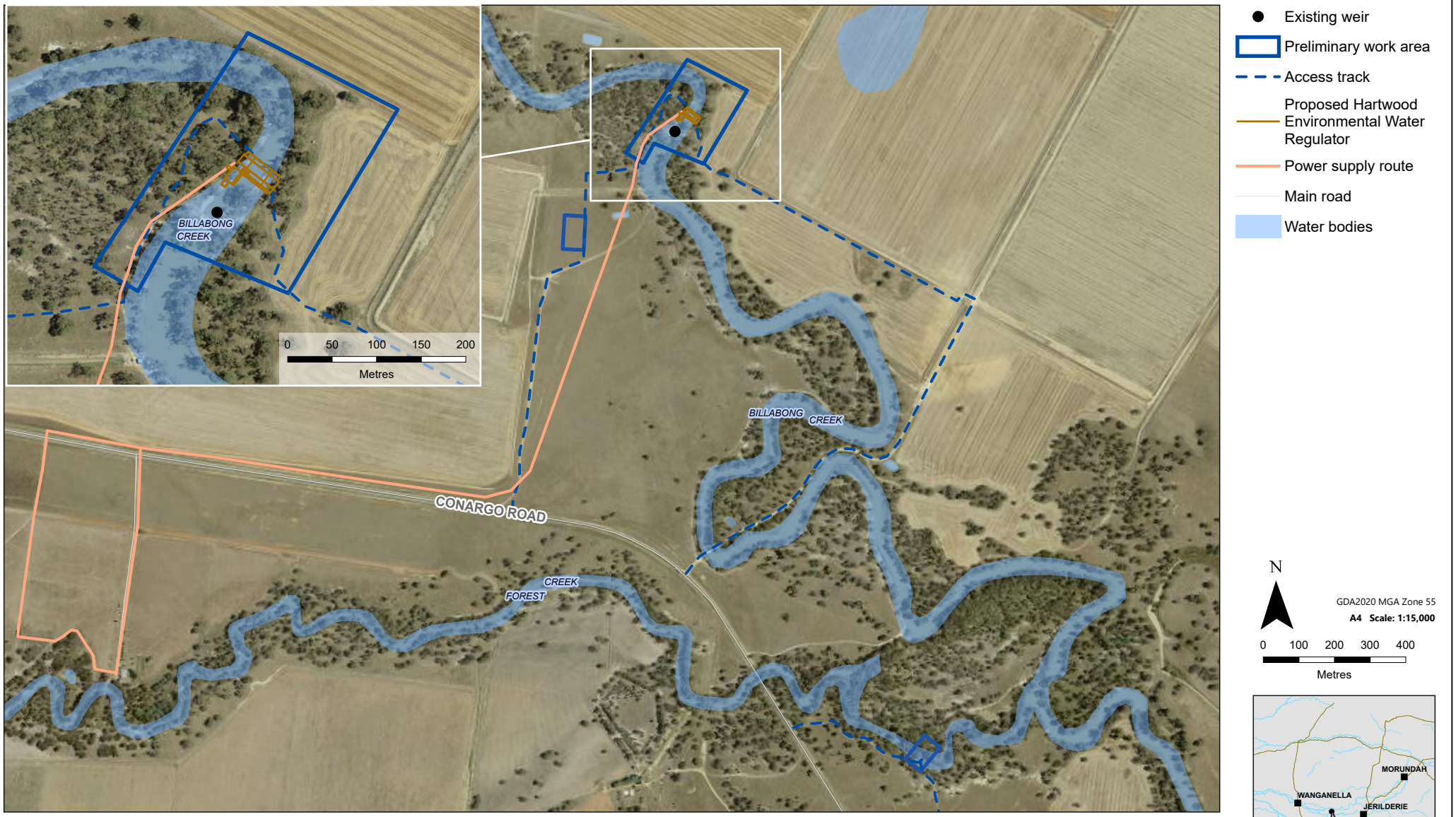

Figure 3.1 Location of Hartwood Environmental Water Regulator and proposed works

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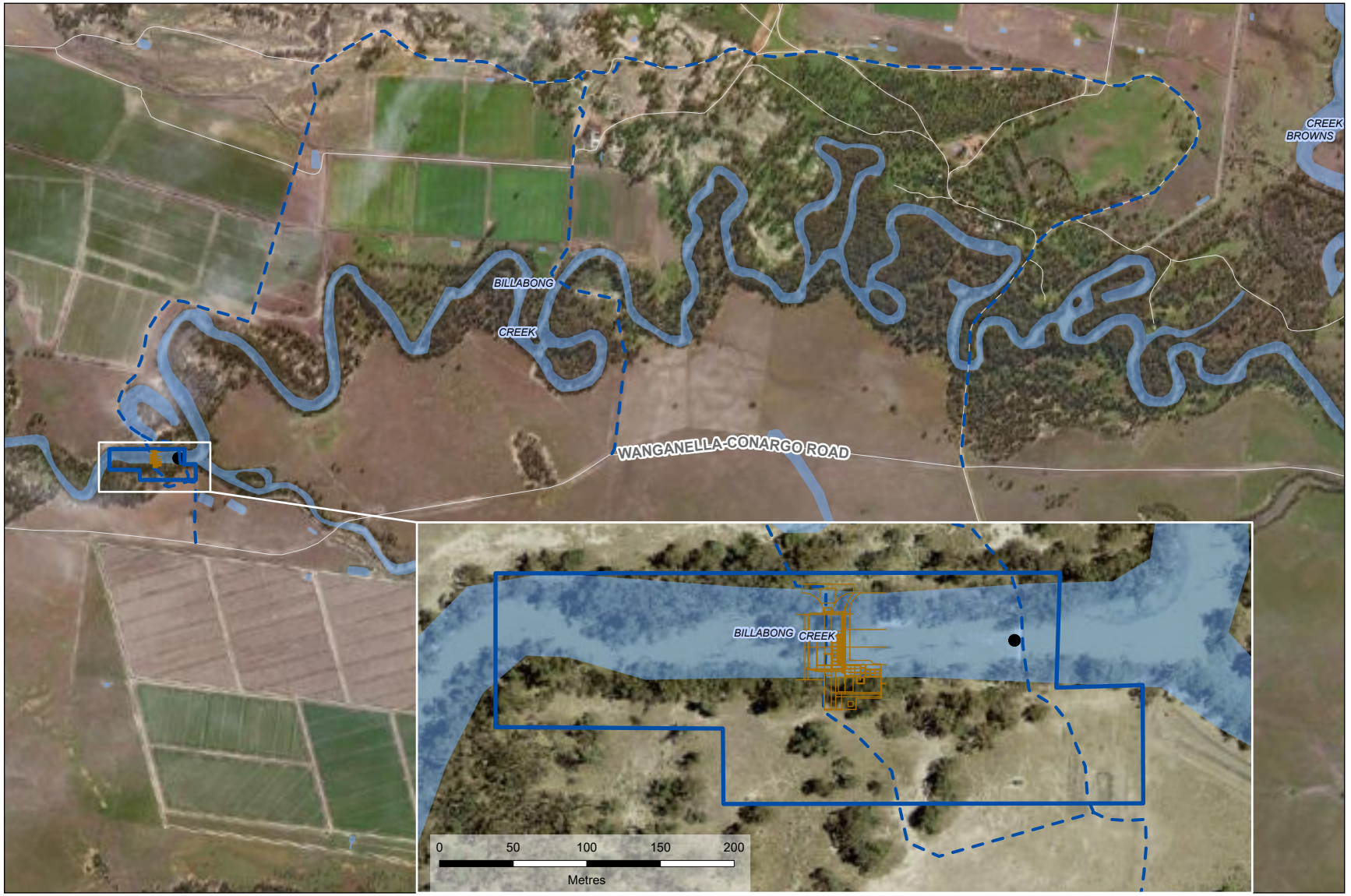

Figure 3.2 Location of the Environmental Water Regulator and proposed works at Piccaninny Creek

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Figure 3.3 Location of Wanganella Environmental Water Regulator and proposed works

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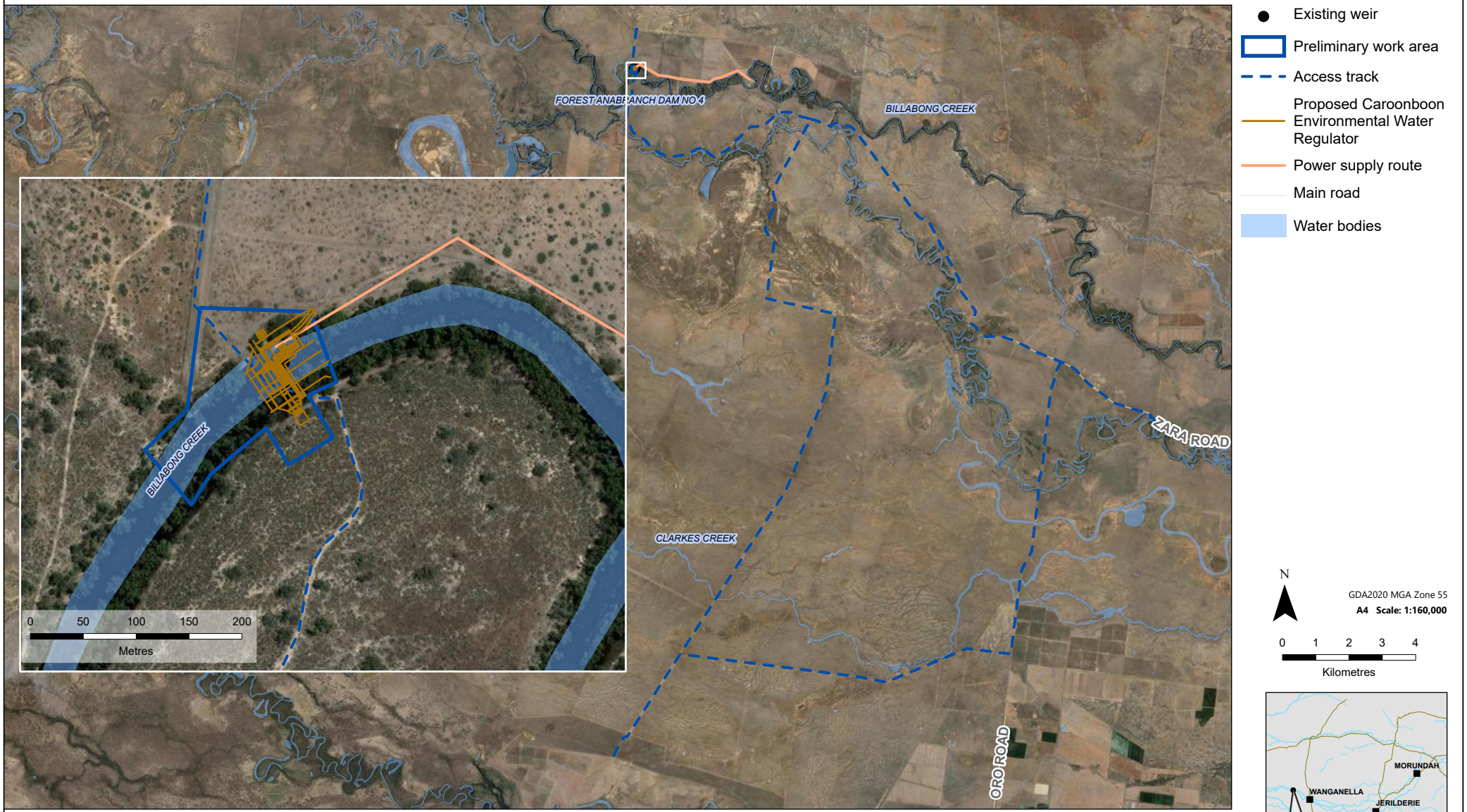

Figure 3.4 Location of Caroonboon Environmental Water Regulator and proposed works

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3.3. Construction information

Subject to receiving planning approval, it is expected that construction would commence in mid 2024 and take about 17 months to complete by the end of 2025.

Key activities and staging of main construction components are outlined in Table 3-4. Works would be similar for each weir location. Generally, site establishment works would occur, then the fishway and layflat gates would be constructed, then the fixed crest environmental regulator would be constructed and finally the site would be rehabilitated.

Construction of the proposal would be staged to enable water to be flowing through part of the creek bed throughout construction. To achieve this, construction needs to be undertaken in two stages; half of the creek needs to remain unobstructed to maintain the flow of water while construction is undertaken on the other side. This is achieved by utilising a temporary cofferdam around the work zone using sheet piles.

A Land Management Plan will be developed to manage access to these sites during construction and consultation with property owners. A number of access routes will be required to reach each of the four proposal sites. Where possible, existing tracks will be used. Where this is not possible, an investigation into alternate routes and consultation requirements, will be carried out.

The most substantial impacts of the proposal are likely to occur in the early phases of construction during:

- **vegetation removal:** Vegetation would be removed to upgrade access tracks, clear areas for crane pads and crane slew zone and to establish site facilities. Vegetation removal will be minimised, where possible.
- **creek works:** Works undertaken in the creek bed would likely mobilise silt or debris increasing creek turbidity. A floating silt curtain and water quality monitoring would be used to reduce and monitor potential impacts to water quality.

Table 3-4 Indicative staging for construction components of the proposal

Stage Number	Stage Name	Activities
1	Fishway and layflat gates	• undertake tree removal, clearing and grubbing and access track upgrades • construct hardstands for the compound, laydown areas and crane pad(s) • install site facilities and mobilise plant • demolish small section of existing weir to allow cofferdam through structure • install all the temporary cofferdams around new structures and old weirs separately and dewater work zones • prepare subgrade and initial earthworks including any remediation if required

Stage Number	Stage Name	Activities
		• install permanent sheet pile wall • form, reinforce and pour all slabs (fixed crest structure, stilling pool, apron and fishway) • form, reinforce and pour all walls (gates and fishway) • install scour protection and finalise backfill of new structure • potentially demolish existing weir including reshaping of creek bed • install and commission layflat gates and fishway furniture • flood cofferdam and remove the sheet piles around the new structure only
2	Fixed crest structure	• install temporary sheet pile cofferdam for the fixed crest weir section and seal against the new structure (at this point the new gates will be operational) • remove the cofferdam around the existing weir and reinstall around the other side of the existing weir • dewater the two new work zones • prepare subgrade and initial earthworks including any remediation if required • install remaining permanent sheet pile wall • form, reinforce and pour remaining slabs (fixed crest structure, stilling pool and apron) • form, reinforce and pour remaining walls (fixed crest structure) • install scour protection and finalise backfill of other side • potentially simultaneously demolish other side of the existing weir including reshaping of creek bed • flood both cofferdams and remove the sheet pile • rehabilitate work areas and demobilise from site

The existing weirs at each location may be removed entirely or in part to ensure the effective operation of the new environmental regulators.

The indicative works area for each environmental regulator is shown in Figure 3-1 to Figure 3-4.

3.4. Operation of the regulators

3.4.1. Operational structures

Each of the four new environmental regulators would be fully automated and remotely operated from a WaterNSW control room. Flow management would occur using the SCADA system. Flow management and downstream fish passage would be assisted with automated layflat gates. Upstream fish passage would occur via a 'keyhole' type vertical slot fishway. Power would be provided using a mix of underground and overhead electricity cables connecting the structure to the grid. The alternative of battery and solar power is also being investigated and will be addressed in the EIS.

Access for maintenance activities would use tracks which have a negotiated right of carriageway, or easement for access. The need for electricity easements to supply power to the proposal sites will be reviewed prior to the completion of the EIS. Maintenance access would be assisted using the top of the environmental regulator which would be trafficable but secured so it could not be used by the public. The concrete piers would also be fitted with maintenance bulkhead slots.

The proposed environmental regulators would consist of the following operable design elements:

- automated layflat gates across the crest of the weir to assist with flow management and downstream fish passage
- concrete piers with maintenance bulkhead slots
- fish passage to assist with upstream fish passage with allowances to adjust for variable headwater
- the top of the environmental regulator would be trafficable by maintenance vehicles but secured so it could not be used by the public
- a mix of underground and overhead electricity cables connecting the structure to the grid
- monitoring and recording equipment to relay data to the SCADA control system.

The area surrounding Wanganella Environmental Water Regulator is part of the Wanganella Recreation Reserve. Consultation with Edward River Council is underway regarding providing improved community facilities at this location associated with the proposal.

3.4.2. Operational principles

The proposal would be operated in accordance with the operating requirements established with the new asset owner and developed in consultation with key stakeholders. These operating requirements, known as the Yanco Creek system operating plan, are currently under development. They would take into account the regulation requirements at each environmental regulator, as well as constraints such as limits to rates of rise and fall to accommodate fish breeding requirements.

The proposed environmental regulators will provide greater control of water levels which will be operated to meet environmental and water supply objectives. The water levels will be more variable (either higher or lower) than that currently stored behind the existing weirs, in accordance with the new proposed operations plan.

An outline of the proposed general operational principles, including the differences between the four environmental regulators, is provided in Table 3-5.

Table 3-5 General operating principles of the four environmental regulators

Environmental water regulator	General operating principles
Hartwood Environmental Water Regulator	• improved control of flows to better match downstream environmental water requirements and consumptive water (irrigation and town supply) demands • primarily used to maintain a weir pool height sufficiently high enough to deliver normal regulated flow requirements (including managed environmental flows) at the Forest Creek offtake • used to create a pumping pool for seven irrigation pumps within the influence of the weir pool and to provide re-regulation capacity of flows in the Billabong Creek — some stock and/or domestic pumps also extract water from within the influence of the weir pool • regulation gates to be fully open during moderate to large unregulated flow events at every possible opportunity to enable unrestricted fish passage opportunities • fish ladder to provide for improved fish passage linking upstream and downstream sections of the creek for fish movement and breeding • equitable sharing of adverse outcomes across water access licence holders during unexpected supply shortfalls • optimisation of weir pool operations to minimise the risk of adverse environmental outcomes
Environmental water regulator at Piccaninny Creek	• improved control of flows to better match downstream environmental water requirements and consumptive water (irrigation and town supply) demands • used to create a pumping pool for two irrigation pumps plus a large stock and domestic pump within the influence of the weir pool and to provide re-regulation capacity of flows in Billabong Creek — some smaller stock and/or domestic pumps also extract water from within the influence of the weir pool • regulation gates to be fully open during moderate to large uncontrolled flow events at every possible opportunity to enable unrestricted fish passage opportunities • fish ladder to provide for improved fish passage linking upstream and downstream sections of the creek for fish movement and breeding • equitable sharing of adverse outcomes across water access licence holders during unexpected supply shortfalls • optimisation of weir pool operations to minimise the risk of adverse environmental outcomes

Environmental water regulator	General operating principles
Wanganella Environmental Water Regulator	• improved control of flows to better match downstream environmental water requirements and consumptive water (irrigation supply) demands • primarily used to create a pumping pool for Wanganella's town water supply, one irrigation pump and to provide re-regulation capacity of flows in the Billabong Creek — some stock and/or domestic pumps also extract water from within the influence of the weir pool — another irrigation pump benefits from the weir pool when operated within upper parts of the yellow zone • fish ladder to provide for improved fish passage linking upstream and downstream sections of the creek for fish movement and breeding • regulation gates to be fully open during moderate to large uncontrolled flow events at every possible opportunity to enable unrestricted fish passage opportunities • optimisation of weir pool operations to minimise the risk of adverse environmental outcomes
Caroonboon Environmental Water Regulator	• Improved control of flows to better match downstream environmental water requirements and consumptive water (irrigation supply) demands • primarily used to create a pumping pool for three irrigation pumps plus a large stock and domestic pump and to provide re-regulation capacity of flows in the Billabong Creek — some stock and/or domestic pumps also extract water from within the influence of the weir pool • regulation gates to be fully open during moderate to large uncontrolled flow events at every possible opportunity to enable unrestricted fish passage opportunities • fish ladder to provide for improved fish passage linking upstream and downstream sections of the creek for fish movement and breeding • equitable sharing of adverse outcomes across water access licence holders during unexpected supply shortfalls • optimisation of weir pool operations to minimise the risk of adverse environmental outcomes

4. Statutory context

An overview of the key statutory requirements for the proposal are provided in Table 4-1.

