The Victorian Constraints Measures Program

Feasibility Study – Technical Report

VICTORIA State Government
Energy, Environment and Climate Action

Acknowledgements

The Department of Energy, Environment and Climate Action acknowledges the efforts of the Constraints Consultative Committee in its guidance and discussion on the technical information to advise the Department and the Victorian Minister for Water on the feasibility of relaxing constraints in Northern Victoria.

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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.

DEECA is committed to genuinely partnering with Victorian Traditional Owners and Victoria's Aboriginal community to progress their aspirations.

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Executive Summary

Overview

The Victorian Constraints Measures Program (Victorian CMP) is assessing the feasibility of relaxing river operational constraints on regulated environmental flows in the Goulburn River and the Victorian side of the Murray River of Northern Victoria. By relaxing constraints, in a manner which balances environmental, social, cultural and economic considerations, the project seeks to protect and restore water-dependent ecosystems and contribute to fulfilling Victoria's commitments to the Murray-Darling Basin Plan (Basin Plan).

Background to the feasibility study

Constraints Management Strategy

Constraints measures have been under consideration since 2012 as part of the Basin Plan. In 2013, the Murray Darling Basin Authority (MDBA) presented the Constraints Management Strategy (CMS) which proposed constraints relaxation (lifting regulated flow limits on environmental flows) across the southern connected basin to achieve systemwide environmental outcomes through the reconnection of rivers to their floodplains.

The MDBA initiated the development of business cases for constraints relaxation including the 'Hume to Yarrawonga' and 'Yarrawonga to Wakool' reaches of the Murray River, and the mid- and Lower Goulburn River from Lake Eildon to the Murray River. The concept business cases were completed in 2016.

A summary of how the Victorian CMP aligns with the principles of the Basin Plan is included in Appendix H.

Sustainable Diversion Limit Adjustment Mechanism

Modelling of the CMS by the MBDA showed that constraints relaxation when combined with other environmental works projects and initiatives resulted in Basin Plan environmental outcomes being achieved with 605 GL less water recovery than was originally predicted in the Basin Plan.

In 2018, the Basin Plan was amended to allow the adjustment of the Sustainable Diversion Limit (SDL), subject to implementation of 36 Sustainable Diversion Limit Adjustment Mechanism (SDLAM) projects by 2024. The SDLAM includes the Hume to Yarrawonga and Yarrawonga to Wakool projects. The Goulburn project was not nominated as a SDLAM project; however, the success of the Murray constraints projects relies at least partially on constraints relaxation within the Goulburn.

Independent expert panel review

In response to community concerns about the MDBA initiated constraints relaxation business cases, in 2019, the Victorian and New South Wales Ministers for Water appointed an Independent Expert Panel Review to review the business case modelling. The review found that the conceptual modelling used to develop constraints measures was not suitable for informed discussions with impacted landowners, did not fully assess the impact of relaxed constraints on the use of the environmental water portfolio, did not compare the 'do nothing case' and did not include climate change scenarios.

Furthermore, the review found that community engagement had been inadequate and that information on the impacts and benefits of constraints relaxation was deficient. The panel recommended that the project be reset, and that community and impacted stakeholders be given greater opportunity to meaningfully engage with the project.

The Victorian Constraints Measures Program

In 2021, the Victorian and Commonwealth governments agreed to a reset of Victoria's constraints relaxation projects in the form of the Victorian Constraints Measures Program to address the community engagement and modelling deficiencies identified by the independent expert panel.

This Feasibility Study is assessing the benefits, costs, risks, and consequently the feasibility of progressing with constraints relaxation in Victoria informed by the views and insights of a Consultative Committee. The Consultative Committee established by the Department of Energy, Environment and Climate Action (DEECA) for this study consists of members from impacted communities, stakeholders and government agencies. If government decides to proceed with the program, technical investigations, engagement with affected Victorian landholders to confirm impacts, and discuss possible mitigation activities.

The planning and staging of the program will be further considered through the development of the *Constraints relaxation implementation roadmap*, a requirement of the *Water Amendment (Restoring Our Rivers) Act 2023*, enacted at the end of the Committee's tenure.

This feasibility study

In 2021, Victoria's lead agency for the Victorian CMP, DEECA (then the Department of Environment, Land, Water and Planning (DELWP)), completed an open tender for the preparation of the feasibility study. This led to the appointment of a project consulting team (led by Sequana) to conduct the required technical work and policy frameworks, support a community co-design approach with the DEECA appointed Consultative Committee and prepare a feasibility study report to consolidate the technical information (this document).

This feasibility study has been prepared to address key requirements of the specific terms of reference for the study set out in in DEECA's scope specification. The departments project specification included the following requirements:

- confirmation of the range of potential constraints relaxation flow scenarios
- development of best practice inundation mapping for each relaxed constraints flow scenario
- identification of third-party impacts from constraints relaxation and appropriate mitigation measures
- development of a community engagement and negotiation framework – including easement compensation
- identification of roles and obligations of river operators and asset owners
- assessment of environmental and cultural benefits and risks
- assessment of climate change impacts on constraints relaxation flow scenarios
- assessment of the implementation options
- assessment of whether there is likely community and Traditional Owner support for progression of the program.

In accordance with the Department's specification, the feasibility study does not provide a recommendation on a preferred option as it is recognised that engagement with the broader community, impacted landholders and other Basin states (for the Murray River) will be required to inform the identification of a preferred option. Decisions on relaxed constraint flow rates for the Murray River cannot be made by either state in isolation. Victoria, New South Wales and the Australian Government need to agree on which relaxation options should be considered should Ministers agree to progress the Program.

The feasibility study also does not provide accurate costings for the project or forward estimates for the costs associated with future stages as these costs will be primarily influenced by the outcomes of the engagement with landowners as well as the regulatory approvals required. The detailed costs estimates will be developed in future stages if the program is to proceed. Since the river system is interconnected, it is crucial to consider the benefits and costs for both sides of the Murray River, and downstream at a system level. This should be completed as part of prudent whole-of-system business case development.

Context for the project

Victorian Murray and Goulburn Rivers

The Victorian Murray River and Goulburn River are the state's largest river systems both by volume of flow and catchment area. The rivers contribute significantly to the water resources of the southern connected Murray-Darling Basin[1]. The rivers rise in the Great Dividing Range flowing through the mountainous upper catchment before entering the riverine plains in Northern Victoria and southern New South Wales. Within the riverine plains the rivers become meandering lowland rivers with a broad floodplain that contains an intricate network of anabranch creeks, flood runners, wetlands and billabongs.

Both the Goulburn River and Murray River flow through the traditional land of many Traditional Owners. Traditional Owners have an enduring connection to Country and a crucial interest in water resource management. Everything on Country - the land, water, life, culture, and resources - is connected. Traditional Owners have moral and cultural obligations to care for, protect and heal Country, and have done so

[1] Central Murray | Murray-Darling Basin Authority (mdba.gov.au)

holistically and sustainably for tens of thousands of years. Country connects Traditional Owners to their past, present, and future, and is foundational for identity. Water is an integral part of Country.

Since European settlement, the floodplains of both rivers have been extensity developed for urban and agricultural purposes. Urban areas have been established on the banks of the rivers, and significant dryland and irrigated agricultural industries are located within the region. Tourism based around the river environment and water activities have become economically important to the region.

Floodplain ecosystems

Despite the extensive development of the floodplain, there remains areas of remnant native vegetation and wetlands on the floodplain interspersed amongst private landholdings. These include nationally and internationally significant sites such as the Barmah Forest, the Gunbower Forest, the Lower Goulburn floodplain as well as local conservation reserves and areas of public land that have conservation values such as Crown river frontages. These areas of remnant floodplain ecosystem provide critical habitat for threatened species and support important cultural, recreational and social values to the community.

Problem to be addressed

River regulation

The water resources of the Murray and Goulburn Rivers are regulated to provide water for hydro-electric power generation, urban centres and irrigated agriculture. Weirs and dams were constructed along the river systems throughout the 1900s to regulate water flow and service irrigation areas. Dams and weirs capture and store high winter and spring flows and release the stored water in summer to supply irrigators and other water users downstream of the storages.

In recent decades there has been increased understanding of the risk to the health of river floodplain ecosystems from river regulation. The major hydrological impact of river regulation has been the change or alteration in the regime of river flows. The altered flow regime shows a reduction in the frequency of occurrence of small overbank flows that regularly fill floodplain wetlands and water floodplain forests. In the Murray River small overbank flows that used to occur every second year now occur every 6 to 8 years, In the Goulburn River, small overbank flows occur 20% to 30% less often compared to natural conditions, are 50% to 70% shorter in duration, and have a maximum period between events that are 2.5 to 3.5 times longer[2].

Floodplain ecological decline

The reduction in floodplain watering due to river regulation has seen the health of floodplain forests and wetland ecosystems decline over many decades, which has had negative impacts on native fish, waterbirds and other species that depend on the health of the floodplain ecosystems. A series of studies over the past 30 years paint a picture of the declining health of the floodplain ecosystems:

- Sustainable Rivers Audit (2012): The most comprehensive assessment of the ecological health of rivers in the Murray–Darling Basin, found that the ecosystem of the Murray and Goulburn River in Victoria was in very poor condition ranking in the lowest grouping of the 21 catchments in the Basin. Vegetation on the floodplain was found in the Goulburn River to be in poor condition while in the Murray River vegetation conditions varied from poor to good.
- Basin Plan Evaluation (2020): The condition of floodplain vegetation communities across the Basin has largely been maintained since the implementation of the Basin Plan. Many of these communities were in poor condition following the Millennium Drought and are yet to show significant signs of recovery.
- Streamside Vegetation Index (2020): Streamside vegetation in the mid- and Lower Goulburn River was determined to be in moderate condition with isolated sites in good condition.
- Victorian State of Environment Report Update (2021): The functionality of Victorian floodplains has been dramatically impacted by the regulation of river – dams, weirs and irrigation infrastructure. Floodplains, like their river channels, have been degraded over many years and, although there are efforts to restore parts of some of them, it will require a long-term and comprehensive program of action to begin to improve their status.
- Australia State of Environment (2021): Water-dependent ecosystems and culturally significant sites have received only very limited and sporadic to zero inflows, and there have been limited opportunities for

[2] Overbank flow recommendations for the lower Goulburn River, Department of Sustainability and Environment, February 2011

filling through environmental watering. This has resulted in degradation of habitats, and reduction of breeding grounds and refuges.

Scientific studies have confirmed a consistent pattern of decline in ecosystem health of the Murray and Goulburn River and floodplain over many decades. The long-term pattern of decline is expected to continue into the future if current altered flow regimes persist.

Basin Plan and environmental water

In 2012, governments responded to the decline in river health across the Murray-Darling Basin by implementing the Basin Plan. The plan includes SDLs on the volume of water that can be extracted from rivers and the recovery of water for environmental purposes.

Under the Basin Plan, governments (including the Victorian Government) have agreed to recover 2,750 GL of water for the environment through an $11 billion program of purchasing water entitlements from irrigators and investing in irrigation efficiency. To September 2023, approximately 2,100 GL has been recovered through the Basin Plan, of which around 700 GL is held in the Victorian Murray and Goulburn Rivers. This represents around one third of the total water entitlement in these river systems.

A number of statutory bodies hold and manage environmental water entitlements including the Commonwealth Environmental Water Holder (CEWH) and the Victorian Environmental Water Holder (VEWH). In the Goulburn River and Murray River, environmental water holders work with Catchment Management Authorities (CMA) and River Operators such as the Murray-Darling Basin Authority (MDBA) and Goulburn-Murray Water (GMW) to plan and coordinate the use of environmental water to achieve environmental outcomes.

In both river systems, recovered environmental water is stored in dams and released as environmental flows to achieve environmental outcomes. Environmental flows are released in a manner that replicates components of the natural flow regime and supports environmental values and outcomes at important sites.

River flow operating constraints

Water delivery in regulated river systems occurs by releasing water from dams and weirs in response to water demands. River operators, including GMW in the Goulburn River and the MDBA in the Murray River are responsible for taking water orders from entitlement holders and making regulated releases from dams.

The capacity of the river systems to deliver water are constrained by the size of the river channel. Above a certain flow rate, water may flow out of the river channel onto adjacent floodplain land. Under water management legislation, river operators are liable for losses caused by the flow of water onto land because of regulated release of water from storages. To mitigate this risk, river operators have placed flow constraints on the release of regulated flows from dams and weir storages. The regulated flow constraints in the Victorian Murray River and Goulburn River are set at the gauging stations directly downstream of the major dams and weir storages and include:

- Murray River at Doctors Point (downstream of Hume Dam): 25,000 ML/day
- Murray River at Yarrawonga (downstream of Lake Mulwala): 15,000 ML/day
- Goulburn River at Molesworth (downstream of Lake Eildon): 10,000 ML/day
- Goulburn River at Shepparton (downstream of Goulburn Weir): 9,500 ML/day.

Constraints on environmental flows

River flow operating constraints apply to all regulated releases from dams and weir storages including environmental flows. As both private land and conservation areas exist side-by-side on the low-lying Murray River and Goulburn River floodplain, operating constraints preclude the delivery of higher environmental flows that fill wetlands and flow into forests on the low-lying floodplain.

Due to constraints on river flows, the full range of environmental flow requirements cannot be met by the use of environmental water, especially to water overbank floodplain ecosystems. Currently, a large number of environmental water deliveries are only possible through the use of infrastructure to lift water from the river channel onto the floodplain. It is noted however that some co-ordinated in channel releases between the Murray River and Goulburn River have resulted in the inundation of low-lying areas of high ecological values, for example, the Guttrum and Benwell State Forests as seen in the Spring 2021 event. The vast majority of remnant floodplain forest and wetlands in the Goulburn River and Murray River cannot be currently watered with environmental flows and suffer from lack of regular watering.

Additionally, the relaxation of constraints provides an opportunity to improve the efficiency and effectiveness of environmental water recovered from Victorian communities (based on modelling undertaken by DEECA and the MDBA).

Relaxing constraints on environmental flows

Victorian Constraints Measures

Basin state governments nominated a number of constraints measures projects for key river reaches as part of the SDLAM. The SDLAM constraints measures projects agreed by the Murray-Darling Basin Ministerial Council include three projects requiring mitigation works and measures in Victoria[3] and which form the scope of the Victorian Constraints Measures Program:

- **Hume to Yarrawonga key focus area:** a project to relax constraints up to 40,000 ML/day at the Doctors Point gauging station below Hume Dam on the Murray River. The project is jointly proposed by Victoria and New South Wales Governments and involves mitigation works and measures on both banks of the Murray River, covering both Victoria and New South Wales.
- **Yarrawonga to Wakool Junction key focus area:** a project to relax constraints up to 45,000 ML/day at Yarrawonga Weir on the Murray River. The proponent state for this project is New South Wales, with works and measures predominantly in the Edward Wakool anabranch system of the Murray River in New South Wales. Mitigation activities are required in Victoria but will be limited to Victorian land adjacent to the Murray River.
- **New Goulburn key focus area (nominated as a Constraint Measure only):** the project to relax constraints at two points within the Goulburn River below Lake Eildon and at Shepparton. The proponent state is Victoria with all works and measures to be undertaken on land adjacent to the Goulburn River in Victoria. The project spans the length of the Goulburn River below Lake Eildon to the confluence with the Murray River. For planning purposes, this project is divided into two river reaches being: 1) the Mid Goulburn River reach from Lake Eildon to Goulburn Weir and 2) the Lower Goulburn River reach, from Goulburn Weir to the confluence of the Murray River.

SDLAM implementation timeframe and commitments

In 2018, the Basin Plan was amended to allow the 605GL adjustment to the SDL, subject to implementation of 36 the SDLAM projects by 30 June 2024. The reduction in the SDL is conditional on the implementation of SDLAM projects within the nominated timeframe.

Under the 2018 amendment, if the package of 36 SDLAM projects are not implemented by 30 June 2024, the Commonwealth Government may enter the water market to buy back water from irrigators to make up any shortfall in the 605 GL target. Most Committee members have strongly voiced concerns about the prospect of further water recovery through buybacks. These concerns stem from the observed adverse effects of previous buybacks within northern Victorian communities and is supported by recent research commissioned by the Victorian Government found that the additional purchase of water from irrigation communities would involve significant negative socio-economic impacts[4].

It is noted that the *Water Amendment (Restoring Our Rivers) Act 2023* was enacted at the end of the Consultative Committee's tenure which extended the completion date of the SDLAM projects to 31 December 2026.

Benefits of relaxing constraints

Relaxing river operational constraints on regulated environmental flows has the potential to deliver environmental, social, cultural and economic benefits to the Victorian community within the focus areas. Benefits are also expected to be delivered more broadly to the Australian community at a basin wide level when the Victorian CMP is combined with constraints relaxation in the Murrumbidgee River, Darling River and the South Australian Murray River. The identified benefits of the Victorian CMP are:

- **Protect and restore remnant high ecological value floodplain forest and wetland ecosystems in the Victorian Murray River and Goulburn River**: in total, between 30,300 ha and 51,400 ha of remnant floodplain native vegetation communities (river red gum and black box) in Victoria potentially inundated with environmental water under the Y25D25 & M10L17 constraints relaxation scenarios for the low range

[3] Package of supply, constraint and efficiency measures agreed by the Murray Darling Basin Ministerial Council on 16 June 2017
[4] https://www.water.vic.gov.au/murray-darling-basin-plan/what-is-the-murray-darling-basin-plan/social-and-economic-impacts-of-the-basin-plan-in-victoria

and Y40D40 & M14L25 constraints relaxation scenarios for the high range. This is an approximate increase between 138% to 305% in the area of floodplain receiving environmental watering compared to the ‘do nothing’ scenario[5]. It is noted that this is for Victorian vegetation only, and the benefits for the Murray River in future program phases would need to incorporate the assessments currently being investigated by NSW Reconnecting River Country Program.

- **Increase the effective utilisation of recovered environmental water to achieve environmental outcomes in the Victorian Murray River and Goulburn River**: An increase in effective utilisation of environmental water recovered from Victorian communities to achieve environmental objectives in Victorian river systems, with for example, utilisation of Victorian held environmental water in the Goulburn system modelled to increase from 36% under current constraints to 83% under the highest levels of constraints relaxation explored in this feasibility study. This would increase dam airspace enabling the dams to store more flood inflows and reduce the size of moderate floods. Releasing environmental water throughout the year can provide flood mitigation as a secondary benefit, depending on how the entitlement holders chose to use their water.
- **Avoidance of further water recovery from Victorian irrigation communities by meeting SDLAM commitments**: If SDLAM projects are not delivered, the Australian government may need to recover an equivalent volume of water from other means including potentially buying back water entitlements from irrigators. By implementing constraints relaxation to the levels notified in the Basin Plan, Victoria may avoid the negative impacts of water buyback. These negative impacts include increased water prices, heightened irrigation business risk exposures to high water prices and compromised viability of major irrigation districts and industries. Furthermore, the recommendation from the majority of the Committee to consider overbank flows in the Goulburn River would lead to an increase in the notified constraint flowrate for the Goulburn River, which could potentially designate the Goulburn Project as a supply measure.
- **Contribute to Basin Plan systemwide benefits of constraints relaxation**: Contribute to meeting the enhanced systemwide environmental outcomes for the Murray River system through the cumulative relaxation of constraints across the southern connected Basin as set out in s7.09(e) of the Basin Plan. These benefits include improved outcomes for the Murray River floodplain, Murray River water quality, estuarine health, Murray Mouth opening, higher average lake levels and increased in-stream flows and variability.

Relaxed constraints flow rate scenarios

Overview

The analysis of strategic intervention undertaken in this feasibility study concluded that a solution focused on reach wide constraints relaxation in the Goulburn River and Murray River utilising works and measures was the preferred intervention which best addressed the identified problem and realised the desired benefits.

For this feasibility study, a range of relaxed constraints flow rate scenarios have been examined and assessed against multiple criteria aligned to the project benefits and impacts. Consistent with the scope for the Victorian CMP and the guidance provided by the Consultative Committee, this feasibility study does not recommend a preferred flow rate option. The multi-criteria analysis allows stakeholders to consider a wide range of factors and assess them in a structured way to take an informed view on the merit of different relaxed flow rate scenarios. If the project proceeds past this feasibility stage, the State will undertake a more exhaustive consultation and engagement process to confirm the project impacts in further detail to inform selection of a preferred relaxed constraints flow for the three focus areas. Decisions on relaxed constraint flow rates for the Murray River cannot be made by either state in isolation. Victoria, New South Wales and the Australian Government need to agree on which relaxation options should be considered should Ministers agree to progress the Program.

Notified flow rates

A baseline for consideration of relaxed flow constraint options are the flow rates notified for the Basin Plan SDLAM program. The flow rates notified and agreed by the Murray-Darling Ministerial Council in 2017 and which form the scope of the Victorian CMP are[6]:

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[5] Environmental Benefits and Risks Report, Stage 1A of the Victorian Constraints Measures Program, Alluvium (2023)

[6] Package of supply, constraint and efficiency measures agreed by the Murray Darling Basin Ministerial Council on 16 June 2017, https://www.mdba.gov.au/sites/default/files/docs/Package-constraint-supply-efficiency-measures.pdf

- **Hume to Yarrawonga key focus area:** Relax constraints on regulated environmental flows up to 40,000 ML/day at the Doctors Point gauging station below Hume Dam on the Murray River
- **Yarrawonga to Wakool Junction key focus area:** Relax constraints on regulated environmental flows up to 30,000 ML /day at Yarrawonga Weir on the Murray River, with a buffer for flows up to 50,000 ML/day
- **New Goulburn key focus area (nominated as a constraint measure only):** Relax constraints on regulated environmental flows up to 20,000 ML/day at Shepparton. Note that at the time, the Basin Plan was settled[7], the constraints relaxation proposed for the Goulburn was 25,000 ML/day.[8] At this rate, the river in the Lower Goulburn reach will inundate parts of the low-lying floodplain including private property. In 2017, the State elected to modify the notified flow rate to 20,000 ML/day, a flow rate that would not result in inundation of the Lower Goulburn floodplain but would allow environmentally beneficial bank-full and high in-channel flow rates[9].

Modelled flow rate scenarios

The Consultative Committee endorsed the testing of a range of relaxed constraints flow rates above and below the notified rates to understand the impacts on the expected levels of benefits and costs and the resulting acceptability to stakeholders. Additionally, a number of Consultative Committee members requested consideration of Goulburn relaxed constraints options that include an overbank flow rate (nominally >20,000 ML/day) in the Lower Goulburn which is higher than the notified rate. The request was informed by a University of Melbourne range-finding modelling exercise (Appendix A-2) that examined the environmental impacts of a range of relaxed flow rates and reported on the changes in environmental outcomes. The Murray River and Goulburn River flow rate scenarios modelled for the feasibility study are shown in Table E1 and Table E2.

Table E1 – Murray River relaxed constraints flow rate modelling scenarios

Constraint location	Current constraint (ML/d)	Notified relaxed constraint (ML/d)	Relaxed constraint scenarios (ML/d)[b]			
			Y25D25	Y30D30	Y40D40	Y45D40
Doctors Point (Hume to Yarrawonga)	25,000[a]	40,000	25,000	30,000	40,000	40,000
Yarrawonga Weir (Yarrawonga to Wakool)	15,000	30,000-50,000	25,000	30,000	40,000	45,000

a. The operational constraint at Doctors Point is 17,000 ML/d however agreements have been reached with many (not all) landowners to allow operational flows of 25,000 ML/d.

b. The naming convention used to describe the flow scenarios is: Y = Yarrawonga weir downstream constraint (flow in ML/d); D = Doctors Point river gauge constraint (flow in ML/d). Doctors Point is located approximately 5 km downstream of Albury-Wodonga.

