DELIVERY OF ENVIRONMENTAL MEASURES IN THE SOUTHERN MURRAY-DARLING BASIN

Yanco Offtake – SDLAM Benefits Study

Final Report

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3	06/11/2023	FINAL

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Acronyms and Abbreviations

Term	Description
1D/2D	A linked one-dimensional and two-dimensional computer model
IQQM	Integrated water Quantity and Quality simulation Model – a hydrological river system modelling tool used for water resources management planning
MDBA	Murray Darling Basin Authority
ML	Megalitres
ML/d	Megalitres per day
NSW DPE	NSW Department of Planning and Environment
SDL	Sustainable Diversion Limits
SFI	Specific Flow Indicators (SFIs)
SDLAM	Sustainable Diversion Limit Adjustment Mechanism
TUFLOW	Computer modelling software that can be used for creating hydraulic computer models of the way the water flows through watercourses, floodplains and river structures that control water (such as weirs and regulators)

Executive summary

Background

The Yanco Offtake Benefits Study aims to identify Sustainable Diversion Limit Adjustment Mechanism (SDLAM) benefits associated with modifications to existing infrastructure located at the offtake of the Yanco Creek from the Murrumbidgee River. Investigation of alternate options to deliver SDLAM benefits were out of scope of the study.

The purpose of the study is to assess potential benefits from retaining more water in the Murrumbidgee and reducing flows into the Yanco Creek System, based on a number of SDLAM mechanisms including:

- Increased frequency of meeting the Site-specific Flow Indicator (SFI) targets on the mid-Murrumbidgee River
- Mechanisms to improve management of outflows into Yanco Creek System.

The proposal will require modifications to and/or replacement of existing infrastructure at the location of the offtake from the Murrumbidgee River to the Yanco Creek system. This will involve the raising of the existing weir pool, up to 1.2m, by the provision of upgrades to the Yanco Weir and Yanco Regulator (on the Murrumbidgee River) and a new cutting from the Yanco Offtake to downstream of the Yanco Weir and Regulator. An earlier proposal to include a regulator in the Yanco Offtake cutting was not considered due to the high level of concern from stakeholders.

Project Conclusions and Discussion

The proposed infrastructure changes at the Yanco Weir/Regulator will be designed with the capability to raise the weir pool by up to 1.2m. Weir raising alone, without provision of a regulator in the Yanco Offtake, will significantly increase the flows being driven down Yanco Creek, increasing extent and depths of inundation along the Creek. This would be counter to the aim of limiting uncontrolled flows down the Yanco Creek.

The addition of a return channel from the Yanco Offtake Cutting to the Murrumbidgee River, will mitigate the impacts of weir raising on the upper Yanco Creek floodplain. Fully implementing conveyance features, including the return channel, lay flat gates and no floodplain embankment, is predicted to have the capability to reduce peak flows in Yanco Offtake by 25%.

The hydraulic modelling study evaluated changes in inundation area upstream of the Yanco Weir/Regulator as a result of the 1.2m weir raising, combined with the Yanco Offtake return channel. Significant changes in inundation for the same flow rate at the Narrandera SFI would indicate potential for increased watering of the mid-Murrumbidgee wetlands and a possible resulting SDLAM benefit. However, without a regulator in the Yanco Offtake channel and with the provision of the return channel to facilitate flows from the weir pool downstream of the Yanco Regulator, additional inundation would only be temporary. Hence, this will not underpin sustained floodplain (wetland) inundation. Also, without a regulator in the Yanco Creek cutting, the potential to regulate environmental flows at the Yanco Weir for managed downstream delivery will also be limited.

The modelled inundation extents were extrapolated by the MDBA to estimate inundation changes on the floodplain to around 15 km upstream of Yanco Weir. The results of the analysis showed that there was minimal change in inundation area as a result of the 1.2m weir raising combined with return channel. This would be expected to translate to negligible benefits to the broader mid-Murrumbidgee wetlands upstream, and minimal SDL adjustment potential if any.

Given the initial findings of the upstream assessment, and the limitations of the infrastructure in regulating downstream flows, it was not considered that there would not be any merit in further analysis downstream. Hydrological modelling of the Murrumbidgee to assess SFI sites downstream was not progressed.

Detailed Cost Estimates (DCE) of the proposed infrastructure is significant at $180 million and does not support progressing to a business case on the pursuit of SDL adjustment benefits alone.

Introduction

Background

The Yanco Offtake Benefits Study aims to identify Sustainable Diversion Limit Adjustment Mechanism (SDLAM) benefits associated with modifications to existing infrastructure located at the offtake of the Yanco Creek from the Murrumbidgee River.

The study follows on from previous work undertaken over several years to consider potential works at the Yanco Creek offtake, which aimed to deliver environmental water more efficiently to the mid-Murrumbidgee wetlands. The project was re-scoped in late 2021, resulting in the need to review the potential project benefits.

Study Overview and Objectives

This report presents the activities required to determine the benefits associated with the re-scoped *Improved Flow Management Works at the Murrumbidgee River - Yanco Creek Offtake* supply measure project for the consideration of the case for investment under the Commonwealth Stage 1 Funding for New South Wales Supply and Constraints Measures program. It considers the potential benefits of the infrastructure options for the delivery of equal or improved environmental outcomes through use of less environmental water.

Specifically, the report documents the investigation into the potential SDLAM benefits related to a proposal to increase the Yanco Weir pool by up to 1.2 metres (m), along with building of ancillary infrastructure and including construction of a Yanco Creek “return channel”. This channel would run from the Yanco Offtake channel to the Murrumbidgee River, in order to reduce uncontrolled flows into the Yanco Creek system at high flows in the Murrumbidgee River. The scope of the study did not include the identification or analysis of other options.

In combination with a return channel, the prospective potential benefits of the weir pool raising and contribution to the Basin Plan’s SDL would be through a combination of:

- Using less environmental water to achieve equivalent or improved environmental outcomes, measured by an increased frequency meeting the Site-specific Flow Indicator (SFI) targets on the mid-Murrumbidgee River
- Managing uncontrolled outflows into the Yanco Creek system.

The purpose of the study was to assess potential benefits from retaining more water in the Murrumbidgee and reducing flows into the Yanco Creek System based on these mechanisms.

Study Area and Context

The mid-Murrumbidgee wetlands include the floodplain wetlands from Malebo Range (just west of Wagga Wagga) to Carrathool (Figure 1). They comprise relatively intact flood-dependent vegetation communities that provide habitat for significant fauna species and include several key high value ecological sites that are listed in the Directory of Important Wetlands of Australia (Environment Australia 2001).

The environmental significance of the wetlands includes (MDBA, 2012, former DPIE, 2015):

- Lagoons and swamps along the river that fill from high flows. Aquatic vegetation occurs in these areas, especially when the lagoons and swamps are shallow.
- Terrestrial vegetation that is dominated by River Red Gum.
- Red Gum wetlands (approximately 45,000 ha) between Wagga Wagga and Hay Weir have been shown to be important areas for waterbirds, including breeding of colonial nesting waterbirds.

- Mid-Murrumbidgee wetlands with deep, open water that attracts diving ducks, such as musk dusks and hardheads.
- In the lower section of the mid-Murrumbidgee floodplain system black box woodlands are a common feature on higher ground away from the river.
- The vegetation in the area supports a range of riparian and wetland vegetation communities that are critical to several fish species in the Murrumbidgee.
- The site supports native aquatic habitat and species (e.g., fish, frogs, turtles and invertebrates), including those listed in international agreements for vulnerable and endangered species, such as Murray Cod.
- In the mainstem of the Murrumbidgee River, there are healthy populations of Golden Perch, Silver Perch, Freshwater Catfish, Trout Cod and Murray Cod with spawning and self-sustaining populations of many of these fish.