Table 4-1 Statutory requirements for the proposal

Matter	Discussion
Power to grant approval	Clause 2.13 of *State Environmental Planning Policy (Planning Systems) 2021* identifies that development declared to be State Significant Infrastructure includes: *"(a) the development on the land concerned is, by the operation of a State environmental planning policy, permissible without development consent under Part 4 of the Act, and* *(b) the development is specified in Schedule 3".* The proposal is permissible without consent (see permissibility section below) and Schedule 3, section 4(1) of the *State Environmental Planning Policy (Planning Systems) 2021* states that State Significant Infrastructure includes: *Development for the purpose of water storage or water treatment facilities (not including desalination plants) carried out by or on behalf of a public authority that has a capital investment value of more than $30 million* The proposal would be a water storage facility with a capital investment cost estimate of more than $30 million carried out by a public authority. Therefore, the proposal is classified as State Significant Infrastructure under Part 5, Division 5.2 of the EP&A Act. The Minister for Planning would be the approval authority.
Permissibility	The proposal is classified as development that is permissible without development consent. The basis for this is described below. Clause 2.159(2) of the *State Environment Planning Policy (Transport and Infrastructure) 2021* states that development for the purpose of "water storage facilities", may be carried out by or behalf of a public authority without consent on land in Zone RU1 Primary Production, Zone RU2 Rural Landscape, Zone SP1 Special Activities, Zone SP2 Infrastructure or an equivalent land use zone. A 'water storage facility' is defined under clause 2.158 and means a dam, weir or reservoir for the collection and storage of water and includes associated monitoring or gauging equipment. The *Standard Instrument – Principal Local Environmental Plan (2006)* states that a water storage facility is a type of water supply system. Clause 2.159(6) of the *State Environment Planning Policy (Transport and Infrastructure) 2021* lists those works considered to be for the

Matter		Discussion
		purpose of the development and includes fishways and power supply. The proposal fulfils this requirement. The proposal would be undertaken by WINSW (a statutory body representing the Crown), and owned and operated by WaterNSW (a statutory State owned corporation). Both organisations meet the definition of public authority in the EP&A Act. Each of the proposed regulator sites are located on land within Zone RU1 Primary Production under the *Conargo Local Environmental Plan 2013* and therefore fulfils the land use zone requirement.
Other approvals	Consistent approval	The proposal may require the following additional approvals under Section 5.24 of the EP&A Act: • Consent under section 138 of the *Roads Act 1993* for road upgrades to the public road network.
	Approvals not required	Approvals that may be required to carry out the SSI, if not for Section 5.23 of the EP&A Act, include: • permit for works that block fish passage - section 219, *Fisheries Management Act 1994* • excavation permit - section 139, *Heritage Act 1977* • Aboriginal heritage impact permit - section 90, *National Parks and Wildlife Act 1974* • water management works approvals - section 90, *Water Management Act 2000.*
	EPBC Act approval	Given the presence of EPBC listed threatened and migratory species, a referral to the Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW) will be submitted. The EPBC submission would be 'streamlined' in accordance with the NSW EPBC Act Bilateral Agreement.
	Other approvals	No other NSW and/or Commonwealth approvals are required for the project.
Pre-conditions to exercising the power to grant approval		No pre-conditions to exercising the power to grant approval have been identified for the proposal.

Matter	Discussion
Mandatory matters for consideration	The following key Commonwealth, State and Local legislative and policy instruments are applicable to the project: Commonwealth • EPBC Act • *Native Title Act 1993* NSW • EP&A Act • *State Environmental Planning Policy (Planning Systems) 2021* • *State Environment Planning Policy (Transport and Infrastructure) 2021* • *State Environmental Planning Policy (Biodiversity and Conservation) 2021* • *Protection of the Environment Operations Act 1997* • *Fisheries Management Act 1994* • *Crown Lands Management Act 2016* • *Heritage Act 1977* • *Biodiversity Conservation Act 2016* • *National Parks and Wildlife Act 1974* • *Water Management Act 2000* • *Roads Act 1993* • *Contaminated Land Management Act 1997*

5. Community and stakeholder engagement

Community engagement relating to the modernisation of the Yanco Creek system has been extensive, and included engagement during:

- preparation of the preliminary business case for modernising water infrastructure in Yanco Creek
- development and evaluation of a new set of modernisation options
- preferred option selection
- refinement of preferred options
- evaluation of concept designs for the proposal
- proposed engagement for the EIS and the delivery of the proposal.

WINSW's engagement for work related to modernising the Yanco Creek system, including the proposal, is guided by:

- a community engagement plan developed in partnership with Yanco Creek and Tributaries Advisory Council Inc. (YACTAC) in 2019
- communication and engagement plan
- ongoing 6-monthly stakeholder engagement plans (including specific First Nations activities).

5.1. Engagement carried out

Community engagement for work related to modernising the Yanco Creek system began in late-2018. In late 2019. WINSW developed a community engagement plan (DPIE 2019b) in partnership with YACTAC. YACTAC has been a long-term advocate, together with the broader community, for improvements to the water supply operations and environmental outcomes for the Yanco Creek system. Over 130 people provided written submissions and attended drop-in sessions to provide feedback on the plan. This feedback informed the community engagement approach currently being used for works relating to the modernisation of the Yanco Creek system, including the following:

- community information sessions every six months
- improved information products to facilitate community input and advice
- clear details about the outcomes of proposed options
- establish advisory groups to guide the development of works related to the modernisation of the Yanco Creek system
- ensure industry and local government representation on advisory groups.

A Community Advisory Group was first established in 2019 and now meets as the Stakeholder Advisory Group. The Stakeholder Advisory Group membership includes peak bodies and representatives from council, government agencies, industry, tourism, recreational fishing, and First Nations' groups.

The SAG meets regularly, to discuss project progress and provide community input at various stages of the Yanco Creek modernisation, including to the review and evaluation of Yanco Creek modernisation options.

Complementing the contributions of the Stakeholder Advisory Group, WINSW has held three community information sessions for the general community. These sessions are held 6-monthly and are intended to continue throughout the life of the proposal.

WINSW has held information sessions at five different locations spanning the project area. These sessions were held in March 2021, March 2022 and September 2022, at Wanganella, Moulamein, Conargo, Jerilderie and Morundah. The sessions in September 2021, were held online due to health requirements in response to the COVID-19 pandemic. First Nations specific meetings were also held.

The format of the community sessions was guided by feedback from the community and the Stakeholder Advisory Group and included: a Stakeholder Advisory Group member presenting their perspective on how the proposal is progressing, proposal manager update on progress over the previous six months and plan for the next six months. Each session also included an opportunity for questions from the community. Where possible, updates on other WINSW programs, such as Better Bidgee and Reconnecting River Country were also provided. Each session was customised to that location, to make it as relevant as possible to the attendees.

Engagement with directly affected landowners (i.e. property owners with infrastructure) is ongoing. There has been positive feedback regarding how landowners have been engaged to date. Future engagement will continue to build on this work.

The proposal also consults a Technical Advisory Group and Design Focus Group. These groups include representatives from the Stakeholder Advisory Group together with representatives of key State and Australian government agencies. A full list of the Technical Advisory Group and Design Focus Group membership is provided in Appendix A. The Technical Advisory Group has met 13 times and discusses various technical elements of the proposal including: draft concept designs, hydraulic and hydrologic modelling updates, and fish movement reports.

5.2. Community views

Key issues raised to date from all community and stakeholder engagement activities are summarised in Table 5-1. These issues have informed the preparation of the EIS scoping report. Key issues highlighted by the community, such as flow changes in the Yanco Creek system, have been highlighted in the EIS scoping report and will receive assessment during the EIS.

Table 5-1 Summary of community and stakeholder feedback

Summary of community and stakeholder feedback	
Importance of river flows	Stakeholders stress the importance of maintaining river flows for cultural, environmental and community and economic purposes. Keeping the Yanco, Billabong, Colombo and Forest Creeks flowing is highly valued. Other concerns stakeholders have regarding flows include: • the environment and creek system are important to First Nations people, as is getting water at the right time for Country • concern that there may be less water in the Yanco Creek system • effects of any flow changes in the upper Yanco Creek • need to integrate with other water plans • need holistic understanding of any changes and baseline conditions • ensuring supply in the creeks is maintained to ensure town water supply.
Consideration of alternatives and support for the proposal	Stakeholders value the importance of adequately considering alternatively infrastructure solutions to ensure the best solution is progressed. Alternative solutions discussed with stakeholders include: • location of environmental regulators and construction methods such as in-stream construction, out of stream construction or a hybrid model • consideration of other locations such as existing weirs in the Colombo Creek • a regulator in Yanco Creek was considered but not progressed following a lack of support from key stakeholders. Issues raised in relation to the current proposal include: • support for fishways new infrastructure and ensuring that all fishways are maintained • ensuring that weir pools are not drained as a result of the new infrastructure and that minimum operating levels are set to sill heights of the existing weirs • ensuring that ongoing operations and maintenance costs are adequately considered and included in the proposal • a desire by stakeholders for a guarantee in operation rules to allow future planning • ensure that minimum flow requirements are regulated.
Collaboration and engagement	Stakeholders value ongoing consultation and expressed a strong desire to work collaboratively for the duration of the project. • community updates at local venues are supported and a desire for these to continue • ongoing project communications are supported including targeted stakeholder discussions as required • establishment and operation of the Registered Aboriginal Parties is working well and is supported.

Summary of community and stakeholder feedback	
Key matters for assessment in the EIS	Specific issues raised by stakeholders important to the assessment of the EIS include: • accuracy of the modelling used for identifying changes to stream flows • operating rules for the proposal • ensuring reach by reach minimum baseflows are maintained • impact during construction such as water quality and impact to private properties • effects of weir operations on upstream users and, effects on pumps and pumping costs • reduced flows downstream will encourage vegetation encroachment • ongoing desire and need for environmental monitoring and reporting.

A number of issues were also raised during engagement activities that are beyond the scope of this proposal. These issues relate to other programs within the Yanco Creek system and Murrumbidgee catchment, and water supply operations. Information regarding other programs is being shared with stakeholders to ensure awareness of wider water management initiatives and to align consultation processes and other activities, as appropriate.

5.3. Engagement proposed during preparation of the EIS

Community and stakeholder engagement will continue throughout the preparation of the EIS. This section will outline WINSW's proposed community engagement strategy.

5.3.1. Principles of engagement

WINSW will lead all community engagement with support from delivery partners. WINSW are committed to effective and genuine engagement with the community. By working with communities, they aim to create better outcomes, improve service delivery, and enhance community satisfaction.

Their approach is:

- holistic – considering social, cultural, economic, and environmental factors
- co-designed engagement – designed in partnership with key stakeholders
- guided by community views – with the formation of advisory groups
- accessible and regular – information will be available in a number of ways
- transparent and accountable – we will be open and answerable to the community
- coordinated by a local team.

Engagement will:

- be written in plain English, easily accessible and relevant
- be regular and in a variety of forms (website updates, online and physical newsletters distributed to central locations, emails)

- be designed with community (such as the Stakeholder Advisory Group), where possible
- provide opportunities for feedback
- provide points of contact for further questions.

5.3.2. Engagement activities

The communication and engagement activities for the proposal will build on the previous years of engagement. Engagement will continue with stakeholder groups and the wider community during the preparation of the EIS. There will also be a continued focus on landowners directly affected by the proposed works. The six-monthly community information sessions will continue as well as general updates on the website.

5.4. Engagement during public exhibition of the EIS

The EIS will be placed on public exhibition for at least 28 days.

At a minimum, advertisements will be placed in local newspapers to advise of the exhibition, provide details of where the EIS can be viewed and information about other consultation activities during the exhibition period.

During the exhibition period any stakeholder can make a formal submission regarding the proposal. Submissions will be collated into a report and will be considered in the assessment of the EIS and further development of the proposal.

Communication and engagement to support the exhibition will include:

- community displays at local councils, libraries, and land council offices
- community information sessions and stakeholder forums
- community update and newsletter
- digital engagement tools (such as online meetings and opportunities to provide feedback)
- EIS summary document
- government agency engagement
- independent facilitator updates to Stakeholder Advisory Group
- landowner meetings
- media releases
- proposal email and phone number for enquires
- proposal webpage and Frequently Asked Questions
- stakeholder briefings.

5.5. Engagement following the exhibition of the EIS

Following the exhibition period, WINSW will respond to submissions received.

If the proposal receives planning approval, WINSW will continue to engage with stakeholders and the community during the construction phase. WINSW will develop and lead a construction community engagement program. The construction program will respond to community and stakeholder expectations on ongoing involvement, the details of the approved proposal and the terms of its approval. WINSW will continue to be the single point of contact about the proposal for all stages of the proposal.

6. Proposed assessment of impacts

6.1. Overview

A preliminary environmental assessment based on the project details presented in Section 3 has been carried out to identify potential environmental impacts that may arise and require further assessment in the EIS.

A scoping summary table, including relevant guidelines, has been completed and is included as Appendix B. The appendix provides a summary of the matters for assessment and identifies the level of environmental assessment required for the matters in the EIS (detailed or standard). The appendix also specifies what method of consultation will be required for each matter (specific or general) and which matters will require a cumulative impact assessment.

The preliminary environmental assessment identified the following key environmental matters as requiring detailed assessment in the EIS:

- biodiversity – aquatic flora and fauna
- biodiversity – terrestrial flora and fauna
- water – hydrology (including groundwater, flooding, geomorphology and water quality)
- heritage – Aboriginal
- heritage – historic
- social – community.

The following matters, including cumulative impacts, have been identified as requiring standard assessment:

- rural environment – private property, public land, and agriculture
- access – access to property and traffic and parking
- amenity – noise
- air – atmospheric emissions
- amenity – visual
- hazards and risk – public safety, particulate matter and land contamination
- hazards and risk – waste management and natural resource use.

Further information on these issues is provided in sections 6.2 to 6.16 to inclusive.

Section 6.17 identifies those matters would not require further assessment in the EIS and the justification for excluding those matters.

6.2. Biodiversity – aquatic flora and fauna

Construction of the proposal would have the potential to generate some short-term, temporary impacts on aquatic flora and fauna. Short-term impacts would mostly be related to decreased water quality due to mobilisation of sediments during construction.

In addition, the proposal would have the potential to generate positive and negative long-term impacts on aquatic flora and fauna during operation of the proposal. Long-term impacts generated by the proposal would relate to:

- increased fish movement resulting from the introduction of fishways
- introduction of refuge habitat for species during periods of low creek flows
- potential impacts on nesting fish species or platypuses due to increased water level variability
- conversion of flowing creek habitats (pool and riffle sequence) to longer pool-only habitats (at Wanganella and Caroonboon).

Negative impacts generated by the proposal would be mitigated using operation rules designed to limit impacts to biodiversity.

A detailed aquatic flora and fauna assessment will be required for the proposal and will include:

- a desktop assessment, including:
  - a review and analysis of existing information and data
  - overview of relevant legislation, policies, and guidelines
  - description of the existing upstream and downstream environment with respect to:
    - catchments, waterways, and wetlands
    - aquatic ecology and habitat within the study area
    - physical characteristics and existing water quality of waterways and wetlands
- field surveys to characterise existing environmental conditions and values, including:
  - assessment of aquatic habitat condition with regards to *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) and *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (Fairfull and Witheridge, 2003)
  - classification of sites into key fish habitat type (DPI, 2013) and waterway class (Fairfull and Witheridge, 2003)
  - classification of riparian habitat quality with regards to a modified version of the riparian channel and environment inventory method
  - observation of water of quality indicators, including weather condition at the time of assessment, colour and appearance of water, water flow and level, presence of floating debris or oily film/sheen, presence of odour or frothing and visual amenity rating based on observations
  - in-situ physiochemical water quality measurements, including: temperature, conductivity, pH, electrical conductivity, dissolved oxygen and turbidity
- specific consultation with government agencies such as DPI Fisheries

- interpretation of hydrological and hydraulic modelling results to identify changes that may have impacts to aquatic habitats and species.
- construction, operational and cumulative impact assessment with reference to the A*quatic Ecology in Environmental Impact Assessment - EIA guideline* (NSW Department of Planning, 2003), including:
  - description of key threatening processes that may occur due to the proposal
  - potential impacts to surface water quality and aquatic ecology arising from the construction and operation of the proposal
  - assessment of matters of national environmental significance with reference to Commonwealth and State legislation
- recommendations for mitigation and management measures, including potential ongoing environmental monitoring and reporting as requested by stakeholders (refer Table 5-1).

6.3. Biodiversity – terrestrial flora and fauna

Terrestrial flora and fauna at the proposal site consists of intact riparian vegetation including River Red Gum open forests and River Red Gum - Black Box woodlands as well as numerous hollow-bearing trees. A site visit undertaken on 11 June 2021 also identified Brown Treecreepers (*Climacteris picumnus victoriae*), listed as vulnerable under the *Biodiversity Conservation Act 2016*, *Acacia stenophylla* and *Acacia salicina*,

Results of the database search for protected matters within one kilometre of the proposal are provided in Appendix C.

Construction of the proposal would have the potential to generate some short-term, temporary impacts on terrestrial flora and fauna. In addition, there may be some long-term impacts on terrestrial flora and fauna related to operation of the proposal. Potential impacts generated by the proposal would relate to:

- clearing of mature vegetation
- injury or mortality to fauna due to clearing and increased construction traffic
- loss of movement corridors and connectivity due to vegetation clearing along riparian buffers
- potential changes in the hydrological regime of the creek system.

As requested by stakeholders (refer Table 5-1), potential impacts from vegetation encroachment will be assessed. A detailed biodiversity development assessment report (BDAR) prepared in accordance with the biodiversity assessment method (BAM) will be required for the proposal and will include:

- season surveys stratified between vegetation zones and habitats tailored for flora and fauna likely to the be in proposal area, including:
  - five-day survey in August 2022 targeted Australian Bustard, Regent Parrot (eastern subspecies), White-bellied Sea-eagle, Little Eagle, Barking Owl, Masked Owl, Bush Stone-curlew, Sloane's Froglet and Koala

- five-day survey in September 2022 targeted:
  - threatened flora species: *Brachyscome papillosa, Convolvulus tedmoorei, Leptorhynchos orientalis, Sclerolaena napiformis, Swainsona murrayana, Swainsona plagiotropis, Swainsona sericea* and *Solanum karsense, Brachyscome muelleroides, Maireana cheelii* and *Eucalyptus leucoxylon subsp. pruinose*
  - threatened fauna species: Superb Parrot, Barking Owl, Bush Stone-curlew, Koala
- five-day survey period in December 2022 targeting threatened flora species: *Cullen parvum, Lepidium monoplocoides* and *Pilularia novae-hollandiae*
- five-day survey period in November/December 2022 targeting the following:
  - threatened bird species: Major Mitchell's Cockatoo and Square-tailed Kite, Southern Bell Frog and Southern Myotis

- draft BDAR, including:
  - description of existing environment including terrestrial and aquatic habitats, groundwater dependent ecosystems and potentially affected threatened biota
  - impact assessment, including:
    - direct and indirect impacts on threatened biota
    - identification of steps taken to avoid or mitigate impacts
    - potential serious or irreversible impacts
    - potential impacts to groundwater dependent ecosystems
    - consideration of the results of hydrological and hydraulic modelling undertaken as part of the water studies (refer section 6.4)
    - likely significance of impacts on biodiversity-related matters of national environmental significance pursuant to the EPBC Act significant impact guidelines
  - BAM credit calculations (ecosystem and species credits, as applicable)
  - identification of mitigation and management measures, including potential ongoing environmental monitoring and reporting as requested by stakeholders (refer Table 5-1)
  - options for offsetting impacts in accordance with the BAM, including identification of available matching credits or based on credit availability and consideration of contribution to the Biodiversity Conservation Fund
  - GIS maps and tabulated field survey results as required by the BAM and in a format acceptable to NSW Department of Planning and Environment.

6.4. Water – hydrology (including groundwater, flooding and water quality)

6.4.1. Potential impacts

The proposal could support the objectives of the Commonwealth Environmental Water Holder and NSW Environment and Heritage to deliver water for environmental watering events of Wanganella Swamp, Rhyola Lake and Rhyola Swamp by providing appropriately timed flows in the Forest Creek and Forest Creek Anabranch.

The proposal would potentially alter water management within the Billabong Creek, including:

- changing efficiency and security of environmental and productive water delivery
- maximising available water for general security water customers within the Sustainable Diversion Limits set under the Basin Plan.

During construction and operation, the proposal would potentially influence:

- the hydrological regime of the creek system
- water availability in the creek system
- surface-groundwater interactions
- local flooding characteristics
- water quality.

Preliminary modelling shows that the hydraulic influence of the new Caroonboon environmental water regulator will increase by one kilometre over the existing weir, from 18 kilometres to around 19 kilometres. Changes to Piccaninny, Hartwood and Wanganella weir pools are constrained by existing upstream weirs, Boonoke, Lower Woolshed and Four Mile weirs respectively. As such operation of the proposal is not expected to change the upstream extent of the hydraulic influence of the existing weirs. The predicted change in hydraulic influence of Caroonboon is shown in Figure 6-1.