[7] MDBA (2018) Submission to the South Australian Murray Darling Basin Roll Commission, pg 7
[8] DELWP (2016) Goulburn Constraints Measure Business Case – Phase 2 Investigations
[9] DELWP (2017) New Goulburn Constraints Measure Business Case pg iii

Table E2 – Goulburn River relaxed constraints flow modelling scenarios

Constraint location	Current constraint (ML/d)	Notified relaxed constraint (ML/d)	Relaxed constraint scenario (ML/d)[b]			
			M10L17	M10L21	M12L21	M14L25
Molesworth (Mid Goulburn)	10,000 (notional)[a]	Not notified	10,000	10,000	12,000	14,000
Shepparton (Lower Goulburn)	9,500	20,000	17,000	21,000	21,000	25,000

a. Note: The current constraint at Molesworth is notional. Water released from Eildon Dam is currently limited to a maximum of 9,500 ML/d to stay below the notional constraint at Molesworth as no gauge currently exists.

b. The naming convention used to describe the flow scenarios is: M = Mid Goulburn constraint as managed at Molesworth (flow in ML/d); L = Lower Goulburn constraint as measured at Shepparton (flow in ML/d)

Evaluation criteria

Various quantitative criteria were developed to:

- Assess the ability of each option to address the Problems and realise the Benefits
- Assess the likely landholder and asset owner impacts
- Identify key points of differentiation to effectively compare the scope options.

The assessment criteria are set out in Table E3.

Table E3 – Assessment criteria

Project benefit or impact	Assessment criteria
1. Protect and restore floodplain ecosystems in the Victorian Murray River and Goulburn River	Area of mapped native vegetation (Ecological Vegetation Classes) (EVC)). Frequency of late winter/spring bank-full and overbank flows events. Native vegetation condition in the Victorian Murray River and Goulburn River. Expected mean population size of Murray cod and golden perch
2. Increased utilisation of recovered environmental water to achieve environmental outcomes in the Victorian Murray River and Goulburn River	Rate of utilisation of environmental water portfolio
3. Avoid further Basin Plan water recovery	Proportion of notified constraints relaxation flow rate in the Goulburn River and Murray River.
4. Extent of impact on private landholders	Area of private land inundated Number of private properties inundated

Impact and benefit modelling

The feasibility study commissioned hydrologic, hydraulics, ecological and land use modelling of the river systems to provide information to inform the assessment of impacts and benefits of different level of constraints relaxation within each of the river reaches. The models are fit for purpose and provide a tool for understanding and assessing the likely benefits and impacts of changes in operational constraints on environmental flows. The commissioned modelling included:

- **Hydrologic modelling:** Hydrological models of the Goulburn and Murray systems were used to run 100+ year simulations of flows in the river system assuming current demands, infrastructure and operational rules. The models were used to assess the extent to which the target flow would be achieved under different constraint relaxation scenarios. Modelling was undertaken for this feasibility study by University of Melbourne, DEECA and MDBA. This study is the first time that constraints modelling has been undertaken using the DEECA Goulburn, Broken, Campaspe, Coliban and Loddon (GBCCL) Source Model and the MDBA Source Murray Model (SMM) models. These models provide an enhanced representation of flow dynamics and environmental outcomes in the river systems. Further information on the hydrologic modelling is provided in Section 14.

- **Hydraulic modelling:** Hydraulic modelling is a tool for mapping the floodplain areas likely to be inundated by higher river flow scenarios and the resulting water depth. When combined with the environmental, hydrological and land use data and modelling, the hydraulic modelling results can quantify the expected environmental and land use outcomes of relaxing operational constraints. Hydraulic modelling for this feasibility study was undertaken by consultants HARC for the Goulburn River, Manly Hydraulic Laboratory for the Murray River Barmah to Torrumbarry (Zone 9), and the MDBA for the remaining Murray River hydraulic model zones. The hydraulic models have been calibrated with updated survey and inundation data including the 2017 high flow events in the Murray River and bathymetry data captured in early 2022 for the Mid Goulburn River commissioned by this feasibility study. Note that this feasibility study commissioned aerial photography of the high flows within the range of flows considered by the constraints program in late 2022 for both the Murray River and Goulburn Rivers. The aerial photography captures the inundation at levels consistent with relaxed flows rate scenarios and shows a strong correlation with the modelled inundation footprint. This information will be incorporated into future hydraulic modelling if a decision is made to proceed with the project. Further information on the hydraulic modelling is provided in Section 15.
- **Ecological modelling:** Ecological response models have been used in this feasibility study to simulate the dynamics of floodplain and riverine ecosystems and evaluate the potential impacts (abundance and condition) on flood dependent species of changes to flow rates brought about by relaxed constraints. The models used were developed by the subject matter specialists, for previous related projects including the Environmental Flow Assessment for the Goulburn River (University of Melbourne stochastic models) and the NSW Reconnecting River Country Program (NSW RRCP). The ecological response models are based on data, research and monitoring into the behaviour and response of Australian ecosystems to inundation events, the delivery of environmental water and to the time between events (spells) including droughts. A panel of ecological experts also provided a peer assessment of the modelling results. Further information on the ecological modelling is provided in Section 8.
- **Land use modelling:** A project geographic information system (GIS) was developed with maps of floodplain land use, cadastral boundaries and property information, transport networks and other related datasets sourced from the Victorian Government Data Directory. The GIS database was used to undertake spatial analyses of the land use and asset impacts for the different levels of constraints relaxation. Further information on the Land and asset impact assessment is provided in Section 10.

Outcomes

Table E4 (Goulburn River) and Table E5 (Murray River) provides a summary of the outcomes from the modelling of project benefits and impacts at different relaxed constraints flow scenarios, focusing on the outcomes where there are modelling results for all scenarios.

Table E4 – Summary of benefits and impacts for different relaxed constraints scenarios in the Goulburn River

Flow rate Option	Summary of benefits	Summary of impacts
M10L9.5 * **(Current Constraint)**	Base case	Base case
M10L17	Inundates a maximum of 2,426 ha of native vegetation EVC an 89% improvement on the base case. Increases the frequency of 5+ days winter/spring bank-full events in the Lower Goulburn by approximately 10% and no impact on mean frequency of overbank events.	Inundates 478 ha of private land or 1.1% of total private land on the floodplain Inundates 372 private properties; on average 1.3 ha per affected private property

Flow rate Option	Summary of benefits	Summary of impacts
	Increases the area of river red gum in good or moderate condition by 19% compared to the base case Minor levels of benefit for all three guilds of native fish. Increases the utilisation of environmental water by 77%[a] compared to the base case Delivers 85% of the notified relaxed constraints flow rate	Reduces the area of black box woodland in good or moderate condition by 52%.
M10L21	Inundates a maximum of 3,973 ha of native vegetation EVC a 209% improvement on the base case. Increases the frequency of 5+ days winter/spring bank-full events in the Lower Goulburn by approximately 10% and no impact on the mean frequency of overbank events Has no impact on the area of river red gum in good or moderate condition Higher levels of benefit for all three guilds of native fish Delivers 108% of the notified relaxed constraints flow rate	Inundates 620 ha of private land or 1.4% of total private land on the floodplain Inundates 451 private properties on average 1.4 ha per affected private property Reduces the area of black box woodland in good of moderate condition by 52%
M12L21	Inundates a maximum of 4,216 ha of native vegetation EVC a 228% improvement on the base case. Increases the frequency of 5+ days winter/spring bank-full events in the Lower Goulburn by less than 10% and no impact on overbank events Increases the area of river red gum in good or moderate condition by 83% and black box woodland by 91% Higher levels of benefit for all three guilds of native fish Increases the utilisation of environmental water by 94%[a] compared to the base case Delivers 108% of the notified relaxed constraints flow rate	Inundates 838 ha of private land or 1.9% of total private land on the floodplain Inundates 479 private properties on average 1.8 ha per affected private property
M14L25	Inundates a maximum of 7,190 ha of native vegetation EVC a 459% improvement on the base case Increases the frequency of 5+ days winter/spring bank-full events in the Lower Goulburn by approximately 20% and no impact on the mean frequency of overbank events Increases the area of river red gum in good or moderate condition by 83% and black box woodland by 91% Higher levels of benefit for all three guilds of native fish Increases the utilisation of environmental water by 131%[a] compared to the base case Delivers 125% of the notified relaxed constraints flow rate	Inundates 1,505 ha of private land or 3.3% of total private land on the floodplain Inundates 590 private properties on average 2.6 ha per affected private property

a. Modelled utilisation of environmental water can be used to compare scenarios, however actual utilisation figures will vary significantly due to climate and water availability, environmental demand assumptions and real-world flexibility (rather than fixed model rules).

Table E5 – Summary of benefits and impacts for different relaxed constraints scenarios in the Murray River

Flow rate Option	Summary of benefits	Summary of impacts
Y15D25 * **(Current Constraint)**	Base case	Base case
Y25D25	Inundates a maximum of 27,910 ha of native vegetation EVC a 144% improvement on the base case Increases the frequency of 12+ days winter/spring bank-full events at Yarrawonga Weir by approximately 5% and no impact on overbank events Increases the area of river red gum in good or moderate condition by 3% and black box woodland by 14% A 10% to 11% increase in the expected mean adult population of golden perch and 0% to 7% increase in mean adult population of Murray cod Increases the utilisation of environmental water by 48%[a] compared to the base case Delivers 50%-63% of the notified relaxed constraints flow rate	Inundates 799 ha of private land or 2.7% of total private land on the floodplain Inundates 316 private properties on average 2.5 ha per affected private property
Y30D30	Inundates a maximum of 34,910 ha of native vegetation EVC a 206% improvement on the base case Increases the frequency of 12+ days winter/spring bank-full events at Yarrawonga Weir by approximately 10% and no impact on overbank events Increases the area of river red gum in good or moderate condition by 5% and black box woodland by 12% A 12% to 20% increase in the expected mean adult population of golden perch and 0% to 7% increase in mean adult population of Murray cod Increases the utilisation of environmental water by 73%[a] compared to the base case Delivers 60%-75% of the notified relaxed constraints flow rate	Inundates 1,884 ha of private land or 6.3% of total private land on the floodplain Inundates 383 private properties on average 4.9 ha per affected private property
Y40D40	Inundates a maximum of 44,218 ha of native vegetation EVC a 287% improvement on the base case Increases the frequency of 12+ days winter/spring bank-full events at Yarrawonga Weir by approximately 10% and overbank events by 20% Increases the area of river red gum in good of moderate condition by 10% and black box woodland by 15%	Inundates 3,432 ha of private land or 11.5% of total private land on the floodplain Inundates 450 private properties on average 7.6 ha per affected private property No impact or a 1% decrease in the expected mean adult population of Murray cod

Flow rate Option	Summary of benefits	Summary of impacts
	A 39% increase in the expected mean adult population of golden perch Increases the utilisation of environmental water by 104%[a] compared to the base case Delivers 80%-100% of the notified relaxed constraints flow rate	

a. Modelled utilisation of environmental water can be used to compare scenarios, however actual utilisation figures will vary significantly due to climate and water availability, environmental demand assumptions and real-world flexibility (rather than fixed model rules).

Consultative Committee

Overview

To achieve the community co-design objectives in developing the feasibility study, a Consultative Committee was announced by the Victorian Minister for Water on 27 April 2022 to provide advice to the Minister on the benefits and risks of the Victorian CMP. Co-design places the stakeholders potentially impacted by the change at the centre of the program. The Committee also provides a forum for the discussion and sharing views on the design and feasibility of the program. The views and insights from the Committee have been included in this feasibility study to the extent possible to provide the range of perspectives for consideration by the Minister regarding the feasibility of the Victorian Constraints Measures Program.

The Consultative Committee, chaired by the Hon Patrick McNamara AM, was appointed by DEECA and comprises members from Traditional Owners, local landholders, irrigators, community members, river operators, environmental water managers, local government representation, Catchment Management Authorities, land managers, representative bodies and agencies. DEECA engaged with agencies to identify community members with experience and knowledge of water-based issues.

A vital aspect of the Committee meetings was the opportunity for individual members to present to the broader Committee on areas of critical personal interest or expertise. This was particularly important to highlight the different benefits, risks and issues encountered within the various geographic regions covered by the study.

Committee meetings

The Committee commenced its work in April 2022 and has met regularly through to the end of 2023. Due to significant impacts on Committee members from the large flood event in Northern Victorian in late 2022, a government decision was taken at that time to defer further Committee meetings from the planned October 2022 meeting onwards, and to reconvene in early 2023. The final Committee meeting was held in December 2023.

Committee guidance on the feasibility study

In line with the co-design approach, the Consultative Committee has also provided direction on the technical investigations and methods undertaken for the feasibility study. Advice from the Committee led to:

- further drone and aerial imagery of the Murray River and Goulburn River at key sites of interest
- installation of additional hydrometric monitoring stations in the Mid Goulburn
- additional studies into riverbank erosion and the potential impacts on rates of riverbank erosion of relaxed constraints
- an assessment of the recreational benefits and impacts of changed flow regimes
- investigations into the impacts of higher relaxed constraint scenarios in the Goulburn River.

Committee advice to the Minister

Throughout 2022 and 2023, a diverse range of views and perspectives have been shared through Committee meetings and associated forums, surveys, and correspondence received by the Committee Chair.

The Committee has been instrumental in shaping the direction for thorough technical investigations and policy frameworks. By facilitating open discussions and sharing different perspectives, the Committee has fostered an understanding of the project and constraint relaxation requirements. Committee members recognised the complexities of the Victorian CMP and expressed a range of opinions on the benefits, impacts, and feasibility of advancing to subsequent stages. This information would enable informed conversations with affected landowners and the wider community in the future stages of the program.

While technically feasible and socially challenging, most of the Consultative Committee support further investigations into the benefits, risks, and costs of relaxing constraints to enable overbank flows up to minor flood level on the Goulburn and Murray River.

They strongly advised that key elements of the Feasibility Study should be discussed with community before a preferred relaxation option is adopted by government and discussions are held with all affected landholders.

Most Committee members recommend that relaxed constraints should only be used to provide greater flexibility to deliver already available water for the environment.

Most Committee members have strongly voiced concerns about the prospect of further water recovery through buybacks. These concerns stem from the observed adverse effects of previous buybacks within northern Victorian communities.

Traditional Owners Involvement

Traditional Owners have an enduring connection to Country and a crucial interest in water resource management. Everything on Country – the land, water, life, culture, and resources – is connected. Traditional Owners have moral and cultural obligations to care for, protect and heal Country, and have done so holistically and sustainably for tens of thousands of years. Country connects Traditional Owners to their past, present and future, and is foundational for identity.

Twenty-one Traditional Owner groups with potential interest in the relaxation of constraints were identified for consultation. Fifteen groups shared their perspectives with the engagement team in seven on-Country workshops. The engagement resulted in five submissions on behalf of twelve groups.

This included Traditional Owner groups across the project area and downstream to the Victoria/South Australia border. Traditional Owner involvement to inform the feasibility study was structured to support meaningful and authentic conversations with Traditional Owner Groups.

This approach was designed to support genuine and meaningful conversations with Traditional Owners and empower groups to contribute to current and any potential future stages of the project. The workshops captured Traditional Owner perspectives and helped establish what further information or steps may be required (from a Traditional Owner viewpoint), should the project proceed to a business case.

The purpose of the consultation was to understand Traditional Owner perspectives of the types of benefits and risks expected to arise from relaxing constraints within designated reaches of the Goulburn and Murray Rivers, and further downstream across the Mallee floodplains (from the Wakool River Junction to South Australia).

Outcomes

No single summary view on the project was agreed to by all Traditional Owner groups. Each received submission has been presented as a separate, stand-alone statement to the Victorian Minister for Water as several groups stated it would be inappropriate to merge their statement with that of another group.

The project team identified a set of key themes from the consultation that can be summarised as follows. The majority of Traditional Owner groups engaged:

- Identified potential benefits of relaxing constraints including: benefits for flora, fauna, and wellbeing benefits to individuals and community of healthy Country.
- Identified potential impacts of relaxing constraints on Country and cultural heritage assets from inappropriate timing of water releases, poor water quality and erosion.
- Identified that the true benefits and risks cannot be assessed without both detailed mapping of cultural assets and detailed knowledge of the flow regimes and implications.
- Emphasised the importance of detailed investigation into the cultural, environmental, and broader community benefits and impact associated with the project.
- Supported further exploration of relaxing constraints to achieve the broader environmental and cultural outcomes and gave in principle support to see the project go forward to the next stage of investigation, although some groups require further information to have a better understanding of the project before they determine their level of support.

Furthermore, the majority of the representatives from Traditional Owner groups engaged expressed the desire to see:

- Significant collaboration with Traditional Owner groups in the next stages, including in decision making over water use.
- Holistic management of land and water, considering the interconnectedness and interdependence of these resources.
- Improved information and engagement if the project continues, to ensure that the information about the project can be understood by the broader community.
- Improved integration between government departments and programs to ensure consistency and continuity in government knowledge.

From the feedback received, the following is recommended for future stages:

- There is a need to support Traditional Owners to undertake mapping of cultural values for Country and the many wetlands that would be engaged under relaxed constraints. Traditional Owners want to ensure the protection of current values from any potential negative impacts from relaxing constraints.
- There is a need to improve the integration of planning complementary works for land and water. Relaxing constraints alone will not deliver the full potential for Country. Land and water need to be managed holistically to achieve the full range of potential benefits.
- There is a need to increase the role of Traditional Owners in governance and decision-making regarding water allocation, use and management as per the Water is Life policy. Traditional Owners expressed the need for improved Traditional Owner involvement in future Constraints program governance. Traditional Owners identified the need for actions in relation to many of the wetlands identified, such as the development of cultural management plans and cultural flow requirements to inform and guide planning.
- Future waterways work should be increasingly led and undertaken by Traditional Owner groups. This will help to address the loss of knowledge about Country due to the dislocation of Traditional Owners from Country, and to provide opportunities for employment and knowledge transfer to future generations.

It is proposed that there be continued partnerships and engagement with Traditional Owners for the next phase of the program, recognising their central role for healing Country and identifying areas of cultural value that can be watered by relaxing constraints. Additionally, the aim is to identify areas of key cultural value that need water but will not benefit from relaxing constraints.

Integration

New South Wales

The Murray River constraints key focus areas within the scope of the Victorian CMP are interjurisdictional, as the Murray River forms the border between New South Wales and Victoria, with the river inundating land within both jurisdictions. Victoria and New South Wales are joint proponents for the Hume to Yarrawonga CMP and New South Wales is the lead proponent for the Yarrawonga to Wakool CMP, with input from Victoria to represent the interest of Victorians impacted. The states have different delivery models for their constraints programs, reflecting differences in Ministerial direction, funding and work programs. Both Victoria and New South Wales will lead engagement with their own potentially affected landholders as part of the Hume to Yarrawonga and Yarrawonga to Wakool CMPs.

The New South Wales CMPs are being delivered by the New South Wales Government under the scope of the Reconnecting River Country Project (RCCP). New South Wales completed a strategic business case in July 2022 for the Murray Projects, which is considered the equivalent of a feasibility study in Victoria.

During this stage of the Victorian CMP, the Victorian and New South Wales project teams have collaborated in the development of the projects. This collaboration has included data and information sharing, joint risk workshops, attendance at Victorian Committee and New South Wales Governance meetings and regular progress meetings.

While individual constraint projects need to be assessed for local benefits and impacts, further coordinated planning between states is needed to understand system-wide benefits and implications of relaxing constraints, including the feasibility of achieving flow objectives at the SA border.

River operating rules along the length of the Murray River must work together, upstream, rules should have regard to the downstream rules and vice versa. This is also the case for the operating rules in the Goulburn and Murrumbidgee rivers. These must also work with the rules for the Murray.

The relaxation of constraints along the Murray, Goulburn and Murrumbidgee Rivers needs to be integrated to ensure that the rules work together at the system scale. Integration requires a joined-up project that considers benefits, risks, engagement, and policies across borders.

There must be consistency in compensation and mitigation approaches across state borders to ensure that landowners on both sides of the river are treated fairly.

Regulatory approvals to implement the CMP may require approvals under Victorian, New South Wales and Commonwealth legislation. It is likely that this would be a very unwieldy, time consuming and costly process. It is proposed that a streamlined approval process suitable for assessing interjurisdictional environmental enhancement projects like the CMP be developed by the Commonwealth Victorian and New South Wales regulators.

Enhanced Environmental Water Delivery (EEWD)

The Enhanced Environmental Water Delivery (EEWD) Project is a project underway in the Basin to improve systemwide coordination of environmental flows to maximise the benefits for the environment across the southern connected Basin, which includes parts of Victoria, New South Wales and South Australia. The project is being coordinated by the MDBA with the states as joint proponents.

There is significant interdependence between the Victorian CMP and the EEWD Project in relation to enabling overbank environmental flows. The EEWD project is looking at the required tools, processes and systems to be able to slowly increase targeted flows through an adaptive management approach if the CMP is implemented. As part of the EEWD project, arrangements will be developed to resolve a clear and consistent framework to support environmental water delivery. This work will reduce uncertainty for river operators and enhance their capacity to deliver environmental water, in regulated and unregulated conditions and to achieve in-channel and floodplain outcomes, on behalf of environmental water managers and state partners. Initial discussions have reflected that some change to legislation and operating procedures may be required to better engage with legal and governance risk. The EEWD project will focus on providing the forum to coordinate and align on these issues across jurisdictions.

The EEWD framework will complement the work under the CMP to use flow inundation modelling, mapping and other investigations to inform risk management and buffer investigations to assess the benefits and risks of different flow rates to build trust and confidence with communities, and negotiation of consent arrangements with impacted landholders and asset owners.

Considerations for future implementation

This stage of the Victorian CMP involved exploration of key areas that will need to be considered if the program proceeds to implementation. These involve frameworks and policy principles associated with public and private stakeholders. This section describes the key considerations for any future implementation.

Mitigation Selection and Compensation Framework

While the overarching aim is to water high environmental value public land, the private land, assets and infrastructure would also be unavoidably inundated from the delivery of flows under relaxed constraints. In addition to direct asset impacts, there are potential long-term recurring impacts resulting from regular inundation, such as loss of production, pasture restoration, debris clean-up, fence reinstatement, agistment costs, maintenance and other related factors. A proposed landholder mitigation selection and compensation framework has been developed to provide a framework for a transparent, fair and equitable approach to negotiating agreements with landholders, if a decision is made to proceed with the Victorian CMP.

The framework anticipates the requirement for the acquisition of inundation easements in accordance with the *Victorian Government Land Transactions Policy 2022* and *Land Acquisition and Compensation Act 1986*. It identifies a negotiation process and the use of compensation valuation methods consistent with relevant government legislation and guidelines for public procurement, land acquisition and public grants. Where relevant, the compensation offer to landowners will include a component for future loss or damages associated with inundation impacts in perpetuity (i.e., loss of production, pasture restoration, reinstatement of fencing, agistment costs, etc).

The framework has been developed in the context of the Victorian Government's stated position that Victoria will not inundate land without prior landowner consent nor compulsorily acquire land or easements for the purpose of relaxing constraints. Therefore, the acquisition of easements for the Victorian CMP is dependent on reaching 100% voluntary agreement with impacted landowners. This creates a significant challenge for the Victorian CMP because landholders are under no obligation to agree to an offer of compensation put forward by the Victorian CMP even if the offer is a fair assessment of market value.