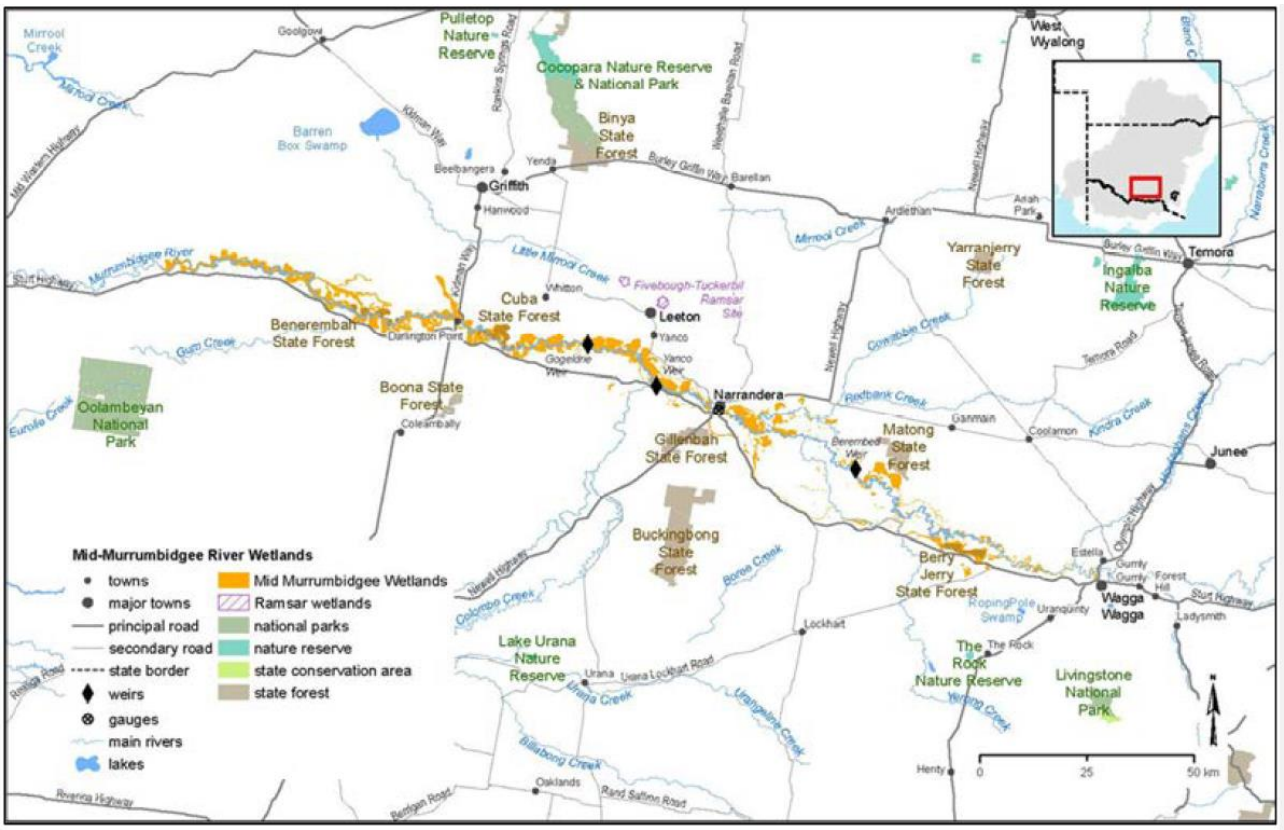

Figure 1 Mid-Murrumbidgee Wetlands (MDBA 2012)

SDL Adjustment Mechanism

The Murray-Darling Basin Plan (MDBA, 2012a) defines the sustainable diversion limit (SDL) for the Murray-Darling Basin. The SDL adjustments are based on achieving the same environmental outcomes as defined by the Basin Plan using less environmental water by the implementation of supply measures. Such a mechanism would allow the SDL to be increased, whilst achieving equivalent or improved environmental outcomes.

Site Specific Flow Indicators (SFIs) are described in the Basin Plan and are water flow targets used to express environmental water requirements at hydrologic indicator sites. The indicators include the volumes, frequency, duration, and the periods during which flows are required at hydrologic indicator sites.

The process resulted in development of the following SFIs (Table 1) to represent the environmental water requirements of the mid-Murrumbidgee Floodplain Wetlands indicator site as flow required for

consecutive days between June and November. These targets range from 26,850 to 63,250 ML/d in the Murrumbidgee River and correspond to flow rates as measured at Narrandera.

Table 1 SFIs for the Mid-Murrumbidgee Floodplain Wetlands at Narrandera

Flow (ML/d)	Consecutive days	% of Years
26,850	5	50
34,650	5	35
44,000	3	30
63,250	3	12

The MDBA assessed the higher flow rates (63,250 ML/d) and concluded these would be too difficult to achieve given the current system constraints. However, the MDBA found that flow rates up to 26,850 ML/d would be achievable and it could be feasible to achieve up to 44,000ML/d under some conditions (MDBA, 2012).

Previous studies

In 2015, NSW submitted a preliminary business case to the Murray Darling Basin Authority (MDBA) that considered the potential for an SDL adjustment arising from the improved flow management works associated with the *Murrumbidgee Rivers – Improved Flow Management Works at the Yanco Creek offtake* supply measure project (The Yanco Creek Offset project).

The 2015 preliminary business case proposed upgrades to existing infrastructure at the location of the offtake from the Murrumbidgee River to the Yanco Creek system. This included infrastructure modifications at the existing Yanco Regulator and two new fishways to enable more efficient delivery of water to the mid-Murrumbidgee wetlands, as well as to reduce barriers to fish passage. Also, the 2015 assessment considered that the main mechanism by which the improved flow delivery would occur was to install a regulator at the Yanco Creek offtake to limit the volume of uncontrolled flow into the Yanco Creek system at higher flows in the Murrumbidgee River, thereby allowing more water to be delivered into the Murrumbidgee during managed events.

Infrastructure was proposed to raise the Yanco Weir pool to allow more delivery of flows to the Yanco Creek such that flows excluded during watering of mid-Murrumbidgee wetlands could be delivered to the Yanco Creek at a different time.

Although the Narrandera SFI site (Table 1) is located upstream of the Yanco Regulator/Weir, as the representative site for the mid-Murrumbidgee wetlands, it was used as the SFI site in the original 2015 business case investigation. The project focused on delivery of environmental water in the flow range from 36,850 to 44,000 ML/d, as described in that business case. Based on the comparison at Narrandera, the 2015 business case concluded the original project would be able to deliver equivalent environmental outcomes as proposed in the Basin Plan but with less water, so generating a possible SDL offset.

However, the Yanco Creek Offtake SDLAM Project caused a high level of concern in the community.

As an outcome of extensive consultation with community and technical stakeholder groups, it was confirmed that options incorporating weir pool raising of a scale up to 2.5 metres would be unacceptable to stakeholders. Stakeholders also considered incorporation of a regulator in the Yanco Offtake cutting to be unacceptable.

It was recognised that this project had unique sensitivities and could not be delivered in its notified form within the Basin Plan timeframes (which at the time included completion by June 2024).

Therefore, NSW undertook a review and revision of the proposed scope of the project (the Modified Project).

Yanco Creek system

Yanco Regulator/Weir on the Murrumbidgee River is approximately 875 km downstream of Burrinjuck Dam and 25km downstream of the nearest major settlement, Narrandera. The study area, illustrated in Figure 2, extends from approximately 15km upstream and 5km downstream of Yanco Regulator/Weir down on the Murrumbidgee River, and also extends for approximately 5km down the Yanco Creek.