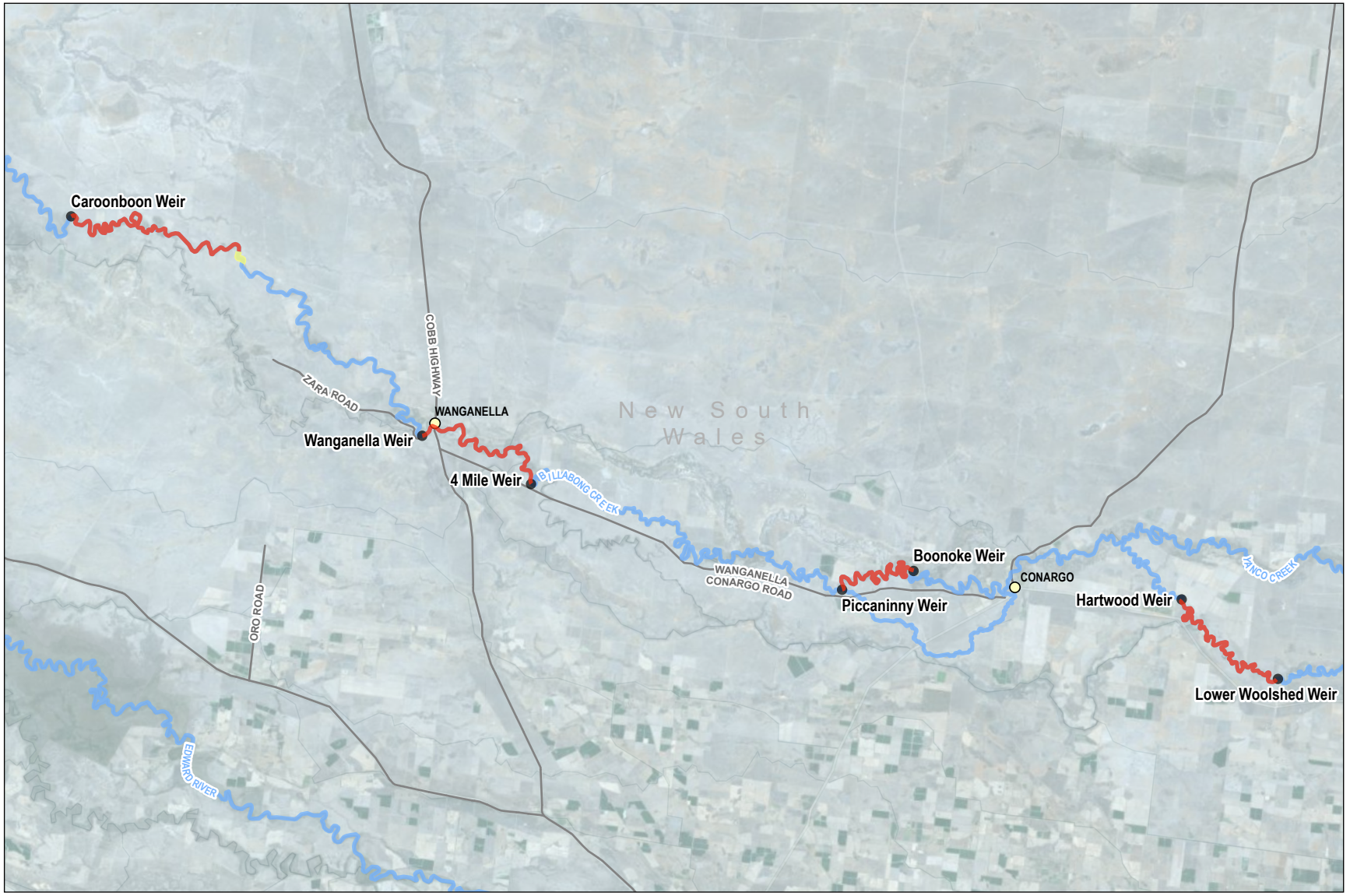

Figure 6.1 Predicted change in weir pool extent

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6.4.2. Hydrology assessment proposed

A detailed hydrology impact assessment will be required for the proposal and will include:

- a baseline assessment characterising the existing hydrological conditions of the system, based on:
  - modelled results from the existing eWater Source hydrologic model
  - site visit to the proposal site
  - groundwater monitoring
  - existing information regarding the current use of water for supply, irrigation, and environmental purposes
- identification and assessment of potential construction impacts, including potential changes to the hydrological regime and surface water-groundwater interactions
- identification and assessment of potential operational impacts with reference to the proposed operating rules, including:
  - changes to the hydrological regime
  - changes to groundwater drawdown and groundwater flow regime
  - changes to environmental water availability and flows – both regulated/licence and unregulated/rules-based sources
  - changes related to reach by reach minimum baseflows
  - compliance with relevant water sharing and water resource plans and legislation, with reference to:
    - *Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016*
    - *Water Sharing Plan for the Murrumbidgee Regulated River Water Source Order 2020*
    - Sustainable Diversion Limits of the Basin Plan
- consideration of potential cumulative impacts
- identification of potential mitigation and management measures, including potential ongoing environmental monitoring and reporting as requested by stakeholders (refer Table 5-1).

The assessment will comment on the accuracy of the modelling and operating rules for the proposal used for the hydrology impact assessment as was requested by stakeholders (refer Table 5-1).

6.4.3. Flooding impact assessment proposed

A detailed flooding impact assessment will be required for the proposal and will include:

- a baseline assessment and description of existing flooding conditions based on modelling results, including:
  - hydraulic modelling for:
    - up to six annual exceedance probability (AEP) events plus climate change for the 1% AEP event and probable maximum flood (PMF) – eight in total for each environmental regulator
    - up to four operational flows

  - documentation of existing Council flood risk management plans and SES flood emergency plans
- identification and assessment of potential construction impacts, including:
  - flood impact assessment for the construction of each environmental regulator – up to three AEP events with no climate change event
  - consideration of the potential for change in scour during one AEP event
- identification and assessment of potential operational impacts, including:
  - flood impact assessments for each environmental regulator for each AEP event plus the climate change event and PMF – eight in total for each environmental regulator
  - hydraulic impact assessment – four for each environmental regulator
  - assessment of change in scour for one AEP event
  - assessment of dam failure for each environmental regulator
  - consideration of social and economic impacts
- consideration of potential cumulative impacts, including:
  - cumulative impact assessment for up to eight flood events
- identification of potential mitigation and management measures, including:
  - assessment of up to three iterations of flood mitigation at each environmental regulator
  - high level advice on management and mitigation measures for operational flows.

The assessment will comment on the accuracy of the modelling and operating rules for the proposal used for the flooding impact assessment as requested by stakeholders (refer Table 5-1).

6.4.4. Water quality assessment proposed

As requested by stakeholders (refer Table 5-1), potential impacts to water quality will be assessed in the EIS.

A standard water quality impact assessment will be required for the proposal and will include:

- a review of water quality information and data
- identifying the ambient NSW Water Quality Objectives and environmental values for the Billabong Creek impacted by the proposal
- a description of the existing environment including local soils, topography, and landscapes
- details of sediment and erosion controls
- an assessment of potential impacts on quality of surface and groundwater sources, including salinity
- proposed mitigation and management measures, including potential ongoing environmental monitoring and reporting as requested by stakeholders (refer Table 5-1).

The outcomes of this assessment will inform the aquatic biodiversity assessment.

6.5. Heritage – Aboriginal

Archaeological surveys of the proposal area were undertaken on 2 - 11 May 2022 and 8 – 10 August 2022 with the participation of the Yarkuwa Indigenous Knowledge Centre, the Deniliquin Local Aboriginal Land Council (DLALC), the Narrandera Local Aboriginal Land Council (NLALC), the Leeton and District Local Aboriginal Land Council (LDLALC) and the Cummeragunja Local Aboriginal Land Council (CLALC). Further surveys are required to complete this initial component.

The surveys identified numerous Aboriginal cultural heritage sites in the vicinity of the proposal, including some within the anticipated disturbance footprint. Thus, the proposal has the potential impact on Aboriginal sites during construction.

Protection measures would be needed to protect identified artefacts within the proposal footprint from potential impacts. The proposal has been, and would continue to be, refined to avoid and minimise direct and indirect impacts to Aboriginal heritage as far as possible.

Operation of the proposal has the potential to impact Aboriginal sites along creek banks upstream of the new environmental regulators that may become inundated due to increased water levels. Alterations to the operational water regime may also affect Aboriginal cultural heritage values, connection to Country, and/or use of traditional areas.

A detailed Aboriginal cultural heritage impact assessment will be required for the proposal and will include:

- desktop assessment, including:
  - searches of relevant databases
  - analysis of work previously undertaken in the area
  - consideration of the local environment
  - consideration of current levels and types of disturbance
  - consideration of predictive model designed for the proposal area
- continuing archaeological surveys of potentially impacted areas, for example proposed power supply lines, and archaeological test excavations, where required
- continued consultation with registered Aboriginal parties (Stages 2 – 4)
- identification of cultural values for the proposal
- significance assessment of cultural heritage associated with the proposal footprint
- identification and assessment of construction and operation impacts on identified and potential cultural heritage
- assessment of cumulative impacts
- recommendation of mitigation and management measures for any impacts to cultural heritage.

6.6. Heritage – historic

Hartwood Weir is listed in WaterNSW's Heritage and Conservation Register under section 170 of the *Heritage Act 1977*. The existing Hartwood Weir is a good example of concrete weir construction in the early twentieth century, in particular, the use of brick block as an aggregate. It is also one of the oldest weirs in the area.

Piccaninny, Wanganella and Caroonboon weirs are likely to be of similar ages to Hartwood Weir, however they do not have heritage listings. The heritage value of these weirs would be confirmed as part of the EIS.

Construction of the proposal has the potential to impact these historic structures and may involve partial or full demolition of the existing weirs.

A detailed heritage assessment and statement of heritage impact will be completed for the proposal and will include:

- a desktop review of relevant statutory registers and previous heritage assessments/surveys
- field survey to focus on the identification and verification of non-Aboriginal heritage places and values in the study area, including:
  - assessment of known heritage items
  - identification and recording of any other visible remains and/or areas of potential archaeological deposits
- description of the existing environment of the study area
- identification of listed and potential heritage items and values that may be affected by the proposal and their significance, including:
  - assessment of heritage significance (i.e. local or state) in accordance with *Assessing Heritage Significance* (NSW Heritage Office, 2001)
- assessment of the direct and indirect impacts on existing and potential heritage items(s) during construction and operation, and including:
  - potential cumulative impacts
  - assessment of impact of removal in accordance with the *State Agency Heritage Guide* (Heritage Council of NSW and Heritage Office, 2005) - Guideline 3.55 Establishing Significance Prior to Demolition
- historical archaeological assessment
- photographic archival recordings of Hartwood Weir
- identification of potential mitigation and management measures.

6.7. Social – community

A Phase 1 social impact assessment (scoping and initial assessment) has been carried out in accordance with The Department of Planning and Environment's *Social Impact Assessment Guideline for State Significance Projects* (DPE, 2021) to determine the size and scale of likely social impacts of the proposed development.

A summary of the findings from the scoping and initial assessment is presented the Social Impact Worksheet in Appendix D.

The summary identified the potential social impacts associated with the principal matters of concern and provides an assessment of the significance of each impact with consideration given to the management and / or mitigation measures to be implemented:

The principal matters of concern relate to:

- Aboriginal cultural values
- access impacts
- demand on social infrastructure services and facility, including accommodation for construction workers
- minor environmental amenity impacts from traffic, dust, noise, and vibration.

Potential positive impacts relating to the proposal would include:

- increased water security
- positive economy, employment, and business outcomes
- reduced agricultural impacts from water buy backs.

A detailed Social Impact Assessment carried out in accordance with the *Social Impact Assessment Guideline for State Significant Projects* (DPE, 2021) (Phase 2 Report) will be required for the proposal and will include:

- a detailed investigation into the social locality to establish the social baseline
- a programme of targeted consultation with key stakeholders affected by the proposal
- identification and assessment of socio-economic impacts and benefits
- identification of mitigation and management measures.

6.8. Land – stability (geomorphology)

Construction of the proposal would have the potential to generate some short-term, temporary impacts on geomorphology. Potential impacts generated by the proposal would relate to:

- reduced bank stability due to clearing of riparian vegetation and water diversion works
- bank slumping due to changes in weirs pools after partial or full demolishment of the existing weirs, although this impact is anticipated to be unlikely given the new environmental regulators will be constructed downstream of the existing weirs.

Operation of the proposal would have the potential to generate some longer-term impacts on geomorphology.

Potential impacts generated by the proposal would relate to:

- variability in weir pool levels and changes to areas of inundation
- localised increase in turbulence and flow velocity immediately downstream of new environmental regulators potentially increasing scour or erosion of the riverbed and banks.

Management measures would be integrated into the operating rules for the structures to reduce potential geomorphology impacts.

A standard geomorphology impact assessment will be required for the proposal and will include:

- a baseline assessment of the existing geomorphic environment, including:
  - characterisation of the existing geomorphic environment including:
    - river styles, channel features, bank stability, bed stability, riparian vegetation condition, fragility, and restoration potential
    - qualitative channel / floodplain morphological characterisation determined from available LiDAR data
  - identification of the key processes determining the existing geomorphic forms and processes, including:
    - bank and bed soils and sediments (relative stability)
    - riparian vegetation structure – coverage, width, continuity of ground, shrubs, and tree presence
    - qualitative assessment of sediment transport processes, including assessment of the hydraulic capacity of the creek to transport the bed material
    - interpretation of hydraulic modelling results to determine distribution of likely deposition and scour areas on the floodplain under various operational conditions
- consultation of key stakeholders including DPI Fisheries
- identification and assessment of potential construction impacts
- identification and assessment of potential operational impacts
- identification of mitigation and management measures.

6.9. Rural environment – private property, public land, and agriculture

The proposal would require construction on private property and public land. As a result, the proposal may generate some impacts to private property and public land, including potential impacts to future land use at the proposal site. Land access and/or acquisitions at the locations of the new works and easements for access will be negotiated with local landholders.

As requested by stakeholders (refer Table 5-1), potential impacts to private property will be assessed in the EIS. This assessment will also investigate third party impacts, including the impact of environmental regulator operation on upstream users and, effects on pumps and pumping costs.

A standard land use assessment will be required for the proposal and will include:

- baseline assessment including:
  - assessment of current land use using publicly available information NSW DPE land use data
  - identification of any important or strategic agricultural land potentially impacted
  - land classification (8-class land and soil capability)
  - cumulative impact assessment focusing on any major projects in the vicinity of the proposal
- assessment of Crown Reserves, Travelling Stock Reserves, mineral resource and exploration activities at and near the proposal site
- document social and economic costs through a qualitative assessment of impacts on private land and community resulting from inundation, including:
  - review of data available from Australian Bureau of Agricultural and Resource Economics and Sciences and Agricultural Census Data published by the Australian Bureau of Statistics
  - overall impacts on regional agricultural production
  - analysis of the agricultural production and value by commodity for the four environmental regulator locations and supporting infrastructure and the corresponding LGAs and determine the effect on agricultural production at the site on the regional agricultural production
  - third party impacts such as impacts on upstream users and effects on pumps and pumping costs
- identification of potential construction and operation impact and mitigation measures.

6.10. Access – access to property and traffic and parking

The proposal would require access across private tracks and local roads, including Wanganella-Conargo Road, Zara Road and Wanganella-Moulamein Road. It is expected that some works would be needed to provide reliable access for construction along private tracks. This could include upgrades to provide all weather access, tree trimming or clearing to provide clearance and new access roads.

The proposal would also result in increased traffic movements along key access roads including Conargo Road, Wanganella-Conargo Road, Cobb Highway and Wanganella-Moulamein Road. Increased traffic would be a temporary, short-term impact limited to construction of the proposal.

A standard traffic impact assessment will be required for the proposal and will include:

- details of the existing traffic and transport environment
- existing available traffic counts in the vicinity of the proposal
- available crash data and identification of road safety implications of the proposal
- existing operational performance of the surrounding road network from the available traffic data and a desktop assessment of the site access arrangements
- traffic generation calculations for construction and operational phases of the proposal
- trip distribution (construction and operational)

- traffic modelling analysis (SIDRA or Austroads intersection warrants assessment) to identify the operational performance level of up to two key intersections
- assessment of:
  - traffic implication from the construction and operational activities on road network capacity, safety and amenity
  - potential impacts to public transport, pedestrians and bicycle riders
  - site access and internal access arrangements, including suitability of parking provision
- qualitative discussion of potential cumulative impacts of construction and operation with other concurrent development
- identification of potential mitigation and management measures.

6.11. Air – atmospheric emissions

The proposal has the potential to increase atmospheric emissions through:

- operation of machinery during construction
- clearing of vegetation
- electricity use during construction and operation of the proposal
- generation of construction waste disposed of in landfill
- increased inundated land
- operation of machinery during maintenance activities during operation of the proposal.

A standard Greenhouse Gas Assessment will be required for the proposal and will include:

- quantitative assessment of the potential scope of greenhouse gas emissions from the development
- identification of all scope 1 and scope 2 emissions, and significant scope 3 emissions resulting from the proposal
- description of mitigation measures including measures management of emission-generating waste material
- identification of potential mitigation and management measures.

6.12. Amenity – noise

The proposal has the potential to create some short-term temporary noise during construction activities. Noise would be generated during earthworks, delivery of construction materials and operational of construction plant and equipment.

There are limited residential receivers near the proposal sites thus impacts to amenity from noise are considered minimal. However, there may be some temporary noise impacts to residents in Wanganella village and users of Wanganella Camping Reserve.

Operational noise emissions are not anticipated to be significant. Vibration impacts are considered negligible.

A standard Noise and Vibration Impact Assessment will be required for the proposal and will include:

- identifying existing sensitive receivers
- analysing noise impacts from the construction and operation of the proposal
- identification of potential mitigation and management measures.

6.13. Amenity – visual

Construction activities, plant and equipment may be visible to sensitive visual receptors such as users of the Wanganella Camping Reserve and roads in the immediate vicinity. These impacts would be limited in their extent and duration given the remote location of the proposal and relatively small construction footprint.

Other than the proposed work at Wanganella, the works would be set back from nearby roads and would be generally screened from public viewpoints by trees. Works undertaken in the Wanganella Camping Reserve would be limited to a small area of the recreation reserve to limit potential visual impacts to users of the reserve.

Once constructed, the environmental regulators would have a more modern appearance than the existing degraded concrete weirs. The operational visual amenity impact of the proposal would be limited due to the lack of sensitive receivers near the structures and the relatively small size of the new environmental regulators. Parts of the structure, including equipment to operate the gates and the trafficable deck, will be above the surface level.

Other infrastructure would include the control room which would comprise a small shed like structure near the environmental regulator, and overhead powerlines and poles along the new electrical cabling route.

A standard visual impact assessment will be required for the proposal to assess the visual amenity impact at private receptors and public vantage points. This would comprise a qualitative assessment, in keeping with the remote location and small operational structures. This assessment will include:

- identifying local landscape features
- analysing impacts to views and vistas
- identifying the settings of heritage items that may be impacted
- assessing impacts to public recreation areas
- identification of potential mitigation and management measures.

6.14. Air – particulate matter

The proposal has the potential to generate some short-term, temporary dust emissions during earthworks, movement of construction materials and potential partial or full demolishment of the weirs. Impacts from dust and other particulate matter are expected to minimal due to the lack of nearby sensitive receivers. Dust would be minimised through appropriate mitigation measures, implemented through a construction environmental management plan.

A standard air quality impact assessment will be required for the proposal. This will comprise a qualitative assessment of potential impacts and will include:

- assessment of impacts for dust and particulate matter
- identification of mitigation measures.

No significant operational impacts are anticipated to air quality from the proposal.

6.15. Hazards and risks – public safety and land contamination

Construction of the proposal has the potential to result in hazards and risk to public safety and contamination of the environment, including:

- risks associated with an accidental fuel spill from equipment in the event of a vehicle or construction equipment incident
- risks associated with mobilisation of contaminants from existing contaminated soil, if present, to the environment
- increase in risk of fire ignition from hot works.

Other construction activities could result in impacts to the health and safety of site workers, users, visitors, and the local community if improperly managed. These include:

- operation of vehicles and construction equipment on site
- transportation of equipment, excavated spoil and material to and from site
- potential for risks to public safety resulting from unauthorised access to construction work areas.

Operation of the proposal would involve limited risks to public safety and land contamination. However, recreational use around the new environmental regulators and the new regulator pools may pose a risk to visitors.

All construction work areas would be isolated and secured from the public. Health and safety risks during construction would be managed by the implementation of standard workplace health and safety requirements. A work health and safety management plan, and safe work method statements, would be developed in accordance with regulatory requirements.

A standard public safety and land contamination assessment will be undertaken for the proposal and will include:

- a review of the relevant regulatory framework and applicable guidelines
- identification of construction and operational activities with the potential to cause impacts to offsite receivers
- description of design features of the proposal that would manage risk and hazards during the operational stage
- qualitative assessment of potential impacts
- identification of mitigation and management measures.

6.16. Hazards and risk – waste management and natural resource use

Construction of the proposal would generate construction waste and spoil. Waste generated during operation of the proposal would be minor and mostly associated with maintenance activities and equipment replacement as required in the long term.

Waste would be managed in accordance with the waste provisions contained within the *Protection of the Environment Operations Act 1997* and, where reused off-site, would comply with relevant EPA resource recovery exemptions issued pursuant to the *Protection of the Environment Operations (Waste) Regulation 2014*. The assessment will consider the *NSW Waste Avoidance and Resource Recovery Strategy* 2014-21 (NSW EPA, 2014) and the waste hierarchy.

A standard waste management and natural resource use impact assessment will be required for the proposal and will include details of:

- estimated quantity of key waste streams that may be generated by the proposal
- identification of types of resources required for the proposal
- identification of a management hierarchy to reduce the volume of spoil needing to be disposed
- identification of the availability of materials from the region, including from quarries, potential material suppliers and reuse of materials
- assessment of the potential waste management approach and impacts
- summary of the approach to managing contaminated soil should these be encountered
- identification of mitigation and management measures. Measures identified would include waste management plan that would detail proposed waste management practices. The waste management plan would be prepared in accordance with the NSW EPA's waste classification guidelines.

6.17. Matters requiring no further assessment

Table 6-1 summarises the matters that require no further assessment and the justification for their exclusion. Where a specific matter will be captured under another matter's assessment (such as soil chemistry being assessed under land contamination), this has been specified.

Table 6-1 Summary of matters requiring no further assessment.

Matters requiring no further assessment	Justification
Access – port and airport facilities, road and rail facilities	Issues regarding access including road use and traffic has been discussed in section 6.10. No port, airport or rail facilities would be impacted by the proposal.
Air – gases	Issues regarding greenhouse gases and particular matter are discussed in sections 6.11 and 6.14. No other gases are anticipated to be generated as a result of the proposal.
Biodiversity – conservation areas	Issues regarding biodiversity are discussed in sections 6.2 and 6.3. A search of the NSW SEED portal has not identified any land reserved for conservation under the *National Parks and Wildlife Act 1974* near the proposal. Therefore, this matter does not require separate assessment.
Built environment – public infrastructure, design quality	The proposal involves the building of public infrastructure. The design of the proposal and the purpose of the public infrastructure will be discussed throughout the EIS and thus will not require separate assessment.
Economic – opportunity cost, livelihood	Social and economic costs from changes to agricultural production would be assessed as part of the rural environment (section 6.9) and social (section 6.7) assessments. Impacts to opportunities costs and livelihoods are anticipated to be marginal and therefore do not require separate assessments. Natural resources to be used for construction of the proposal are anticipated to be negligible. As such, a natural resource assessment would not be required.
Hazards and risks – coastal hazards, dangerous goods, land movement	The proposal is not near any coastal lines and therefore coastal hazards is not applicable. Construction and operation of the proposal would not require any dangerous goods or activities that may result in land movement. Therefore, these matters do not require separate assessment.
Heritage – natural	Natural heritage assets near the proposal would relate to threatened species and other biodiversity matters that would be assessed under biodiversity (sections 6.2 and 6.3). Therefore, these matters do not require separate assessment.