The Committee advised that attaining 100% voluntary agreement from landowners for mitigation and compensation packages is highly unlikely given previous experiences with programs such as the surface drainage program and the Connections Project. Most of the Committee supported the use of compulsory powers on the understanding that a threshold of voluntary agreements were achieved, i.e. compulsory powers were only used as a last resort to ensure the broad environmental benefits of relaxing constraints are not realised because of the opposition of a small minority of property owners. Options for managing the risk of needing 100% landholder voluntary agreement in order to delivery environmental flows under relaxed constraints will need to be considered in future stages of the project. This is detailed further in Section 9.

Asset ownership framework

The delivery of flows under relaxed constraints for environmental watering will result in varying levels of inundation of private and public assets on the floodplain. Impacted assets may include pumps, roads, tracks, rural levees, recreational facilities and fences. If the project should proceed to implementation there would be a requirement to mitigate the impacts on affected assets generally through upgrades to the asset to bring the asset above the inundation water level. This brings into question issues of ownership and maintenance responsibilities for upgraded assets.

As part of this stage of the Victorian CMP, an assessment has been undertaken of the policies and arrangements for asset ownership and maintenance responsibilities. The assessment principally draws on existing government asset management policies and practices for water and floodplain protection infrastructure. From the assessment, proposed policy positions for the ownership and maintenance of the range of assets delivered by the project have been developed and are detailed further in Section 11.

River operations

An assessment of the risks and mitigations for river operations from relaxing flow constraints was undertaken for this feasibility study.

The assessment involved conducting risk workshops with representatives from various organisations involved in river operations and environmental water management. These workshops identified and reviewed key risks and explored potential options to mitigate these risks to facilitate the delivery of higher environmental flows.

The key risks identified include:

- Implementing higher environmental flows under relaxed constraints requires better cooperation and coordination among multiple organisations and jurisdictions. Clear roles and responsibilities are crucial for a coordinated approach.
- Uncertainty regarding managing liability related to overbank environmental flows, and unclear boundaries for managing this responsibility.
- Needing comprehensive system-wide and landscape-scale environmental water planning. It is unclear who would be responsible for managing this expanded scale of planning under the current arrangements.
- Lack of investment in resources, capacity, and capability to effectively carry out landscape planning and coordination.
- Concerns about the understanding of risk-based flow forecasting, especially among landholders and the general public. There is a worry that public expectations regarding the accuracy of flow forecasts may be unrealistic.
- Risks associated with notifying landholders and the public about current and projected flows.

Based on the analysis, several key mitigations have been identified to support river operations under a relaxed constraints regime. Many of these already form part of the key mitigations being progressed as part of the EEWD project. These mitigations could include:

- Establishing a clear statutory responsibility or function for river operator organisations to deliver overbank environmental flows. This ensures that river operators can release water within agreed limits and have the necessary legal certainty.
- Reviewing statutory functions and accountabilities of GMW and the MDBA. This issue has also been recognised by the EEWD and NSW Reconnecting River Country projects.
- Incorporating an additional buffer zone when determining primary mitigation measures, such as easements and other works. This accounts for residual forecasting uncertainty despite efforts to improve river flow forecasting tools.
- Implementing arrangements for compensation in rare cases where river flows exceed agreed limits, even if the river operator organisations have followed the agreed procedures and arrangements. This serves as a fail-safe mechanism for stakeholders and river operators.
- Reviewing policies and procedures to ensure best practices and quality assurance for delivering higher environmental flows. This also helps build understanding and confidence among stakeholders regarding the management of risks.
- Phasing implementing higher environmental flows and conducting trials to manage risks effectively. This staged approach is recognised as an important mitigation measure.
- Investing in the capacity and capability of human resources, developing operations tools for improved flow forecasting, and providing better information to support enhanced flow forecasting. This would ensure a stronger foundation for managing environmental flows.

Recreational impact and benefit assessment

The Consultative Committee advised that some socio-economic components of the Victorian CMP should be brought forward and be considered within the feasibility study with a focus on recreational impacts. For the recreational assessment, workshops were conducted with public land and waterway managers in the Murray River and Goulburn River, focusing on the impacts of relaxed constraints at six case study areas. The case studies were Gunbower Island, Barmah National Park, Nyah-Vinifera Park, Lake Moodemere, Gemmill Swamp and Molesworth Recreation Reserve.

The assessment found that constraints relaxation has the potential to deliver a range of positive outcomes for recreation, particularly in the long-term, as well as some associated negative impacts on recreational values, largely during and immediately following inundation. The environmental outcomes of relaxing constraints are expected to improve the ecological condition and amenity value of the areas they affect. This is anticipated to enhance the experience visitors derive from these sites in the long-term, support recreation activities, and improve community cohesion and appreciation for natural assets. While environmental watering is noted to restrict access for certain types of recreation during the inundation period, it provides conditions for other recreational pursuits (e.g., canoeing / kayaking, birdwatching, wading, sightseeing).

The negative impacts of constraints relaxation may be able to be mitigated through site planning and associated works. Moreover, the winter/spring timing of relaxed constraint flows is generally prior to peak visitor activity, with certain sites already enforcing park closures for current flow regimes. Impacts to site access have been described as ‘challenges’ that could be addressed through changes to the operations and management plans in consultation with land and waterway managers. Risks to recreation values outside periods of inundation can only be mitigated with adequate funding for land and waterway managers to maintain suitable access and landscape condition to support visitor experiences.

Hydrometric network upgrades

Accurate and up to date information on river flows and rainfall will be critical to the delivery of delivery of flows under relaxed constraints for environmental watering. Within the Mid Goulburn catchment, there are gaps in the unregulated streamflow and rainfall monitoring network, with approximately 57% of the catchment and lengthy sections of the mainstem of the Goulburn River not equipped with rainfall or streamflow monitoring. To improve coverage of the hydrometric network system, this stage of the Victorian CMP has installed new streamflow and rainfall gauges in high priority sites in the Mid Goulburn catchment.

A shortlist of 11 streamflow and rainfall gauging sites for the new installation was Identified through consultation with the key stakeholders–- GMW, GBCMA, DEECA and BOM. The shortlist of sites was then subject to field investigations to confirm the suitability of the proposed sites. Following detailed field investigations and stakeholder engagement, including consultation with Consultative Committee members, the streamflow and rainfall gauging sites were confirmed.

The project also secured a funding source for the O&M costs associated with the new sites. As the new gauges are required for planning and managing environmental flows in the Goulburn River (under relaxed constraints scenarios), it is confirmed that ongoing O&M costs are funded by the DEECA Environmental Water Team through existing funding arrangements.

Installation and operation of all newly identified sites is expected to be completed by the end of 2023 subject to the necessary approvals.

Regulatory approvals

The regulatory environment for relaxing constraints is complex, as the impacts of the program by nature of its geography, covers multiple jurisdictional boundaries and requires involvement of regulatory authorities and approvals under both Commonwealth and State legislation. A Regulatory Approvals Strategy (RAS) for the Victorian CMP has been developed that identifies the key approvals required to deliver the program. The strategy is informed by a regulatory approvals perspective on the program’s governance arrangements, proponent(s) and approach to program delivery (across scope, spatial and temporal contexts), and has considered the interdependencies of each aspect.

The strategy has identified two feasible pathways for navigating key approvals for the program, either through a program-wide Strategic Assessment or separate assessment of the Goulburn River and Murray River. The advantages and disadvantages of each option are outlined in the strategy for consideration alongside other factors relevant to program deliver.

An indicative schedule has been prepared to support consideration of the approval pathway and indicates that key approvals could take in the order of 3 years, noting that this would be reliant on successful engagement between Commonwealth, New South Wales and Victorian governments to establish a partner agreement that allows an interjurisdictional approach. The strategy also identifies key next steps to expedite the regulatory approvals including:

- continued early and ongoing engagement with regulatory authorities

- early identification of program assets, values and uses to inform development of an effects framework to frame the program's benefits and adverse impacts
- commencement of a referral self-assessment process informed by assets, values and uses.

Stakeholder and community engagement

If the Victorian CMP proceeds to the next stage (Business Case), wider stakeholder and community engagement will be a core component of program delivery. The Consultative Committee has provided guidance on its expectations around engagement for the next stages of the project. The Committee has recommended that the project meet with impacted landowners and occupiers. The Committee has stressed that any engagement needs to be supported with clear and concise information on the benefits, potential impacts, and mitigation and compensation options associated with the different constraint relaxation scenarios. The Committee has also recommended that the inundation modelling output be ground-truthed with impacted landowners and occupiers as part of this future engagement. The occurrence of high flows in Spring 2022 allowed the project to capture aerial photography of flows within the scenarios under consideration. This observed event will be critical to support engagement activities.

Principles for stakeholder engagement for any future stages of the program have been developed and is discussed in Section 5.1. The principles will ensure that any future delivery of the Victorian CMP will be founded on a robust strategic engagement and communication process. Bespoke engagement plans will be prepared for each key stakeholder group including Traditional Owners, private landholders, public land and local government authorities and the broader community. The key objectives for the engagement will include collaborating with stakeholders on elements of the program's design and development, building support and trust for the program by reinforcing local benefits, and proactively engaging with media to improve understanding of the project.

It would be critical that the treatment of landholders, communication and messaging is consistent across both sides of the border should the constraints project progress to development of a business case. This would include aligning program delivery approaches and timelines, as well as maintaining a consistent approach when engaging with landowners and Traditional Owners. Additionally, it is important to strive for consistency in approaches to acquiring easements, compensating impacted landowners, and implementing mitigation measures.

Governance

If the project proceeds, the proposed governance structure to oversee and strategically guide the delivery of the next phase will be further considered through the development of the *Constraints relaxation implementation roadmap*, a requirement of the *Water Amendment (Restoring Our Rivers) Act 2023*, enacted at the end of the Committee's tenure.

Risk management

A comprehensive risk assessment for the Victorian CMP has been completed to identify the key risks to project implementation and consequent mitigation activities. The key program risks are:

- inability to meet originally legislated Basin Plan timelines. Although it is noted that the *Water Amendment (Restoring Our Rivers) Act 2023* was enacted at the end of the Committee's tenure which extended the completion date of the SDLAM projects to 31 December 2026.
- ability to achieve 100% voluntary landowner acceptance
- difficulty of articulating the benefits of the Victorian CMP
- overly complex and inter-jurisdictional regulatory approvals
- requirement for a large number of landholder agreements to be negotiated
- requirement to scale up Valuer General process and ability to resource valuation requirements
- need for coordination on key project policy across multiple-jurisdictions
- impact of 2022 floods on community perception of the Victorian CMP
- lack of agreed roles and responsibilities across landscape-scale environmental water planning and consultation process

- difficulty in achieving river operating agency acceptance of the risks of relaxed constraints operation.

Mitigations have been identified and articulated for each of these key risks and are detailed in Section 17.

Key outcomes

Having assessed the supporting information in detail, the key outcomes from the Feasibility Study are:

- While technically feasible and socially challenging, most of the Consultative Committee support further investigations into the benefits, risks, and costs of relaxing constraints to enable overbank flows up to minor flood level on the Goulburn and Murray River
- The investigations have identified that there are no major technical or policy barriers suggesting that constraints relaxation is not feasible to progress to the next stage. However, this would require the support and alignment of Ministers from the Australian Government, New South Wales, and South Australia
- Technical investigations into hydrology, land and asset mapping and environmental benefits analysis have addressed significant data and modelling gaps and enabled meaningful and informed conversations. The program now addresses recommendations of the 2019 Wilson Report, by delivering a step change in the models used to inform the CMP assessment, including the use of daily models across the system, the most contemporary data available and an increased resolution of hydraulic model outputs
- Modelling efforts were coordinated across inter-jurisdictional government agencies. This included the establishment of the DEECA SWAM GBCCL Source Model for the purpose of the Victorian CMP, which is the first time in Basin Plan history that daily model outputs from the GBCCL Source have been available as inputs to the Murray Source Model. It is also the first time that daily models have been used across the Basin Plan system for the assessment of Constraint Relaxation which provides improved modelling of the interaction between the Murray and the Goulburn
- The majority of the 21 individual Traditional Owner groups consulted supported further exploration of relaxing constraints to achieve the broader environmental and cultural outcomes and gave in-principle support to see the project go forward to the next stage of investigation. Some groups requested further information to have a better understanding of the project before they determine their level of support.
- Constraints relaxation generates substantial net-positive environmental benefits for floodplain and riverine ecosystems in the Goulburn and Murray rivers.
- Relaxing constraints, generally up to the minor flood level, will result in an increased area of inundation of private land. Analysis shows that the private land impacted is classified as rural or agricultural and there are no residential or built-up areas impacted
- Hydraulic modelling, showing the estimated inundation area, indicates that between 143 and 511 properties (net) across the Goulburn and Murray Rivers are inundated under relaxed constraint scenarios. Modelling of the existing constraint scenarios has identified 545 properties may already experience some form of inundation. Properties are impacted mainly through flows into floodplain depressions and flood runners on sections of property adjacent to the river systems
- Investigations identified that the total area of private land impacted by constraints relaxation is estimated to be:
  - Goulburn River: 478 ha to 1,505 ha or 1.1% - 3.3% of the total area of private land within the designated flood overlay
  - Murray River: 799 ha to 3,576 ha or 2.7% - 12% of the total area of private land within the designated flood overlay
- Appropriate compensation offers would be required to ensure voluntary agreements from landholders. Past experience in creating flood easements suggests that some landholders will withhold their agreement. This was further highlighted in discussions with the Consultative Committee. Appropriate compensation offers would be required to ensure voluntary agreements from landholders. The recommended approach is to use these Government powers as a last resort, after every effort has been made to create flood easements voluntarily and where there is an overwhelming community benefit in creating the easements.

- Regulatory approvals to implement the CMP may require approvals under Victorian, New South Wales and Commonwealth legislation. It is likely that this would be a very unwieldy, time consuming and costly process. It is proposed that a streamlined approval process suitable for assessing interjurisdictional environmental enhancement projects like the CMP be developed by the Commonwealth Victorian and New South Wales regulators.
- River operating rules along the length of the Murray River must work together, upstream rules should have regard to the downstream rules and vice versa. This is also the case for the operating rules in the Goulburn and Murrumbidgee rivers. Because of this interconnection, it's critical that Basin States and the Commonwealth agree to proposed relaxed operating rules before initiating extensive community engagement. The establishment of system-wide parameters and governance is necessary to ensure efficient and transparent collaboration with affected communities.

Contents

List of tables

List of figures

List of abbreviations

Term	Definition
ALA	Atlas of Living Australia
AMAF	Asset Management Accountability Framework
BLMG	BirdLife Murray Goulburn
BoM	Bureau of Meteorology
CEWH	Commonwealth Environmental Water Holder
CMA	Catchment Management Authority
CMS	Constraints Management Strategy
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DEECA	Department of Energy, Environment and Climate Action
DELWP	Department of Environment, Land, Water and Planning
DTF	Department of Treasury and Finance
EEWD	Enhanced Environmental Water Delivery
EPBC	Environment Protection and Biodiversity Conservation
EPI	Erosion Potential Index
EVC	Ecological Vegetation Classes
EWR	Environmental Water Requirements
GBCCL	Goulburn Broken Campaspe Coliban Loddon
GBCMA	Goulburn Broken Catchment Management Authority
GIS	Geographic Information System
GMID	Goulburn Murray Irrigation District
GMW	Goulburn Murray Water
GVIAP	Gross Value of Irrigated Agricultural Production
H2Y	Hume to Yarrawonga
IVT	Inter-valley trade
LGA	Local Government Authority
LiDAR	Light detection and ranging
LMW	Lower Murray Water
LTAAY	Long-term average annual yield
MCMA	Mallee Catchment Management Authority
MDBA	Murray-Darling Basin Authority
MHL	Manly Hydraulics Laboratory
NCCMA	North Central Catchment Management Authority
NECMA	North East Catchment Management Authority
NSW RRCP	NSW Reconnecting River Country Program
O&M	Operations and Maintenance

Term	Definition
PCG	Project Control Group
RAS	Regulatory Approvals Strategy
RiM-FIM	The River Murray Floodplain Inundation Model
RMO works	Murray River Operations works
S&D	Stock and domestic
SDL	Sustainable Diversion Limits
SDLAM	Sustainable Diversion Limit Adjustment Mechanism
SGEFM	Stochastic Goulburn Environmental Flow Model
SMM	Source Murray Model
TEI	Total estimated investment
VGV	Valuer General of Victoria
VEWH	Victorian Environmental Water Holder
VMFRP	Victorian Murray Floodplain Restoration Project
Y2W	Yarrawonga to Wakool

Glossary

Term	Definition
Assets	Assets are resources that provide benefit. This includes, for example, infrastructure such as roads, bridges, pipes and pumps, water assets such as dams, and community assets such as sporting facilities, camping grounds and Parks. Natural assets are assets of the natural environment, for example waterways, wetlands and vegetation. Source: DEECA
Anabranches	Branch of a river that leaves the mainstem and re-joins it downstream.
Bank-full flows	The maximum amount of water a river channel can hold before overflowing over or through the riverbanks onto the adjacent floodplain. Engages the riparian zone, anabranches and flood runners and wetlands located within the meander train. Inundates all in channel habitats including all benches, snags, and backwaters. Source: DPIE
Baseline, or base case	Conditions regarded as a reference point for the purpose of comparison.
Basin Plan	Is an agreed approach between the Basin state governments on how water is to be managed in the Murray Darling Basin. The Basin Plan was passed into law in November 2012 under the *Water Act 2007*.
Basin state	A state (or territory) with an area of the Murray–Darling Basin within its borders. Usually, the term is used to mean the governments of those states. The Basin state governments are New South Wales, Queensland, South Australia, Victoria and the Australian Capital Territory.
Billabong	Billabongs are wetlands will lakes on the floodplain that originate from a change in the course of the river over time. They are also called, oxbows, or cut-off meanders. Ryan's lagoon downstream of Lake Hume is an example of the cut-off meanders.
Black box	Black box (*Eucalyptus largiflorens*) is a tree native to Australia, which relies on regular flooding to maintain health and promote regeneration. Black box are typically found on the outer edge of the floodplain.
Bulk entitlement	A right to use and supply water in a waterway, water in storage works of a water corporation. Water corporations and other specified bodies defined in the *Water Act 1989* can hold bulk entitlements
Commonwealth Environmental Water Holder	Commonwealth government body responsible for managing the Commonwealth environmental water portfolio.
Carryover	An arrangement that allows a water entitlement holder to take unused water allocations from one season into the next season to use and/or trade.
Confluence	The place where a tributary stream flows into the mainstem of river.
Connectivity	Connections between natural habitats, such as a river channel and adjacent wetland areas. Connectivity is a measure or indicator of whether a water body (river, wetland, floodplain) has water connections or flow connections to another body.
Constraint	An operating limit on the rate of regulated flow that can be released from a storage put in place by river operators to minimise the risk of inundating private land on the floodplain.
Constraints Measures	Constraints Measures are projects for relaxing constraints within specified river reaches defined in the Constraints Management Strategy and notified as Supply Measures projects under the Sustainable Diversion Limit Adjustment Mechanism.

Term	Definition
Constraints Management Strategy	Is a strategy released by the MDBA in 2013 that identifies the primary operating constraints in the southern connected basin and sets out a strategy for relaxing constraints, including Constraints Measures projects in the Goulburn River and the Hume to Yarrawonga and Yarrawonga to Wakool reaches of the Murray River.
Crown land	Land is owned by the state, often referred to as public land.
Dam	A structure built across a river, primarily to store water , but sometimes also to control flooding and generate electricity
Delivery of water	Physically getting water to the users who have ordered it. This includes providing water to state storages (in some cases), individual irrigators and environmental water holders. This involves managing the flows and connections of water in the river system.
Ecological Vegetation Classes (EVCs)	A vegetation classification system used in Victoria derived from groupings of vegetation communities based on floristic, structural and ecological features.
Ecosystem	A biological community of interacting organisms and their physical environment. It includes all the living things in that community, interacting with their non-living environment (weather, earth, sun, soil, climate and atmosphere) and with each other. Source: DPIE
Edward Wakool system	The Edwards River (Kolety River) is the largest anabranch of the Murray River and breaks away from the river at the Barmah choke. The Edwards River flows through the Southern river land of New South Wales. Before re-joining the Murray, the Edward splits into the Wakool River. The Wakool River flows into the Murray River north of Swan Hill.
Environmental entitlement	A right to water granted to the Victorian Environmental Water Holder to maintain an environmental water reserve or improve the environmental values and health of the water ecosystems and other users depending on the condition of the environment. Source: Victorian Water Register
Environmental flow	The release of environmental water from storage with the intention of maintaining or improving river health.
Environmental flow event	A single event of the release of environmental water from storage.
Environmental water	Water available under a water access right or a bulk entitlement for the purposes of achieving environmental outcomes (including water specified in a water access right to be for environmental use).
Environmental water requirements	The amount of water needed to meet and ecological environmental objectives.
Flood	Flows that are high enough at their peak to overrun riverbanks or cause flow through high-level anabranches, flood runners or to wetlands and other floodplain features.
Floodplain	Flat or nearly flat land adjacent to a stream or river that experiences occasional or periodic flooding. Natural floodplains are some of the most diverse and productive ecosystems on earth. Source: Bureau of Meteorology
Floodplain depression	Floodplain depressions are shallow depressions on the floodplain that resemble lakes and are connected to the river system and can be inundated at a high bank-full flows and low overbank flows undated. An example of a floodplain depression in the study area is Lake Moodemere.

Term	Definition
Flood-runner	A natural channel on the floodplain, which carries flowing water, only during periods of high flow or flood.
Flow	The rate of water discharged by a river measured in terms of volume per unit time, e.g., ML/day.
Flow components	A classification of the different elements that make up the characteristic patterns of river flow. They typically include 'cease-to-flow' periods, 'base flows', 'freshes', 'bank-full flows' and 'over-bank flows'.
Flow regime	The characteristic pattern of river's flow quantity, timing, and variability.
Gauging	Physical measurement of instantaneous streamflow to develop the stage-discharge relationship.
Gigalitre	1,000 megalitres, which also is 1,000,000,000 litres.
GIS	Geographic information system
Goulburn River	The Goulburn River is a tributary of the Murray River that is located in northern Victoria. It is the largest river in Victoria by annual discharge and by length.
Goulburn Murray Water	Is a Victorian Water Corporation that manages water resources and water delivery in the Victorian Murray River and Goulburn Rivers.
Headworks	Large dams, weirs and associated works used for the harvest and supply of water.
Hume to Yarrawonga Reach	Is the section of the Murray River between Lake Hume and Lake Mulwala at Yarrawonga.
Hydraulics	The study of the conveyance of liquids through pipes and channels.
Hydraulic modelling	A computer simulation that combines topographic data and river flow equations to generate information about the depths and velocity of floods for different river flow levels.
Hydrology	The study of the occurrence, distribution, and movement of water.
Hydrological connectivity	The flow that links natural aquatic environments. Lateral connectivity is the flow linking river channels and the floodplain. Longitudinal connectivity relates to the consistent downstream flow along the length of rivers.
Hydrological modelling	Mathematical process or computer simulation representing part of the hydrologic cycle, used primarily for prediction of water behaviour within catchments and associated water supply systems.
Hydrometric	Monitoring of the hydrological cycle including rainfall, surface water and groundwater characteristics, as well as water quality.
Inflows	Water flowing into a storage (reservoir or lake) or river system.
Inter-valley water trade	A transaction to transfer a water right or water allocation from one legal entity to another in a different trading zone or valley.
Inundation	To cover with water, usually by the process of flooding.
Levee	An embankment that is built next to a river in order to prevent the river from flowing onto adjacent land on the floodplain.
Lower Goulburn	Is the reach of the Goulburn River between Goulburn Weir and the confluence of the Goulburn River, with the Murray River.
Meander	A curve or bend in the course of a river.
Megalitre	1,000,000 litres.