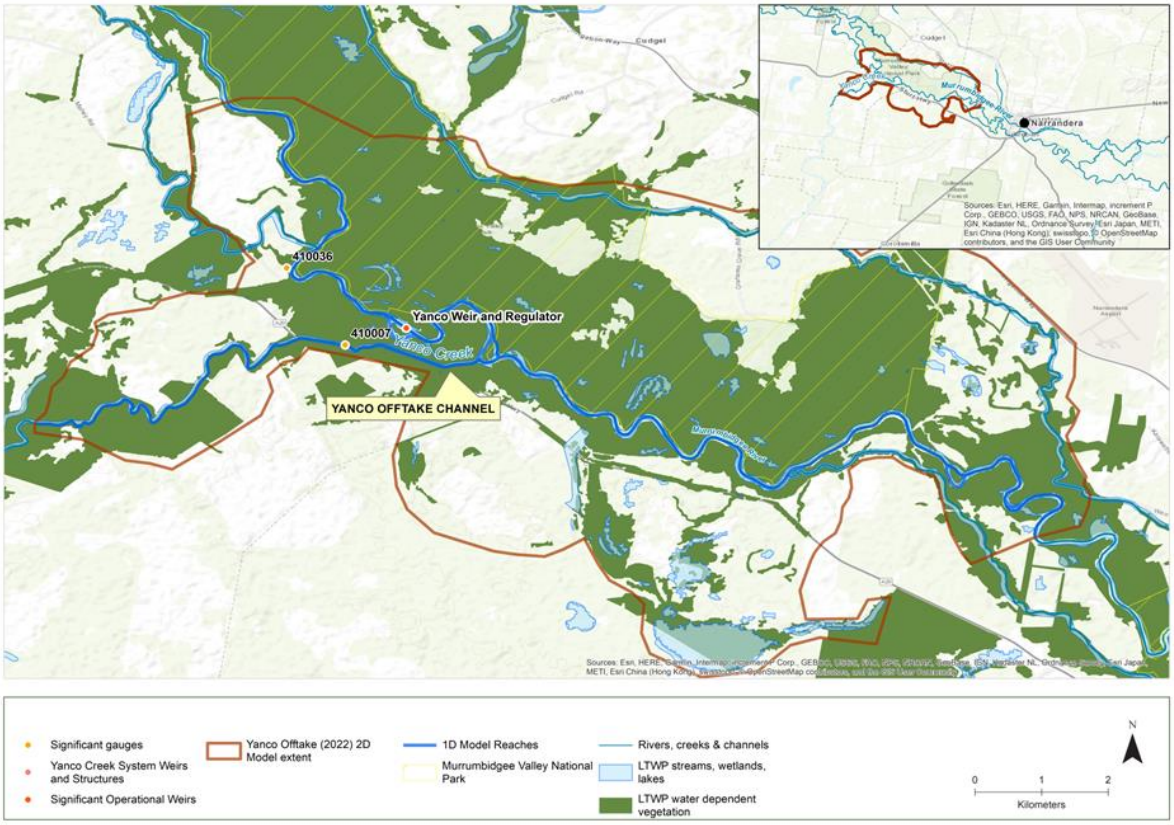

Figure 2 Locality plan

The Yanco Creek system is a channel and floodplain system that commences from the Murrumbidgee River at Yanco Regulator/Weir located about 20km west of Narrandera. It commences in the traditional lands of the Wiradjuri people and flows through Bangerang, Barrapa Barapa and Wemba Wemba traditional country.

The Yanco Creek system consists of a series of creeks on the southern side of the Murrumbidgee. Prior to the 1850s, Yanco Creek was an intermittent stream that connected the Murrumbidgee River to the Murray River via a series of braided channels and wetlands. As a predominantly ephemeral system, the Yanco Creek only connected to the Murrumbidgee when flows were very high (>40,000 ML/d) but would stop flowing in low rainfall periods (DPIE, 2015).

With the regulation of the Creek in later years, Yanco Creek was deepened and was made to flow permanently. Initially this was for stock and domestic use and town water supply, but more recently this has been used for irrigation. The most recent engineering works were completed near the offtake in 1981. The offtake joins Yanco Creek to the Murrumbidgee River and provides flow to the creek system, even when flow in the Murrumbidgee River is quite low.

Most of the water supplied to the Yanco Creek system is via the Yanco Offtake channel on the Murrumbidgee River. Some additional flows from the Murrumbidgee also enter the system from drainage channels out of the Coleambally Irrigation Area (the Coleambally Catchment Drain, Drainage Canal 800, West Coleambally Channel). (DPIE, 2015).

There are a number of key high value ecological sites in the Mid and Lower Murrumbidgee wetlands, which are watered through water passing through the Yanco Regulator. The result of the historic

diversion works to the Yanco Creek means a reduction in flows in the Murrumbidgee River, which reduces the environmental watering efficiency of the dam releases for these target sites.

The current flow share between the Murrumbidgee and the Yanco Creek system is illustrated in Figure 3 below. Under current operating conditions, the Yanco weir pool can only control the volume of water diverted from the Murrumbidgee River into Yanco Creek when Murrumbidgee River flows are less than 10,000 ML/d. At higher flows, up to 10% of the water is diverted uncontrollably into Yanco Creek.

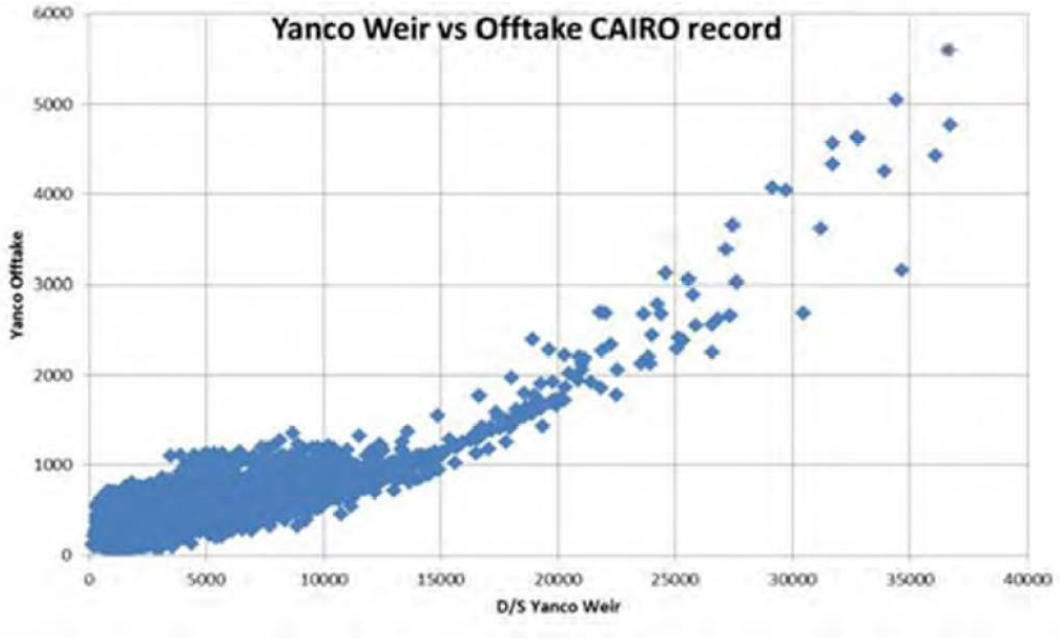

Figure 3 Current relationship between flows in the Murrumbidgee River downstream of Yanco Weir and to Yanco Creek

As indicated in Table 1, flows significantly greater than 10,000 ML/d would be required in the Murrumbidgee River to meet the Basin Plan's environmental objectives (i.e., the SFI range is between 26,850 ML/d and 44,000 ML/d).

Unless changes to the existing infrastructure are made, it is inevitable that some of the water released to meet environmental objectives in the mid-Murrumbidgee wetlands would be diverted to Yanco Creek. Therefore, under current conditions, any water released to meet mid-Murrumbidgee wetlands environmental watering requirements would need to allow for these inefficiencies.

Yanco Weir and Regulator infrastructure

Yanco Regulator and Yanco Weir together form a significant barrier across the Murrumbidgee River and a weir pool is formed behind the two structures. This weir pool drives flows down the Yanco Offtake, which is a constructed channel excavated between the Murrumbidgee River and Yanco Creek to manage flow transfers more effectively between the watercourses. The Yanco Offtake is, however, unregulated and flows into the Creek are dependent on the height of the weir pool and flows in the Murrumbidgee River.

The current infrastructure (refer Figure 4) includes a gated regulator on the Murrumbidgee River (Yanco Regulator) and an older-fixed crest weir (Yanco Weir).

The existing weir pool is created from two key structures:

- Yanco Regulator – a gated regulator on the Murrumbidgee River consisting of two large regulating gates and a fish ladder that is ineffective for allowing native fish passage Figure 5
- Yanco Weir – an older-fixed crest weir (Figure 6).