Matters requiring no further assessment	Justification
Land –land capacity, soil chemistry, topography	The proposal would be constructed on relatively flat land and would not require a separate stability or topography assessment. Subsidence issues are not considered a likely outcome of the proposal. Matters regarding soil chemistry would be assessed under land contamination (section 6.15) and land capacity would be assessed under agriculture (section 6.8). Therefore, these matters do not require separate assessment.
Social – way of life, accessibility, cultural, health and wellbeing, surroundings, livelihoods, decision-marking systems	The social assessment will include a broad range of matters related to social and economic wellbeing along with community. An analysis of key issues for inclusion is provided in Appendix D.

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Appendices

Appendix A Stakeholder and advisory group membership

Stakeholder Advisory Group membership
Creek Country Alliance
Edward River Council
Federation Shire Council
First Nations representatives
Murrumbidgee Council
Murrumbidgee Field Naturalists
NSW Farmers Association
recreation representative
tourism representative
YACTAC
regular observers from WaterNSW,
regular observers from Department of Planning and Environment – Environment and Heritage and the Commonwealth Environmental Water Office

Technical Advisory Group membership
WaterNSW
Department of Planning and Environment – Environment and Heritage
Department of Primary Industries – Fisheries
Department of Climate Change, Energy, the Environment and Water
Department of Agriculture, Fisheries and Forestry
Murray-Darling Basin Authority
Commonwealth Environmental Water Office

Technical Advisory Group membership
YACTAC
Murray Irrigation
Coleambally Irrigation
National Parks and Wildlife
Department of Planning and Environment – Water

Note: the First Nations people have been invited to this group as observers, while terms of reference are being developed.

Design Focus Group membership
3Rivers
Department of Primary Industries – Fisheries
Department of Climate Change, Energy, the Environment and Water
Department of Agriculture, Fisheries and Forestry
WaterNSW
YACTAC
SMEC
Commonwealth Environmental Water Office

Appendix B Scoping summary table

Level of assessment	Matter	CIA	Engagement	Relevant government plans, policies and guidelines	Scoping report reference
Detailed	Biodiversity – aquatic flora and fauna	Y	Specific	• Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013) • Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (Fairfull and Witheridge, 2003) • Riparian Channel and Environment (RCE) inventory method (Peterson, 1992; Chessman et al., 1997) • The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) • NSW Water Quality Objectives (WQOs) (DECCW, 2006) • Guidelines for Managing Risks in Recreational Water (NHRMC, 2008) • Aquatic Ecology in Environmental Impact Assessment – EIA guideline (NSW Department of Planning, 2003) • Approved Methods for Sampling and Analysis of Water Pollutant in NSW (NSW EPA, 2022) • Survey Guidelines for Australia's Threatened Fish (DSEWPC, 2011)	Section 6.2

Level of assessment	Matter	CIA	Engagement	Relevant government plans, policies and guidelines	Scoping report reference
Detailed	Biodiversity – terrestrial flora and fauna	Y	Specific	• NSW Biodiversity Offsets Scheme (OEH, 2017) • 2020 Biodiversity Assessment Method (BAM) (DPIE, 2020) • Surveying threatened plants and their habitats: NSW survey guide for the Biodiversity Assessment Method (DPIE, 2020) • Determining serious and irreversible impacts (DPIE, 2020) • NSW Survey Guide for Threatened Frogs: A guide for the survey of threatened frogs and their habitats for the Biodiversity Assessment Method (DPIE, 2020) • Koala (*Phascolarctos cinereus*) Biodiversity Assessment Method Survey Guide (DPE, 2022d) • 'Species credit' threatened bats and their habitats NSW survey guide for the Biodiversity Assessment Method (OEH, 2018)	Section 6.3

Level of assessment	Matter	CIA	Engagement	Relevant government plans, policies and guidelines	Scoping report reference
Detailed	Water – hydrology (including groundwater, flooding, geomorphology and water quality)	Y	Specific	• Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016 • Water Sharing Plan for the Murrumbidgee Regulated River Water Source Order 2020 • Sustainable diversion limits of the Murray-Darling Basin Plan. • Australian Groundwater Modelling guidelines • Sustainable diversion limits of the Murray-Darling Basin Plan • The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) • NSW Water Quality Objectives (WQOs) (DECCW, 2006) • Guidelines for Managing Risks in Recreational Water (NHRMC, 2008) • Approved Methods for Sampling and Analysis of Water Pollutant in NSW (NSW EPA, 2022)	Section 6.4
Detailed	Heritage – aboriginal (AH)	N	Specific	• Code of practice for archaeological assessment in NSW (DECCW 2010) • Guide to investigating, assessing and reporting for Aboriginal cultural heritage in NSW (DECCW 2011) • Aboriginal cultural heritage consultation requirements for proponents (DECCW 2010)	Section 6.5
Detailed	Heritage – historic (NAH)	Y	Specific	• Assessing Heritage Significance (NSW Heritage Office, 2001) • State Agency Heritage Guide (Heritage Council of NSW and Heritage Office, 2005)	Section 6.6

Level of assessment	Matter	CIA	Engagement	Relevant government plans, policies and guidelines	Scoping report reference
Detailed	Social – community	Y	Specific	• Social Impact Assessment Guidelines for State Significant Projects (Department of Planning Industry and Environment, 2021)	Section 6.7
Standard	Land – Stability (geomorphology)	Y	Specific	• Refer Scoping Report	Section 6.8
Standard	Rural environment – private property, public land and agriculture	N	Specific	• NSW DPI Primefact 1063: Infrastructure proposals on rural land (Department of Primary Industries, 2013) • Managing Biosecurity Risk Management in Land Use Planning and Development (Department of Primary Industries, 2020)	Section 6.9
Standard	Access – access to property and traffic and parking	Y	General	• Guide to Traffic Generating Developments Version 2.2 (RTA, 2002). • Guide to Traffic Management Part 12: Traffic Impacts of Development (Austroads, 2016)	Section 6.10
Standard	Air – atmospheric emissions	N	General	• National Greenhouse Account (NGA) Factors workbook (Commonwealth Department of Science, Energy and Resources, 2021)	Section 6.11

Level of assessment	Matter	CIA	Engagement	Relevant government plans, policies and guidelines	Scoping report reference
Standard	Amenity – noise	N	General	• Interim Construction Noise Guideline (Department of Environment, Climate Change and Water, 2009) • Assessing Vibration: A Technical Guideline (Department of Environment and Conservation, 2006) • Noise Policy for Industry (NPfI) (EPA, 2017) • Road Noise Policy (DECCW, 2011)	Section 6.12
Standard	Amenity – visual	N	General	• Refer Scoping Report	Section 6.13
Standard	Air – particulate matter	N	General	• Refer Scoping Report	Section 6.14
Standard	Hazards and risks – public safety and land contamination	N	General	• Refer Scoping Report	Section 6.15
Standard	Hazards and risks – waste management and natural resource use	N	General	• Waste Classification Guidelines • Refer Scoping Report	Section 6.16
No further assessment	Refer Table 6-1.	-	-	-	Section 6.17

Appendix C Results of protected matters search

Australian Government
Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 29-Aug-2022

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	4
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	5
Listed Threatened Species:	22
Listed Migratory Species:	9

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	15
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	3
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar Wetlands)		[Resource Information]
Ramsar Site Name	Proximity	Buffer Status
Banrock station wetland complex	300 - 400km upstream from Ramsar site	In feature area
Hattah-kulkyne lakes	150 - 200km upstream from Ramsar site	In feature area
Riverland	300 - 400km upstream from Ramsar site	In feature area
The coorong, and lakes alexandrina and albert wetland	400 - 500km upstream from Ramsar site	In feature area

Listed Threatened Ecological Communities			[Resource Information]
For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps. Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.			
Community Name	Threatened Category	Presence Text	Buffer Status
Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions	Endangered	Community may occur within area	In feature area
Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	Endangered	Community likely to occur within area	In feature area
Natural Grasslands of the Murray Valley Plains	Critically Endangered	Community likely to occur within area	In feature area
Plains mallee box woodlands of the Murray Darling Depression, Riverina and Naracoorte Coastal Plain Bioregions	Critically Endangered	Community may occur within area	In feature area
Weeping Myall Woodlands	Endangered	Community likely to occur within area	In feature area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat likely to occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area
Pedionomus torquatus Plains-wanderer [906]	Critically Endangered	Species or species habitat likely to occur within area	In feature area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area	In feature area
Polytelis swainsonii Superb Parrot [738]	Vulnerable	Species or species habitat may occur within area	In feature area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area	In feature area
FISH			
Galaxias rostratus Flathead Galaxias, Beaked Minnow, Flat-headed Galaxias, Flat-headed Jollytail, Flat-headed Minnow [84745]	Critically Endangered	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Maccullochella macquariensis Trout Cod [26171]	Endangered	Species or species habitat may occur within area	In feature area
Maccullochella peelii Murray Cod [66633]	Vulnerable	Species or species habitat known to occur within area	In feature area
Macquaria australasica Macquarie Perch [66632]	Endangered	Species or species habitat may occur within area	In feature area
FROG			
Crinia sloanei Sloane's Froglet [59151]	Endangered	Species or species habitat may occur within area	In feature area
Litoria raniformis Growling Grass Frog, Southern Bell Frog, Green and Golden Frog, Warty Swamp Frog, Golden Bell Frog [1828]	Vulnerable	Species or species habitat likely to occur within area	In feature area
MAMMAL			
Nyctophilus corbeni Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area	In feature area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Endangered	Species or species habitat may occur within area	In feature area
PLANT			
Austrostipa wakoolica [66623]	Endangered	Species or species habitat likely to occur within area	In feature area
Brachyscome papillosa Mossgiel Daisy [6625]	Vulnerable	Species or species habitat may occur within area	In feature area
Lepidium monoplocoides Winged Pepper-cress [9190]	Endangered	Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Maireana cheelii			
Chariot Wheels [8008]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Swainsona murrayana			
Slender Darling-pea, Slender Swainson, Murray Swainson-pea [6765]	Vulnerable	Species or species habitat likely to occur within area	In feature area

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			
Apus pacificus			
Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
Migratory Terrestrial Species			
Motacilla flava			
Yellow Wagtail [644]		Species or species habitat may occur within area	In feature area
Myiagra cyanoleuca			
Satin Flycatcher [612]		Species or species habitat may occur within area	In feature area
Migratory Wetlands Species			
Actitis hypoleucos			
Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Calidris acuminata			
Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area	In feature area
Calidris ferruginea			
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Calidris melanotos			
Pectoral Sandpiper [858]		Species or species habitat may occur within area	In feature area
Gallinago hardwickii			
Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Numenius madagascariensis			
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area

Other Matters Protected by the EPBC Act

Listed Marine Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos			
Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Apus pacificus			
Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area
Bubulcus ibis as Ardea ibis			
Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area	In feature area
Calidris acuminata			
Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area	In feature area
Calidris ferruginea			
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area
Calidris melanotos			
Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Chalcites osculans as Chrysococcyx osculans			
Black-eared Cuckoo [83425]		Species or species habitat likely to occur within area overfly marine area	In feature area
Gallinago hardwickii			
Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area overfly marine area	In feature area
Haliaeetus leucogaster			
White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area	In feature area
Merops ornatus			
Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area
Motacilla flava			
Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area	In feature area
Myiagra cyanoleuca			
Satin Flycatcher [612]		Species or species habitat may occur within area overfly marine area	In feature area
Neophema chrysostoma			
Blue-winged Parrot [726]		Species or species habitat likely to occur within area overfly marine area	In feature area
Numenius madagascariensis			
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area
Rostratula australis as Rostratula benghalensis (sensu lato)			
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area	In feature area

Extra Information

EPBC Act Referrals				[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Not controlled action				
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed	In feature area
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed	In feature area
Not controlled action (particular manner)				
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval	In feature area

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 29-Aug-2022

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	4
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	5
Listed Threatened Species:	23
Listed Migratory Species:	9

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	16
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	3
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar Wetlands)		[Resource Information]
Ramsar Site Name	Proximity	Buffer Status
Banrock station wetland complex	400 - 500km upstream from Ramsar site	In feature area
Hattah-kulkyne lakes	200 - 300km upstream from Ramsar site	In feature area
Riverland	400 - 500km upstream from Ramsar site	In feature area
The coorong, and lakes alexandrina and albert wetland	500 - 600km upstream from Ramsar site	In feature area

Listed Threatened Ecological Communities			[Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text	Buffer Status
Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions	Endangered	Community may occur within area	In feature area
Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	Endangered	Community likely to occur within area	In feature area
Natural Grasslands of the Murray Valley Plains	Critically Endangered	Community likely to occur within area	In feature area
Weeping Myall Woodlands	Endangered	Community likely to occur within area	In feature area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area	In feature area

Listed Threatened Species	[Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat likely to occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat may occur within area	In feature area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area
Pedionomus torquatus Plains-wanderer [906]	Critically Endangered	Species or species habitat known to occur within area	In feature area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area	In feature area
Polytelis swainsonii Superb Parrot [738]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area	In feature area
FISH			
Galaxias rostratus Flathead Galaxias, Beaked Minnow, Flat-headed Galaxias, Flat-headed Jollytail, Flat-headed Minnow [84745]	Critically Endangered	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Maccullochella macquariensis			
Trout Cod [26171]	Endangered	Species or species habitat may occur within area	In feature area
Maccullochella peelii			
Murray Cod [66633]	Vulnerable	Species or species habitat known to occur within area	In feature area
Macquaria australasica			
Macquarie Perch [66632]	Endangered	Species or species habitat may occur within area	In feature area
FROG			
Litoria raniformis			
Growling Grass Frog, Southern Bell Frog, Green and Golden Frog, Warty Swamp Frog, Golden Bell Frog [1828]	Vulnerable	Species or species habitat may occur within area	In feature area
MAMMAL			
Nyctophilus corbeni			
Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area	In feature area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)			
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Endangered	Species or species habitat may occur within area	In feature area
PLANT			
Brachyscome papillosa			
Mossgiel Daisy [6625]	Vulnerable	Species or species habitat may occur within area	In feature area
Lepidium monoplocoides			
Winged Pepper-cress [9190]	Endangered	Species or species habitat likely to occur within area	In feature area
Maireana cheelii			
Chariot Wheels [8008]	Vulnerable	Species or species habitat may occur within area	In feature area
Sclerolaena napiformis			
Turnip Copperburr [11742]	Endangered	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Swainsona murrayana			
Slender Darling-pea, Slender Swainson, Murray Swainson-pea [6765]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Swainsona plagiotropis			
Red Darling-pea, Red Swainson-pea [10804]	Vulnerable	Species or species habitat may occur within area	In buffer area only

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			
Apus pacificus			
Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
Migratory Terrestrial Species			
Motacilla flava			
Yellow Wagtail [644]		Species or species habitat may occur within area	In feature area
Myiagra cyanoleuca			
Satin Flycatcher [612]		Species or species habitat may occur within area	In feature area
Migratory Wetlands Species			
Actitis hypoleucos			
Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Calidris acuminata			
Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area	In feature area
Calidris ferruginea			
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Calidris melanotos			
Pectoral Sandpiper [858]		Species or species habitat may occur within area	In feature area
Gallinago hardwickii			
Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Numenius madagascariensis			
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area

Other Matters Protected by the EPBC Act

Listed Marine Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos			
Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Apus pacificus			
Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area
Bubulcus ibis as Ardea ibis			
Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area	In feature area
Calidris acuminata			
Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area	In feature area
Calidris ferruginea			
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area
Calidris melanotos			
Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat likely to occur within area overfly marine area	In feature area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area overfly marine area	In feature area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area	In feature area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area	In feature area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area overfly marine area	In feature area
Neophema chrysostoma Blue-winged Parrot [726]		Species or species habitat likely to occur within area overfly marine area	In feature area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area	In feature area

Extra Information

EPBC Act Referrals				[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Not controlled action				
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed	In feature area
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed	In feature area
Not controlled action (particular manner)				
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval	In feature area

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

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Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 29-Aug-2022

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	4
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	5
Listed Threatened Species:	22
Listed Migratory Species:	9

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	16
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	3
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar Wetlands) [Resource Information]

Ramsar Site Name	Proximity	Buffer Status
Banrock station wetland complex	400 - 500km upstream from Ramsar site	In feature area
Hattah-kulkyne lakes	200 - 300km upstream from Ramsar site	In feature area
Riverland	300 - 400km upstream from Ramsar site	In feature area
The coorong, and lakes alexandrina and albert wetland	400 - 500km upstream from Ramsar site	In feature area

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text	Buffer Status
Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions	Endangered	Community may occur within area	In feature area
Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	Endangered	Community likely to occur within area	In feature area
Natural Grasslands of the Murray Valley Plains	Critically Endangered	Community likely to occur within area	In feature area
Weeping Myall Woodlands	Endangered	Community likely to occur within area	In feature area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community may occur within area	In feature area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat likely to occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat may occur within area	In feature area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area
Pedionomus torquatus Plains-wanderer [906]	Critically Endangered	Species or species habitat known to occur within area	In feature area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area	In feature area
Polytelis swainsonii Superb Parrot [738]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area	In feature area
FISH			
Galaxias rostratus Flathead Galaxias, Beaked Minnow, Flat-headed Galaxias, Flat-headed Jollytail, Flat-headed Minnow [84745]	Critically Endangered	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Maccullochella macquariensis			
Trout Cod [26171]	Endangered	Species or species habitat may occur within area	In feature area
Maccullochella peelii			
Murray Cod [66633]	Vulnerable	Species or species habitat known to occur within area	In feature area
Macquaria australasica			
Macquarie Perch [66632]	Endangered	Species or species habitat may occur within area	In feature area
FROG			
Litoria raniformis			
Growling Grass Frog, Southern Bell Frog, Green and Golden Frog, Warty Swamp Frog, Golden Bell Frog [1828]	Vulnerable	Species or species habitat may occur within area	In feature area
MAMMAL			
Nyctophilus corbeni			
Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area	In feature area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)			
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Endangered	Species or species habitat may occur within area	In feature area
PLANT			
Brachyscome papillosa			
Mossgiel Daisy [6625]	Vulnerable	Species or species habitat may occur within area	In feature area
Lepidium monoplocoides			
Winged Pepper-cress [9190]	Endangered	Species or species habitat may occur within area	In feature area
Maireana cheelii			
Chariot Wheels [8008]	Vulnerable	Species or species habitat may occur within area	In feature area
Sclerolaena napiformis			
Turnip Copperburr [11742]	Endangered	Species or species habitat may occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
[Swainsona murrayana](#) Slender Darling-pea, Slender Swainson, Murray Swainson-pea [6765]	Vulnerable	Species or species habitat likely to occur within area	In feature area

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			
[Apus pacificus](#) Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
Migratory Terrestrial Species			
[Motacilla flava](#) Yellow Wagtail [644]		Species or species habitat may occur within area	In feature area
[Myiagra cyanoleuca](#) Satin Flycatcher [612]		Species or species habitat may occur within area	In feature area
Migratory Wetlands Species			
[Actitis hypoleucos](#) Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
[Calidris acuminata](#) Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area	In feature area
[Calidris ferruginea](#) Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
[Calidris melanotos](#) Pectoral Sandpiper [858]		Species or species habitat may occur within area	In feature area
[Gallinago hardwickii](#) Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area	In feature area
[Numenius madagascariensis](#) Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area

Other Matters Protected by the EPBC Act

Listed Marine Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area	In feature area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat likely to occur within area overfly marine area	In feature area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area overfly marine area	In feature area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area	In feature area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area overfly marine area	In feature area
Neophema chrysostoma Blue-winged Parrot [726]		Species or species habitat likely to occur within area overfly marine area	In feature area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area	In feature area

Extra Information

EPBC Act Referrals				[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Not controlled action				
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed	In feature area
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed	In feature area

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Not controlled action (particular manner)				
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval	In feature area

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-Western Australian Herbarium
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National Heritage Places:	None
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Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	5
Listed Threatened Species:	24
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A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	17
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	3
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar Wetlands) [Resource Information]

Ramsar Site Name	Proximity	Buffer Status
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Riverland	300 - 400km upstream from Ramsar site	In feature area
The coorong, and lakes alexandrina and albert wetland	400 - 500km upstream from Ramsar site	In feature area

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Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text	Buffer Status
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Natural Grasslands of the Murray Valley Plains	Critically Endangered	Community likely to occur within area	In feature area
Weeping Myall Woodlands	Endangered	Community likely to occur within area	In feature area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community may occur within area	In buffer area only

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text	Buffer Status
BIRD			
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area	In feature area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
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Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat may occur within area	In feature area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area
Pedionomus torquatus Plains-wanderer [906]	Critically Endangered	Species or species habitat known to occur within area	In feature area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area	In feature area
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Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area	In feature area
FISH			
Galaxias rostratus Flathead Galaxias, Beaked Minnow, Flat-headed Galaxias, Flat-headed Jollytail, Flat-headed Minnow [84745]	Critically Endangered	Species or species habitat may occur within area	In feature area