Term	Definition
Mid Goulburn	Is the catchment of the Goulburn River between Eildon Dam and Goulburn Weir.
Minor flooding	Flooding causing inconvenience. Low-lying areas next to watercourses are inundated which may require the removal of stock and equipment. Minor roads may be closed, and low-level bridges submerged. Source: Bureau of Meteorology
Modelling	Application of a mathematical process or computer algorithm (such as a hydraulic or hydrolologic model) to simulate a natural phenomenon and Alan analyse the effects of changes in some characteristics.
Murray River	The Murray River (in South Australia: River Murray) is a river in south-eastern Australia. It is Australia's longest river at 2,508 km in length and flows through Victoria and New South Wales and South Australia. It forms the border between New South Wales and Victoria.
Murray Darling Basin	The Murray–Darling Basin is a large area of south-eastern Australia where water flows through a system of interconnected rivers and lakes. The mainstem of the Basin river system is the Murray River.
Murray Darling Basin Authority	The Murray Darling Basin Authority (MDBA) is a Commonwealth government agency that was established under the *Water Act 2007* to manage water resources in the Murray Darling Basin.
Natural flow regime	Flow of a stream under natural, as opposed to regulated, conditions.
Over-bank flows	Flows that spill over the riverbank or extend onto the adjacent floodplain. They benefit a broad range of biota (including floodplain vegetation communities, birds and native fish) and support important ecosystem functions.
Regulated flows	A river flow resulting from an upstream release from a dam and storage.
Regulated river	A river in which flow is controlled or regulated by dams and weirs.
Relaxing constraints	Lifting the operating limit on the rate of regulated flow that can be released from storage.
Riparian	The part of the landscape adjoining rivers and streams that has a direct influence on the water and aquatic ecosystems within them.
River channel	The part of the river where the water usually flows; it includes the bed and the lower part of the banks.
Riverbank	Riverbanks are the sides of the river between which water normally flows.
River reach	In this study defined as the length of river between two geographic points, such as between storages or between storages and the confluence with major tributaries.
River Murray System	The River Murray system (RMS) extends from Hume Dam, at Albury New South Wales, downstream to the Coorong, Lower Lakes and Murray Mouth in South Australia. It includes connected anabranches, creeks and major tributaries such as the Murrumbidgee, Edward–Wakool, Kiewa, Ovens, Goulburn, Broken, Campaspe, Loddon, Avoca and the lower Darling River (south of Menindee Lakes). Water delivery in the RMS is managed by the MDBA on behalf of Victoria, New South Wales and South Australia.
River red gum	A tree of the genus *Eucalyptus camaldulensis*. It is one of around 800 in the genus. It is native to Australia where it is widespread, especially beside inland water courses.

Term	Definition
Southern connected Basin	The southern-connected Basin is a term used to describe the River Murray and regulated reaches of its major tributaries, which include Murrumbidgee, lower Darling, Kiewa, Ovens, Broken, Goulburn, Campaspe and Loddon rivers.
Spill	When water is discharged from the storage when there is more water in supply than demand for water. Source: Victorian Water Register
Stock and domestic	Use of water for nonurban domestic consumption (e.g., drinking, cooking, washing, watering household gardens, filling swimming pools associated with domestic premises) and to water stock on a property.
Streamflow	The flow of water in streams, rivers, and other channels.
Sustainable Diversion Limit	The limit on how much water can be used by Basin towns, communities, farmers, and industries, over the long-term, while leaving enough water in the river system to sustain natural ecosystems. Sustainable diversion limits are set at a catchment level and defined in the Basin Plan.
Sustainable Diversion Limit Adjustment Mechanism	A mechanism to adjust Sustainable Diversion Limits, requiring a suite of projects (supply and efficiency measures) to be implemented which offset the need to recover water from consumptive use under the Basin Plan
Traditional Owner	Traditional Owners are Aboriginal people who have traditional connection to an identified geographical area of Country. Source DELWP (2019), DELWP's Traditional Owner and Aboriginal Community Engagement Framework
Tributary	A river or creek contributing its flow to a larger river or other body of water.
Vegetation Quality	For this study relates to the vigour of the tree canopy, where health is measured by reference to the crown extent and density.
Victorian Environmental Water Holder	Is a Victorian Government statutory body responsible for holding and managing Victoria's environmental water entitlements and allocations.
Victorian Murray River	is the area covered by the Victorian Murray water resource plan area. The area is made up to connected regions. The part of the Victorian Murray within the study area of the Victorian Constraints Measures Program is the Victorian Murray River floodplain between Hume Dam and the confluence of the Wakool River.
Watercourse	A river, creek, or other natural watercourse (whether modified or not) in which water is contained or flows (whether permanently or from time to time). Source: Bureau of Meteorology
Water allocation	The specific volume of water allocated to water access entitlements in a given season or given accounting period.
Water - dependent ecosystem	An ecosystem or species that depends on periodic or sustained inundation, waterlogging or significant inputs of water for natural functioning and survival.
Water entitlement	A right to take/use/extract/have water delivered to a property boundary.
Water level	The elevation of the water surface at a particular time and date, measured relative to a specified datum.
Water trade	A transaction to transfer a water right or water allocation from one legal entity to another.

Term	Definition
Weir	A structure built across a river to raise water levels to enable water to be diverted by gravity onto land. May also have a water storage function.
Wetland	Wetlands are areas whether natural, modified or artificial, subject to permanent or temporary inundation, that hold static or very slow-moving water and develop, or have the potential to develop, biota adapted to inundation and the aquatic environment. The definition of a wetland in the Victorian wetland classification framework includes This includes waterbodies such as lakes, swamps, billabongs, bogs, and marshes. Wetlands can be permanent, seasonal into medical and episodic.
Unregulated flow	A river flow not resulting from the upstream release from a dam and storage. Note unregulated flows can occur in both regulated and unregulated rivers.
Unregulated river	A river where flows are not controlled by upstream release from a dam and weirs.
Yarrawonga to Wakool	Is the section of the Murray River from downstream of Yarrawonga Weir to the junction of the Wakool River with the Murray River.

PART A – FEASIBLITY STUDY

1. Introduction

1.1 Overview

This stage of the Victorian Constraints Measures Program (Victorian CMP) is assessing the feasibility of relaxing river operational constraints on regulated environmental flows in the Goulburn River and Murray River of Northern Victoria. By relaxing constraints, in a manner which considers environmental, social, cultural and economic aspects, the project seeks to protect and restore water-dependent ecosystems in the target Victorian river systems and contribute to fulfilling the state's commitments to the Basin Plan.

Opportunities for constraints relaxation in the major regulated rivers of the Murray-Darling Basin have been under consideration through the Basin Plan since 2012. This feasibility study provides an updated assessment of the project with a specific focus on:

- addressing shortcomings in the previous constraints relaxation technical assessments as identified in a report by the New South Wales and Victorian Minister's Independent Expert Panel in 2019[10]
- re-scoping and staging of the Victorian river reach constraints relaxation projects following the Ministerial Council decision on community codesign of constraints measures projects[11]
- assessing and quantifying the local and regional impacts and benefits of the project, and where applicable, Basin Plan systemwide considerations.

The Victorian CMP is the first step to addressing key technical and knowledge gaps and considering options for the extent of constraints relaxation within the focus river reaches. It is anticipated that if the feasibility study is endorsed by government, then the project will proceed to its next stages which will include engagement with affected landholders and the development of a business case, detailed design and approvals and an implementation stage.

The future planning and staging of the program will be further considered through the development of the *Constraints relaxation implementation roadmap*, a requirement of the *Water Amendment (Restoring Our Rivers) Act 2023*, enacted at the end of the Committee's tenure.

The Victorian and Australian governments have entered into a contract for the Victorian CMP to develop this feasibility study. This first stage is being led by the Victorian Department of Energy, Environment and Climate Action (DEECA), and involving insights and opinions from a Consultative Committee with an independent chair, who explored the benefits, risks and concerns associated with lifting current river flow limits.

Key technical investigations for the feasibility study have been completed in collaboration with the New South Wales government through the parallel NSW Reconnecting River Country Program (NSW RRCP). This has provided a consistent approach to hydrological and hydraulic assessment in the Murray River and has delivered significant efficiencies in the assessment approach.

1.2 Context

1.2.1 Basin Plan and Constraints Management Strategy

The feasibility study is being developed to meet Victoria's commitment to delivery of constraints measures under the Basin Plan's SDLAM. The MDBA developed a Constraints Management Strategy (CMS) 2013 to 2024 to guide the work of relaxing operational constraints[12]. The MDBA CMS noted that "Relaxing constraints up to these levels (or possibly at lower levels) will be examined through implementation of the CMS"[13]. In 2017, the Basin state governments nominated seven constraints measures projects for key river reaches as part of the SDLAM. The constraints measures projects agreed by the Murray-Darling Basin

10 Murray Darling Basin Constraints Modelling – Report by the NSW and Victorian Ministers Independent Expert Panel, 16 December 2019
11 https://www.water.vic.gov.au/murray-darling-basin-plan/victorias-progress
12 MDBA (2013) Constraints Management Strategy 2013 to 2024
13 MDBA (2013). Constraints Management Strategy 2013 to 2024. Appendix B – Modelled constraints used to inform the Basin Plan 2012

Ministerial Council identified three projects requiring mitigation works and measures in Victoria and which form the basis of the Victorian CMP[14]:

- **Hume to Yarrawonga key focus area:** a project to relax constraints up to 40,000 ML/day at the Doctors Point gauging station below Hume Dam on the Murray River. The project is jointly proposed by Victoria and New South Wales and involves mitigation works and measures on both banks of the Murray River, covering both Victoria and New South Wales
- **Yarrawonga to Wakool Junction key focus area:** a project to relax constraints up to 30,000 ML/day at Yarrawonga Weir on the Murray River, with buffer flows up to 50,000 ML/day. The proponent state for this project is New South Wales, with works and measures predominantly in the Edward Wakool anabranch system of the Murray River in New South Wales. Mitigation activities are required in Victoria but will be limited to land adjacent to the Murray River in the state
- **New Goulburn key focus area (nominated as a Constraint Measure only):** the project to relax constraints at on the Goulburn River at Shepparton up to 20,000 ML/day. The proponent state is Victoria with all works and measures to be undertaken on land adjacent to the Goulburn River in Victoria. The project spans the length of the Goulburn River below Eildon Dam to the confluence with the Murray River. For planning purposes, this project is divided into two river reaches the Lower Goulburn River Reach, from Goulburn Weir to the confluence of the Murray River and the Mid Goulburn River reach from Lake Eildon to Goulburn Weir.

Figure 1 below shows the location of the Victorian CMP projects. It is anticipated that relaxing constraints in these river reaches along with other constraints relaxations projects proposed in New South Wales (Murrumbidgee and Darling rivers) will deliver benefits downstream to the lower Murray in Victoria, New South Wales and South Australia.

Figure 1 – Victorian Constraints Measures Program – River reach project areas

14 Package of supply, constraint and efficiency measures agreed by the Murray Darling Basin Ministerial Council on 16 June 2017, https://www.mdba.gov.au/sites/default/files/docs/Package-constraint-supply-efficiency-measures.pdf

1.2.2 Minimising socio-economic harm

A key context for the feasibility study is consideration of the socio-economic criteria embedded in the Basin Plan which have informed Victoria's approach to meeting Basin Plan commitments while minimising socio-economic impacts. Relaxing constraints may have adverse impacts on low-lying floodplain landholders, asset owners and other users, including by inundating and reducing access to parts of private property and public facilities. A range of mitigations are being considered, including property works (eg raised crossings culverts and tracks), relocation of infrastructure and non-infrastructure solutions including inundation easements and compensation.

The guiding principle of the Victorian CMP is that constraints relaxation will not inundate private land without the landholder's consent.

2. Problem Definition

2.1 Deteriorating floodplain ecosystem health

2.1.1 River regulation

The Murray-Darling Basin is Australia's largest river system. Comprising 23 main river valleys, the Basin extends over 1 million km^2 of south-eastern Australia, covering three-quarters of New South Wales, more than half of Victoria, significant portions of Queensland and South Australia, and all of the Australian Capital Territory. The Basin includes more than 77,000 km of rivers, creeks and watercourses, and an estimated 30,000 wetlands[15].

Many of the major rivers within the Basin are regulated by large public dams and weir structures which allow the controlled supply of water to consumptive uses supporting social and economic development across the Basin. Average annual inflows of water to the Basin streams (including inter-basin transfers) are of the order of 32,500 GL. The capacity of major water storages in the Basin is about 34,500 GL[16].

The headwaters of the mainstem of the Murray River are regulated by Hume Dam (3,005 GL), which was constructed in 1936 and then enlarged in 1961, and Dartmouth Dam (3,856 GL), which was completed in 1979. Flows along the Murray River are controlled by a series of locks and weir pools, the largest of which is Yarrawonga Weir.

The Goulburn River is regulated by Lake Eildon which is a publicly owned water storage constructed in the headwaters of the Goulburn River in 1929 and enlarged in 1956. The storage has a capacity of 3,334 GL and supplies water to irrigation, environment, and urban entitlements holders. Stream flows to the lower reaches of the river are controlled by Goulburn Weir (23 GL in capacity) which is used to hold up the river flow so it can be diverted into the Goulburn Murray Irrigation District (GMID).

2.1.2 Altered flow regimes

River regulation and the supply of water to consumptive users has altered the natural flow regime of the major river systems of the Murray-Darling Basin. Releases from dams to supply water to consumers occur for prolonged periods at low flow rates which are contained within the river channel to avoid inundating low-lying private property on the floodplain. A large proportion of mid-ranged winter and spring river flows resulting from rainfall events in upper catchments are captured and stored in headworks dams and released in summer at constant flow rates to meet downstream consumptive demands[17].

Before the construction of dams and weirs, the Murray River's flow or height was often described as a "pulse" or "heartbeat" (Figure 2). The river's natural rhythm involved a regular cycle of wetting (highs) and drying (lows). However, the construction of Lock 1 in 1922 and the Hume Dam in 1936 marked a turning point. These structures brought about a notable shift in the river's pulse, diminishing low flows and disrupting the natural flow pattern.

15 Basin Plan pg 156
16 Basin Plan pg 157
17 As dams have a limited capacity to capture and store major flows, the frequency of major flooding has only slightly decreased.

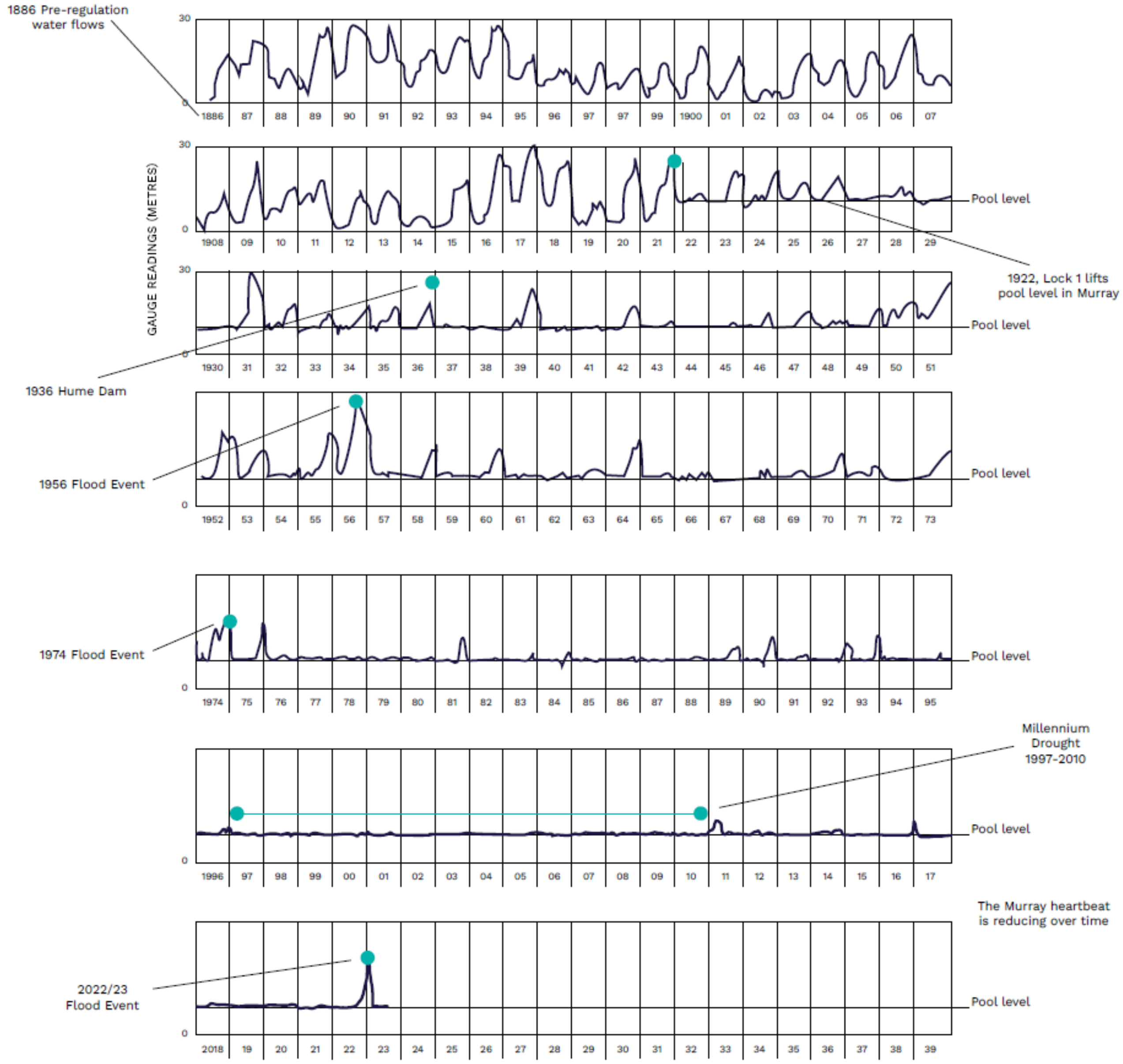

Figure 2 - Mapping the Murray's heartbeat: 1886-2023 river heights at Lock 1 South Australia

In the Murray and Goulburn Rivers downstream of the major headworks dams, the frequency of mid-ranged overbank flows that inundate floodplain forest and wetland habitats adjacent to the river channel has significantly reduced in many locations and is now less than half what it was under pre-regulation conditions[18]. Similarly, the length of time between these medium sized flood events during dry times has grown substantially.

For example, mid-ranged flow events between 15,000 and 40,000 ML/day in the Mid Goulburn River between Murchison and Shepparton:

- occur 20% to 30% of their natural frequency (see Figure 3)
- last for 50% to 70% of the natural duration
- have a maximum period between events that is 2.5 to 3.5 times longer than natural[19].

18 MDBA (2012) Hydrologic modelling of the relaxation of operational constraints in the southern connected: Method and results pg iii
19 DSE (2011) Overbank Flow Recommendations for the Lower Goulburn River pg 18

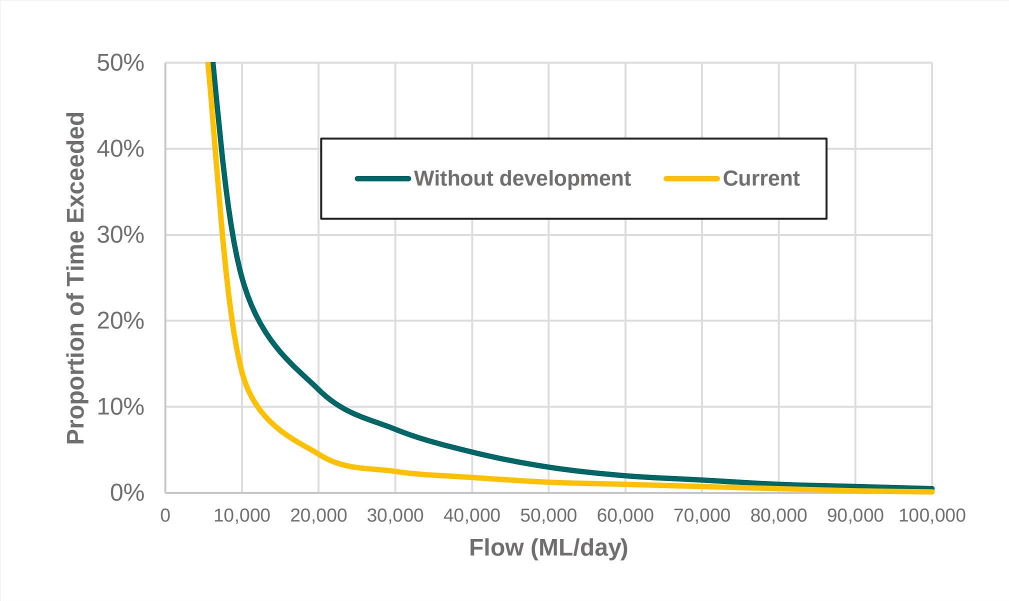

Figure 3 – Flow duration curve for the Goulburn River at McCoys Bridge [20]

In the Murray River at the Barmah-Millewa Forest, Australia's largest remnant river red gum forest, under natural conditions 70% of the forest would be flooded for an average of 2.9 months in 78% of years. Since regulation, this level of flooding is only experienced for an average of 1.3 months in 37% of years. Overall, the frequency of flooding and the duration of inundation in the major vegetation communities have been significantly reduced[21].

2.1.3 Deteriorating Victorian Murray and Goulburn River floodplain ecosystem health

Floodplain river ecosystems represent complex interdependent systems, where floodplains, wetlands, and channels work together. These systems encompass various components, such as flood-dependent vegetation like floodplain wetlands, red gum forests, and red gum and black box woodlands, all of which rely on flooding. This vegetation plays a crucial role in facilitating the movement of essential nutrients, carbon and sediment between land and water environments. Moreover, it serves as vital habitat and food sources for diverse aquatic life, including fish, birds, invertebrates, as well as reptiles, amphibians, and mammals like rakali and platypus.

Beyond their ecological significance, floodplain river ecosystems offer a range of valuable services. These include soil creation, water purification, climate regulation, and various cultural, educational and recreational opportunities. Recent research has revealed that healthy wetlands can store more carbon per unit area compared to forest ecosystems, contributing to carbon sequestration efforts.

Emerging evidence underscores the critical connections between floodplains and main river channels. The movement of water, sediment and carbon particles within the channels significantly affects floodplain productivity. In turn, floodplain-derived carbon is released into the channels during flooding events. This flood-derived carbon becomes a major contributor to the carbon content within the water, which in turn fuels aquatic productivity. This productivity extends to various organisms like benthic algae, phytoplankton, and submerged aquatic plants, which then form the basis of the food chain for creatures like macroinvertebrates, fish, turtles and platypus.

Numerous species have life cycles that necessitate access to both main river channels and wetland habitats. A prime example is the native catfish, which begins its life in wetlands before migrating to the river channels for further development and dispersal.

Unconfined, meandering lowland rivers such as the Murray River and Goulburn River have a high natural frequency of out-of-channel flow inundating the adjacent floodplain. Typically, the geomorphology of such rivers evolves to form a channel capacity capable of carrying a one in two-year flood event. Flows greater

[20] adapted from MDBA (2012) Assessment of environmental water requirements for the proposed Basin Plan: Lower Goulburn River pg 9

[21] Riverina Bioregion Regional Forest Assessments: River red gums and Woodland forests, pg 170

than this spill onto the floodplain through anabranches and flood-runners inundating floodplain wetlands and forests[22].