The Yanco Regulator was designed to control the river level in the Murrumbidgee River upstream of the Weir to deliver flow to the Yanco Creek. The Yanco Regulator is designed to regulate flows into Yanco Creek in combination with the water level created by Yanco Weir.

Figure 4 Existing Yanco Creek Offtake infrastructure (source: DPE April 2022)

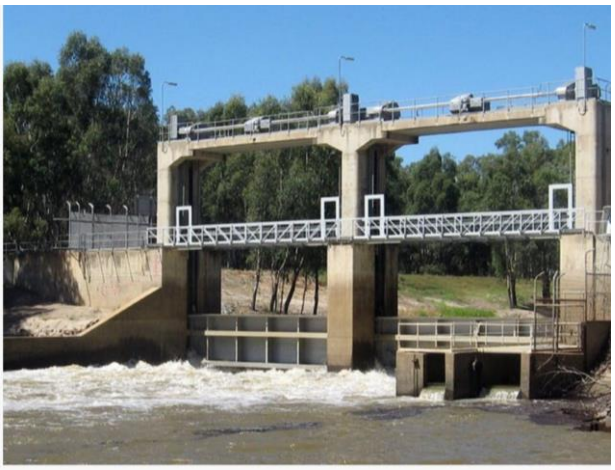

Figure 5 Yanco Regulator

Figure 6 Yanco Weir (Fixed Crest Weir)

Modified Yanco Offtake project

As a result of stakeholder consultation, NSW substantially revised the Yanco Creek Offtake Project, moving away from the original plan proposing to raise the existing water level upstream of Yanco Weir by up to 2.5m under normal operating conditions. A proposed new regulator in the Yanco Creek offtake channel was removed from the scope of the proposal due to being deemed unacceptable to the Yanco Creek stakeholders.

Instead, a range of smaller scale options were identified that aimed to deliver improved operational flexibility and environmental outcomes. The options ranged from between a 0m to 1.2m raise to the existing water level upstream of Yanco Regulator/Weir under normal operating conditions. The re-

scoped project also introduced the concept of a Yanco Creek “return cutting”. The return cutting would be a channel constructed from the Yanco offtake channel to return flows to the main stem of the Murrumbidgee, downstream of Yanco Regulator/Weir.

The current study considered the following potential SDLAM benefits associated with a Yanco Creek Offtake project:

- More efficient delivery of environmental flows to the mid-Murrumbidgee wetlands upstream (using less water to achieve equivalent or improved environmental outcomes
- Managing uncontrolled outflows into the Yanco Creek system.

Report structure

This report is structured as follows:

- **Introduction**
- **Approach** – this section describes the methodology used to assess the potential project benefits, which included inter-agency consultation and hydraulic modelling.
- **Key findings** – describes the outcomes of the benefits assessment.
- **Potential benefits** – summarises the potential SDLAM benefits and costs.

Approach

Overview

A modelling methodology was developed for the purposes of assessing the potential benefits associated with the Modified Yanco Offtake project.

The full modelling methodology that was developed is documented in the modelling methodology report *Rescoped Yanco Creek Offtake – SDLAM Benefits Study: Modelling Methodology and Parameters (NSW DPE, March 2023)* and key aspects of the hydraulic modelling are summarised in this section.

The Modified Yanco Offtake project proposed to revise the infrastructure and operation of the Yanco Creek Regulator/Weir, with a number of potential options being considered. A hydraulic and hydrological modelling approach was initially identified to assess the potential benefits arising from retaining more water in the Murrumbidgee and reducing flows into the Yanco Creek system based on:

- increased frequency of meeting the Site-specific Flow Indicator (SFI) targets on the mid-Murrumbidgee River
- inform an investigation into mechanisms to improve management of outflows into the Yanco Creek System.

However, the DPE hydrological modelling team confirmed that without a mechanism directly to regulate flows into the Yanco Offtake cutting, there was little merit in exploring potential SDL benefits downstream of the site. It was agreed that the IQQM hydrological modelling be placed on hold whilst a high-level preliminary assessment of benefits was undertaken in consultation with the MDBA.

Hence, the MDBA assessment (MDBA 2023) considered the potential changes in inundation upstream of the Yanco Weir/Regulator for consideration of potential benefit to the mid-Murrumbidgee wetlands upstream of the Yanco Offtake. This assessment was undertaken by reviewing outputs of a hydraulic modelling analysis undertaken by the DPE Environment and Heritage Group (DPE-EHG) modelling team and reviewing changes in inundation.

The DPE-EHG hydraulic modelling team undertook hydraulic modelling to assess various infrastructure configurations to better understand the feasibility and constraints of options under different flow scenarios and operating conditions.

Project (hydraulic) modelling

Model specifications

The hydraulic modelling (Streeton, 2023) conducted for this project, utilised the modelling study used to inform the Reconnecting River Country Program and extended its upstream modelling boundary at the Narrandera gauging station to capture the immediate influence of structure manipulations. The model also included an additional embankment in place across the riverine floodplain to maintain a weir pool behind the proposed raised weir. The embankment formed a significant obstruction across the floodplain.

The hydraulic model was developed using TUFLOW modelling software, incorporating a each of the Murrumbidgee River and Yanco Creek, in the vicinity of Yanco Weir. The model was a linked 1D/2D hydraulic model. This type of model was chosen because it is capable of representing the inundation impacts arising from a variety of river flow scenarios and can include complex rules-based structure operations. A model with 2D functionality was used to simulate flow pathways across floodplains which are otherwise difficult to define.

The model was used to assess if the implementation of the re-scoped options were capable of delivering targeted environmental flows and so have potential to provide a SDLAM benefit.

Assumptions

The key limitation of the model was that it was calibrated for flows up to approximately 45,000 ML/day at Narrandera, and any application of the modelling for significantly higher flows would require the model domain to be expanded and the model to be further calibrated.

It is also noted that the model was developed to represent flows greater than 10,000 ML/D in the Murrumbidgee at the Offtake and was not considered suitable for use at flow ranges lower than this due to difficulties in accurately representing the flow split between the Murrumbidgee River and Yanco Creek. The operation of the Yanco Regulator has a significant influence on this flow split which results in a substantial range of possible flow splits.

During the development of any hydraulic model a series of assumptions and generalisations are made, and these are described further in the modelling methodology report (refer to References).

Infrastructure schematisation

The proposed infrastructure was represented in the hydraulic model (DPE March 2023) and is illustrated in Figure 7 and described in Table 2.