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Maccullochella peelii Murray Cod [66633]	Vulnerable	Species or species habitat known to occur within area	In feature area
Macquaria australasica Macquarie Perch [66632]	Endangered	Species or species habitat may occur within area	In feature area
FROG			
Crinia sloanei Sloane's Froglet [59151]	Endangered	Species or species habitat may occur within area	In feature area
Litoria raniformis Growling Grass Frog, Southern Bell Frog, Green and Golden Frog, Warty Swamp Frog, Golden Bell Frog [1828]	Vulnerable	Species or species habitat likely to occur within area	In feature area
MAMMAL			
Nyctophilus corbeni Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area	In feature area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Endangered	Species or species habitat may occur within area	In feature area
PLANT			
Austrostipa wakoolica [66623]	Endangered	Species or species habitat likely to occur within area	In feature area
Brachyscome papillosa Mossgiel Daisy [6625]	Vulnerable	Species or species habitat known to occur within area	In feature area
Lepidium monoplocoides Winged Pepper-cress [9190]	Endangered	Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Maireana cheelii			
Chariot Wheels [8008]	Vulnerable	Species or species habitat likely to occur within area	In feature area
Sclerolaena napiformis			
Turnip Copperburr [11742]	Endangered	Species or species habitat may occur within area	In feature area
Swainsona murrayana			
Slender Darling-pea, Slender Swainson, Murray Swainson-pea [6765]	Vulnerable	Species or species habitat likely to occur within area	In feature area

Listed Migratory Species			[Resource Information]
Scientific Name	Threatened Category	Presence Text	Buffer Status
Migratory Marine Birds			
Apus pacificus			
Fork-tailed Swift [678]		Species or species habitat likely to occur within area	In feature area
Migratory Terrestrial Species			
Motacilla flava			
Yellow Wagtail [644]		Species or species habitat may occur within area	In feature area
Myiagra cyanoleuca			
Satin Flycatcher [612]		Species or species habitat may occur within area	In feature area
Migratory Wetlands Species			
Actitis hypoleucos			
Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Calidris acuminata			
Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area	In feature area
Calidris ferruginea			
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area	In feature area
Calidris melanotos			
Pectoral Sandpiper [858]		Species or species habitat likely to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area	In feature area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area	In buffer area only

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State	Buffer Status
Communications, Information Technology and the Arts - Telstra Corporation Limited		
Commonwealth Land - Australian Telecommunications Commission [15350]	NSW	In feature area

Listed Marine Species [Resource Information]

Scientific Name	Threatened Category	Presence Text	Buffer Status
Bird			
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area	In feature area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area	In feature area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area	In feature area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat likely to occur within area overfly marine area	In feature area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat likely to occur within area overfly marine area	In feature area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area overfly marine area	In feature area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area	In feature area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat may occur within area overfly marine area	In feature area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area	In feature area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area	In feature area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area overfly marine area	In feature area

Scientific Name	Threatened Category	Presence Text	Buffer Status
Neophema chrysostoma Blue-winged Parrot [726]		Species or species habitat known to occur within area overfly marine area	In feature area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area	In feature area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area overfly marine area	In feature area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area overfly marine area	In buffer area only

Extra Information

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status	Buffer Status
Not controlled action				
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed	In feature area
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed	In feature area
Not controlled action (particular manner)				
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval	In feature area

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Appendix D Social Impact Assessment Worksheet

Technical Memorandum

August 2022

To	Water Infrastructure NSW
From	Lauren Harding; Sonya Pascoe
Project Name	Billabong Creek Environmental Water Regulators
Subject	Billabong Creek Environmental Water Regulators – Social Impact Scoping - technical memorandum

1. Introduction

The Billabong Creek Environmental Water Regulators proposal involves replacing four existing weirs along Billabong Creek with new environmental regulators (the proposal). The weirs being replaced and included in the proposal are Hartwood Weir, Piccaninny Weir, Wanganella Weir and Caroonboon Weir.

Operating rules for the proposed environmental regulators are being established with the proposed new asset owner WaterNSW. Operating rules have been proposed to manage the impacts of the proposal on biodiversity, bank stability and flooding. The environmental regulators would be fully automated and remotely operable meaning river operators could control flow remotely which would increase the efficiency of flow control in Billabong Creek. The new environmental regulators would also feature fishways to support fish movement past the new structures.

The proposal is subject to environmental and planning approvals under *the NSW Environmental Planning and Assessment Act 1979* (EP&A Act) and, potentially, the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The proposal is State significant infrastructure (SSI), and the Minister for Planning is the approval authority. An Environmental Impact Statement (EIS) is required to accompany the application for approval of the development.

A Scoping Report has been prepared on behalf of Water Infrastructure NSW (WINSW) (the proponent) for construction of four environmental regulators along Billabong Creek, NSW. The Scoping Report has been prepared to support a request for Secretary's Environmental Assessment Requirements (SEARs) for the preparation of an EIS.

1.1 Purpose of this Memorandum

The purpose of this memorandum is to provide a scoping of social impacts to support the *Billabong Creek Environmental Water Regulators State Significant Instructure Scoping Report* prepared by 3Rivers Joint Venture for WINSW. This initial scoping of social impacts has been prepared in accordance with the Department of Planning and Environment's (DPE) *Social Impact Assessment Guideline* and the *Social impact Assessment Guideline: State Significant projects* (DPE, 2021), and includes a Social Impact Assessment (SIA) Scoping Worksheet in Attachment 1

1.2 Scope and limitations

This technical memorandum has been prepared by 3Rivers Joint Venture for Water Infrastructure NSW. It is not prepared as, and is not represented to be, a deliverable suitable for reliance by any person for any purpose. It is not intended for circulation or incorporation into other documents. The matters discussed in this memorandum are limited to those specifically detailed in the memorandum and are subject to any limitations or assumptions specially set out.

2. Social impact scoping

Scoping of social impacts involves:

– Establishing the social locality to understand the communities likely to be affected by the proposal
– An initial evaluation of the social baseline of the social locality
– An initial evaluation of social impacts and benefits
– Consideration and articulation of any proposal refinements.

This process is assisted by applying the SIA worksheet provided by DPE. The SIA worksheet for this proposal is located in Attachment 1. The following section provides an overview of the social locality and the outcomes of the initial evaluation of potential social impacts and benefits.

2.1 Social locality

A preliminary social locality was identified based on the locations of the proposal sites and the communities most likely to experience impacts or benefits as a result of the proposal. The preliminary social locality is outlined in Table 1.

Table 1 Preliminary social locality study areas

Study area	Area (ABS Census area)	Interaction with proposal
Local	Barratta	The site of the proposed Caroonboon Environmental Regulator is located over the localities of Barratta and Wanganella. There is a very small residential population that live in Barratta, as such there is limited ABS Census data available. As such, a demographic profile cannot be provided for this area. Landholders hosting project infrastructure, local residents and businesses in the area may potentially experience social impacts and benefits during construction and operation of the proposal.
	Wanganella	The site of the proposed Caroonboon Environmental Regulator is located over two localities, Wanganella and Barratta. The site of the proposed Wanganella Environmental Regulator is located within the locality of Wanganella, near the village of Wanganella, situated within the Wanganella Camping Reserve. There is a very small residential population that live in the locality of Wanganella, and there is limited ABS Census data available. As such, a demographic profile cannot be provided for this area. Recreational users of the camping reserve, local residents and businesses in the area may potentially experience social impacts and benefits during construction and operation of the proposal.
	Conargo	The site of the proposed Piccaninny Environmental Regulator is within the locality of Conargo. The site of the proposed Hartwood Environmental Regulator is located over two localities, Conargo and Hartwood. Landholders hosting project infrastructure, local residents and businesses in the area may potentially experience social impacts and benefits during construction and operation of the proposal.

Study area	Area (ABS Census area)	Interaction with proposal
	Hartwood	The site of the proposed Hartwood Environmental Regulator is located over two localities, Hartwood and Conargo. There is a very small residential population that live in Hartwood, as such there is limited ABS Census data available. As such, a demographic profile cannot be provided for this area. Landholders hosting project infrastructure, local residents and businesses in the area may potentially experience social impacts and benefits during construction and operation of the proposal.
Regional	Edward River	Barratta, Wanganella, Conargo and Hartwood are all located within the Edward River Local Government Area (LGA). Communities across Edward River LGA may experience some social impacts and benefits during construction and operation of the proposal. The regional study area will also be important to gain an understanding of the demographic profile and character of the local study area, as there are limited ABS census and other data available for the local study areas.

2.2 Existing environment

2.2.1 Billabong Creek

The proposal is located in Billabong Creek, which is part of the Yanco Creek system. The Yanco Creek system is a complex system of waterways connecting the Murrumbidgee and Murray Rivers, both of which form part of the Murray Darling Basin (MDB). The MDB is Australia's largest river system and has important social, economic and environmental values.

Land adjacent to Billabong Creek is predominantly used for dryland grazing and cropping with water from the water course used to support these agricultural activities. The majority of irrigation water licences in the Yanco Creek system are general security and supplementary licences used for seasonal crops. Billabong Creek is also an important source of domestic water supply for users in surrounding areas, and in the case of Wanganella, provides town water supply.

Billabong Creek attracts local and regional visitors for recreation and tourism. Billabong Creek is known as an attraction for creek-based activities including walking, biking, kayaking, camping, bird watching and fishing. Flows from Billabong Creek also contribute to environmental watering of two key environmental assets in the Yanco Creek system: Wanganella Swamp, Rhyola Lake and Rhyola Swamp.

Community engagement was undertaken by WINSW, involving local communities in the Yanco Creek System area. This included community sessions in Wanganella, Moulamein, Conargo, Jerilderie and Morundah, as well as ongoing consultation with directly affected landowners and members of the Aboriginal community. Consultation identified that for some local Aboriginal communities (refer to Section 2.2.2), the flow of Billabong River is important to supply water for cultural and environmental purposes, such as water for Country. Community engagement also highlighted that some members of the local Aboriginal community have high interest in recorded and unrecorded Aboriginal archaeological items within the Yanco Creek System.

2.2.2 Local study area

The sites of the four environmental regulators are proposed to be located within the sparsely populated, rural localities of Barratta, Wanganella, Conargo and Hartwood. These localities adjoin Billabong Creek and are all located within the Edward River LGA.

The environmental regulators are proposed on a mixture of private and public land (State and Crown) within these localities, as follows:

– The proposed Caroonboon Environmental Regulator would be located on private land predominantly used for agriculture, about 24 kilometres north-west of Wanganella Village. There are no residents within two kilometres of the site. The site would be accessed via Wanganella-Moulamein Road.
– The Wanganella Environmental Regulator is proposed to be located on the Wanganella Camping Reserve, which is Crown Land, about one kilometre south-west of the Wanganella township. The existing weir pool, which may be removed as part of the proposal, is used for recreational water-based activities. There is an accommodation facility about one kilometre east of the site. The township has a local grocery store, post office, and petrol station which are all located about one kilometre north-east of the site. There is also a playground and church located about one kilometre north-east of the site. There is a horse stud located about 1.5 kilometres north of the site. The surrounding land uses are predominantly agricultural. The site would be accessed by Zara Road and Cobb Highway.
– The proposed Piccaninny Environmental Regulator would be located on privately owned land, about 9.5 kilometres west of the Conargo township. The surrounding land uses are predominantly agricultural. The nearby Piccaninny Weir currently provides a weir pool that is used for irrigation supply. There are no residential receivers within two kilometres of the site. The site would be accessed by Wanganella-Conargo Road.
– The proposed Hartwood Environmental Regulator would be located 10 kilometres east of the Conargo township, on land owned by WaterNSW. The surrounding land is privately owned and Crown Land. The existing Hartwood Weir is used to supply water to Forest Creek. The site would be accessed via Conargo Road.

According to the 2021 Census, Barratta had a population of 12 persons, Wanganella had a population of 61 persons, Conargo had a population of 117 persons, and Hartwood had a population of 26 persons (ABS, 2021). Barratta, Wanganella, and Hartwood have small populations, and as such there is limited data available for these localities, and as such a demographic profile cannot be provided for these areas.

The proposed environmental regulators are located within the area of different Aboriginal language groups, including Wemba Wemba and Baraba Baraba. These language group areas all sit within the Deniliquin Local Aboriginal Land Council (LALC) area. Community engagement carried out by WINSW identified the importance of maintaining river flows for various cultural, environmental, community, and economic purposes, in particular for local Aboriginal communities.

2.2.3 Regional study area

The Edward River LGA is located within the Riverina Murray Region of south-western NSW, about 200 kilometres south-east of Mildura, and 120 kilometres north-west of Albury. Edward River LGA had an overall population of 8,456 persons in 2021 (ABS, 2021). The Edward River LGA is characterised by sparse rural-residential living, dominated by agricultural land uses.

The gross regional product for Edward River LGA in 2021 was $0.52 billion, and there are 930 local businesses (economy.id, 2022). The largest industries by employment in Edward River LGA are Agriculture, Forestry, and Fishing (17.7 per cent), followed by Health Care and Social Assistance (15.9 per cent) then Construction (8.6 per cent) (economy.id, 2022).

Within Edward River LGA, 4.8 per cent of the population, or 410 persons, identified as Aboriginal and/or Torres Strait Islander, which is higher than the NSW average of 3.4 per cent (ABS, 2021). The unemployment rate for the March 2022 Quarter in Edward River was 4.6 per cent, which is consistent with the NSW rate, which was also 4.6 per cent (SALM, 2022). According to the Index of Relative Socio-Economic Advantage/Disadvantage (IRSAD)[1] Edward River LGA had a relatively higher level of disadvantage ranking at decile 4 within the state (ABS, 2016).

Water-based recreational activities, such as boating, fishing, canoeing and kayaking, are popular attractions for visitors to Edward River LGA (Visit the Murray, 2022). Fishers are attracted to the area for the population of Murray Cod and other native fish.

[1] The Index of Relative Socio-Economic Advantage/Disadvantage (IRSAD) divides a population into ten equal groups, called a decile. A decile number of 1, indicates the highest level of disadvantage, and a decile of 10, indicates the highest level of advantage.

2.3 Initial evaluation of social impacts

The potential social impacts and benefits that may result from construction and operation of the proposal have been identified through a review of the information presented in this Scoping Report, the understanding of the social locality, and based on previous professional experience undertaking social impact assessment for state significant projects in NSW. The potential social impacts have been evaluated according to the characteristics of magnitude as defined in DPE's *Social Impact Assessment Guideline for State significant projects* (DPE, 2021). The outcomes of the social impact scoping process are detailed in Attachment 1, and summarised below.

2.3.1 Aboriginal cultural values

Archaeological surveys undertaken within the proposal area identified numerous Aboriginal sites within the vicinity of the proposal, including some within the disturbance footprint. Construction and operation of the proposal has the potential to disturb items and places of significance and/or reduce the ability of those in the Aboriginal community to gain sustenance, spiritual or otherwise, from the land and water. This has the potential to lead to cultural or spiritual loss for local Aboriginal communities. Consultation carried out by WINSW indicates that Aboriginal groups have high interest in being involved with archaeological finds within the Yanco Creek System.

The proposal may provide potential businesses opportunities for local Aboriginal communities. There are opportunities for Traditional Owners and the local Aboriginal community to continue to be involved in the proposal by sharing traditional knowledge for the proposal design as well as for Aboriginal businesses to provide services such as Aboriginal cultural surveys. This may enhance wellbeing and livelihoods for local Aboriginal communities through supporting connection to Country activities. It is also expected the families and communities associated with the owners and employees of these businesses would directly benefit from this income.

2.3.2 Environmental amenity

Traffic, dust, noise and vibration would be generated from construction works, staff movements, haulage of materials and delivery of machinery and equipment, which may have localised impacts to amenity, including visual amenity. This would also include additional heavy and light vehicle movements in the regional road networks surrounding the proposal sites.

Because the proposal sites are in sparsely populated areas, and landowners hosting both project infrastructure and along haul roads will be consulted with throughout proposal planning and delivery, it is expected that these receivers would be adaptable to any changes to amenity. However, because the Wanganella Environmental Regulator site is closer to some sensitive receivers, such as recreational users of the Wanganella Camping Reserve and visitors using the nearby accommodation facilities, amenity changes may be more noticeable over the construction period.

2.3.3 Access

The establishment of work zones will temporarily interrupt usual access to areas around the river. Three of the proposed environmental regulator sites are amongst sparsely populated, privately owned areas, and landowners will be consulted throughout planning and construction. As such, these landowners are expected to be adaptable to any changes. However, the site of the proposed Wanganella Environmental Regulator in within the Wanganella Camping Reserve, any changes to access may exclude recreational visitors and campers form visiting the site during these times. While this would be temporary, this may inconvenience some users.

2.3.4 Accommodation

The construction of the proposal may require a number of non-resident workers to be accommodated in existing short-term accommodation located in the local and regional study area. This would increase demand for accommodation, which would benefit accommodation providers, but could reduce availability for tourists.

2.3.5 Social infrastructure services and facilities

A non-resident workforce may increase demand on social infrastructure services and facilities such as emergency services, health services, and recreational facilities. This is most likely to occur in areas where the non-resident workforce would be accommodated. This would increase demand for services, which would benefit providers, but could reduce availability for the local area.

2.3.6 Water security

The operation of the proposal would provide efficient and secure water delivery of held environmental water along with consumptive waters for water users in the local and regional communities. This would benefit those in the community through flexible irrigation schedules and improved town water supply. Water quality and security would support the operations of businesses, particularly agricultural, that are reliant on water from Billabong Creek.

The operation of the proposal will bring about new operational rules to manage impacts on biodiversity, bank stability and flooding. While the intention of the proposal is to provide more efficient environmental and productive water, there may be a perceived risk to water availability for agriculture or other irrigator-related uses due to the changed management systems for this water.

2.3.7 Economy, employment, and business

Potential for local and regional businesses to participate in procurement opportunities during construction. Local businesses may also benefit from construction workers spending money at local businesses, such as food outlets located in nearby townships. Potential procurement opportunities and increased patronage is likely to be viewed as important to local businesses. Some business owners are expected to have a high to moderate level of interest in procurement and increased patronage.

Improved water quality and fish populations has the potential to attract more visitors for recreation and eco-tourism. Local tourism operators, such as accommodation providers, dining and retail, may benefit from increased patronage. Some business owners are expected to have a high to moderate level of interest in increased patronage.

2.4 Assessment approach

The outcomes of the SIA Scoping Worksheet (Attachment 1) indicate that the potential social impacts and benefits that may occur during construction and operation would require assessment in the EIS. A standard level of assessment is considered appropriate and would include:

- A desktop review of relevant secondary data sources including population and economic data and research.
- Targeted consultation with relevant local stakeholders such as local Aboriginal stakeholders, Edward River Council, Regional Development Australia Murray, managers of the Wanganella Camping Reserve, and Murray-Riverina NSW Business Chamber
- Coordination with EIS communication and engagement activities would also be key to the SIA to leverage existing relationships and reduce consultation fatigue. This will be particularly important for stakeholders that may be more sensitive to potential impacts, such as landowners. Collaboration with the cultural heritage specialists and the Department's Aboriginal engagement teams will also be critical to reduce consultation fatigue and demands on time for Aboriginal stakeholders.

Regards

Lauren Harding
Technical Director – Social Sustainability

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This Technical Memorandum is provided as an interim output under our agreement with Water Infrastructure NSW. It is provided to foster discussion in relation to technical matters associated with the project and should not be relied upon in any way.

Attachment 1

SIA Scoping Worksheet

	Social Impact Assessment (SIA) Worksheet				Project name: Billabong Creek Regulators EIS Scoping Report								Date: 29.07.2022					
PROJECT ACTIVITIES	**CATEGORIES OF SOCIAL IMPACTS**	**POTENTIAL IMPACTS ON PEOPLE**		**PREVIOUS INVESTIGATION OF IMPACT**		**CUMULATIVE IMPACTS**		**ELEMENTS OF IMPACTS Based on preliminary investigation**					**ASSESSMENT LEVEL FOR EACH IMPACT**				**PROJECT REFINEMENT**	**MITIGATION / ENHANCEMENT MEASURES**
Which **project activity / activities** could produce social impacts ?	what **social impact categories** could be affected by the project activities	What impacts are likely, and what concerns/aspirations have people expressed about the impact? Summarise how each relevant stakeholder group might experience the impact. NB. Where there are multiple stakeholder groups affected differently by an impact, or more than one impact from the activity, please add an additional row.	Is the impact expected to be **positive or negative**	Has this impact previously been investigated (on this or other project/s)?	If "yes - this project," briefly describe the previous investigation. If "yes - other project," identify the other project and investigation	Will this impact combine with others from this project (think about when and where), and/or with impacts from other projects (cumulative)?	If yes, identify which other impacts and/or projects	Will the project activity (without mitigation or enhancement) cause a material social impact in terms of its: You can also consider the various magnitudes of these characteristics					Level of assessment for each social impact	What methods and data sources will be used to investigate this impact?			Has the project been refined in response to preliminary impact evaluation or stakeholder feedback?	What **mitigation / enhancement measures** are being considered?
								extent i.e. number of people potentially affected?	**duration** of expected impacts? (**i.e. construction vs operational phase**)	**intensity** of expected impacts i.e. scale or degree of change?	**sensitivity** or vulnerability of people potentially affected?	**level of concern/interest** of people potentially affected?		Secondary data	Primary Data - Consultation	Primary Data - Research		
Construction and operation Aboriginal cultural values	culture		Negative	Yes - other project	Potential impactc to Aboriginal communities resulting from the proposal are generallly well understood due to ongoing consultation carried out by WINSW for Yanco Creek Modernisation, and as such have identifyied some key areas of interest to date.	N/A	N/A	No	No	No	Unknown	Yes	Standard assessment of the impact	Required	Targeted consultation	Potentially targeted research	Yes	WINSW will continue to engage local Aboriginal groups and representatives as part of a the preparation of the project EIS. This engagement will seek to co-design with these groups to identify opportunities to mitigate impacts and enhance benefits. The SIA will identify and assess these opportunities at a high level.
Construction and operation Aboriginal cultural values	culture		Positive	Yes - other project	Potential impactc to Aboriginal communities resulting from the proposal are generallly well understood due to ongoing consultation carried out by WINSW, and as such have identifyied some key areas of interest to date.	N/A	N/A	No	No	No	Unknown	Yes	Standard assessment of the impact	Required	Targeted consultation	Potentially targeted research	Yes	WINSW will continue to engage local Aboriginal groups and representatives as part of a the preparation of the project EIS. This engagement will seek to co-design with these groups to identify opportunities to mitigate impacts and enhance benefits. The SIA will identify and assess these opportunities at a high level.
Construction Traffic, noise, vibration, air quality and visual amenity	way of li		Negative	Yes - other project	Traffic, dust, noise and vibration and visual amenity impacts from construction activities and resulting impacts to communities' way of life are generally well understood due to investigations on the majority of major projects.	No	Not required	No	No	No	Unknown	No	Minor assessment of the impact	Required	Limited - if required (e.g. local council)	Not required	No	Changes to local amenity during operation such as visual, noise and vibration and air quality are expected to be relatively localised and would be assessed in the EIS by studies such as noise and vibration, air quality, and landscape and visual assessments. These studies are expected to recommend appropriate mitigation measures which would assist to manage impacts to local communities way of life. A stakeholder engagement strategy would assist to communicate to local communities how potential impacts would be managed.
Construction and operation Access to recreational areas	access		Negative	Yes - other project	Flooding and drainage impacts from construction and operation activities and resulting impacts access are generally well understood due to investigations on the majority of major projects.	No	Not required	No	No	No	Unknown	No	Minor assessment of the impact	Required	Limited - if required (e.g. local council)	Not required	No	Changes to flooding and drainage are expected to be relatively localised and would be assessed in the EIS by studies such hydrology. These studies are expected to recommend appropriate mitigation measures which would assist to manage impacts to access. A stakeholder engagement strategy would assist to communicate to local communities how potential impacts would be managed.