As a consequence of the natural regime of inundation, the floodplains of the Goulburn River and Murray River are home to a diverse range of water dependent vegetation types including river red gum (*Eucalyptus camaldulensis*) and black box (*Eucalyptus largiflorens*) as well as wetland species. These floodplain ecosystems have adapted over millennia to the variability and seasonality of natural river flow regimes. As illustrated in Figure 4, the ecology of both the river channel and floodplain is reliant upon the connectivity between the two systems created by frequent inundation.

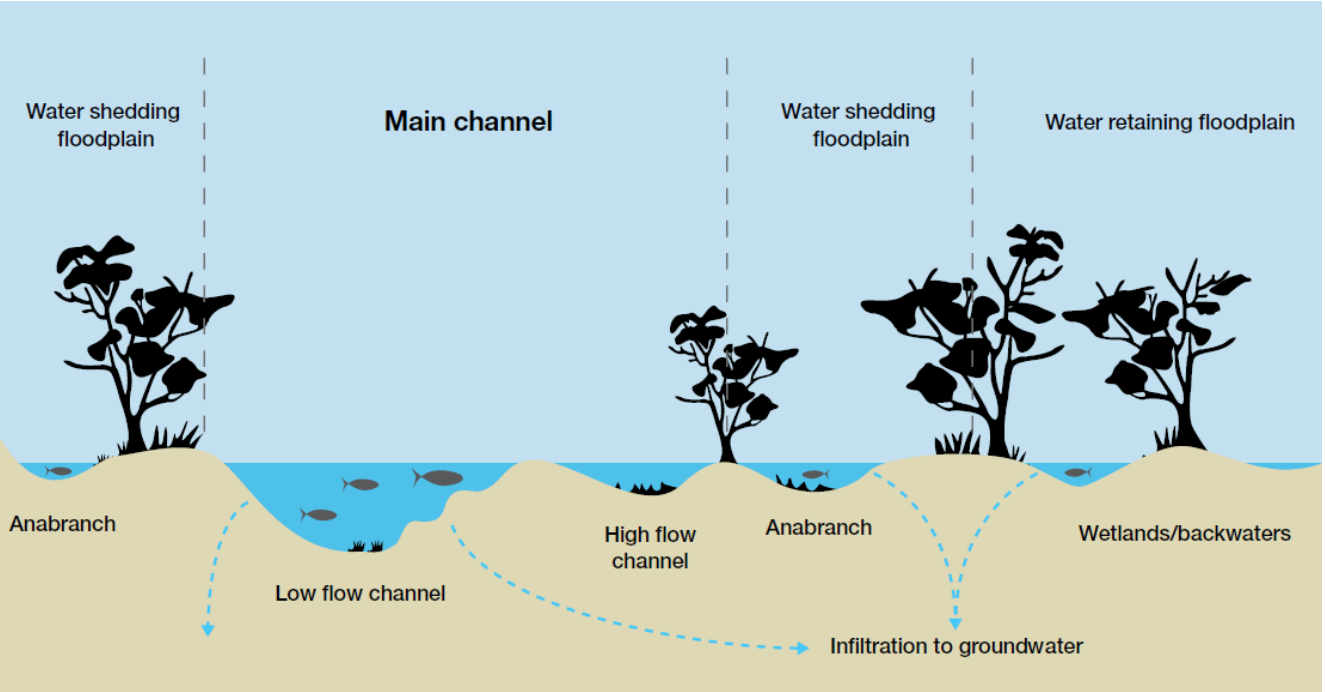

Figure 4 – Cross section view of ecological functions and the hydrology of red gum forests[23]

Since European settlement, the Goulburn and Murray River floodplains have been extensively settled and developed for agriculture, and to a lesser extent, urban, commercial and recreational purposes. Approximately 60% of the low-lying area of the floodplain (defined as the 100-year ARI floodway) of these river systems in Victoria is held as private land. Despite this development, significant areas of the low-lying floodplain are protected for conservation in public parks and reserves. These remnant forest and wetland areas on the floodplain include national and regional parks, state forests, nature reserves and flora and fauna reserves including:

- Barmah National Park: covering 28,500 ha, which together with the adjoining Millewa Forest in New South Wales, forms the largest remaining river red gum forest in Australia and is a listed wetland of international significance under the Ramsar Convention
- Gunbower National Park: a floodplain forest and wetland area of 9,800 ha and a listed wetland under the Ramsar Convention
- Lower Goulburn National Park: a 9,320 ha area of floodplain containing nationally important wetlands through to the confluence with the Murray River
- Riparian corridor of contiguous vegetation along the length of the river system, including the proposed Murray River Park and the Goulburn River Crown water frontage
- Nature conservation reserves: multiple dispersed conservation sites set adjoining the main river channel and containing intact wetlands found along the length of the Goulburn River and Murray River.

The public conservation areas located on the Murray River and Goulburn River floodplains are show in Figure 5, Figure 6, and Figure 7.

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[22] Ibid pg 163
[23] Ibid pg 165

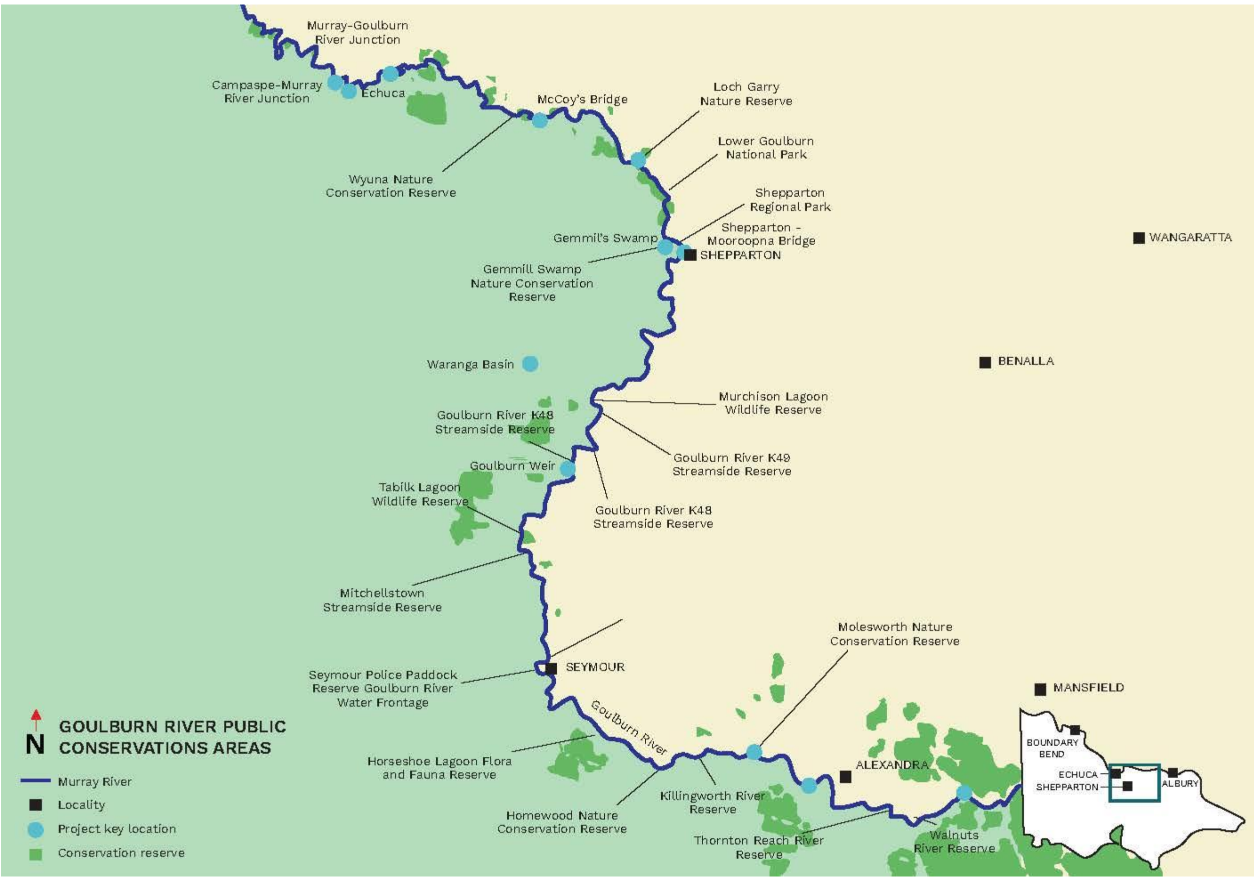

Figure 5 – Public conservation areas located on the Goulburn River floodplain

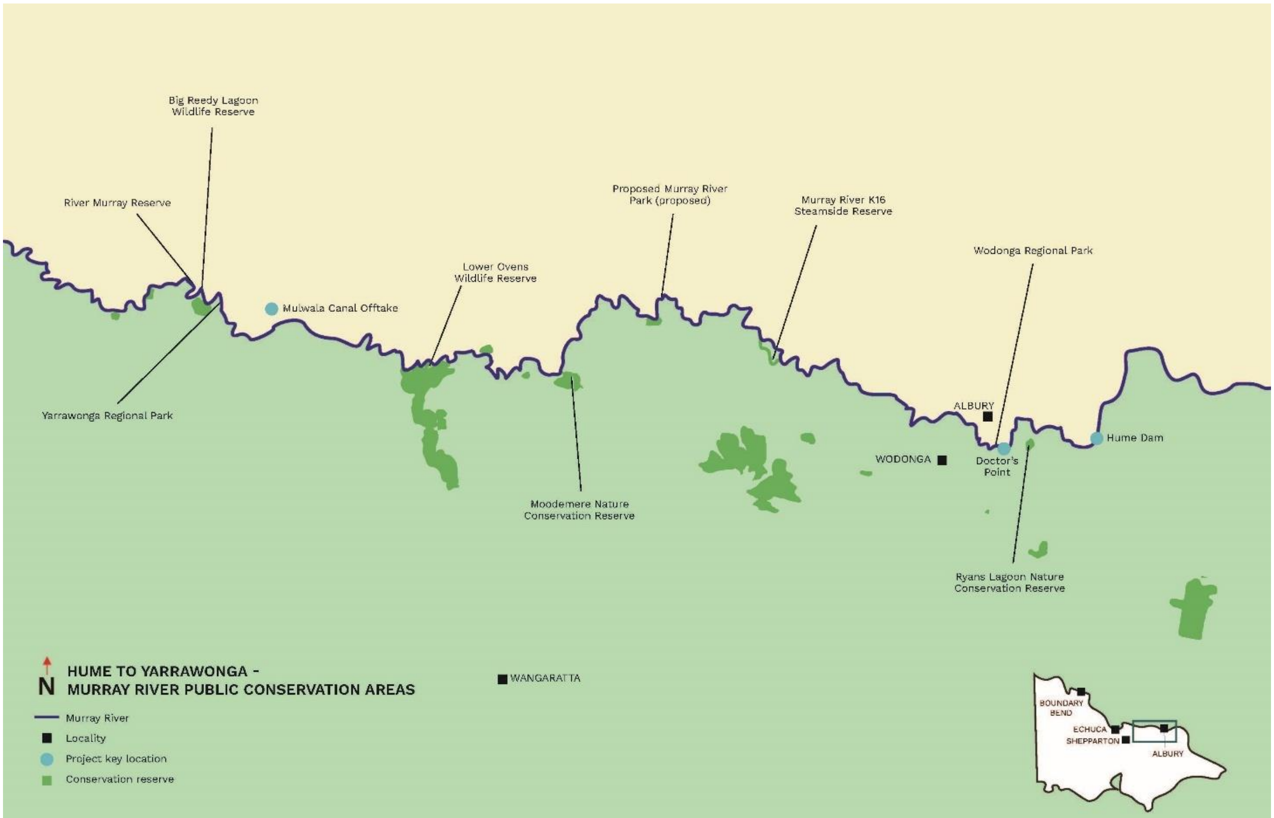

Figure 6 – Public conservation areas located on the Murray River floodplain, Hume to Yarrawonga

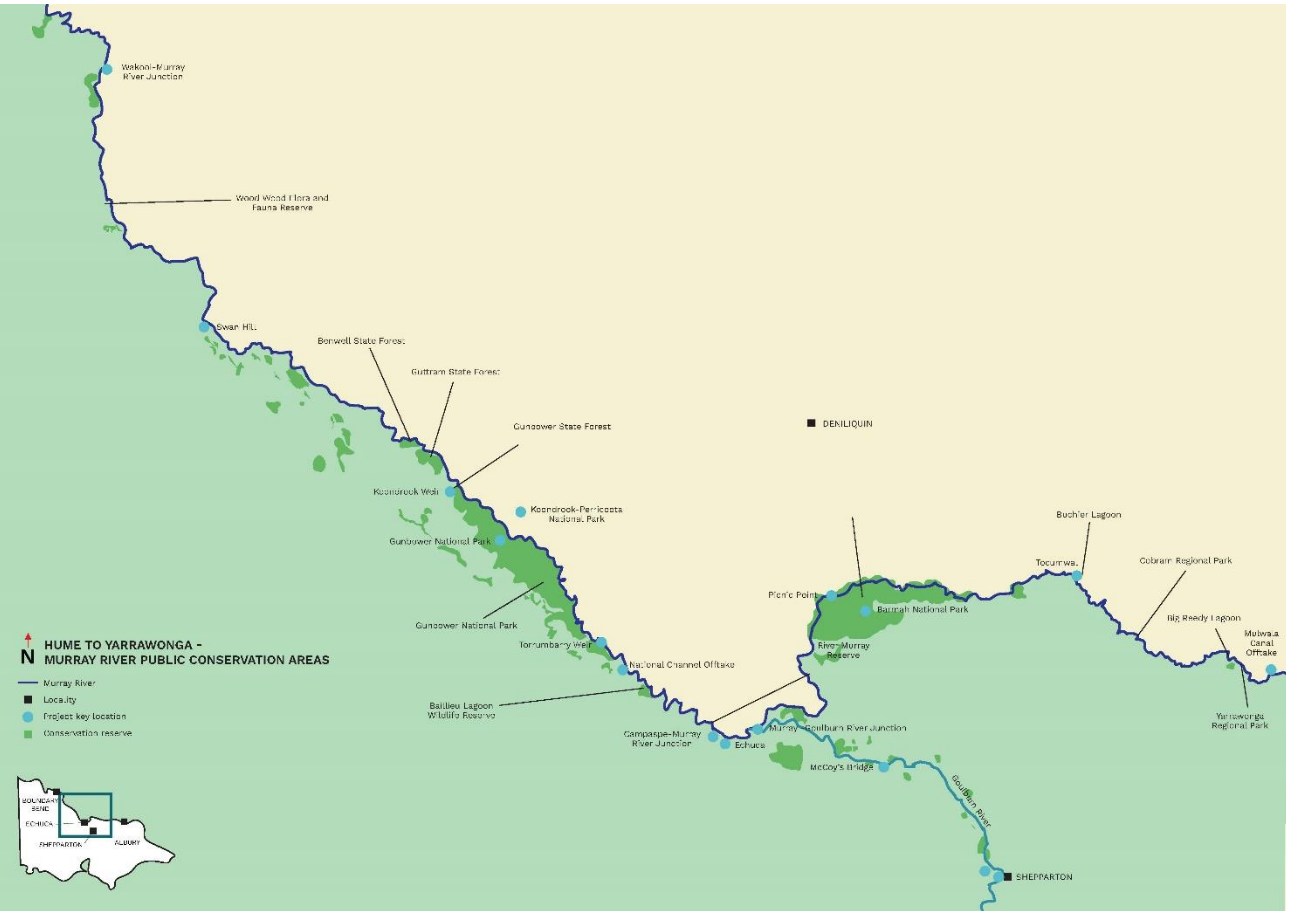

Figure 7 – Public conservation areas located on the Murray River floodplain, Yarrawonga to Wakool

There are also areas of remnant vegetation and wetland located on private property, some of which are actively managed by landholders for biodiversity conservation.

Altered flow regimes and the subsequent reduction in the frequency and duration of floodplain inundation has adversely impacted on the health of remnant floodplain forest and wetland ecosystems. For example, in the Goulburn River and Murray River, the condition of river red gum and black box floodplain forests is generally moderate to poor with the most recent Basin Plan progress evaluation completed in 2020 finding that less than 5% of floodplain river red gums were in good condition with the remaining 95% stressed to some degree (moderate, poor or degraded) – see Figure 8[24].

[24] https://www.mdba.gov.au/publications/mdba-reports/2020-basin-plan-evaluation-reports-data.

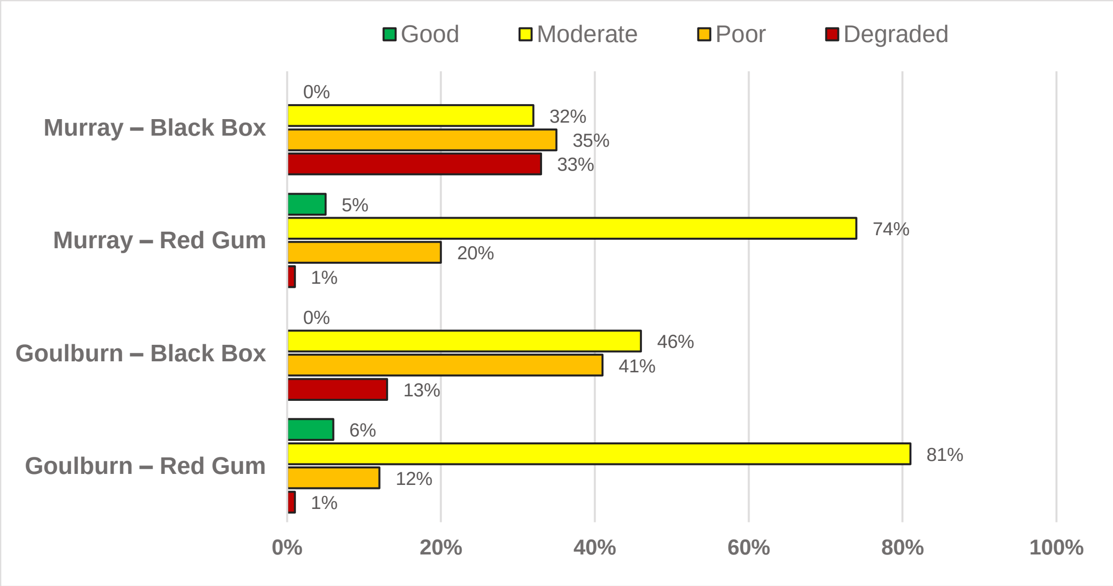

Figure 8 – Floodplain forest condition in the Murray and Goulburn catchments - 2020 Basin Plan Evaluation [25]

Other threats, such as clearing and fragmentation, firewood collection, livestock grazing, timber harvesting and exotic plants and animals, have also contributed to the decline in floodplain ecosystem condition[26].

Floodplain vegetation provides habitat and food resources for other biota such as birds, frogs and fish, erosion reduction through sediment stabilisation, primary productivity and nutrient cycling[27]. The decline in the condition of floodplain vegetation has flow-on effects for a range of dependent biota including waterbirds. River regulation and the loss of wetland biodiversity has reduced habitat for waterbirds feeding and breeding leading to a decline in waterbird numbers and breeding rates across the Murray-Darling Basin[28]. This decline is evident in the annual survey of water bird abundance in eastern Australia (includes all the major wetlands in the Murray-Darling Basin[29]) – see Figure 9[30].

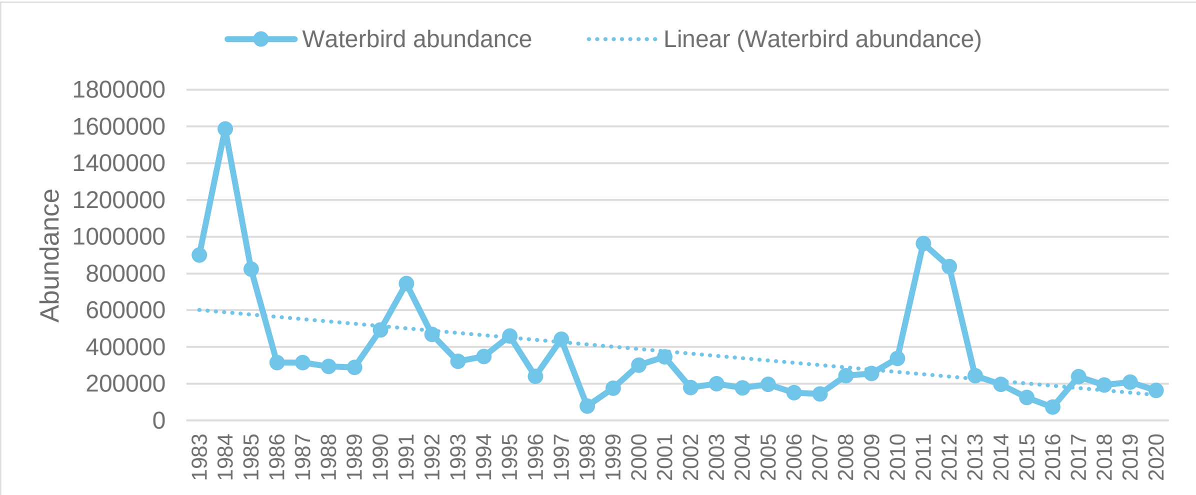

Figure 9 – Change over time in total abundance of breeding water bird species in eastern Australia [31]

In the Murray River, the Hume to Yarrawonga reach supports 15 native fish species while the Yarrawonga to Wakool reach supports 18 native fish species. This includes six species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act): flathead galaxias, southern pygmy perch,

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25 https://www.mdba.gov.au/publications/mdba-reports/2020-basin-plan-evaluation-reports-data. The MDBA's assessment is based on estimated stand condition from remotely sensed data validated by field sampling (see https://www.mdba.gov.au/sites/default/files/pubs/bp-eval-2020-tree-stand-condition-assessment-tool.pdf) accessed 4 September 2022

26 Riverina Bioregion Regional Forest Assessments: River red gums and Woodland forests, page 76

27 Arthur Rylah Institute (2021) Wetland Monitoring and Assessment Program for Environmental Water Stage 3 Final Report, page 17

28 https://www.vewh.vic.gov.au/news-and-publications/stories/protecting-waterbirds-in-climate-change

29 Kingsford et al. (2020) Aerial surveys of waterbirds in Australia, Scientific Data, vol 7, 172

30 Porter et al. (2020) Aerial Survey of Wetland Birds in Eastern Australia – October 2020 Annual Summary Report

31 https://www.soe.epa.nsw.gov.au/all-themes/water-and-marine/wetlands-2021 accessed 4 November 2022

Murray crayfish, Murray cod, trout cod and silver perch[32,33].These are wetland specialist fish species that rely on overbank flows to maintain their habitat. Their populations are in significant decline or have been lost locally due to a reduction in frequency of wetland connecting flows and decline in condition of their habitats.

2.1.4 System-wide environmental impacts

The impact of altered flow regimes is most pronounced in the lower sections of the Murray River due to the cumulative influence of dams in the headwaters of the Murray and its tributaries, coupled with the cumulative effects of diversions throughout the Basin[34]. For example, at the Chowilla floodplain, which is a Basin Plan indicator site[35] for the lower Murray downstream of the Murray-Darling Junction, mid and high range flow events occur at 25% to 40% of their natural frequency[36] (see Figure 10).