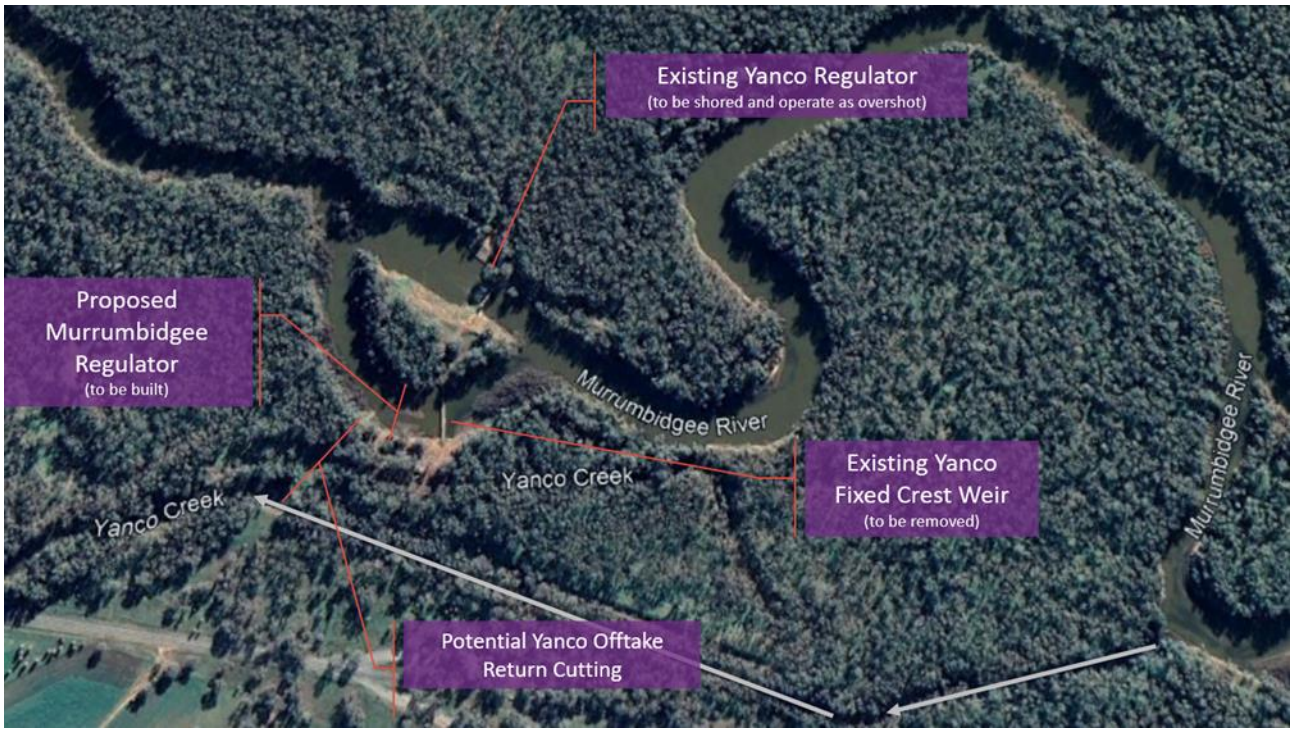

Figure 7 Summary of potential infrastructure

During the course of model development and calibration, it was identified that, under existing conditions, flows bypass the Yanco Regulator for an event of 20,000 ML/d and greater, with significant floodplain breakout flows and flood runners occurring, particularly in the northern floodplain.

For the model run which attempted to closely match the 2015 Business Case proposal by investigating pooling water behind the Regulator/Weir (closed regulator scenarios), an embankment feature was also added into the model. Building of an embankment on the floodplain, as indicated approximately in Figure 8, would need to be an inherent requirement of the options modelled in this benefits study.

Table 2 Modelling infrastructure

Infrastructure components	Change to Offtake relationship
Replacement of Fixed Crest Weir (FCW) with lay-flat gates	No change in the minimum flows into the Yanco
Inclusion of a Yanco Creek return cutting	Has the potential to manage flows into the Yanco Creek system
Replacement of Fixed Crest Weir (FCW) with lay-flat gates (open position) and inclusion of a Yanco Creek return cutting	Has the potential to reduce the minimum flow into the Yanco (while retaining a minimum flow into the Yanco)
New gated structures and associated works to support up to a 1.2m weir pool increase.	No change in the minimum flows into the Yanco

Figure 8 Modelled floodplain embankment in red

Hydrological inputs

Each scenario was simulated for two inflow hydrographs, a smaller event within the range of operational management (5,000-2,0000 ML/day) and a larger 'small flood' event (20,000–50,000 ML/day). This was in order to check whether different hydrographs result in changes in flow relationship, particularly during low flow events. To develop a representative hydrograph, DPE undertook an analysis of events of similar magnitude using data from Murrumbidgee at Narrandera gauge (410005) with a period extending from 1970 to 2023. Rates of rise and fall associated with events of similar magnitude were analysed and the median observed rates applied to the synthetic hydrographs shown in Figure 9.

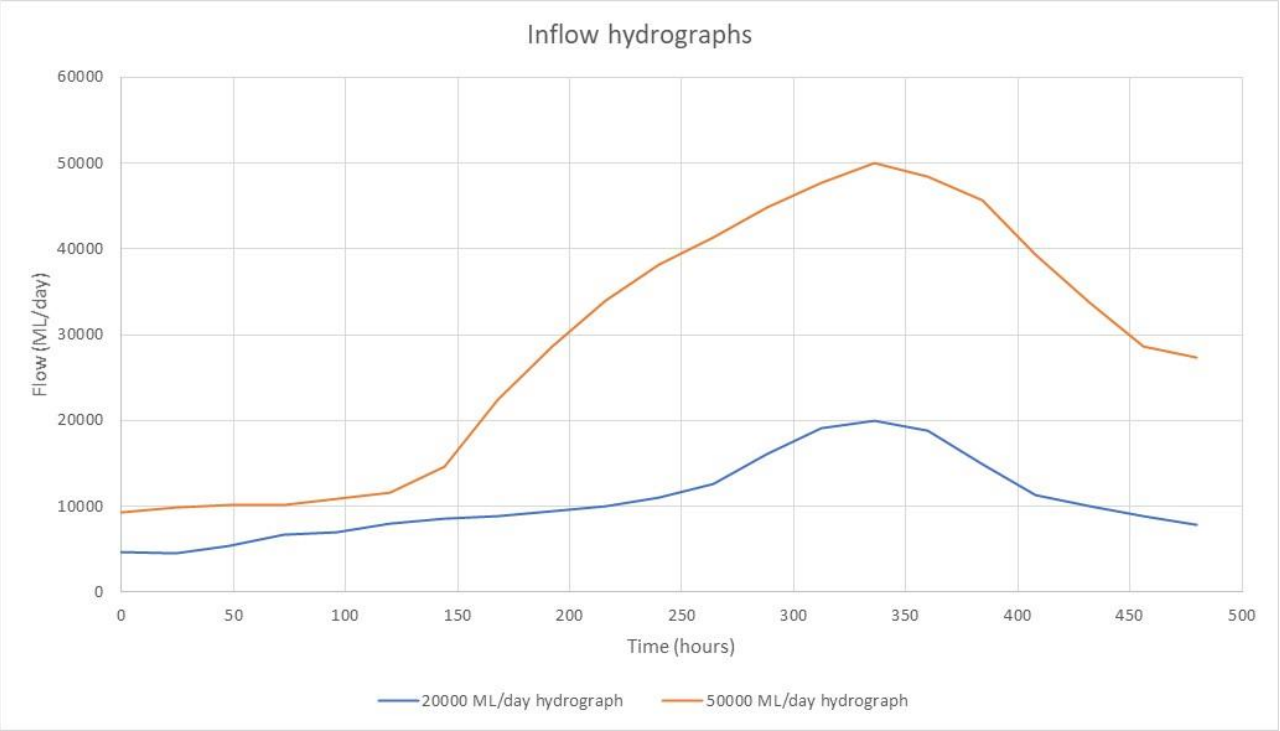

Figure 9 Input hydrographs for 20,000 and 50,000 ML/d at Narrandera

Modelling scenarios

There were two key scenarios modelled in addition to the base case (current infrastructure and operation) scenario. They were:

- Scenario 1: Weir Pool is raised by 1.2 m with Yanco Regulator on the Murrumbidgee River closed, and
- Scenario 2: Weir Pool is raised by 1.2 m with Yanco Regulator on the Murrumbidgee River closed and return channel installed between the Yanco Creek and Murrumbidgee River to return a portion of the flow in Yanco Creek back into the Murrumbidgee River.

The modelling results were used to investigate different inundation extents as a potential method to obtain SDL adjustment potential from the alternatives, using a linear interpolation.

It should be noted that this was only for the purposes of a model assessment to understand any potential as a SDL adjustment in isolation, and it does not consider other management rules and policy changes that may need further discussions in inter-jurisdictional forums.

Outcomes of hydraulic modelling

Figure 10 shows the outcomes of various modelled scenarios with respect to the flow split between the Yanco Creek Offtake and the Murrumbidgee River downstream of Yanco Regulator/Weir.

Compared to the baseline (existing) scenario, the results (purple line) show that with the Yanco Regulator closed, the Yanco Weir pool raised and no return channel, significantly more flow is routed to the Yanco Creek than under the existing conditions.

Replacement of the Fixed Crest Weir (FCW) with lay-flat gates (open position) and inclusion of a Yanco Creek return channel (blue lines) results in substantially reduced flows going into the Yanco Creek system compared to the baseline, within the flow range of interest. Also, the results for the closed regulators and inclusion of the return channel (green line) are comparable with the baseline for the flows greater than 30,000 ML/d although there are greater Yanco outflows for the lower flow range.