PROJECT ACTIVITIES	CATEGORIES OF SOCIAL IMPACTS	POTENTIAL IMPACTS ON PEOPLE		PREVIOUS INVESTIGATION OF IMPACT		CUMULATIVE IMPACTS		ELEMENTS OF IMPACTS Based on preliminary investigation					ASSESSMENT LEVEL FOR EACH IMPACT				PROJECT REFINEMENT	MITIGATION / ENHANCEMENT MEASURES
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Construction Accommodation	access	The construction of the proposal may require a number of non-resident workers to be accommodated in the in existing short-term accommodation located in the local and regional study area. This would increase demand for accommodation, which would benefit accommodation providers, but could reduce availability for tourists.	Negative	Yes - other project	Changes to access resulting from the establishment of a work site, and resulting impacts to communities' access, are generally well understood due to investigations on the majority of major projects.	Yes	Access to social infrastucture services and facilities	Unknown	No	No	No	No	Minor assessment of the impact	Required	Limited - if required (e.g. local council)	Not required		Changes to the access and resulting impacts to the community would be assessed in the social impact assessment at a high level. This would recommend appropriate mitigation measures which are expected to manage impacts to access for local communities, which may include communication of construction timeframes.
Construction Social infrastructure	access	A non-resident workforce may increase demand on social infrastructure services and facilities such as emergency services, health services, and recreational facilities. This is most likely to occur in areas where the non-resident workforce would be accommodated. This would increase demand for services, which would benefit providers, but could reduce availability for the local area.	Negative	Yes - other project	Increased demand on social infrastructure resulting from a non-resident workforce, and resulting impacts to communities' access, are generally well understood due to investigations on the majority of major projects.	Yes	Access to accommodation	Unknown	No	No	No	No	Minor assessment of the impact	Required	Limited - if required (e.g. local council)	Not required		Changes to the availability of social infrastructure would be assessed in the social impact assessment at a high level. This would recommend appropriate mitigation measures which are expected to manage impacts to access for local communities.
Opertation Water security	access	The operation of the proposal would provide efficient and secure water delivery of consumptive waters for water users in the local and regional communities. This would benefit those in the community through flexible irrigation schedules and improved town water supply. Water quality and security would support the operations of businesses, particularly agricultural, that are reliant on water from Billabong Creek.	Positive	Yes - other project	Potential benefits to water users has been understood by onoing consultation being carrie dout by WINSW. Perceptions to water security is generally well understood due to investigations on the majority of major projects of his nature.	Yes	N/A	Unknown	No	No	No	yes	Minor assessment of the impact	Required	Limited - if required (e.g. local council)	Not required		Water management would be assessed in other technical studies being prepared for the EIS. ، WINSW will continue to engage the comunity as part of a the preparation of the project EIS to gather perceptions and concerns, and address these through project refinement. THe SIA will address these at a high level.
Opertation Water security	access	The operation of the proposal will bring about new operational rules to manage impacts on biodiversity, bank stability and flooding. While the intention of the proposal is to provide more efficient environmental and productive water, there may be a perceived risk to water availability for agriculture or other irrigator-related uses due to the changed management systems for this water.	Negative	Yes - other project	The perceptions of stakeholder and community has been understood by onoing consultation being carrie dout by WINSW. Perceptions to water security is generally well understood due to investigations on the majority of major projects of his nature.	Yes	N/A	Unknown	No	No	No	yes	Minor assessment of the impact	Required	Limited - if required (e.g. local council)	Not required		Water management would be assessed in other technical studies being prepared for the EIS. ، WINSW will continue to engage the comunity as part of a the preparation of the project EIS to gather perceptions and concerns, and address these through project refinement. THe SIA will address these at a high level.

PROJECT ACTIVITIES	CATEGORIES OF SOCIAL IMPACTS	POTENTIAL IMPACTS ON PEOPLE		PREVIOUS INVESTIGATION OF IMPACT		CUMULATIVE IMPACTS		ELEMENTS OF IMPACTS Based on preliminary investigation					ASSESSMENT LEVEL FOR EACH IMPACT				PROJECT REFINEMENT	MITIGATION / ENHANCEMENT MEASURES
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Construction and operation Economy, employment and business	livelihoods	Potential for local and regional businesses to participate in procurement opportunities during construction. Local businesses may also benefit from construction workers spending money at local businesses, such as food outlets located in nearby townships. Potential procurement opportunities and increased patronage is likely to be viewed as important to local businesses. Some business owners are expected to have a high to moderate level of interest in procurement / increased patronage.	Positive	Yes - other project	Potential economic benefits of construction projects are generally well understood and qualitatively assessed in investigations for most major projects.	N/A	N/A	No	No	No	No	Unknown	Minor assessment of the impact	Required	Limited - if required (e.g. local council)	Not required	No	Impact and employment opportunity figures will be addressed in the EIS prepared for the proposal, and will be assessed at a high level in an SIA if required. Local communities may be interested in local employment opportunities.
Operation Economy, employment and business	livelihoods	Improved water quality and fish populations has the potential to attract more visitors for recreation and eco-tourism. Local tourism operators, such as accommodation providers, dining and retail, may benefit from increased patronage. Some business owners are expected to have a high to moderate level of interest in increased patronage.	Positive	Yes - other project	Potential economic benefits of improved environment to eco-tourism and recreation are generally well understood and qualitatively assessed in investigations for most major projects of this nature.	N/A	N/A	No	No	No	No	Unknown	Minor assessment of the impact	Required	Limited - if required (e.g. local council)	Not required	No	Impact will not be assessed in other studies, and will be assessed at a high level in an SIA if required. Local businesses may be interested in tourism opportunities.

Appendix E Yanco Creek fish movement model

Yanco Creek fish movement model

Unpublished Client Report

Ivor Stuart

APRIL 2022

Arthur Rylah Institute for Environmental Research
Unpublished Client Report

Arthur Rylah Institute for environmental research

VICTORIA State Government | Environment, Land, Water and Planning

Acknowledgment

We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it. We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

We are committed to genuinely partner, and meaningfully engage, with Victoria's Traditional Owners and Aboriginal communities to support the protection of Country, the maintenance of spiritual and cultural practices and their broader aspirations in the 21st century and beyond.

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Yanco Creek fish movement model

Unpublished Client Report for Water Infrastructure NSW

Ivor Stuart[1]

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Arthur Rylah Institute for Environmental Research
Unpublished Client Report for Water Infrastructure NSW

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Contents

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1. Summary

The Yanco Creek modernisation project is part of the Sustainable Diversion Limit Adjustment Measures (SDLAM) program being implemented by Water Infrastructure NSW. Included within the project are: investigations of infrastructure modernisation to improve water management in the Yanco Creek system (i.e. Yanco, Billabong, Colombo and Forest creeks). The objective of this report is to develop a conceptual *Yanco Creek fish movement model*, for Water Infrastructure NSW, to broadly scope fish passage requirements for consideration under the Yanco Creek modernisation project.

The present report provides a conceptual model for fish movement in Yanco Creek (i.e., Yanco-Billabong-Colombo system) to inform the *Yanco modernisation project* objectives, hydrological operating scenarios and fish passage discussions. The information provided reviews the available literature and concentrates on conceptually integrating three main elements: (i) hydrology/hydrodynamics, (ii) fish ecology and (iii) eco-hydraulic fish movement model. The eco-hydraulic fish movement model provides the context for fishway objectives to aid in restoring the Yanco system.

From the literature review, the Yanco system, along with the connected Murrumbidgee River, supports approximately 15 fish species with a small number of fish surveys conducted in the last 10 years. Nationally threatened Trout Cod (*Maccullochella macquariensis*) are present in the upper system where lotic (flowing) reaches remain with high snag density. Murray Cod (*Maccullochella peelii*) are also present in the upper Yanco, Colombo and Billabong system. A remnant population of Freshwater Catfish (*Tandanus tandanus*) are also present in the mid Yanco/Billabong and Forest creek systems. Generalist small-bodied native fish are also common in the Yanco system.

As an important baseline context, the present report highlights that within the Yanco system, the native fish community is highly degraded and fragmented with over 30 re-regulating weirs, only one of which has a fishway. The Yanco system is also flow stressed and characterised by highly variable flows and slow flowing shallow weir pool habitats. Recruitment of large-bodied native fish appears predominately reliant on stocking. Hence, fish recovery will be contingent on addressing all threats, including improving fish passage, baseflows, spring pulses, hydrodynamic complexity, depth and physical habitat. For the Yanco modernisation project, restoring fish passage needs to be supported by an integrated approach to fish recovery, in particular flow restoration.

To meet the objective of this report, a conceptual eco-hydraulic fish movement model for Yanco Creek was developed. This model identified five major management priorities to inform the Yanco modernisation project, including: (i) restoring fish passage in the upper and lower 50 km of the Yanco-Billabong system to better connect flowing habitats and provide recolonisation opportunities from the Murrumbidgee and Edward rivers, (ii) providing perennial flows throughout the Yanco system with spring rise (fish breeding hydrograph) implemented each spring, (iii) winter baseflows, (iv) fishways to cater for the full size range of native fish, (v) fishways prioritised for the upper and lower Yanco-Billabong system, such as at Windouran Weir. The conceptual model provides a framework for prioritising these five interventions, which will be important in recognising the current degraded state of the Yanco-system native fish community and implementing a sound plan for recovery of a valuable regional fish assemblage.

2. Introduction

Context

Water Infrastructure NSW is implementing the Yanco Creek modernisation project as part of the Sustainable Diversion Limit Adjustment Measures (SDLAM) program. The project includes, investigating the modernisation of infrastructure to improve water management in the Yanco Creek system – including Yanco, Billabong, Colombo and Forest creeks. The SDLAM program is being delivered by the NSW Government with funding provided by the Australian Government under the Murray-Darling Basin Plan.

The objective of this report is to develop a conceptual *Yanco Creek fish movement model*, for Water Infrastructure NSW, to broadly scope fish passage requirements for consideration under the Yanco Creek modernisation project. The conceptual model was developed by examining published and unpublished information to review knowledge, identify NSW DPI Fisheries priorities and develop generic models of native fish migration. The intent of the conceptual model was to provide background material to inform the *Yanco modernisation project* objectives, hydrological operating scenarios as outlined in the long-term watering plan (DPIE 2020) and fish passage discussions. No specific fish recovery plan exists for Yanco Creek, as have been developed for similar systems elsewhere (Mallen-Cooper et al. 2013); hence fish movement and restoration of connectivity is considered in the context of integrated system management here. The information provided here concentrates on conceptually integrating three main elements:

i. Hydrological/hydrodynamic review
ii. Ecological review
iii. Eco-hydraulic fish movement model

Project scope

The scope of the present report includes:

- Review of background material relevant to native and non-native fish and hydrology of the Yanco-Billabong system,
- Construction of a fish movement model (FMM) for the Yanco-Billabong system, particularly as it relates to the Yanco modernisation project,
- Provide insight into how the FMM informs fishway design objectives and criteria,
- Provide broad context of fishway objectives for restoration of Yanco-Billabong system,
- Integrate stakeholder input into refinement of the FMM,
- Geographically, the scope of the study extends to the regulated Yanco-Billabong-Colombo system only.

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2.1. Yanco system and native fish

The Yanco system, in south-western NSW, is characterised by three major spatial reaches: (i) upper Yanco Creek from the Murrumbidgee River to Colombo Creek, (ii) Colombo Creek, (iii) lower Yanco Creek and Billabong Creek, including Forest Anabranch (Figure 1 and 2). There are also several major wetlands including Molly's Lagoon, Dry Lake and Wanganella Swamp.

The Yanco Creek system, including the Billabong, Colombo, Forest and Yanco creeks, contains an important fish fauna and with the mid-Murrumbidgee River encompasses the range of at least 15 native fish species (Gilligan 2005; Baumgartner and Harris 2007; Appendix 1). Specific fish survey information in Yanco Creek is sparse compared to the Murrumbidgee River but some fish survey data are available from three main reports (Sharpe et al. 2013; Sharpe and Stuart 2014; Sharpe 2018).

There is a Trout Cod population in the upper reaches of Yanco Creek above Tarabah Weir, including Yanco cutting (Sharpe et al. 2013). A small number of Trout Cod have also been collected from Colombo Creek near the offtake from Yanco Creek (Sharpe and Stuart 2014) indicating these fish occur in the upper reaches where driving head creates flowing water conditions. Young-of-the year Trout Cod are present in low numbers above Tarabah Weir though populations appear to be declining with poor spawning and recruitment documented in a recent comprehensive larval survey (Sharpe 2018).

Murray Cod are also present in the upper Yanco and Colombo creeks and appear relatively abundant in the Billabong system. There are many angler reports of Murray Cod through the broader areas of Yanco-Billabong-Colombo systems (Tanya Thompson, Yanco Science Advisory Group). With regular and intense artificial fingerling stocking, it is not clear if Murray Cod are naturally recruiting but a low level of natural recruitment is possible within the flowing areas (Sharpe et al. 2013). Similarly, a remnant population of Freshwater Catfish are also present, mostly in the mid Yanco/Billabong and Forest creek systems (Sharpe et al. 2013) and these may also be recruiting in the shallow flowing pools. Juvenile Golden Perch are collected in Billabong Creek though these are most likely stocked fish (Crook et al. 2015). In the Murrumbidgee River there are populations of Golden Perch, Silver Perch, Freshwater Catfish, Trout Cod and Murray Cod (Baumgartner 2007; Baumgartner and Harris 2007).

Small-bodied native fish are also common in Yanco Creek, as they are elsewhere in the lowlands of the Murrumbidgee River catchment and these include Australian Smelt, Carp Gudgeons, Murray-Darling Rainbowfish, Flatheaded Gudgeons, Dwarf Flat-headed Gudgeons and Unspecked Hardyhead.

Non-native fish

Several non-native fish are also present in the Yanco system including Carp, Goldfish, Redfin Perch and Gambusia. Carp dominate the large-bodied non-native fish community and young-of-the-year occur annually. Wanganella Swamp appears to be an important recruitment point source. In addition, many areas of the mid-lower Yanco system contain large floodplains and wetlands that are connected at minimum regulated flows; hence Carp recruitment may also be widespread.

2.2. Flow regulation and connectivity

In the main Murrumbidgee River, there is no functional fish passage at Yanco Weir. Flows are regulated into the Yanco Creek until the Murrumbidgee River exceeds 10,000ML/day at Narrandera, above that level the flows are uncontrolled. Approximately 10% of Murrumbidgee River flow, at the confluence of the Yanco Creek, is diverted into the Yanco Creek.

The Yanco-Billabong system is highly regulated and fragmented, with over 30 private fixed crest structures which re-regulate water throughout the system (Cooling and Gippel 2017). Only one structure, Tarabah Weir, has a functional fishway. Hence, fish passage throughout the system is extremely limited and this explains the high degree of spatial fragmentation evident for native fish (Sharpe et al. 2013; Sharpe and Stuart 2014). For example, there is no connectivity for fish moving from the Edward River into the Billabong system due to the barrier at Windouran Weir.

Trout Cod mostly occur upstream of Tarabah Weir in the fast-flowing reach, with strong physical habitat, connected to the Murrumbidgee River. There are also some Murray Cod in the offtake reach. Murray Cod, Golden Perch and Freshwater Catfish are mostly found in the Billabong and mid-Yanco systems. Silver Perch are very uncommon but occasionally found in Billabong Creek. From historic survey data, Colombo Creek supports relatively fewer native large-bodied fish, compared to the Yanco-Billabong system and this is likely related to the more regulated and degraded nature of this system. The exception is near the Tarabah offtake where Murray Cod and Trout Cod are present. Anglers also report Murray Cod from the Colombo, Yanco and Billabong systems. Small-bodied native fish are found throughout the Yanco-Billabong and Colombo Creek system but are spatially and temporally patchy. In summary, spatial connectivity is poor and the whole native fish community can be considered disconnected and degraded.

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Figure 1. The Yanco-Billabong system, the red and dark blue circles indicate stream barriers. The orange circles represent low priority barriers. Map courtesy NSW DPI Fisheries.

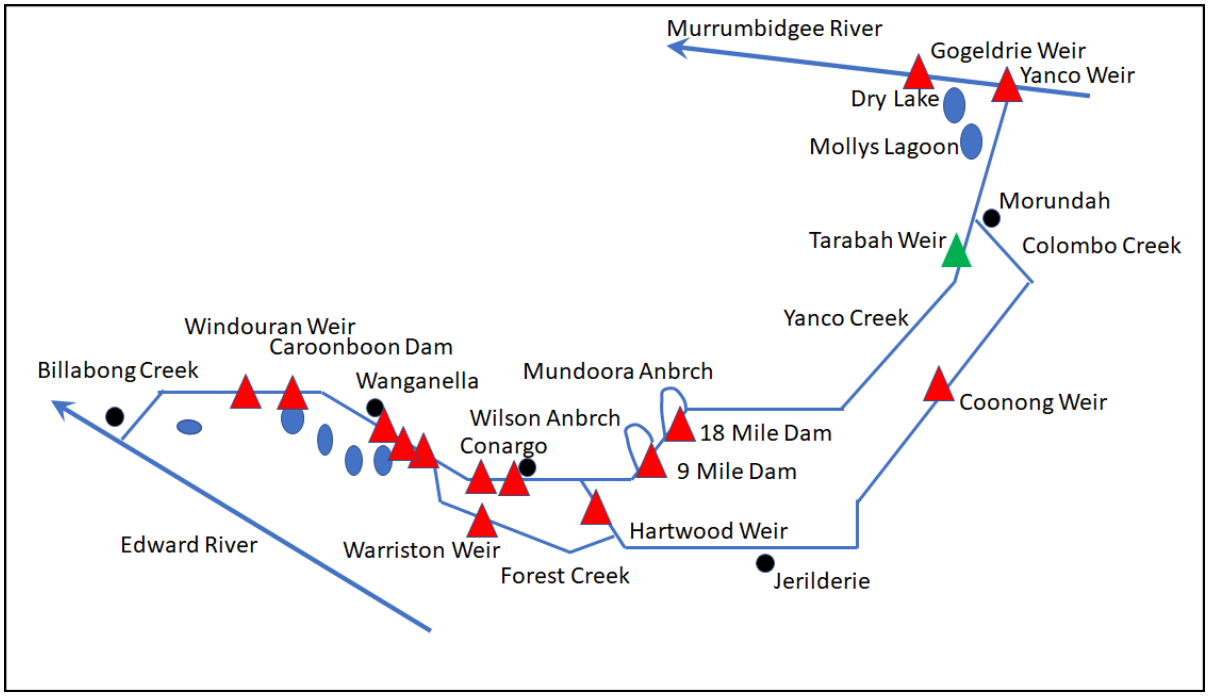

Figure 2. Schematic of the Yanco-Billabong system showing some of the stream barriers (red triangles). The only barrier with a fishway at Tarabah Weir is shown by a green triangle.

Physical habitat

In-stream physical habitat, such as snags, are relatively abundant in the upper Yanco Creek with natural features also including deep holes, long anabranches (i.e., Washpan Creek), backwaters, and snags downstream to well below Morundah. Coupled with fast water hydraulics these are the primary reasons why Trout Cod and Murray Cod occur in this reach (Sharpe et al. 2013; Koehn et al. 2020). Colombo Creek has the most instream structures, the poorest in-stream physical habitat attributes and in general in-stream and riparian physical habitat quality declines as downstream distance increases. The Yanco-Billabong system, near Conargo, is characterised by flowing weir pool habitats with occasional short anabranches (Wilson and Mundoora) and a long anabranch (Forest Creek).