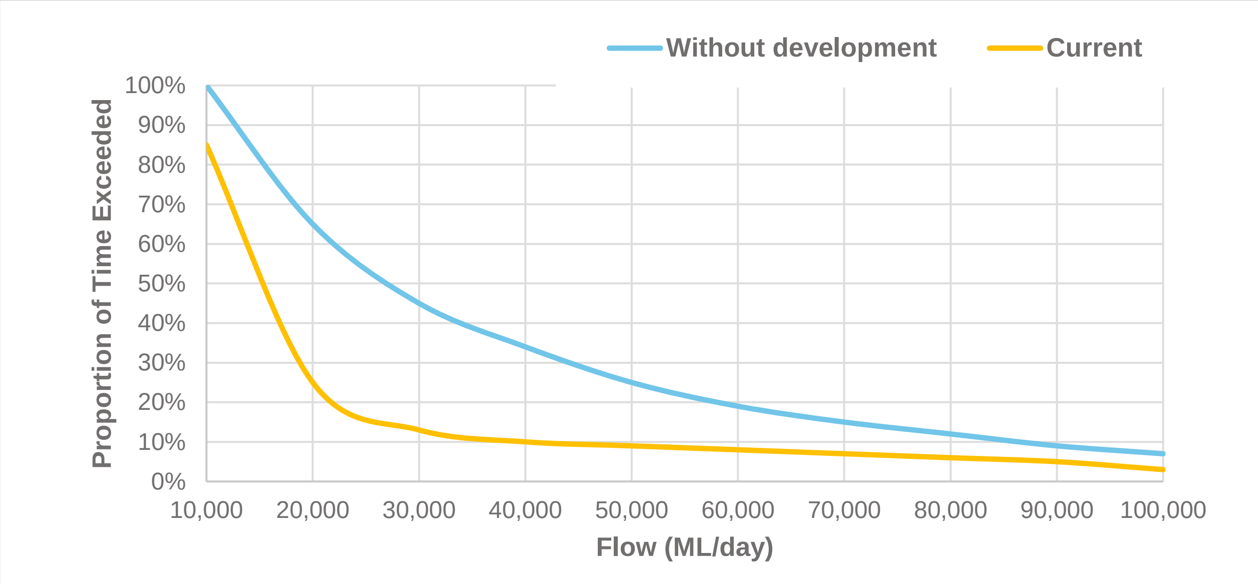

Figure 10 – Flow duration curve for the Lower Murray River (South Australian border) [37]

The Chowilla floodplain, which contains the largest remaining natural river red gum forest in the Lower Murray and a range of diverse aquatic habitats, has experienced severe ecological decline due to long periods without flooding[38]. This has resulted in rising soil salinity, the decline of trees, particularly red gum and black box, and fewer breeding opportunities for floodplain wildlife[39]. An example of the impact of reduced inundation in the South Australian Murray floodplain is provided in Figure 11, which shows highly degraded woodlands on the floodplain at Gerard near Loxton.

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32 NSW Department of Primary Industries–Water. (2016). Yarrawonga to Wakool Junction Reach Constraints Measure Concept Proposal Business Case

33 NSW Department of Planning and Environment. (2020). Murray-Lower Darling Long Term Water Plan. Part A: Murray-Lower Darling catchment

34 MDBA (2012), Hydrologic modelling of the relaxation of operational constraints in the southern connected: Method and results pg ii

35 The SDLs in the Basin Plan have been informed by detailed hydrologic modelling of the environmental water requirements at selected indicator sites at key locations along the river system – see MDBA (2011) The proposed 'environmentally sustainable level of take' for surface water of the Murray–Darling Basin: Method and outcomes

36 https://www.environment.sa.gov.au/topics/river-murray/improving-river-health/wetlands-and-floodplains/chowilla-floodplain accessed 5 November 2022

37 adapted from MDBA (2012) Assessment of environmental water requirements for the proposed Basin Plan: Lower Murray River pg 10

38 https://www.environment.sa.gov.au/topics/river-murray/improving-river-health/wetlands-and-floodplains/chowilla-floodplain accessed 7 November 2022

39 MDBA (2012) Chowilla Floodplain Environmental Water Management Plan pg

Figure 11 – Dead river red gum and black box trees – Murray River Floodplain, Gerard, South Australia[40]

2.2 Constrained environmental water delivery

2.2.1 Environmental water recovery

Since the mid-90s there has been a concerted effort by Basin governments to address the environmental impacts of over-allocation and river regulation. A key element of this effort has been the implementation of the Basin Plan and the recovery of 2,750 GL of water from the consumptive pool for the environment. To September 2023 the Basin Plan has recovered 2,107 GL for the environment[41].

As of 2023 around 700 GL (long-term average annual yield or LTAAY) of water entitlement is held by the Commonwealth Environmental Water Holder in total across the Goulburn River and the Victorian share of the Murray River (Figure 12). In addition, there are significant volumes of environmental water available, which are held by the Victorian Environmental Water Holder (VEWH) and the MDBA, recovered through other water recovery initiatives including The Living Murray Program and the Snowy Initiative.

40 https://www.abc.net.au/news/science/2022-08-27/river-red-gum-trees-health-disappearing-murray-river/101347492 , accessed 7 November 2022

41 https://www.dcceew.gov.au/water/policy/mdb/progress-recovery accessed 2 November 2023

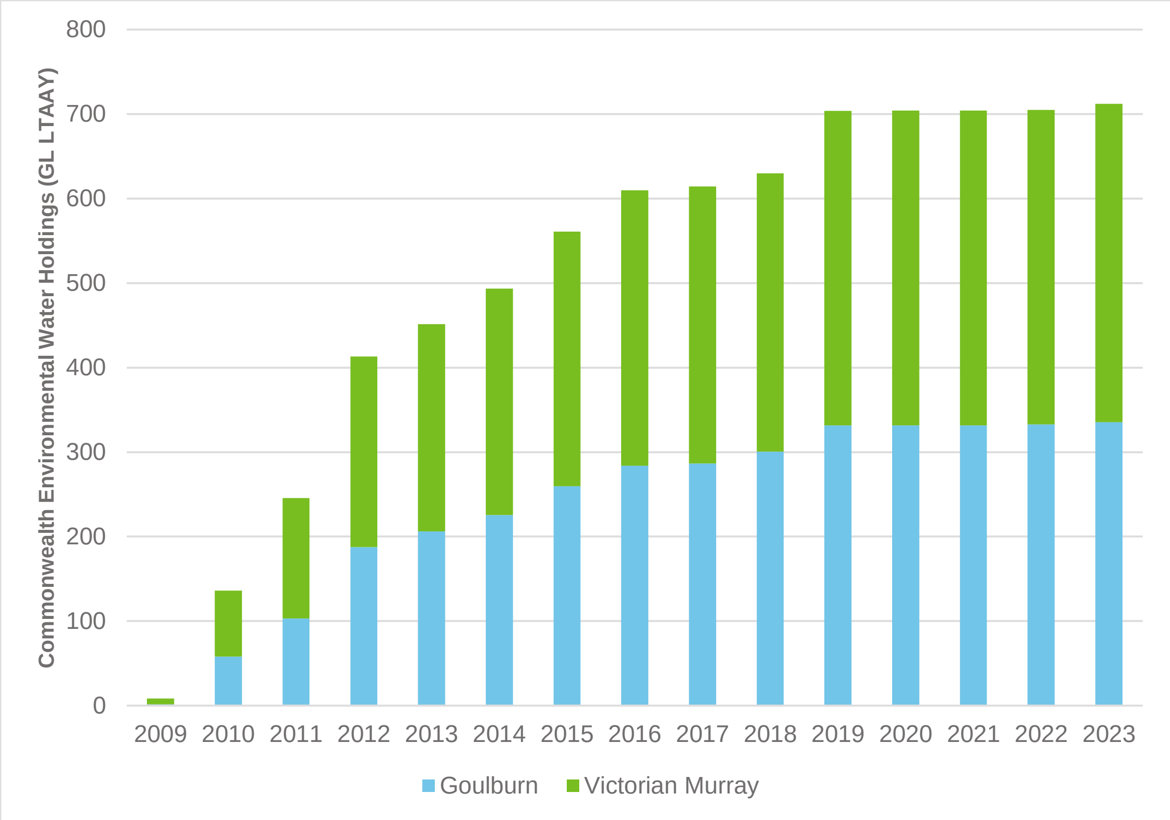

Figure 12 – Annual Commonwealth environmental water holdings, Goulburn and Murray Rivers (cumulative)[42]

A comprehensive institutional and planning framework has been developed to manage the portfolio of Commonwealth and State held environmental water to deliver environmental flows or environmental watering events. In the 2022/23 water year, around 590 GL[43] of environmental water was released from dams and storages as environmental flows across both the Goulburn River and the Victorian Murray River systems targeting a wide range of environmental objectives and involving multiple environmental flow events.

2.2.2 Constraints on regulated river flows

The delivery of water, both for consumptive and environmental purposes, within the regulated river systems of the Murray-Darling Basin is limited by the narrow size of the river channel and its physical capacity to convey water. 'Constraints' in the context of the Victorian CMP, are operational flow limits that river operators have placed on regulated dam releases to ensure that water deliveries are contained within the capacity of the river channel to:

- minimise the possibility of regulated flows overtopping the river channel and inundating private land and assets on the floodplain surrounding the river. Operational constraints are key elements of river operations management policy to mitigate the risk of river operations causing third party injury, damage and loss
- avoid losses in the delivery of water to consumptive users, as a proportion of the regulated water spilling onto floodplain does not return to the river and will be lost to evaporation and seepage

The key operating constraints in the Murray River and Goulburn River are set at the gauging stations downstream of the major headworks dams and weir storages shown in Table 6[44]:

42 https://www.dcceew.gov.au/water/cewo/about/water-holdings#commonwealth-environmental-water-holdings accessed 4 November 2023
43 https://www.waterregister.vic.gov.au/water-availability-and-use/available-water-by-owner-type accessed 4 November 2023
44 MDBA (2013) Preliminary Overview of Constraints to Environmental Water Delivery in the Murray Darling Basin

Table 6 – Current river operating flow limits

Location	Current constraint (ML/d)	Current constraint (river height m)	Minor flood level (m)
Murray River at Doctors Point (downstream of Hume Dam)[a]	25,000	3.7	4.3
Murray River at Yarrawonga Weir (downstream of Lake Mulwala)	15,000	2.4	6.4
Goulburn River at Molesworth[b] (downstream of Lake Eildon)	10,000	-	-
Goulburn River at Shepparton (downstream of Goulburn Weir)	9,500	5.52	9.0

a. The operational constraint at Doctors Point is 17,000 ML/d however agreements have been reached with many (not all) landowners to allow operational flows of 25,000 ML/d. The minor flood level presented is that at Albury

b. Note: The current constraint at Molesworth is notional. Water released from Eildon Dam is currently limited to a maximum of 9,500 ML/d to stay below the notional constraint at Molesworth as no gauge currently exists. As such there is no associated constraint river height or minor flood level established at Molesworth.

The location of the existing constraints of regulated river flows is shown in Figure 13.

Figure 13 – Key operating constraints in the Goulburn and Murray Rivers[45]

Flows through these narrow parts of the river are carefully managed to ensure water does not flow over the riverbank and onto the land surrounding the river. At times, such as during large floods or with high inflows from tributaries, the inundation of surrounding land cannot be avoided and occurs naturally.

[45] Extracted from notified business cases

2.2.3 Constraints on environmental flows and low rates of effective utilisation

Most Victorian rivers have been subject to an environmental flow study to identify the hydrologic regimes and flow requirements required to sustain the environmental assets associated with the waterways[46].

It's not simply the amount of water flowing in a river that's important. Environmental flows aim to mimic the natural flow regime including the volume, timing, duration, frequency and quality of flows that are provided. Like the natural flow of rivers, different combinations of flow components provide a range of benefits for ecosystems. The roles of these different flow components are shown in Figure 14.

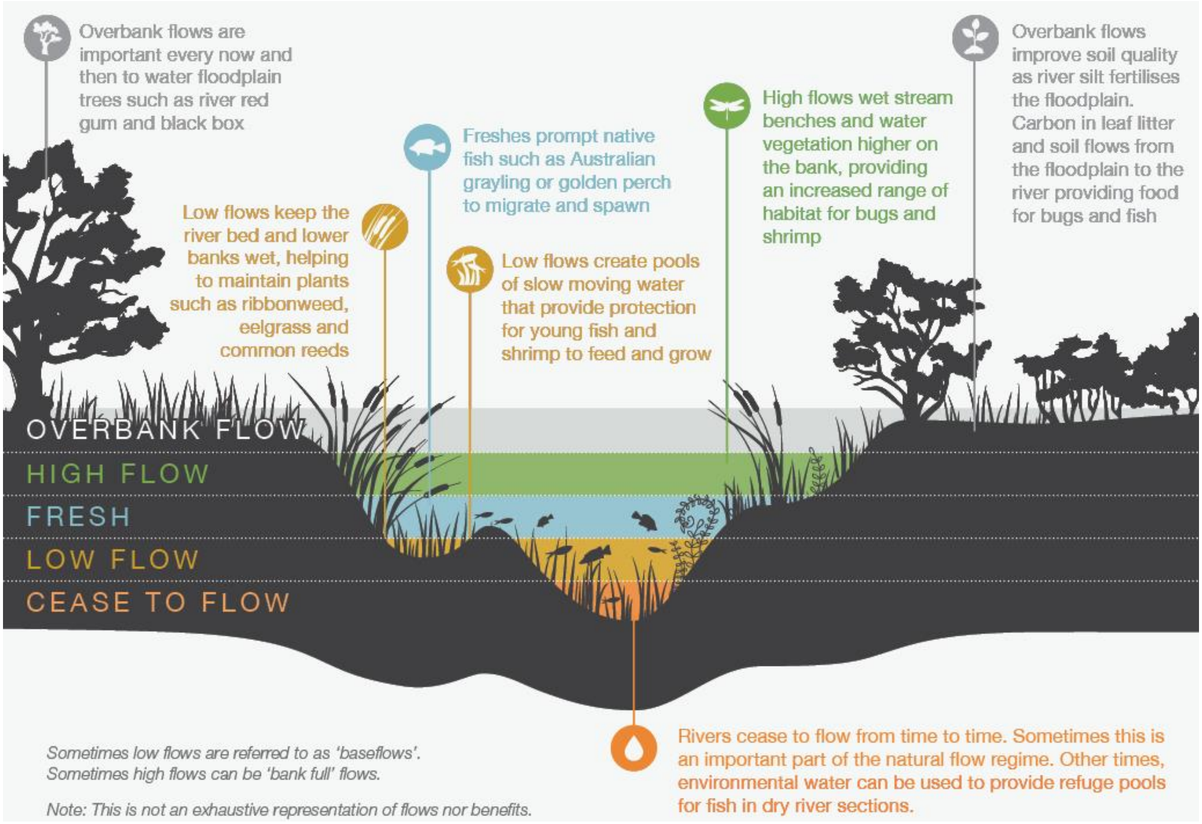

Figure 14 – The role of different environmental flow components[47]

Environmental water requirements consider these flow components to establish the amount, frequency and duration of water required to maintain and preserve aquatic ecosystems, with a minimum risk of degradation.

Developing environmental flow and watering recommendations is a complex scientific task that uses information on the hydrology, geomorphology and ecology of the river system. The method follows a process to establish specific environmental objectives that depend on water flows and determine the flow regime necessary to achieve those objectives.

The environmental water requirements for the Murray River and Goulburn River are documented in Long-Term Watering Plans and Environmental Water Management Plans[48]. These requirements take the form of recommendations for frequency and duration of different flow components and associated flow rates. As an example, Figure 15 is a diagrammatic representation of the environmental flow recommendations for the Hume to Yarrawonga reach of the Murray River.

[46] DEPI. (2013). FLOWS – a method for determining environmental water requirements in Victoria

[47] Source: VEWH, https://www.vewh.vic.gov.au/news-and-publications/stories/understanding-flows-some-terminology-explained

[48] https://www.water.vic.gov.au/waterways-and-catchments/rivers-estuaries-and-waterways/environmental-water

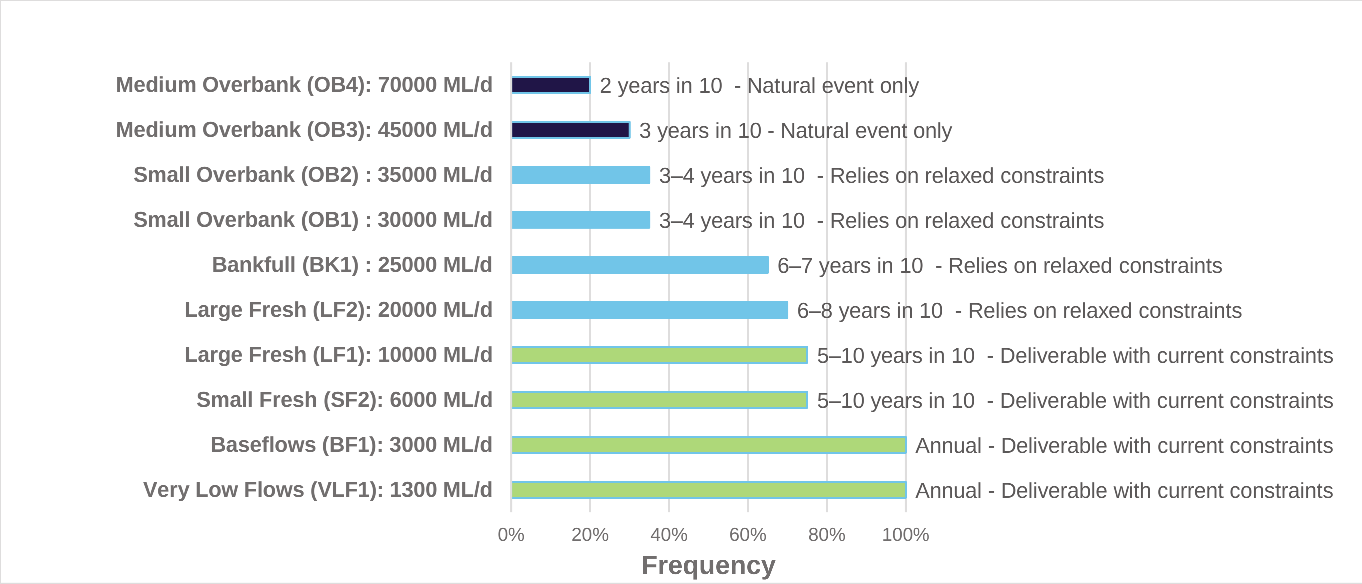

Figure 15 – Environmental flow recommendations - Murray River Hume to Yarrawonga

Constraints on the flow rate of releases from dams and storages are applied by river operators to all water deliveries including environmental flows. Under current constraints, environmental watering events are limited to in-channel flows at most locations and recommended flow rate components in excess of the constrained flow rate are undeliverable (see Figure 15).

Hydrologic modelling undertaken for this feasibility study, indicates that over a 100-year simulation period with existing constraints on regulated flow releases, only 36% of the available environmental water portfolio held in the Goulburn system is effectively utilised[49]. This outcome is reflected in the low volumes of environmental water delivered to floodplain, with only 13% of the total volume of environmental water delivered in Victoria over the period of published record (2013-14 to 2020-21) supplied to floodplain wetlands and the remaining 87% delivered as in-channel flows[50] (see Figure 16).

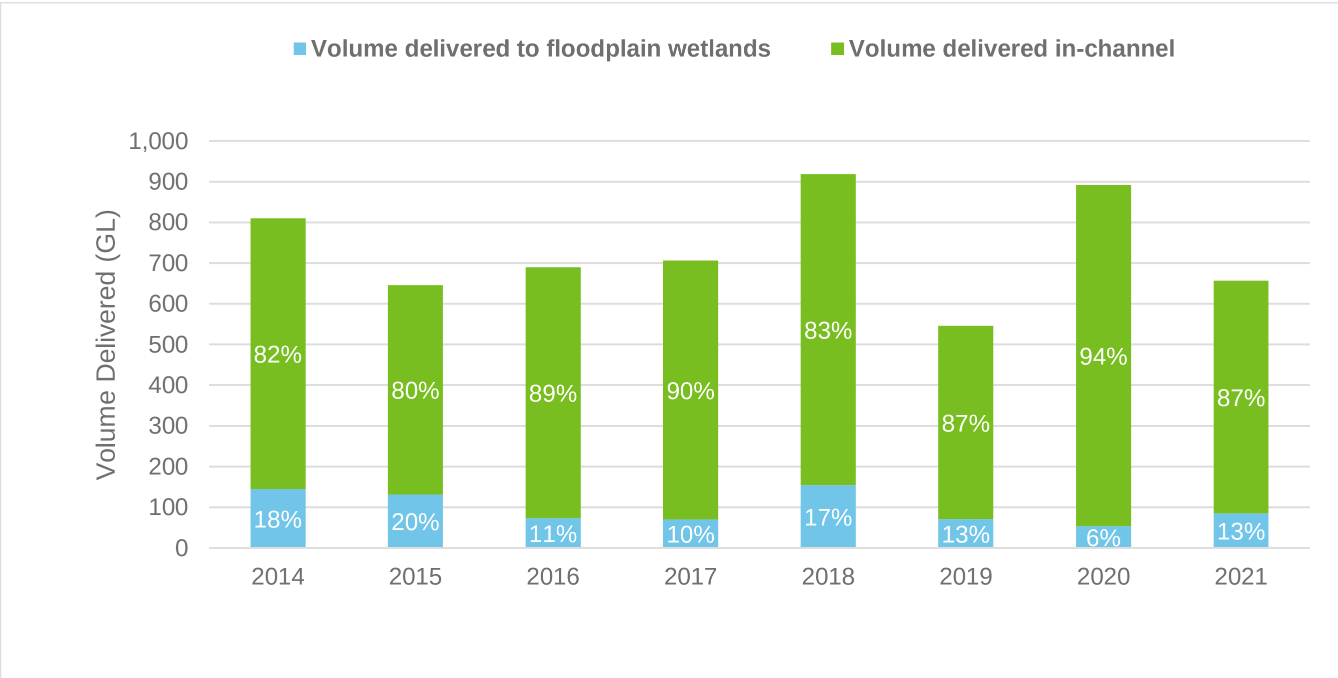

Figure 16 – Annual Environmental Water Deliveries (Vic) – Volume delivered in-channel and to floodplain wetlands[51]

49 DEECA (2023) GBCCL Source Modelling for the Constraints Measures Project, pg 11
50 Victorian Water Accounts 2013-14 to 2020-21
51 Victorian Water Accounts 2013-14 to 2020-21

2.2.4 Environmental implications of doing nothing more[52]

Floodplain ecosystems are a system with critical interdependencies between floodplain, wetland and channel components. For example, floodplain dependent vegetation communities, such as floodplain wetlands, red gum forests, and red gum and black box woodlands, all depend on overbank inundation. The vegetation community in turn influences critical nutrient, carbon and sediment movements between terrestrial and aquatic environments, and provides critical habitat and food resources for fish, bird and invertebrate communities and species of reptile, amphibians and mammal (e.g., rakali, platypus).

Linkages between floodplains and main river channels are an important driver of river health (see Figure 17). Water, sediment and particulate carbon transported in the river channel are critical to floodplain productivity. Conversely, floodplain carbon becomes available to the river channel during overbank inundation. When transported back into the river, floodplain carbon becomes a major source of instream carbon that drives instream productivity. This instream productivity includes benthic algae, phytoplankton and instream submerged vegetation. The products of this instream production become the food source for other life forms including macroinvertebrates, fish, turtles and platypus. There are also a range of species whose life cycles require access to both main river channel and wetland habitats. One example is the catfish, which spends early life stages in wetlands before moving into the river channel and dispersing.