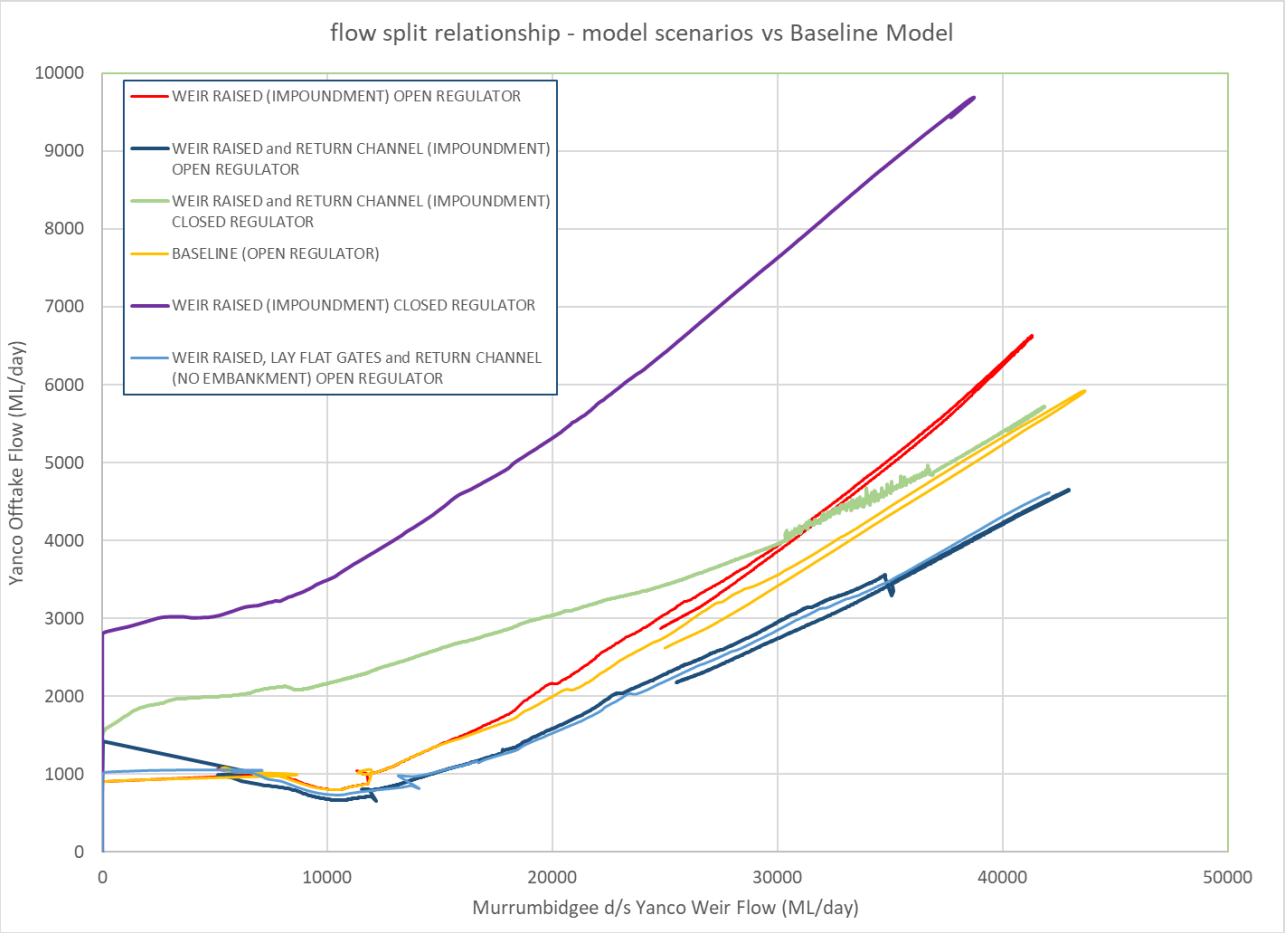

Figure 10 Murrumbidgee River / Yanco Offtake split, various modelled scenarios

Impacts of the scenarios on floodplain inundation are shown in Figure 11 to Figure 13 for a 50,000 ML/d flow scenario. The figures show:

- Fully opening the Yanco Regulator with a raised weir results in some additional inundation and floodplain depths upstream of the embankment and within the upper Yanco floodplain.
- Fully closing the Yanco Regulator/Weir with a raised weir pool results in significant additional inundation and floodplain depths upstream of the embankment and within the upper Yanco floodplain.
- Fully closing the Yanco Regulator, weir raising and installing the return channel maintains existing water levels within the upper Yanco and downstream of Yanco Regulator/Weir. There is additional inundation extent upstream of Yanco Regulator/Weir.
- Fully opening the Yanco Regulator, weir raising and installing the return channel reduces water levels across the majority of the floodplain, increasing the conveyance of the system.
- Fully opening the existing Yanco Regulator and installing the return channel and new Murrumbidgee Regulator reduces water levels within the upper Yanco and upstream of Yanco Weir.

Figure 12 shows the modelled effects of a 1.2m raise in the fixed crest weir, a closed Yanco regulator and the inclusion of the Yanco return channel as compared to the existing case. With the potential infrastructure in place, inundation extents and levels upstream of the Yanco Weir/Regulator are increased over the existing case, whilst levels downstream (including in the Yanco Creek system) are decreased.

The increased inundation represents a potential benefit in terms of increased watering potential for the mid-Murrumbidgee wetlands upstream of the Yanco Weir/Regulator. The results also indicate that the return channel could be effective at managing excess flows to the Yanco Creek system.

Impacts of the increased inundation are shown mostly to be confined to the floodplain, with some breakouts to the south across the Sturt Highway and potential inundation of irrigated land. If the proposal were to proceed, any potential impacts from this inundation would need to be assessed and managed.

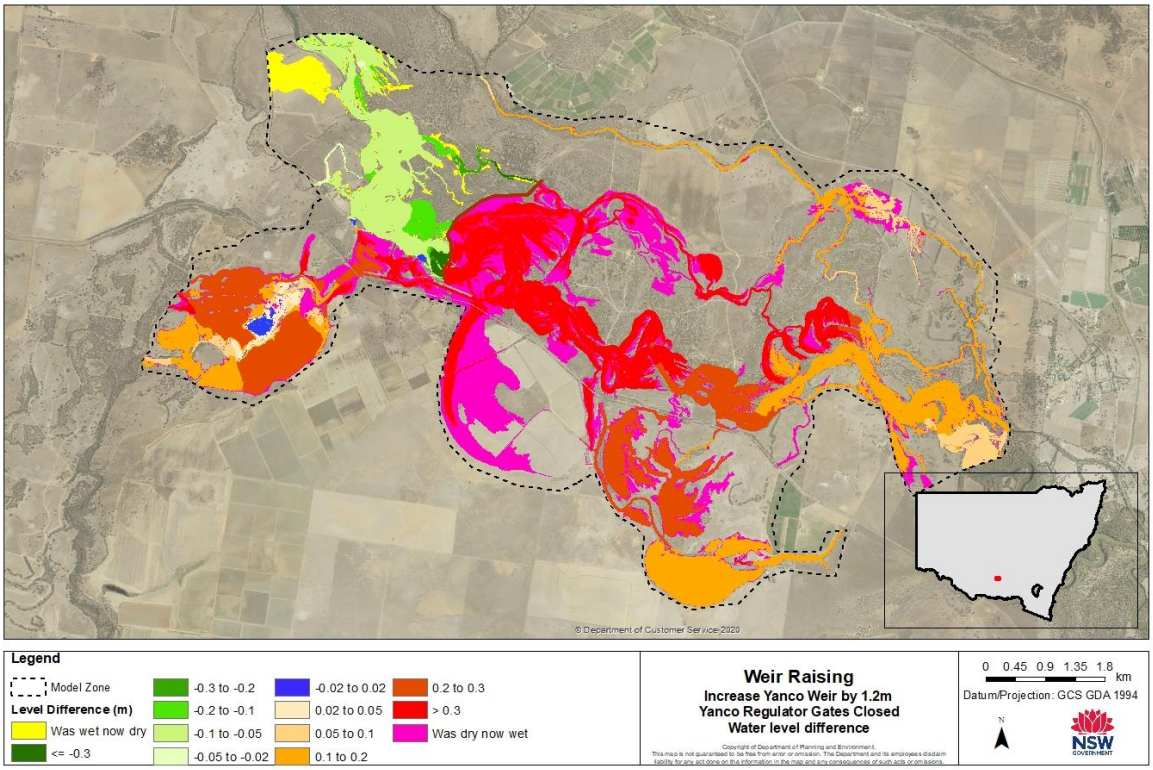

Figure 11 Impact of weir raising on water levels, Yanco Regulator shut (with embankment)