Hydrodynamics

Hydrodynamics is defined as the change in hydraulic conditions (e.g., water level, depth, velocity and turbulence) through time. In Yanco Creek, hydrodynamics is used to describe a key division in aquatic habitats between visibly *flowing water* (lotic) and *stillwater* or *pool* (lentic) habitats. Hydrodynamic complexity (fast and slow flowing water) is a fundamental element of functional riverine ecosystems but this has been lost from large areas of the southern Murray-Darling basin (Mallen-Cooper and Zampatti 2018). Permanent lotic water is crucial for supporting spawning and recruitment conditions for Trout Cod and Murray Cod, and spawning for Golden Perch and Silver Perch (Koehn et al. 2020).

Where dams and weirs have transformed lotic habitats into lentic (still water) environments, such as Yanco Creek, flowing-water specialist species (Murray Cod, Golden Perch, and Silver Perch) populations have declined. In Yanco Creek, the broadscale hydrodynamics are characterised by permanent fast water in Yanco Creek upstream of Colombo Creek offtake and slow flowing weir pools further downstream and in Billabong Creek. After rainfall, several anabranches also provide lotic habitats. There appears to be some level of recruitment in the slow flowing pools for Murray Cod and Freshwater Catfish. A hydraulic model for the system would help to prioritise fish passage and other fish recovery outcomes and Table 1 outlines some useful velocity classifications.

Table 1. Water velocity and depth increments relevant to fish habitat use.

Water velocity (m/s)	Fish habitat
0.00- 0.03	Backwaters
0.04- 0.10	Weirpools
0.11- 0.17	Slow-flowing
0.18- 0.30	Moderate-flowing
0.31- 0.50	Fast-flowing
> 0.50	Very fast

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Hydrology

Hydrology is defined as the change in river discharge or flow (e.g. expressed in units of ML/d) through time. Under natural conditions, there were regular winter-spring flow pulses but under regulated conditions these have reduced frequency and magnitude due to diversions upstream, but when they do occur, they are a major stimulus for fish migration. To inform the fish movement model, a brief review of the gauged flow data is provided here. From these data, it is evident that Yanco, Colombo and Billabong creek are all extremely flow stressed, characterised by low flows and highly variable water levels. Discharge at the Yanco Creek Offtake (gauge #410007) shows high variability during the spring spawning season (Figure 3). Downstream of Tarabah Weir (gauge #4100213) discharge regularly drops below 100 ML/d over winter (Figure 4) which persist well downstream with Morundah gauge (#410015) also shown in Figure 5. These low discharges are illustrative of the flow split between Yanco and Colombo creeks where that latter system generally has higher flows (Figure 6). At the downstream end of the system, at Darlot (gauge #410134), on Billabong Creek, the system is still characterised by highly variable water levels (Figure 7) and discharge (Figure 8). A minimum daily flow of 50 ML/d at Darlot is usually provided to maintain connectivity with the Edward River at the downstream end of the Yanco-Billabong system.

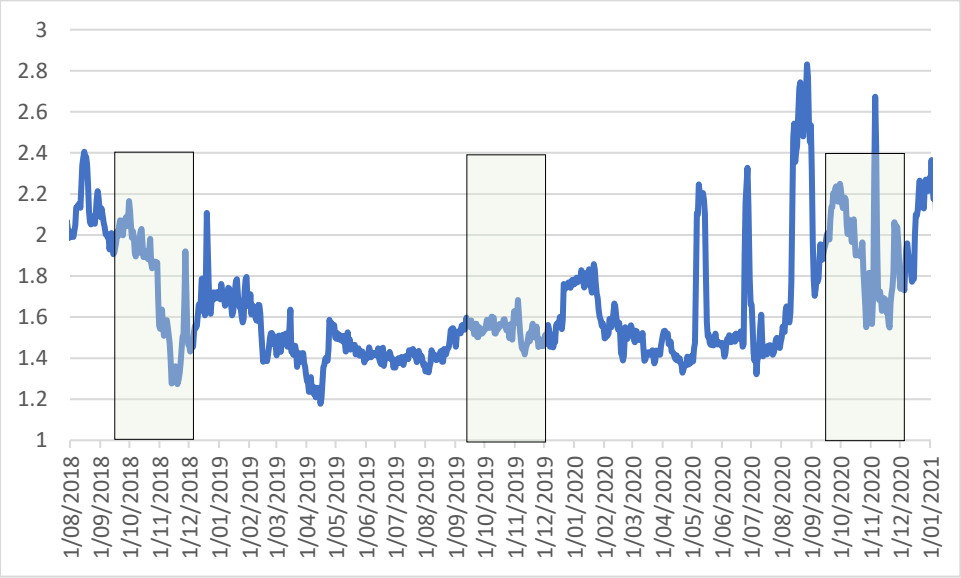

Figure 3. Recent water level gauging at Yanco Creek offtake (gauge #410007) with green rectangles indicating the nesting season for Trout Cod, Murray Cod and Freshwater Catfish. The 2018 and 2020 seasons were characterised by high variability (i.e., approximately 1 m). The 2019 season had relatively low variability (i.e., 0.25 m). Nesting species require low variability to promote breeding success.

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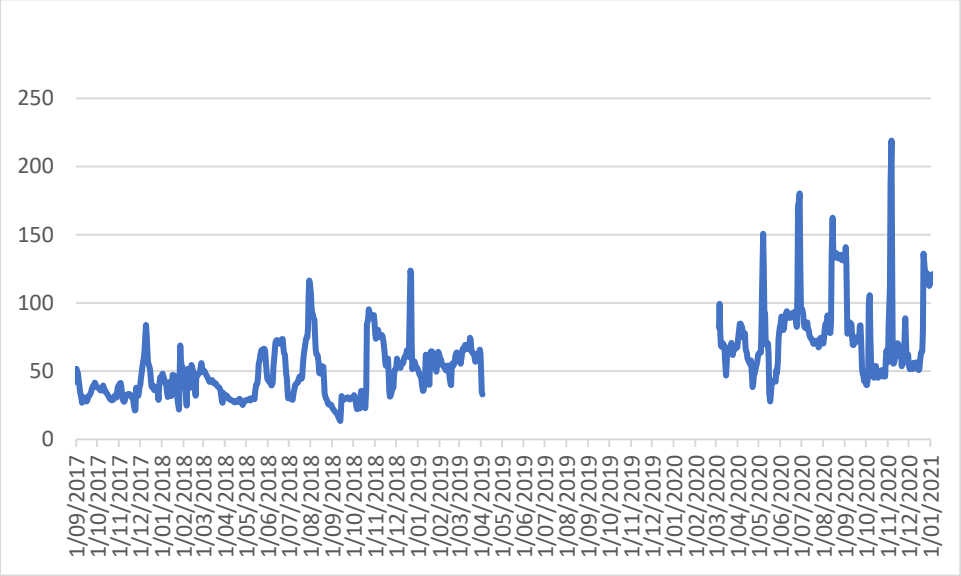

Figure 4. Recent discharge (ML/d) below Tarabah Weir (gauge #41000213) showing regular low flows into the Yanco system (i.e., <100 ML/d).

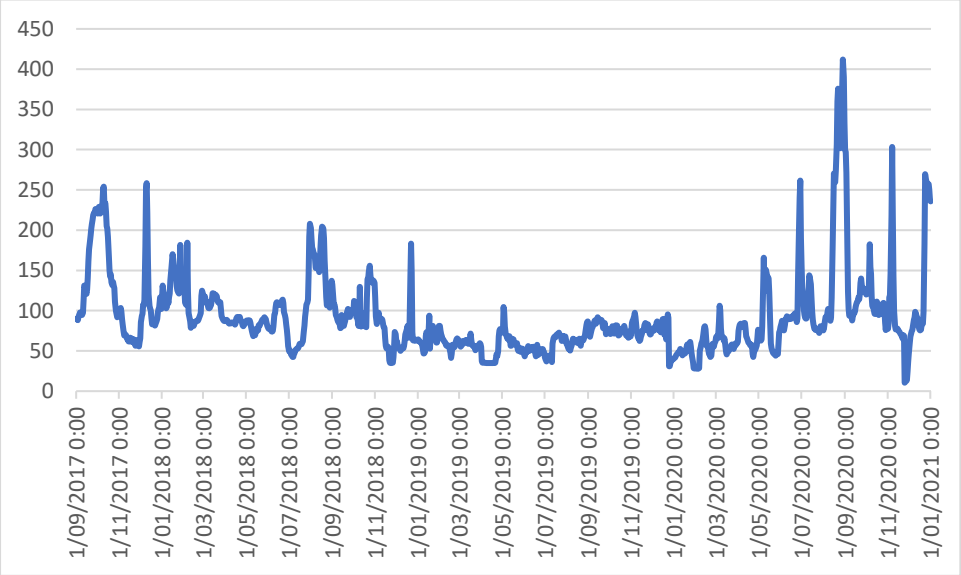

Figure 5. Recent Yanco Creek discharge (ML/d) at Morundah (gauge #410015) showing regular low flows (i.e. <100 ML/d).

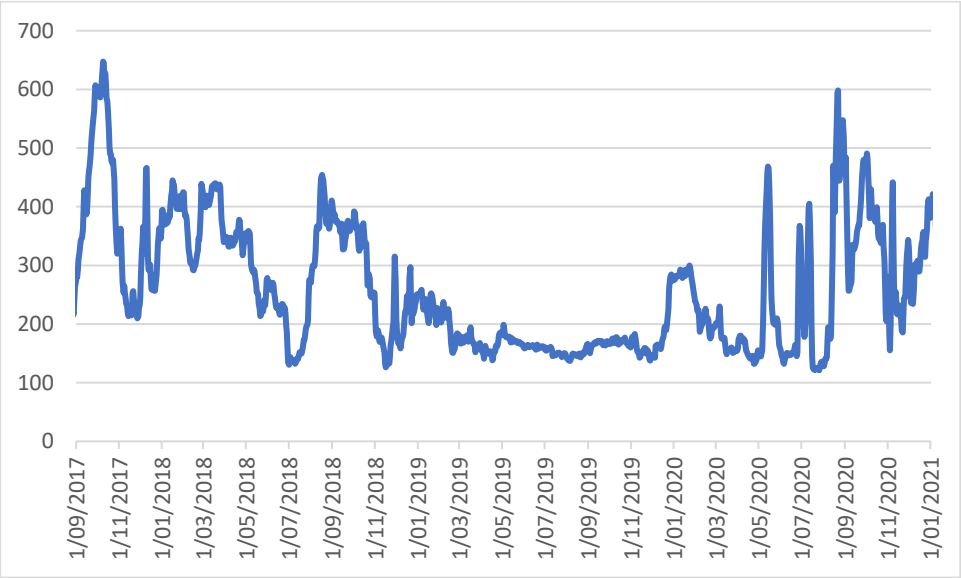

Figure 6. Recent Colombo Creek discharge (ML/d) at Morundah (gauge #410014) showing regular low flows (i.e. >100 ML/d).

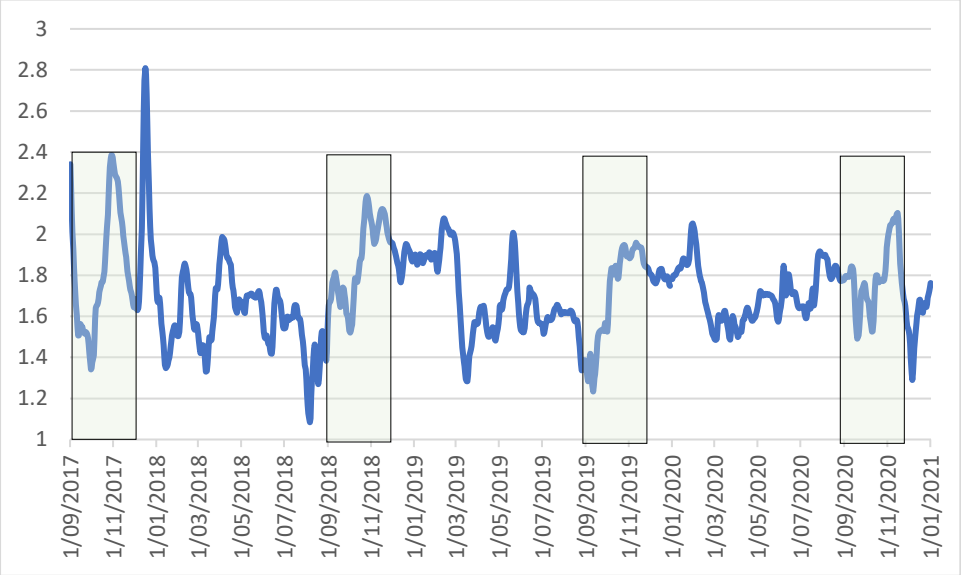

Figure 7. Recent water level (m) in Billabong Creek at Darlot (gauge #410134) with green rectangles indicating the nesting season for Trout Cod, Murray Cod and Freshwater Catfish. The 2017, 2018 and 2019 seasons were characterised by high variability (i.e., approximately 0.8-1 m). The 2020 season had moderate variability (i.e., 0.5 m). Nesting species require low variability to promote breeding success.

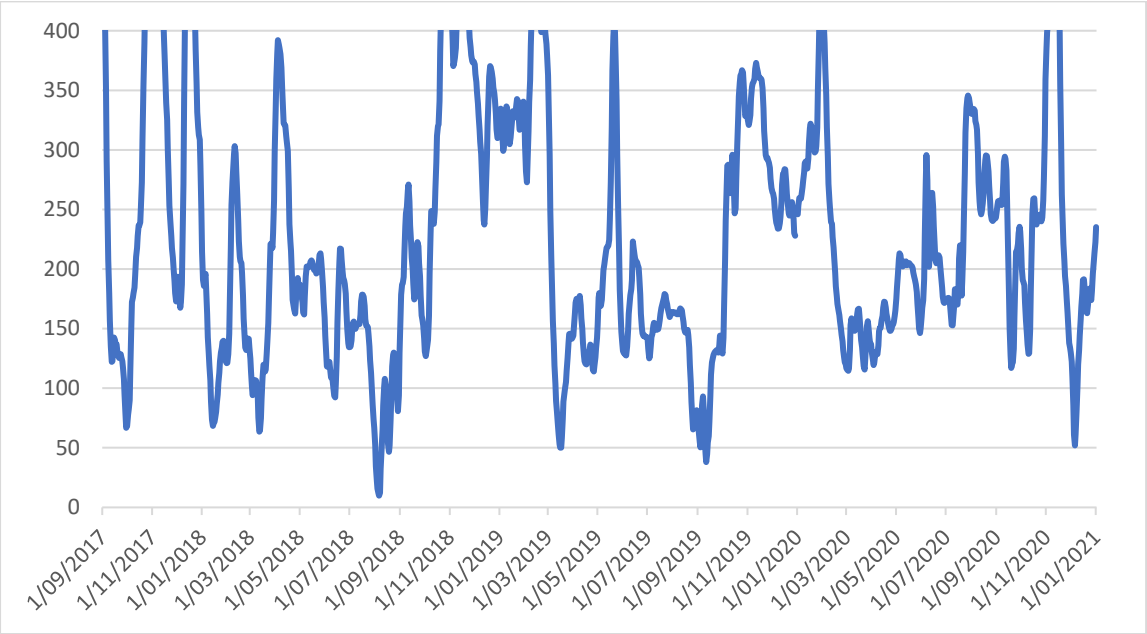

Figure 8. Recent discharge in Billabong Creek at Darlot gauge (gauge #410134) showing high variation with brief periods when flows drop to <50 ML/d. Note that the y-axis scale (ML/d) is truncated to show the low flows.

3. Discussion

Some reaches of the Yanco system are severely flow stressed and characterised by highly variable flows and slow flowing shallow weir pool habitats. The major flow threats can be summarised as (i) a highly regulated and fragmented system that impedes fish passage, (ii) high variable flows, with low winter baseflows that likely result in poor survival of juvenile fish. For example, the upper Yanco Creek often displays flow variability of 1-1.5 m within a few days which severely limits the nesting success of several key species, including Trout Cod. These threats are addressed in the long-term watering plan (DPIE 2020). Optimising flow conditions continues to represent an opportunity to improve several major elements of native fish ecology, including: very limited connectivity, lack of hydraulic complexity, depth and physical habitat, and non-optimised hydrological conditions for movement, breeding and survival. Hence, restoring fish passage needs to be considered in the context of all other stressors to fish recovery, these are:

1) Connectivity and fish passage

   At present the many weirs and regulators throughout the Yanco system provide no upstream passage of fish during regulated conditions. Hence, opportunities for many native fish to develop local self-sustaining populations or regularly recolonise from the Murrumbidgee or Edward rivers are limited. Windouran Weir at the downstream end of the system highlights the present lack of connectivity between the Edward and lower Billabong system.

2) Improved flows for fish movement

   The Yanco system is severely flow restricted and requires a permanent and greater flow regime which may require modification of the flow split between the Yanco-Colombo systems at Tarabah Weir. For the upper/mid Yanco Creek and Billabong Creek (including Wilson and Mundoora anabranches), prioritising greater annual discharge with permanent seasonal baseflows (i.e., 250 ML/d; Sharpe et al. 2013; Alluvium 2013) especially in winter, spring increases in discharge and end-of-system fish attraction flows that match contemporary knowledge for fish recovery. Fish 'hydrographs' promote movement, breeding and survival of native fish (Stuart and Sharpe 2021) and should be refined for each system (Tonkin et al. 2021). For Yanco Creek, refinements could include end-of-system flows to maximise fish recolonisation from the Edward system.

3) Variation in water level

   The upper Yanco system and the lower Billabong system are characterised by rapid changes in water level during the fish breeding season which likely reduces nesting success for Murray Cod, Freshwater Catfish, and Trout Cod. Preventing major drops (i.e., >0.2 m) in water level during the nesting season (September to December) will likely improve fish recovery.

4) Hydrodynamic diversity

   As previously defined, hydrodynamic diversity refers to variation in velocity, turbulence, depth, width, but the key component that has been lost from much of the mid and lower Yanco system are fast-flowing (>0.2 m/s), complex (created by woody debris) reaches, which are a key habitat for large-bodied native fish. At present there is extensive slow-

flowing or still reaches with fast-flowing reaches only in the upper reaches. A model is required for a detailed evaluation of hydraulic attributes.

5) Physical habitat

Physical habitats are relatively intact upstream of Morundah but in-stream habitat and riparian zones are generally degraded below Morundah. These elements will likely require restoration for full fish population recovery.

These threats are readily solvable in Yanco Creek. It is important to note that all five threats are interlinked and addressing only one impact will provide little benefit, for example providing fish passage only will not attract fish into Yanco Creek if there is little flow. Providing flow should also be viewed in the context of and providing hydrodynamic and structural diversity. Other threats to native fish, such as loss into irrigation channels, anoxic blackwater and wetland restoration, are not reviewed here but may also be exerting constraints on local fish communities.

3.1. Other case-studies of fish recovery

For fish recovery in Yanco Creek there is an opportunity to briefly examine learnings from other sites. Recent research demonstrates the resilience and recovery potential of aquatic systems like Yanco Creek. For example, in the Edward-Wakool, Gunbower and lower Darling River, Murray Cod populations can be recovered with a managed hydrograph that promotes base flows, flow pulses, perennial lotic conditions, hydraulic complexity and prevention of cease-to-flow conditions (Stuart et al. 2019; Tonkin et al. 2021). The major mechanisms for increasing Murray cod abundance is: (i) promoting spring nesting success and (ii) enhancing over-wintering survival of young-of-the year and juvenile size-classes, including stocked and naturally spawned fish.

The spatial scale of these restorations is flexible and can be as little as 5 km for Murray cod or as large as 500 km for Golden Perch (Stuart and Sharpe 2021). In some cases, fish recovery has occurred following major disturbances, such as anoxic blackwater and fish deaths (Thiem et al. 2017). This logic of implementing fish recovery hydrographs can potentially be extended to Murray Cod, Freshwater Catfish and Trout Cod in the Yanco system with a high degree of certainty of positive ecological outcomes. There may also be an opportunity to investigate whether Molly's Lagoon can be used as a recruitment habitat (i.e. nursery area) for Golden Perch, particularly during natural high flows in the Murrumbidgee system, much like the recent successful case-study in the Yanga wetlands. Some planning may be required at the outlet structure to ensure fish can successfully outmigrate downstream.

3.2. Fish movement model to guide fish passage restoration

NSW DPI Fisheries have developed a Fish and Flows Management Framework that explores the flow conditions (or flow/hydraulic components) that different groups of native fish need (Ellis 2016). That information was used in the formulation of the Yanco Creek fish migration model but is not specifically repeated here.

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A key objective of the *Yanco fish movement model* is to be able to generate fish passage criteria suitable for any site in the system. To do this we present here a regional and local conceptual model of fish migration that consolidates a review of hydrology, hydrodynamics, and ecology. Thus, developing a conceptual model that identifies the expected species and sizes (life-history stage) within the Yanco biogeographic region, their seasonality of migration, diel movement patterns, migratory biomass, migratory direction (upstream or downstream) and the target range of flows which are ecologically relevant helps to set transparent ecological objectives. These models of migration then inform a broad view of fish migration requirements, with application to prevailing hydrological regimes and enable identification of generic fishway design criteria.