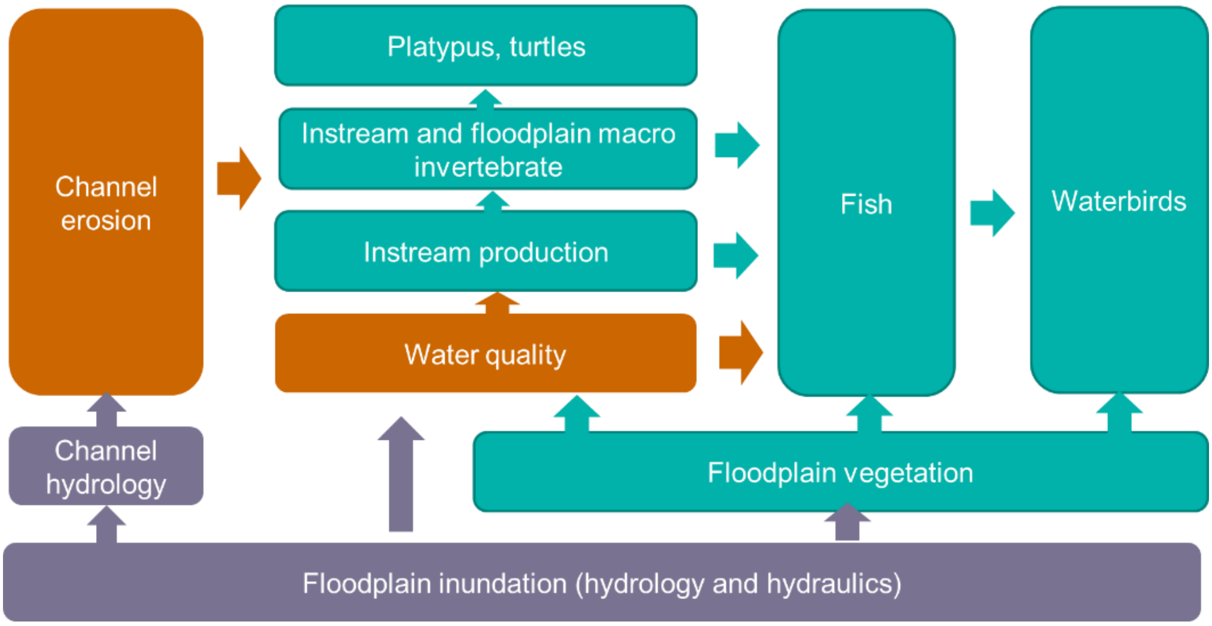

Figure 17 – River channel and floodplain ecological processes

In a scenario where no further action is taken and current river operations persist, regulated environmental flows would mostly be restricted to the primary channels of the Goulburn and Murray Rivers. In addition, the currently available water for the environment would continue to face competition for channel capacity against other entitlements. This approach proves insufficient as the species targeted for environmental preservation are predominantly situated within the floodplain areas. Additionally, species present in the main river channels also rely on connections to the floodplain. Consequently, this approach lacks the capability to break the cycle of severe decline that currently afflicts both river systems and the broader Basin.

Species relying on floodplain habitats for crucial stages of their life cycles are anticipated to diminish progressively. Likewise, species within the river channels will also experience population decreases. The disconnection of vital floodplain-originating food sources reverberates through the entire food web. This impact extends from the foundational biofilms and macroinvertebrates, through small fish and crustaceans, up to the birds and platypus that rely on these fish and smaller invertebrates as sustenance.

By constraining flows within the river channels, there is a notable increase in the erosive action of water along the riverbanks, leading to escalated erosion rates. In a "do nothing more" scenario, the accelerated pace of bank erosion will persist. Such rapid erosion holds implications for populations of species heavily dependent on bank habitats. This includes aquatic plants, macroinvertebrates, fish, and platypus.

52 Alluvium (2023) Stage 1A of the Victorian Constraints Measures Program – Environmental Benefits and Risks Report

Moreover, the continuous delivery of environmental water within the river channels does not optimise its efficient use. Allowing more environmental water to be delivered up to the new constraints will likely reduce storage levels at times, creating dam airspace and reducing the chance of spills at higher levels. Instances of late-season spills onto floodplains can elevate the influx of carbon into rivers, intensifying the risk of water quality problems. Additionally, there's an increased potential for the flooding of critical breeding sites for platypus and turtles.

Without the project, significant areas of red gum and black box vegetation that are currently in critical condition and are highly vulnerable to recurring drought conditions would be killed off in the repeat of a drought of the extent of the recent millennium drought. In some instances, this decline in condition will take hundreds of years as long-lived trees will persist, however, understory species will change more rapidly as they are outcompeted by terrestrial species.

Ecological modelling undertaken for this feasibility study shows the decline in floodplain vegetation health (Figure 18) continuing or accelerating in the do-nothing scenario with:

- all river red gum vegetation in the lower parts of the floodplain, within the Lower Goulburn experiencing irreversible decline
- across the total area Murray River floodplain, 47% of river red gum and 29% of black box woodland experiencing a decline in condition.

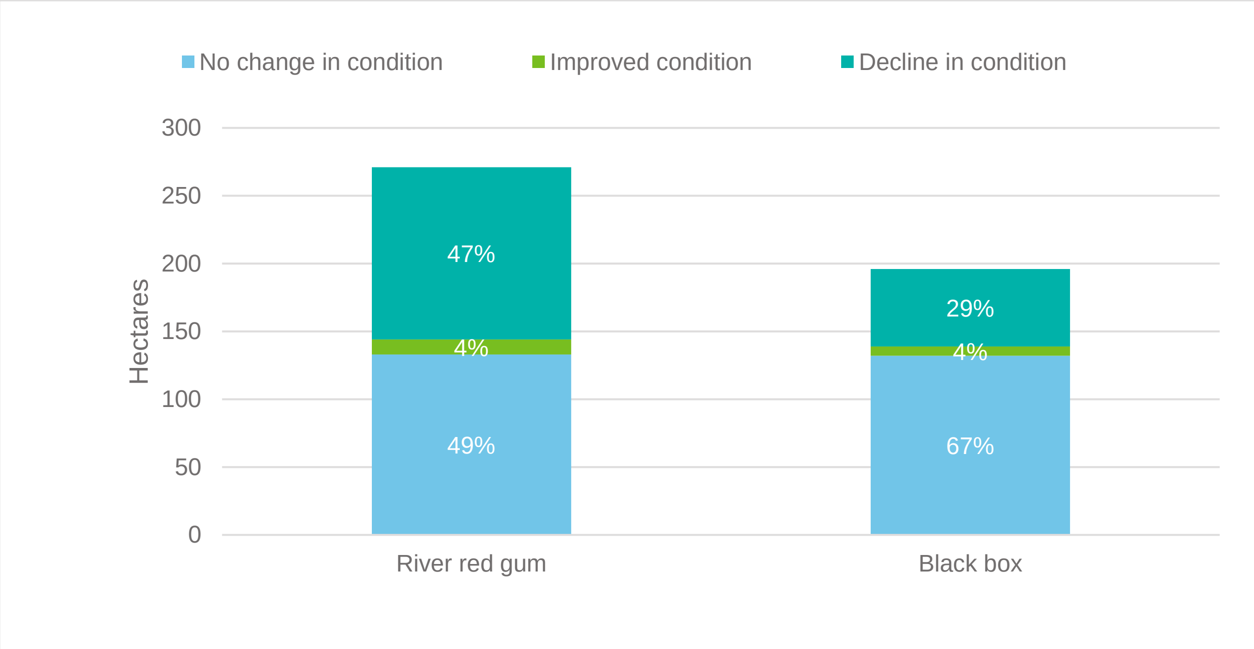

Figure 18 – Modelled change in condition of river red gum and black box woodland, Murray River - without project scenario[53]

The do nothing option also impacts on other aspects of river and floodplain ecology, including[54]:

- **waterbirds:** flows will continue to be insufficient to reach key waterbird sites for both breeding and feeding, and habitat will decline in condition and sites will not be "event-ready" for breeding during unregulated high river flows
- **native fish:** populations of both Murray cod and golden perch are declining in the Murray and Goulburn River systems and are presently maintained by restocking by fisheries agencies. Without the project, fish population modelling suggests that golden perch populations will decline by 20-29% and the recovery of fish populations will be slower following drought.

[53] Latrobe University (2022) Reconnecting River Country Floodplain Vegetation Condition Predictive Modelling, Part 1: Murray River Floodplain

[54] NSW DPE (2022) Murray Benefits and Risk Analysis Synthesis

"I don't think do nothing is an option. It is not sustainable. From an environmental view we have everything to lose with the health of our rivers. We are virtually condemning it by doing nothing." Consultative Committee Member

2.3 Negative socio-economic impacts of water recovery

2.3.1 Basin Plan

The Victorian CMP forms part of Victoria's commitments under the Basin Plan. The Basin Plan is a statutory plan made under the Commonwealth *Water Act 2007*. Its objective 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[55].

The Basin Plan was legislated in 2012 and its implementation was agreed in 2013 through an intergovernmental agreement between the Basin states and the Commonwealth[56].

The key elements of the Basin Plan include[57]:

- an SDL on consumptive water use in the Basin of 10,873 GL
- recovery of 2,750 GL of water entitlement for the environment from consumptive use, otherwise known as 'Bridging the Gap'
- Under the Basin Plan, the SDL is to be achieved through water recovery generated by improving the efficiency of irrigation water delivery and buying back water entitlements from irrigators[58]. Water recovered is to be used to achieve environmental outcomes with the recovered water held by government in the form of environmental water entitlements and bulk entitlements[59]. Water recovery is the essential legal requirement of the Basin Plan[60].

2.3.2 Sustainable Diversion Limit Adjustment Mechanism

In 2018, as part of the negotiations between the states and the Commonwealth to establish the management arrangements required by the Basin Plan, the 'Bridging the Gap' water recovery target of 2,750 GL was amended by reducing the water recovery target by 675 GL to 2,075 GL[61].

This reduction in the target is to be achieved by following offsets:

- 70 GL: an SDL increase in the northern Basin arising from the Northern Basin Review, reduced the recovery target by 70 GL to 2,680 GL
- 605 GL: the implementation of 36 SDLAM projects which are designed to deliver similar or improved environmental outcomes with 605 GL less water recovery[62].

In 2017, leading up to the SDLAM amendment, the Basin states and the Commonwealth agreed on a notified[63] package of 36 SDLAM projects across the southern connected Murray-Darling Basin with the aim of achieving the 605 GL of offsets.[64]

55 https://www.mdba.gov.au/basin-plan/plan-murray-darling-basin
56 Murray Darling Basin Plan 2012 Implementation Agreement
57 MDBA (2015) Submission to the Select Committee on the Murray Darling Basin Plan
58 https://www.mdba.gov.au/basin-plan/water-recovery
59 MDBA (2015) Submission to the Select Committee on the Murray Darling Basin Plan
60 Frontier Economics (2022) Socio-economic context of the Victorian Constraints Measures Program
61 https://www.water.vic.gov.au/murray-darling-basin-plan/what-is-the-murray-darling-basin-plan/the-sustainable-diversion-limit-adjustment-mechanism-sdlam-murray-darling-basin-plan
62 Ibid.
63 Chapter 7 of the Basin Plan sets out the process, roles and requirements for the notification of SDL adjustment projects (measures). Notified measures are measures that have been notified under subsection 7.12(1). This means they are measures that have been proposed by the Basin Officials Committee, will have entered operation by 30 June 2024 (section 7.12(3)(a)) and are to be taken into account by the Authority for proposing adjustments under section 7.11 of the Basin Plan (Reconciliation).
64 https://www.water.vic.gov.au/murray-darling-basin-plan/what-is-the-murray-darling-basin-plan/the-sustainable-diversion-limit-adjustment-mechanism-sdlam-murray-darling-basin-plan

Six constraints measures projects were included in the notified package of projects[65]. Victoria was the proponent or co-proponent for two of the notified constraints measures projects[66]:

- Goulburn River key focus area
- Hume to Yarrawonga key focus area.

Works and measures are required in Victoria for the delivery of a third constraints measures project, for which New South Wales is the proponent:

- Yarrawonga to Wakool junction key focus area.

The original Goulburn River constraints project (April 2016) was withdrawn as a supply measure due to concerns around landholder and community impacts[67]. In June 2017, a New Goulburn project was developed by Victoria and submitted as a constraints project only and not included as part of the SDLAM determination[68]. The three notified constraints projects listed above form the scope of the Victorian CMP (Table 7).

Table 7 – Notified extent of proposed constraints relaxation - Victorian CMP projects

Notified project	Current operational flow limit (ML/day)	Notified extent of constraints relaxation
Goulburn River key focus area	9,500 ML/day at Shepparton and 10,000 ML/day at Molesworth	Investigation of opportunities to address in-channel constraints to the delivery of higher regulated flows up to 20,000 ML/day at Shepparton.
Hume to Yarrawonga key focus area	25,000 ML/day at Doctor's Point	Investigation of opportunities to address constraints to the delivery of higher regulated flows up to 40,000 ML/day from Hume Dam.
Yarrawonga to Wakool key focus area	15,000 ML/day at Yarrawonga Weir	Investigation of opportunities to address constraints to enable the delivery of higher flows up to 30,000 ML/day downstream of Yarrawonga Weir, with a buffer for flows up to 50,000 ML/day.

The Basin Plan also provides for the recovery of 450 GL of additional water for the environment through 'efficiency measures above the 2,750 GL target[69]. This additional water recovery is outside the scope of the projects being assessed in the Victorian CMP.

2.3.3 Impacts of not delivering SDLAM projects

Under the Basin Plan, in 2024 the MDBA is required to assess whether the notified SDLAM projects have been implemented as proposed and have achieved the equivalent of 605 GL of water recovery. If the package of notified measures is not implemented (or is changed in a way that would impact on the adjustment amount under the 2017 determination), the Authority must undertake a reconciliation, which may lead to a revision of the adjustment amount[70]

A number of the SDLAM projects have been completed and are in operation as of 2023. These projects to 2022 are estimated to generate 278.7 GL SDLAM offset [71] leaving a balance of 326.3GL to be recovered from projects that are yet to be completed. The Victorian CMP projects are expected to provide a total of 41.2GL SDL offsets[72].

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65 MDBA (2021) Annual Assurance Report 2021, Sustainable diversion limit adjustment mechanism, pg 5
66 https://www.mdba.gov.au/sites/default/files/20180504-s7.13-Register-of-Sustainable-Diversion-Limit-Adjustment-Mechanism-%28SDLAM%29-measures.pdf
67 DELWP (2017) New Goulburn Constraints Measure Business Case, pg i
68 https://www.mdba.gov.au/sites/default/files/20180504-s7.13-Register-of-Sustainable-Diversion-Limit-Adjustment-Mechanism-%28SDLAM%29-measures.pdf
69 https://www.water.vic.gov.au/murray-darling-basin-plan/what-is-the-murray-darling-basin-plan/additional-water-recovery
70 MDBA (2021) Annual Assurance Report 2021, Sustainable diversion limit adjustment mechanism, pg 1
71 Frontier Economics (2022) Socio-economic context of the Victorian Constraints Measures Program
72 Ibid

It is a topic of current debate about how to address any shortfall in SDL offsets if the remaining SDLAM projects are not implemented as notified. Possible approaches to making up any shortfall include:

- buying back water entitlements from irrigators
- investing in on or off farm infrastructure projects to improve water use efficiency

Research, supported by comments from Consultative Committee members, indicates that these alternatives will result in negative social and economic impacts due to reductions in the consumptive pool and flow on effects causing reduced agricultural production and/or increased water allocation prices[73].

These impacts would need to be considered in any decision not to proceed with the Victorian CMP to implementation.

It is noted that the *Water Amendment (Restoring Our Rivers) Act 2023* was enacted at the end of the Committee's tenure which extended the completion date of the SDLAM projects to 31 December 2026.

> *"We stand to lose as irrigators by not doing anything. So this project helps us achieve towards the package of the Plan. Otherwise we could end up with water being taken straight out of the consumptive pool."* Consultative Committee Member

2.4 Benefits to be delivered

Relaxing river operational constraints on regulated environmental flows has the potential to deliver environmental and socio-economic benefits to the Victorian community within both the impacted river reaches and more broadly to the Australian community at a basin-wide level when combined with constraints relaxation in the Murrumbidgee, Darling and South Australian Murray. A program investment logic map was developed to identify the key benefits delivered by the project. The identified benefits are described below.

2.4.1 Regional benefits

- Protect and restore remnant high ecological value floodplain forest and wetland ecosystems in the Victorian Murray and Goulburn Rivers:
  - Up to 50,000 ha of remnant floodplain native vegetation communities (river red gum and black box woodland) in Victoria can be inundated with environmental water under the highest levels of constraints relaxation explored in this feasibility study. This is an approximate 200% increase in the area of floodplain receiving environmental watering compared to the do nothing scenario[74]
  - Improving floodplain vegetation resilience by increasing the proportion of water-dependent vegetation communities that can be held in good condition between dry spells. This keeps the vegetation communities out of the critical condition status and increases the likelihood of surviving extended dry periods[75].
- Increase the effective utilisation of recovered environmental water to achieve environmental outcomes in the Victorian Murray River and Goulburn River:
  - An increase in effective utilisation of environmental water held in the Goulburn to achieve environmental objectives in the Goulburn system from a modelled 36% currently to 83% under the highest levels of constraints relaxation explored in this feasibility study[76]
  - Maximising the local and regional benefits of environmental water recovered from Victorian communities by utilising a higher proportion of this water to achieve environmental targets within the Victorian Murray and Goulburn River floodplains.
- Avoid further water recovery from Victorian irrigation communities by meeting SDLAM commitments:

[73] Ibid
[74] Alluvium (2023) Stage 1A of the Victorian Constraints Measures Program – Environmental Benefits and Risks Report
[75] Alluvium (2023) Stage 1A of the Victorian Constraints Measures Program – Environmental Benefits and Risks Report
[76] DEECA (2023) Victorian Constraints Measures Program Stage 1A GBCCL Source Modelling

- If SDLAM projects are not delivered, an equivalent volume of water may need to be recovered from other means including potentially buying back water entitlements from irrigators or investing in irrigation efficiency
- Socio-economic and equity impacts of any potential water buyback from Victorian irrigators is a concern, with an independent assessment of social and economic impacts of the Basin plan undertaken for the Victorian Government in 2022 confirming that water recovery has had significant impacts on irrigators and communities in Northern Victoria. The impacts of water buyback include increased water prices, heightened irrigation business risk exposures to high water prices and compromised viability of major irrigation districts and industries[77].

2.4.2 System-wide benefits

- Contribute to the environmental outcomes set out in the Basin Plan[78]:
  - s5.02 (2) (c) healthy and resilient ecosystems with rivers and creeks regularly connected to their floodplains and, ultimately, the ocean
  - s5.03 (1) (a) to protect and restore water-dependent ecosystems of the Murray-Darling Basin
  - s5.03 (1) (b) to protect and restore the ecosystem functions of water-dependent ecosystems
  - s5.03 (1) (c) to ensure that water dependent ecosystems are resilient to climate change and other risks and threats
- Contribute to meeting the enhanced systemwide environmental outcomes for the Murray River system through the cumulative relaxation of constraints across the southern connected basin as set out in s7.09 (e) of the Basin Plan. These benefits include improved outcomes for the Murray River floodplain, Murray River water quality, estuarine health, Murray Mouth opening, higher average lake levels and increased in-stream flows and variability.

[77] Frontier Economics (2022) Social and economic impacts of Basin Plan water recovery in Victoria
[78] Commonwealth of Australia, Water Act 2007, Basin Plan, 22 November 2012

3. Evaluation of relaxed constraints scenarios

3.1 Overview

In this section, multiple relaxed constraints flow rate scenarios for the preferred intervention of reach wide constraints relaxation have been examined and assessed. The assessment uses quantitative modelling to estimate the impacts and benefits of different relaxed flow rates against multiple benefit and impact factors.

Consistent with the scope for the Victorian CMP, this feasibility study does not recommend a preferred flow rate option. The multi-criteria analysis allows stakeholders to take into account a wide range of factors and assess them in a structured way in order to take an informed view on the merit of different relaxed flow rate scenarios. If the project proceeds past this feasibility stage, the State will undertake a more exhaustive consultation and engagement process to confirm the project impacts and inform the selection a preferred relaxed constraints flow rate. Decisions on relaxed constraint flow rates for the Murray River cannot be made by either state in isolation. Victoria, New South Wales and the Australian Government need to agree on which relaxation options should be considered should Ministers agree to progress the Program.

3.2 Scenarios

3.2.1 Notified relaxed constraints flow rates

As part of the study, various flow scenarios up to the minor flood level were selected so modelling could be done.

All modelled flow scenarios were analysed based on the volume of presently available environmental water holdings, without considering any potential additional water recovery measures, such as the 450 GL outlined in the Basin Plan. Most Committee members strongly voiced concerns about the prospect of further water recovery through buybacks. These concerns stem from the observed adverse effects of previous buybacks within northern Victorian communities.

A baseline for considering the relaxation of flow constraints is established by the flow rates specified in the Basin Plan SDLAM program. Notified flow rates are the maximum flow rates proposed to be targeted for environmental flows as part of constraint measure projects. The flow rates were notified in concept business cases prepared as part of the Basin Plan's SDLAM process. These notified flow rates, which were based on scientific studies that aimed to maximise ecological outcomes, were agreed upon by the Murray-Darling Ministerial Council in 2017[79] and form the scope of the Victorian CMP, are as follows:

- **Hume to Yarrawonga key focus area:** Relax constraints on regulated environmental flows up to 40,000 ML/day at the Doctors Point gauging station below Hume Dam on the Murray River
- **Yarrawonga to Wakool Junction key focus area:** Relax constraints on regulated environmental flows up to 30,000 ML/day at Yarrawonga Weir on the Murray River. Additionally, a risk buffer is included to accommodate flows up to 50,000 ML/day.
- **New Goulburn key focus area (nominated as a Constraint Measure only):** Relax constraints on regulated environmental flows up to 20,000 ML/day at Shepparton. It is important to note that originally, when the Basin Plan was settled[80], the proposed constraints relaxation for the Goulburn was 40,000 ML/day.[81] At this rate, the river in the Lower Goulburn reach will inundate parts of the low-lying floodplain including private property. However, the State decided to modify the notified flow rate to 20,000 ML/day, to prevent the inundation of the Lower Goulburn floodplain while still allowing environmentally beneficial bank-full and high in-channel flow rates[82]. This modification was also in response to community concerns about the impacts of larger flows.

3.2.2 Relaxed constraints flow rates options

The Committee used the notified flow rates and boundary parameters as a starting point for their discussions on relaxing flow constraints in the Murray and Goulburn Rivers. These parameters align with the Victorian

[79] Package of supply, constraint and efficiency measures agreed by the Murray Darling Basin Ministerial Council on 16 June 2017, https://www.mdba.gov.au/sites/default/files/docs/Package-constraint-supply-efficiency-measures.pdf
[80] MDBA (2018) Submission to the South Australian Murray Darling Basin Roll Commission, pg 7
[81] DELWP (2016) Goulburn Constraints Measure Business Case – Phase 2 Investigations
[82] DELWP (2017) New Goulburn Constraints Measure Business Case pg iii

government's position that the Goulburn reach should focus on flows within the river channel only and that overbank flows should not be considered.

3.2.2.1 Murray River

The Committee determined that the proposed baseline flows for modelling in the Murray River were suitable. The Committee also recognised that coordination and communication with the complementary floodplain restoration projects and the New South Wales constraints program equivalent, Reconnecting River Country Program (NSW RRCP), would be necessary.

Table 8 below summarises the scenarios investigated by the Victorian CMP for the Murray River at the constraint locations shown in Figure 19. The flow scenarios for the Murray River align with the relaxed constraints flow rates assessed by the NSW RRCP in the Murray River.