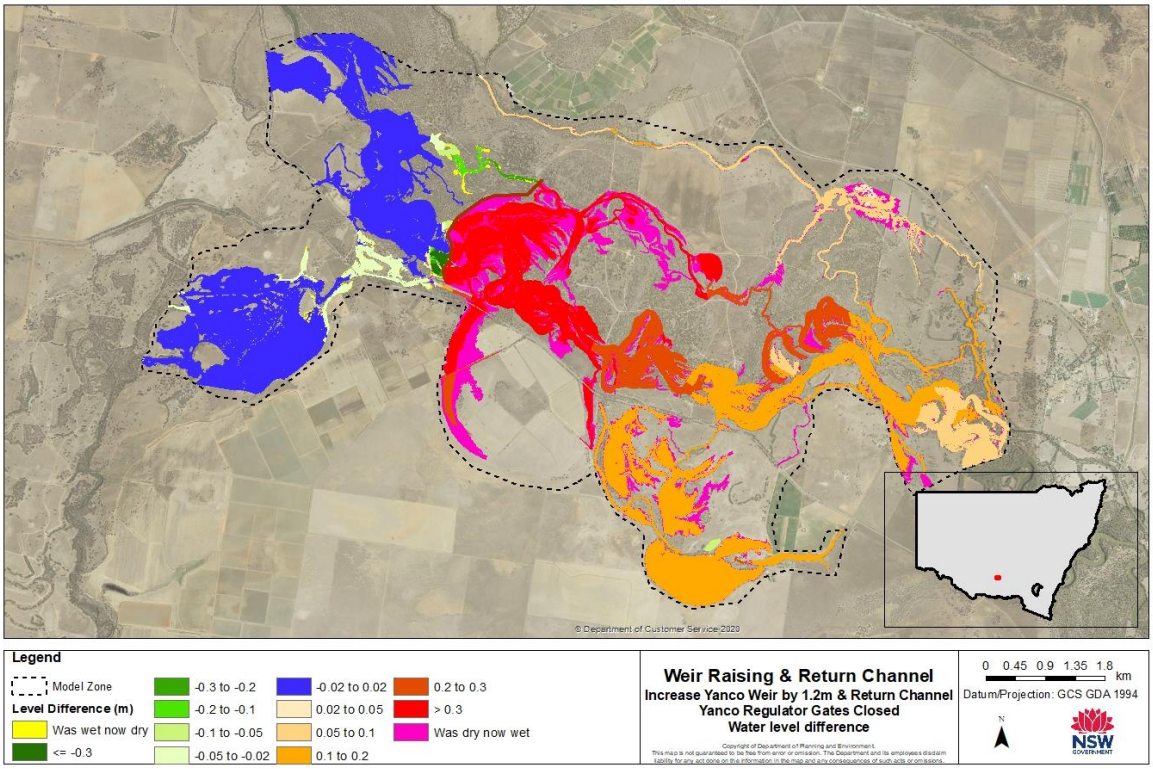

Figure 12 Impact of weir raising on water levels, return channel, regulator closed (with embankment)

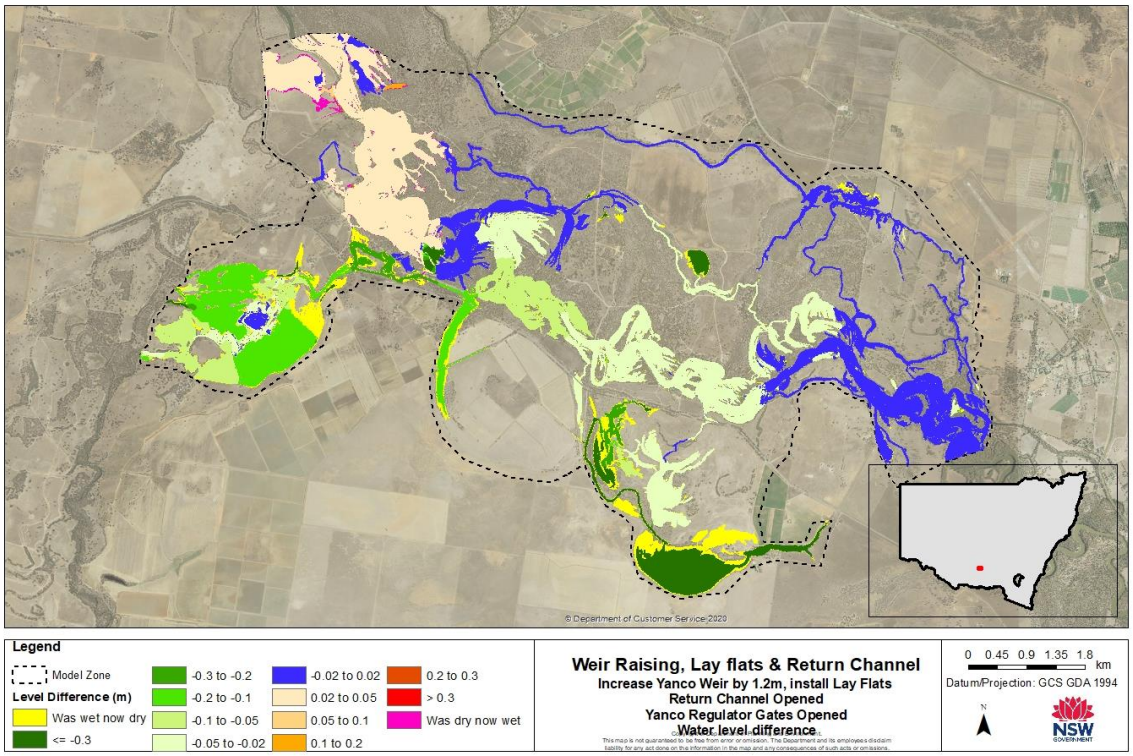

Figure 13 Regulator fully open, return channel installed (no embankment)

Figure 14 illustrates how the raising of the Yanco Regulator/Weir, and operation of the Yanco Regulator substantially alters flows in Yanco Creek. Addition of a return channel is effective at reducing Yanco Offtake peak flows to baseline flow rates, particularly when operated in conjunction with Yanco Regulator. A combination of the return channel and lay flat gates on the Yanco Weir can reduce the Yanco Offtake flows by about 25% compared to the Base case.