- **Large-bodied native fish** (Murray Cod, Trout Cod and potentially Freshwater Catfish):
  - Adult fish can complete their life cycle between weirs if there is flowing water with woody habitat. Fish will move upstream and downstream in the Yanco-Billabong, Murrumbidgee and Edward rivers, mainly from mid-winter to the end of spring and early summer (Figure 9). The major cue for these species is rising seasonal water temperature but also spring freshes. Adult fish will move into the Yanco-Billabong-Colombo system from late-winter to early summer. Adult and sub-adult fish will move to recolonise following hypoxic blackwater events. The Yanco-Billabong appears to provide optimal hydraulic and physical habitats.
  - Large-bodied fish will distribute throughout the Yanco system, usually targeting habitats with fast velocities (i.e., >0.25 m/s), deep pools and snags, including anabranches (i.e., Wilson and Mundoora).
    - When water levels fall at the end of the irrigation season some adult fish will leave. However, there is likely to be constant exchange of fish during spring and summer.
      - Fish will be strongly cued to move by rising or falling water levels (e.g., 150-200 mm/day).
      - More adult fish will move at medium and high flows, including floods
      - Aggregations of these fish below weirs can be expected.
    - Larvae may passively enter Yanco Creek from the Murrumbidgee River during spring/summer where there will likely be a low level of recruitment. There appears to be little spawning and recruitment within Yanco Creek, with the exception of Freshwater Catfish in the lower Yanco and Billabong creeks.
    - Juveniles and sub-adults will likely move upstream and downstream in Yanco Creek during spring and summer, some fish will also move out into the permanent Murrumbidgee River system. Juvenile fish will move at low, medium, and high flows. Aggregations of these fish below weirs can be expected. High base winter flows improve survival of young-of-the year and juvenile size-classes.
    - Large-bodied fish, where permanent flows are maintained in the Yanco-Billabong-Colombo system, then many large-bodied fish will likely become partially resident and there is some potential to form a local self-sustaining Murray Cod and Trout Cod populations in the upper reaches. Where flows are intermittent or seasonal, then most adult and sub-adult large-bodied fish will exit the system when flows recede.

- Freshwater Catfish will likely reside in permanent slow-flowing habitats with relatively stable spring-summer water levels to complete their nesting. These can be expected throughout the Yanco system but particularly in the lower Yanco and Billabong creek area.

- **Medium-bodied native fish** (mainly Golden Perch and Silver Perch)
  - Adult fish will migrate upstream and downstream in spring and summer and especially during a river rise or flooding and will aggregate below weirs. For these species, maximising the access to the whole Yanco system as a foraging and home range habitat for adult and sub-adult fish is the major objective.
  - Eggs and larvae are not expected within Yanco Creek with the exception of drift from the Murrumbidgee River. Low survival is expected unless water enters Molly's Lagoon, usually during a large fresh or flood in the Murrumbidgee River.
  - Juveniles migrate upstream, especially from mid/late-spring and summer though few appear to actively enter Yanco Creek.
- **Small-bodied native fish** (mainly Carp Gudgeons, Australian Smelt, Murray-Darling Rainbowfish and Unspecked Hardyhead)
  - Adult fish will migrate in Yanco Creek throughout spring and summer.
  - Larvae will drift into Yanco Creek from the Murrumbidgee River. Small-bodied fish can be expected to spawn within the Yanco system, especially where there is access to high quality adjacent wetlands with intact macrophyte communities
  - Juveniles will likely inhabit and complete their life-histories in Yanco Creek.

- **Non-native fish (Carp)**
  - Adult fish, particularly Carp, will move within the Yanco system from spring to autumn and use fishways. On rising flows and floods, Carp will access backwater and wetland habitats for spawning, particularly large wetlands such as Wanganella Swamp.
  - Larvae and juveniles will reside in Yanco Creek and grow to adults, with relative densities greater in slow-flowing weir pool habitats and in the mid-lower reaches of the Yanco-Billabong system.

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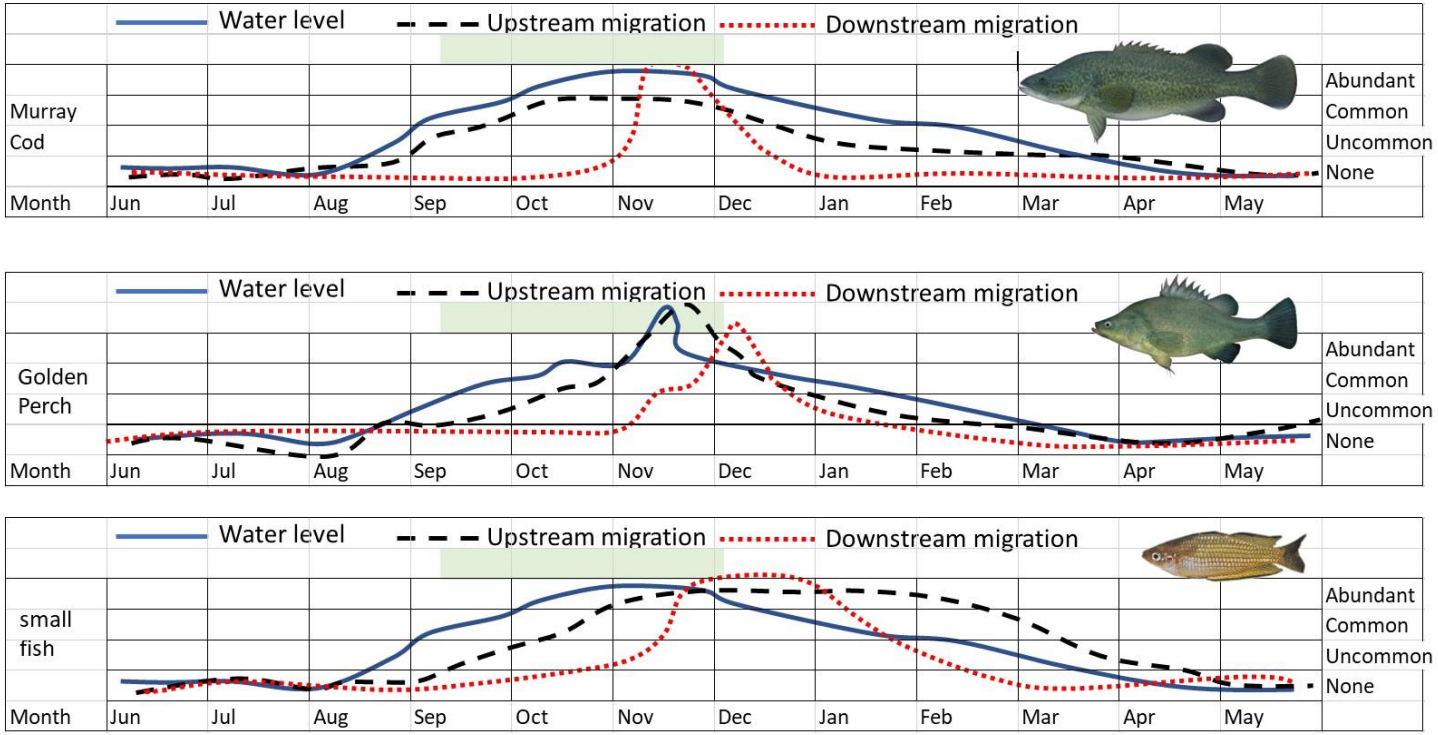

Figure 9. Simplistic conceptual models for fish movements in the Yanco system. The green rectangle indicates the fish spawning season.

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3.3. Fish passage objectives

Fish passage objectives describe what fishway performance is required to meet the broader population and ecological objectives, based on the above conceptual movement models. In general, fish passage objectives centre on the need to pass a required proportion of the fish assemblage, individual species, or life-stages without delay and over an expected range of flows.

Fishway objectives need to also describe both the river flow conditions and timing over which fish passage needs to be provided, both of which are provided in the long-term watering plan (DPIE 2020). Integrating eco-hydraulic outcomes depends on understanding the relationship between fish movement and local hydrology and which was specifically addressed in the conceptual movement model. While specific sites may have bespoke objectives, the broad fish passage requirements for Yanco-Billabong fishways are summarised in Appendix 2 and include:

- Continuous flows in the Yanco-Billabong system to enable fishways to provide system-wide connectivity;
- In general, an ability for the fishways to operate for the full range of hydrological conditions experienced at the sites, up to drown-out;
- Fish will migrate from late winter through to autumn, especially during rising spring flows;
- Fishways should be designed for upstream passage of fish from 30-1,000 mm long and internal hydraulics should conform to current design standards (O'Connor et al. 2015);
- Fishways should be prioritised at the upper and lower ends of the Yanco-Billabong system (i.e. upstream and downstream of Conargo) and should pass large and medium-bodied native fish as the ecological priority. Windouran Weir, the most downstream structure, is among the highest priorities;
- As a general principal, fish passage should also provide safe downstream passage of eggs, larvae, juvenile and adult fish;
- Due to the number of barriers and degraded habitats, fish passage in Colombo Creek can be considered as a second restoration module following the Yanco-Billabong.

3.4. Integrated hydrological and fish passage priorities

From the literature and hydrological/hydraulic review, and interpretation of the conceptual movement model, the following integrated local eco-hydraulic priorities are suggested:

- Promote and support a local breeding population of Trout Cod in the upper Yanco system by implementing (i) a permanent flowing water habitat, (ii) a spring rise in discharge with low variability (i.e. <0.15 m/d), (iii) a high winter baseflow, and (iv) restored connectivity in the upper system (above Conargo), among the Yanco and Murrumbidgee systems (Figure 10). Prioritise fish passage in the upper connected system where this flow can be achieved.

- Protect hydraulic diversity and longitudinal fast flowing reaches in the upper Yanco system. A hydraulic model to determine where the spatial and temporal scale of fast flowing habitats (i.e. >0.25 m/s) that can be protected will help identify the priority spatial zone for fish passage restoration.
- Promote recolonisation of the upper Yanco Creek system by fish from the Murrumbidgee River through providing a perennial flow to enhance residency by fish that move into the system. Re-evaluate the flow split at Tarabah Weir and implement an optimised hydrograph to support fish passage restoration in the Yanco system.
- Consider Colombo Creek as a second fish passage priority after fish passage restoration in the Yanco-Billabong system due to the relatively degraded nature of Colombo Creek, with more stream barriers and more degraded physical, hydraulic and riparian habitats.
- Promote recolonisation of the lower/mid Billabong-Yanco system, including Forest Anabranch, by fish from the Edward River by providing a perennial end-of-system flow with a spring fresh.
- Protect and restore Murray Cod and Freshwater Catfish in the Billabong system (below Conargo) by providing steady spring water levels for fish nesting plus high winter baseflows for enhanced juvenile fish survival. Prioritise fish passage in the lower connected system where this flow can be achieved. Consider including Forest Anabranch as part of the perennial flowing system.
- Fishways in the middle reaches appear to be a secondary priority relative to the upper and lower ends of the system. Windouran Weir at the downstream end of the system is among the highest fish passage priorities.
- Work toward a fully connected Yanco-Billabong system via system-scale flows, weir removals and provision of fish passage. Outcomes will likely be most evident for medium and large-bodied native fish species as these fish are strongly migratory.
- Provide a baseflow throughout the Yanco-Colombo-Billabong system, including Forest, Wilson and Mundoora anabranches to maintain fish habitats and fish communities, particularly breeding populations of Murray Cod, Freshwater Catfish and small-bodied native fish.
- Investigate provision of water to fill Molly's Lagoon and potentially Dry Lake during a Murrumbidgee flood to determine if recruitment of Golden Perch can be achieved. Upgraded fish passage will likely be required at the existing outlet pipe culverts to pass larval and juvenile fish downstream into the connected Yanco-Murrumbidgee system. An exit hydrograph may be required to cue fish to leave wetlands and enter permanent riverine habitats.
- Identify other important wetlands, anabranches and floodplain habitats where lateral connectivity can be improved for small-bodied fish outcomes. This may include wetlands at the lower end of the Forest Creek system between Wanganella and Moulamein. Re-stocking of some locally extinct small-bodied species, such as Olive Perchlet (*Ambassis agassizii*) and Southern Pygmy Perch (*Nannoperca australis*), may be required.
- Additional fish surveys in data poor areas will help to identify local fish recovery priorities (i.e. Forest, Wilson and Mundoora anabranches).
- Consider downstream passage of all life-stages of fish that migrate in the connected Yanco system to maximise passage survival rates.
- Improve physical and riparian habitats along the length of the restored areas.

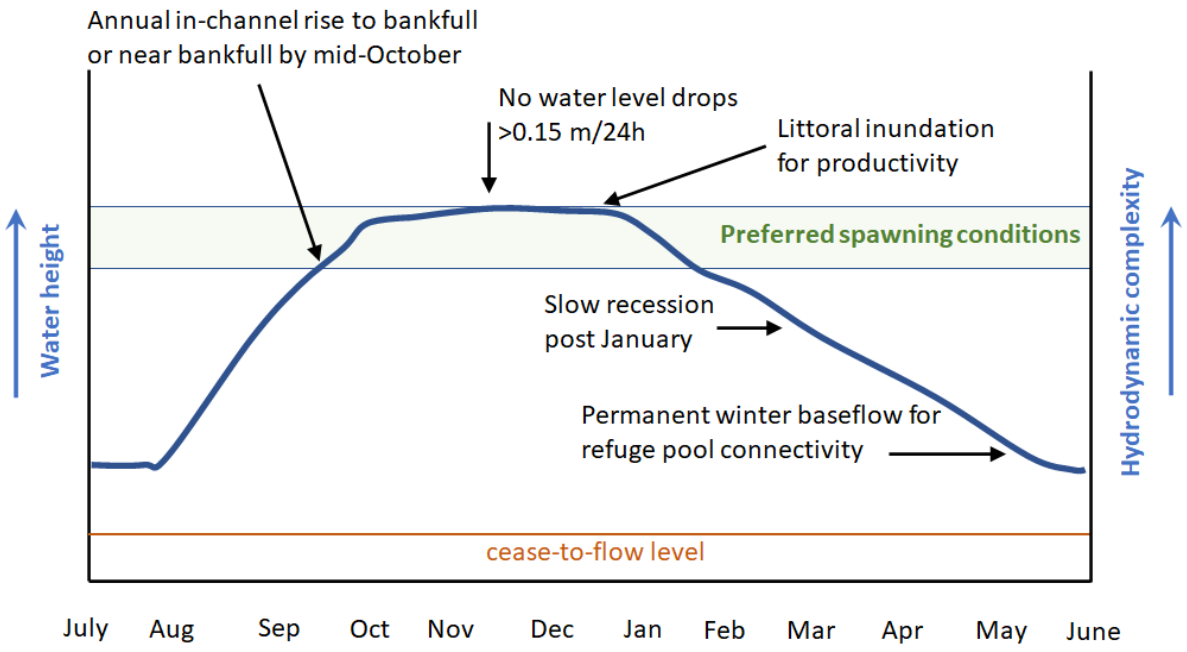

Figure 10. A conceptual model hydrograph for Murray Cod to complete their life history. The important elements are: (i) perennial lotic flows, (ii) spring rise and steady peak without major water level drops, (iii) an attenuated summer recession to (iv) a high winter baseflow.

4. Conclusion

A conceptual eco-hydraulic fish movement model for Yanco Creek was developed which identified five major management priorities to inform the Yanco modernisation project, including: (i) restoring fish passage in the upper and lower 50 km of the Yanco-Billabong system to better connect flowing habitats and provide recolonisation opportunities from the Murrumbidgee and Edward rivers, (ii) providing perennial flows throughout the Yanco system with spring rise (fish breeding hydrograph) implemented each spring, (iii) winter baseflows, (iv) fishways to cater for the full size range of native fish, (v) fishways prioritised for the upper and lower Yanco-Billabong system, such as at Windouran Weir to provide fish recolonisation opportunities from the Edward Rivers. The conceptual model provides a framework for prioritising these five interventions. The current degraded state of the Yanco-system native fish community may be offset by implementing the five priorities listed above with a vision of a return to a valuable regional fish assemblage. Conducting regular fish surveys, before and after these interventions, would assist in demonstrating fish recovery.

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Appendix 1. The fish community which occurs in the Murrumbidgee River. H=high flow, M=medium flow, L=low flow. *Unlikely indicates fish species that once occurred in the Murrumbidgee catchment but have not been recorded in the last 20-30 years. # indicates a species with conservation significance. Scale of movement is micro (<100 metres), meso (100s to 10s km) macro (100s km).

Medium and large-bodied fish	Common name	Murrumbidgee River	Yanco Ck	Usual maximum size	Juvenile migration	Migration river flow	Scale of movement
Macquaria ambigua	Golden Perch	✓	✓	600 mm	Yes	H,M,L	macro
Bidyanus bidyanus#	Silver Perch	✓	✓	500 mm	Yes	H,M,L	macro
Leipotherapon unicolor	Spangled Perch	Unlikely	Unlikely	300 mm	Yes	H,M	macro
Gadopsis marmoratus	River Blackfish	Possible	Unlikely	350 mm	Unknown		meso
Maccullochella peelii#	Murray Cod	✓	✓	1200 mm	Yes	H,M,L	macro
Maccullochella macquriensis#	Trout Cod	✓	✓	700 mm	Yes	H,M,L	meso
Tandanus tandanus	Freshwater Catfish	✓	✓	800 mm	Unknown		meso
Macquaria australasica#	Macquarie Perch	Possible	Unlikely	400 mm	Unknown		meso
Anguilla spp.	Freshwater Eels	Unlikely	Unlikely	1000 mm	Yes	H,M,L	macro
Mordacia mordax	Lamprey	Unlikely	Unlikely	500 mm	Yes	M,L	macro
Nematalosa erebi	Bony Herring	✓y	✓	400 mm	Yes	H,M,L	macro
Small-bodied fish (<100 mm long)							
Hypseleotris spp	Carp Gudgeons	✓	✓	45 mm	Yes	M,L	micro
Craterocephalus stercusmuscarum	Unspecked Hardyhead	✓	✓	80 mm	Yes	M,L	micro
Galaxias olidus	Mountain Galaxiids	Unlikely	Unlikely	100 mm	unknown		meso
Galaxias rostratus	Flat-Headed Galaxias	Possible	Possible	100 mm	unknown	unknown	meso
Philypnodon grandiceps	Flat-Head Gudgeon	✓	✓	90 mm	unknown		micro
Philypnodon sp. 1	Dwarf Flat-Headed Gudgeon	✓	✓	50 mm	Unknown		micro
Retropinna semoni	Australian Smelt	✓	✓	100 mm	Yes	M,L	micro
Melanotaenia fluviatilis	Murray Rainbow Fish	✓	✓	90 mm	Yes	M,L	micro
Ambassis agassizii#	Olive Perchlet	*Unlikely	*Unlikely	60 mm	Unknown	unknown	micro
Mogurnda adspersa#	Southern Purple Spotted Gudgeon	*Unlikely	*Unlikely	100 mm	Unknown	unknown	micro
Nannoperca australis#	Southern Pygmy Perch	*Unlikely	*Unlikely	80 mm	Unknown	unknown	micro
Non-native fish							
Carassius auratus	Goldfish	✓	✓	300 mm	Yes	M,L	
Cyprinus carpio	Common Carp	✓	✓	800 mm	Yes	H,M,L	
Gambusia holbrooki	Gambusia	✓	✓	60 mm	Yes	M,L	

Tinca tinca	Tench	Unlikely	Unlikely	400 mm	Unknown		
Perca fluviatus	Redfin Perch	✓	✓	400 mm	Yes	M,L	
Salmo trutta	Brown Trout	✓	Possible	800 mm	Yes	M,L	
Misgurnus anguillicaudatus	Oriental Weatherloach	Possible	Possible	200 mm	Unknown		

Appendix 2. Fish passage objectives and design criteria

Fish passage objective	Design Criteria
Maximise river discharge in fishway	100% of river discharge in fishway is desirable: target high proportion (e.g. 90%) at low flows and 10% minimum at high flows.
Weir design provides flow patterns that guide fish to fishway entrance	For new weirs, integrate design of crest, gates, abutments, and banks to optimise flow patterns for fish attraction to fishway. Ensure fishway entrance is not masked by competing flows Physical modelling is required to achieve these objectives; CFD can be used to refine the final design at more detailed scales.
Fishway entrance easily located by fish and not bypassed	Locate fishway entrance at the *upstream limit of migration*. This is also part of weir design and physical modelling.
Upstream passage	
Minimum size of fish = 30 mm	Maximum turbulence of 30 W/m^3 (assumed Cd=0.7) Maximum velocity in *vena contracta* (if applicable) of 1.4 m/s Minimum depth of 30 cm
Maximum size of fish = 1000 mm	Maximum turbulence of 90 W/m^3 (Cd 0.7) Maximum velocity in *vena contracta* (if applicable) of 2.0 m/s (Note: turbulence and water velocity for small fish are limiting in design) Minimum depth of 1m for passage of 1.0-1.2 m adult Murray cod at low flows Minimum depth of 1.0 m at low flows
Migration during low flows and large pulse flows e.g. 10,000-20,000 ML/d	Operation of fishway from low flows to drown-out (Note: this determines the range of headwater and tailwater levels for operation of the fishway. “Drown-out” is defined as passage of fish directly over weir and along banks: < 250 mm head differential if rocky banks; <100 mm if vertical concrete abutment)
Downstream Passage	
Drifting eggs and larvae, and fish 50-800 mm	Overshot gates (rather than undershot gates) or fixed crests, with either: plunge pools that have a depth that is 40% of the differential head; or shallow gradient crest. Maximum turbulence in fishway 150 W/m^3 (Note: this is an estimate as there are no data on downstream passage of eggs and larvae in fishways)
Possible passage of adult Murray cod 1.0-1.2 m but not considered an ecological priority	Minimum depth for largest fish = 0.5m (Note: large Murray cod have passed downstream over rock weirs with 0.5 m depth, but may also pass at shallower depths)

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