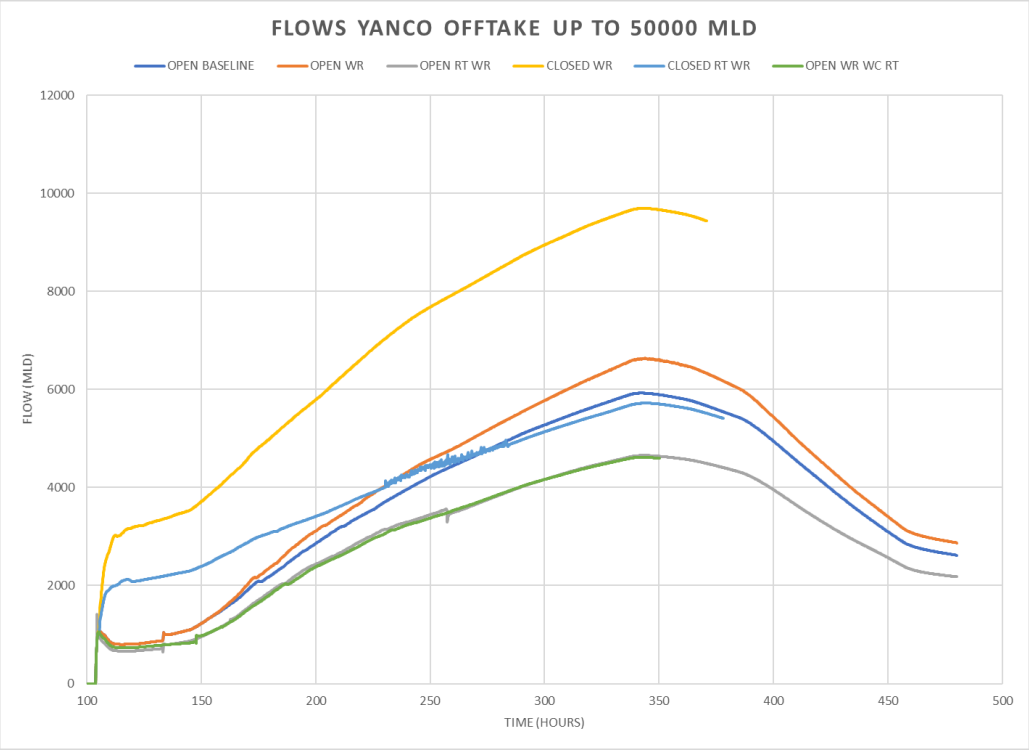

Figure 14 Modelled flows at Yanco Offtake up to 50,000 ML/d, various scenarios
Note: WR (Weir raised), RT (Return channel), WC (Weir configuration (lay-flat gates))

Potential benefits

Background

The SDLAM is a process of determining volumetric contribution from the notified supply projects. This is an exercise of maintaining environmental outcomes equivalent to ones achieved from the Benchmark model (Run No. 1132) with less environmental water recovery as initially planned during the Basin Plan development (MDBA, 2017).

In order to provide additional adjustment volume, a supply project has to achieve the equivalent environmental outcomes with less water. For the modelled scenarios in this study, potential benefits can be estimated by considering the additional mid-Murrumbidgee wetland inundation areas for the scenarios, compared with the base case.

Discussion

Model outcomes

As shown in Table 3, implementation of proposed new infrastructure and operating modes leads to different inundation extents compared to the base case. The incremental increase in inundation extent from Scenario 2 are reduced compared to Scenario 1. Table 4 also shows similar information but for a broader extent where the base case scenario represents the inundation area of the River section from Yanco Weir to a point some 15km upstream. In this table, the inundation areas from the other scenarios are estimated by the incremental changes from the base case outcomes.

Comparing Table 3 and Table 4, the net changes in inundation area are almost identical under all flow scenarios for both the localised area at Narrandera and for the broader mid-Murrumbidgee reach upstream. This suggests that any inundation benefits would be localised to the reach between Narrandera and the Yanco Weir.

For the broader mid-Murrumbidgee reach at a flow indicator of 44,000 ML/d, the increased inundation from the base case scenario is about 2% and 1% under Scenarios 1 and 2, respectively. This represents a negligible benefit for additional inundation of the floodplain.

Even though the analysis was based on the best available information, there are a number of limitations to the method which impact its suitability for assessing a SDL adjustment volume. As a result of the model limitations and simplifications of using a linear interpolation of inundation extents, this method of calculating the SDL adjustment likely overestimates its true potential. The accuracy of the estimate could be improved through some model modifications; however, these have not been pursued given the findings of minimal benefit.

Table 3 Scenario inundation extends (ha) at Narrandera

Flow at Narrandera (ML/d)	Inundation area at Narrandera (ha)		
	Base Case	Scenario 1	Scenario 2
27,000	394	941 (547)	725 (331)
35,000	872	1,382 (510)	1,175 (303)
44,000	1,336	1,803 (467)	1,599 (263)

Note: Figures in brackets represent difference from the Base case.

Table 4 Scenario inundation areas (ha) for the broader mid-Murrumbidgee reach upstream of Yanco Weir

Flow at Narrandera (ML/d)	Inundation area (ha)		
	Base Case	Scenario 1	Scenario 2
27,000	6,715	7,262 (547)	7,047 (332)
35,000	10,486	10,996 (510)	10,789 (303)
44,000	25,637	26,104 (467)	25,900 (263)

Note: Figures in brackets represent difference from the Base case.

Costs

As part of the broader development of the project, a cost estimate for the project was undertaken in parallel to this benefits study. The approach and findings are included in this report as additional context.

In November 2021, NSW DPE – Water engaged 3Rivers to develop cost estimates for a high-level understanding of the requirements of the Yanco Offtake Project. Since 2021, a variety of changes to the project have occurred, as well as new escalation/rates information made available along with other SDLAM project benchmarking data. The following summary provides an overview of the cost updates undertaken by NSW DPE (3Rivers October 2023).

The estimate is based on a high-level understanding of the project assets. This covers modifications and infrastructure alterations at the Yanco Offtake to facilitate a 1.2m weir pool raising, and includes:

- Modifications of the existing Yanco Regulator to operate as overshot gates.
- Installation of a new Murrumbidgee Regulator with vertical slot fishway.
- Upgrade of the existing Yanco Fixed Crest Weir.
- Return cutting and regulators to allow flows to be managed.
- Floodplain embankment and regulator to reduce bypass flows around the Yanco Weir pool.

The level of confidence is considered lower than a Class 5 cost estimate. The contemporary cost estimate for the project is **$180 million** (3Rivers, Oct 2023).

A cost-benefit assessment (CBA) is beyond the scope of this benefits report.

Potential benefits

The proposed infrastructure changes at the Yanco Weir/Regulator will be designed with the capability to raise the weir pool by up to 1.2m. Weir raising alone, without provision of a regulator in the Yanco Offtake, will significantly increase the flows being driven down Yanco Creek, increasing extents and depths of inundation along the Creek. This would be counter to the aims of limiting uncontrolled flows down the Yanco Creek.

The addition of a return channel from the Yanco Offtake Cutting to the Murrumbidgee River, will mitigate the impacts of weir raising on the upper Yanco Creek floodplain. Fully implementing conveyance features, including the return channel, lay flat gates and no floodplain embankment, is predicted to have the capability to reduce peak flows in Yanco Offtake by 25% for a flow scenario peaking at 50,000 ML/d at Narrandera.

The hydraulic modelling study evaluated changes in the inundation area upstream of the Yanco Weir/Regulator due to the 1.2m weir pool raising, combined with the Yanco Offtake return channel. Significant changes in inundation for the same flow rate at the Narrandera SFI would indicate the potential for increased watering of the mid-Murrumbidgee wetlands and a possible resulting SDLAM

benefit. However, without a regulator in the Yanco Offtake and with the provision of the return channel to maintain flows from the weir pool downstream of the Yanco Regulator, additional inundation will be temporary. Hence, any changes would not underpin sustained floodplain (wetland) inundation. Also, without a regulator in the Yanco Creek cutting, the potential to regulate environmental flows at the Yanco Weir for managed downstream delivery, will be limited.

The modelled inundation extents were extrapolated by the MDBA to estimate inundation changes on the floodplain to around 15 km upstream of Yanco Weir. The results of the analysis showed that there was minimal change in inundation area as a result of the 1.2m weir raising combined with return channel. This would be expected to translate to negligible benefits to the broader mid-Murrumbidgee wetlands upstream.

No assessment was made of the volume of additional storage provided upstream of a raised weir. Without a regulator in the Yanco Creek cutting, any change in storage effects would also be temporary. Therefore, the potential to regulate environmental flows at the Yanco Weir for managed downstream delivery would also be limited.

Given the initial findings of the upstream assessment, and the limitations of the infrastructure in regulating downstream flows, it was not considered that there would be any merit in further analysis downstream. Hydrological modelling of the Murrumbidgee to assess SFI sites downstream was not progressed.

The proposed infrastructure cost is considerable at an estimated $180 million and provides minimal SDL adjustment potential.

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