Table 8 – Murray River relaxed constraints flow rate modelling scenarios

Constraint location	Current constraint (ML/d)	Notified relaxed constraint (ML/d)	Relaxed constraint scenarios (ML/d)			
			Y25D25	Y30D30	Y40D40	Y45D40
Doctors Point	25,000	40,000	25,000	30,000	40,000	40,000
Yarrawonga	15,000	30,000-50,000	25,000	30,000	40,000	45,000

The naming convention used to describe the flow scenarios, as outlined in Table 8 is:

- Y = Yarrawonga weir downstream constraint (flow in ML/d)
- D = Doctors Point river gauge constraint (flow in ML/d). Doctors Point is located approximately 5 km downstream of Albury-Wodonga.

For example, the scenario Y45D40, is the combined relaxation of constraints in both lengths of the Murray River. This scenario represents relaxing constraints to:

- Hume to Yarrawonga: 40,000 ML/d, as measured at Doctors Point.
- Yarrawonga to Wakool: 45,000 ML/d, as measured at Yarrawonga Weir.

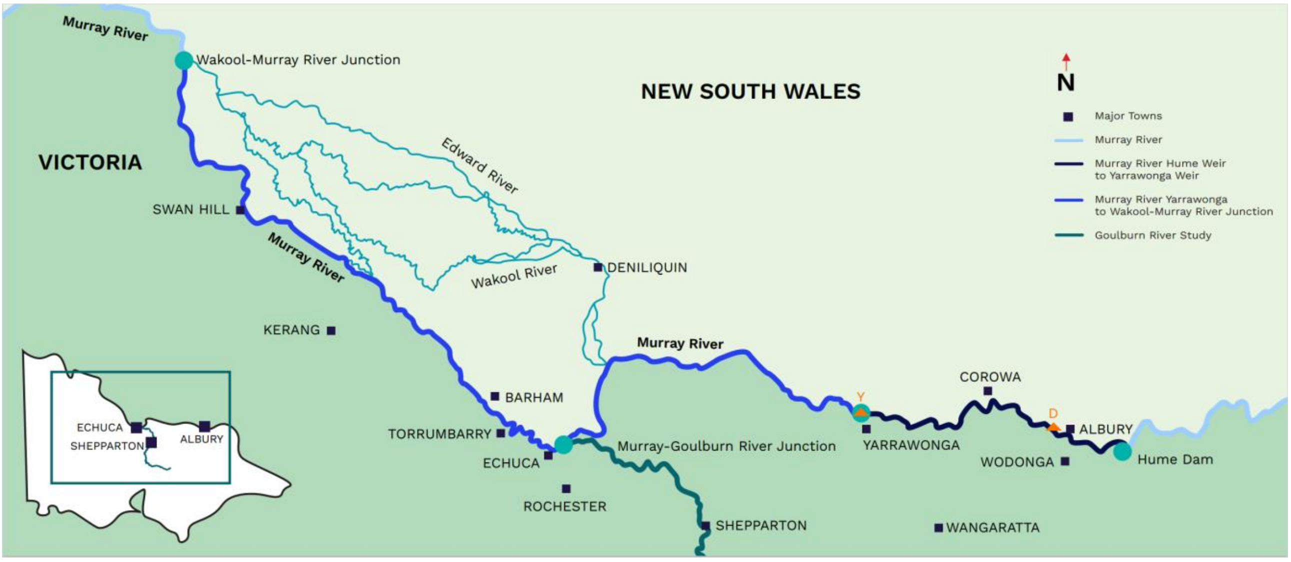


Figure 19 – Location of the modelled Murray River constraints at Doctors Point and downstream of Yarrawonga Weir

3.2.2.2 Goulburn River

Opinions within the Committee varied when it came to the proposed flow ranges for modelling on the Goulburn River. Some members expressed concerns that these flows might not bring sufficient environmental benefits. They suggested exploring higher flows, including overbank flows, to fully understand the advantages and impacts of relaxing constraints. They wanted to ensure that the feasibility study was robust and credible by investigating the benefits and impacts associated with these higher flows. On the other hand, some members argued against changing the established parameters and believed that the focus should solely be on flows within the river channel.

The Consultative Committee endorsed the testing of a range of relaxed constraints flow rates above and below the notified rates (up to the minor flood level, inclusive of a risk buffer) to understand the impacts on the expected levels of benefits and costs and the resulting acceptability to stakeholders. The request was informed by a University of Melbourne range-finding modelling exercise that examined the environmental impacts of a range of relaxed flow rates and reported on the marginal changes in environmental outcomes.

The relaxed constraints scenarios modelled for the Goulburn River are shown in Table 9 and are represented in Figure 20. All flow scenarios are below the minor flood level (where defined) with the minor flood level in Shepparton being 30,800 ML/day.

Table 9 – Goulburn River relaxed constraints flow modelling scenarios

Constraint location	Current constraint (ML/d)	Notified relaxed constraint (ML/d)	Relaxed constraint scenario (ML/d)			
			M10L17[a]	M10L21	M12L21	M14L25
Eildon Release	9,500	Not notified	9,500	9,500	12,000	13,700
Molesworth (Mid Goulburn)	10,000 (notional)	Not notified	10,000[a]	10,000	12,000	14,000
Shepparton (Lower Goulburn)	9,500	20,000	17,000[a]	21,000	21,000	25,000

[a] In-channel constraint scenario originally considered as part of the assessment. Scenarios greater than this were requested by the Committee for broader consideration

The naming convention used to describe the flow scenarios, as outlined in Table 9, is:

- M = Mid Goulburn constraint as managed at Molesworth (flow in ML/d)
- L = Lower Goulburn constraint as measured at Shepparton (flow in ML/d)

For example, the scenario M14L25 is the combined relaxation of constraints in both lengths of the Goulburn River. The M14L25 naming convention represents relaxing constraints to:

- Mid Goulburn: 14,000 ML/d, as managed at Molesworth.
- Lower Goulburn: 25,000 ML/d, as measured at Shepparton.

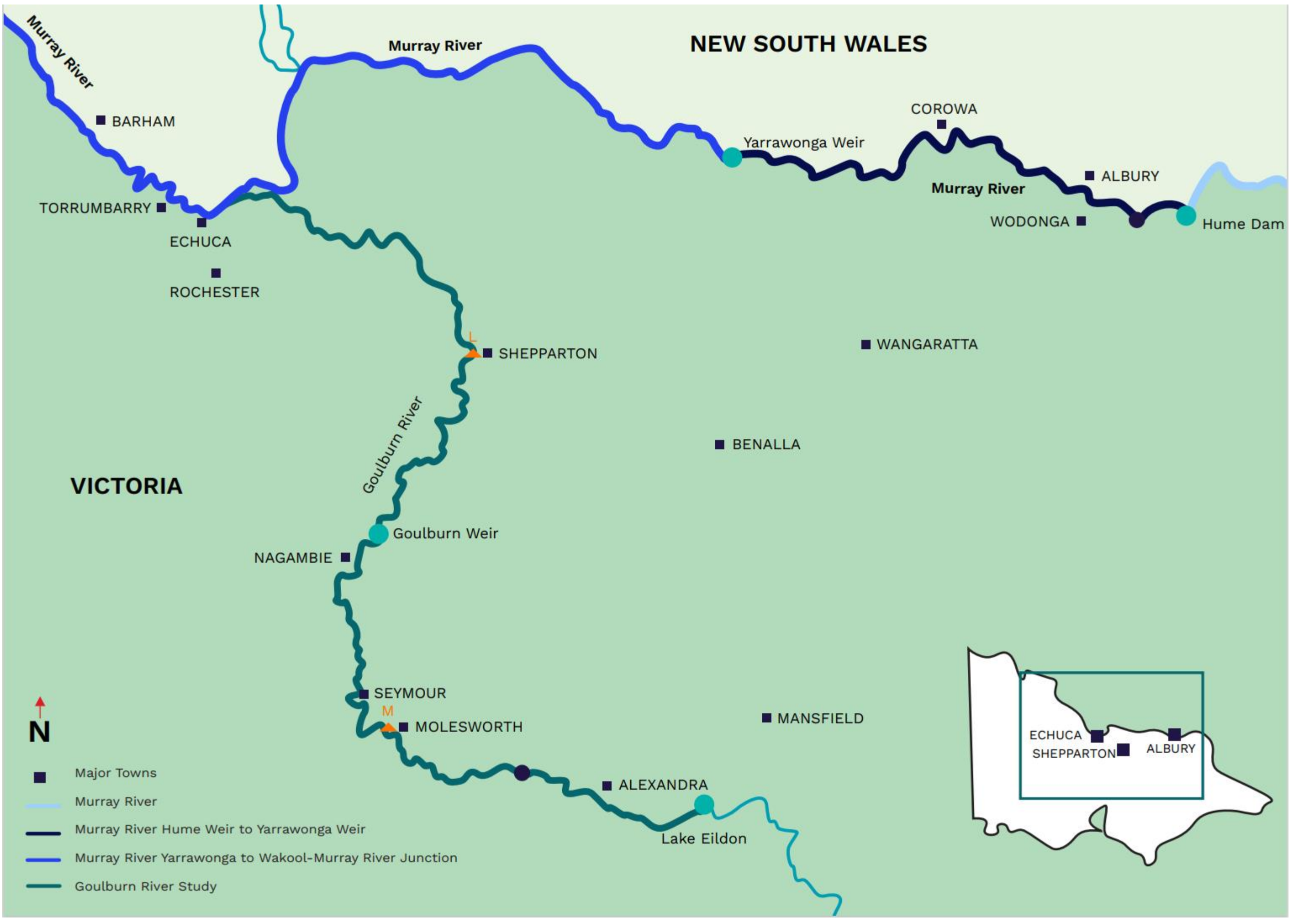


Figure 20 – Location of the modelled Goulburn constraints at Molesworth and Shepparton

3.3 Evaluation Framework

3.3.1 Criteria

Various quantitative criteria were developed to:

- Assess the ability of each option to address the problems and realise the benefits
- Assess the likely landholder and asset owner impacts
- Identify key points of differentiation to effectively compare the scope options.

The assessment criteria are set out in Table 10.

Table 10 – Assessment criteria

Project benefit or impact	Assessment criteria
1. Restoring and protecting floodplain ecosystems in the Victorian Murray and Goulburn Rivers	Area of mapped native vegetation (Ecological Vegetation Classes (EVC)). Frequency of late winter/spring bank-full and overbank flows events. Native vegetation condition in the Victorian Murray River and Goulburn River. Expected mean population size of Murray cod and golden perch.
2. Increased utilisation of recovered environmental water to achieve environmental outcomes in the Victorian Murray Goulburn Rivers	Rate of utilisation of environmental water portfolio compared to under current constraint conditions

Project benefit or impact	Assessment criteria
3. Avoid further Basin Plan water recovery	Proportion of notified constraints relaxation flow rate in the Goulburn and Murray
4. Extent of impact on private landholders	Area of private land inundated Number of private properties inundated

3.3.2 Modelling approach

The feasibility study has commissioned hydrologic, hydrology, ecological and land tenure modelling of the river systems to provide information to inform the assessment of impacts and benefits of different levels of constraints relaxation within each of the river reaches. The models provide a tool for understanding and assessing the likely impacts of changes in operational constraints on environmental flows.

The commissioned modelling involved:

- **Hydrologic modelling**: Hydrological models of the Goulburn and Murray systems were used to run 100+ year simulations of flows in the river system assuming current demands, infrastructure and operational rules, to assess the extent to which the targeted flow rates would be achieved under different constraint relaxation scenarios. The hydrologic modelling was used to investigate the differences in water availability and river flow that would impact the surrounding land including the frequency (how often), duration (how long), timing (what time of year) and size (how big) of river flows.

  Modelling was undertaken for this feasibility study by University of Melbourne, DEECA and MDBA. This study is the first time that constraints modelling has been undertaken using the recently developed DEECA GBCCL Source and the MDBA Source Murray Model (SMM) models. These models provide an enhanced representation of flow dynamics and environmental outcomes in the river systems. Further information on the hydrologic modelling is provided in **Section 14**.

- **Hydraulic modelling:** Hydraulic modelling was used to prepare maps that show the potential land that may be under water under the different flow scenarios. It showed the extent (area covered), depth (how deep) and velocity (how fast) of water flows. When combined with the environmental and land tenure and use data and modelling, the hydraulic modelling results can quantify the expected environmental and land use outcomes of relaxing operational constraints.

  Hydraulic modelling for this feasibility study was undertaken by consultants HARC for the Goulburn River, Manly Hydraulic Laboratory for the Murray River Barmah to Torrumbarry, and the MDBA for the remaining Murray River reaches. The hydraulic models have been calibrated with updated survey and inundation data including flood events in the Murray in 2017 and bathymetry data sets for the Mid Goulburn River commissioned by this feasibility study. This feasibility study also commissioned aerial photography, drone imagery and satellite imagery of the early phase of the late 2022 flood event in the Murray and Goulburn rivers to capture inundation maps at levels consistent with relaxed flows rate scenarios. These maps show the correlation of observed site inundation with the modelled scenarios and will be a valuable and impactful communication tool for facilitating better understanding by individual landowners and within the wider community. Further information on the hydrologic modelling is provided in **Section 15**.

- **Ecological response modelling:** Ecological response models were used to study how the environment would react to changes in how often, how long, and where floodplains get inundated. This was looked at based on historical climate conditions as well as where river flows were reduced due to climate change. The models used were developed by the subject matter specialists for previous related projects, including Environmental Flow Assessment for the Goulburn River (University of Melbourne stochastic models) and the NSW Reconnecting River Country Program. The ecological response models are based on data, research and monitoring into the behaviour and response of Australian ecosystems to flood events, the delivery of environmental water and to spells between events including droughts. Further information on the ecological response modelling is provided in **Section 8**.

- **Land use modelling**: A project GIS was developed with maps of floodplain land use, cadastral boundaries and property information, transport networks and other related datasets sourced from the Victorian Government Data Directory. The GIS database was used to undertake spatial analyses of the land use and transport infrastructure impacts of different levels of constraints relaxation in the Goulburn and Murray rivers. Further information on the land use modelling is provided in **Section 10**.

These models were used to investigate options for relaxing constraints in the Goulburn and Murray rivers (Figure 21). The information required to understand certain elements of impacts of relaxed constraints such as the ecological and hydrologic impacts requires forecasts many years into the future and is subject to the risks and uncertainties inherent in such assessments. The role of models is to provide a structured approach to the assessment that can be interrogated to provide information on implications of different scenarios and interventions.

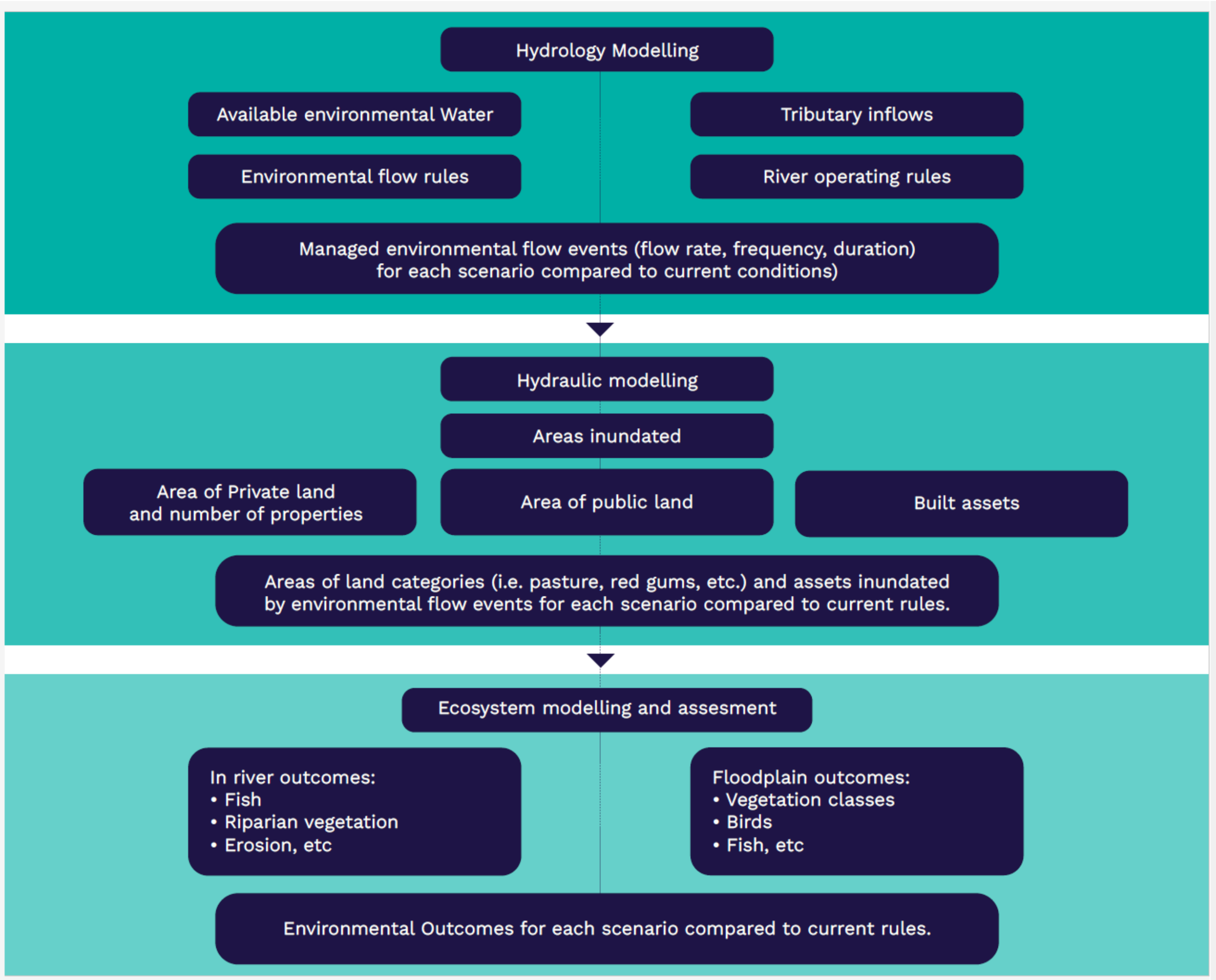


Figure 21 – Feasibility study analysis approach

3.4 Area of flood adapted native vegetation potentially inundated

3.4.1 Context

The floodplains of the Victorian Murray and Goulburn rivers contain significant areas of high ecological value remnant flood adaptive vegetation and wetland both within public and private land. Constraints on environmental flows limit the extent to which these wetlands and forests can be inundated with environmental watering actions. Relaxing constraints on environmental flow rates will result in a greater area of forest and wetland ecosystems receiving environmental water. A key factor distinguishing each of the relaxed constraints scenarios considered in this feasibility study is the potential area of floodplain inundation achievable through a regulated environmental flow event. Higher relaxed constraints flow rate scenarios result in a greater potential area of floodplain inundation, which in turn will produce a greater aerial extent of floodplain native vegetation inundation.

3.4.2 Approach

A measure of the extent of floodplain wetland and forest inundation has been developed for this feasibility study using the following data and assumptions:

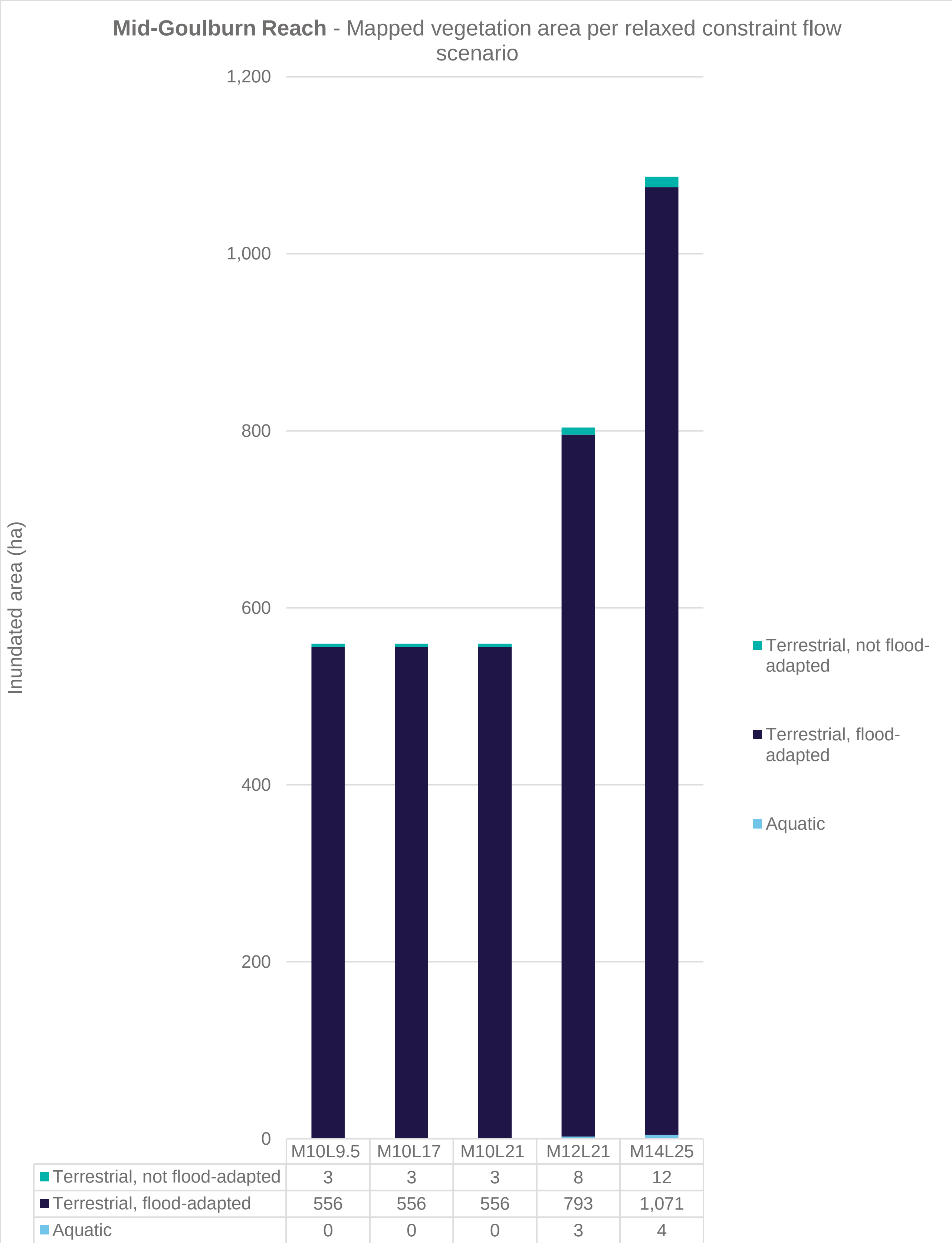
- Ecological Vegetation Class (EVC) mapping within the floodplain: EVCs are the standard unit for classifying remnant native vegetation types in Victoria[83]. The extent of EVCs has been mapped across Victoria and is available as a GIS dataset for the year 2005. The EVCs identified are located on both public and private land.
- The predominant EVC types within the floodplain areas in the scope of this feasibility study are Floodplain Riparian Woodland, Riverine Grassy Woodlands and Plains Woodlands[84]. The EVC classification includes semi-aquatic and aquatic habitats including Billabong Wetlands, Rushy Riverine Swamp and Floodplain Wetland Aggregates.[85]
- Relaxed Constraints inundation mapping: hydraulic inundation mapping undertaken for this feasibility study. The maximum spatial extent of inundation achievable under a relaxed constraints regulated environmental flow event has been simulated for each of the relaxed constraints scenarios in the relevant river reaches.
- GIS overlay analysis is then undertaken, combining the relaxed constraints and EVC native vegetation mapping, the creator dataset that identifies the area of native vegetation inundated under each of the relaxed constraints scenarios.

3.4.3 Results

3.4.3.1 Goulburn River

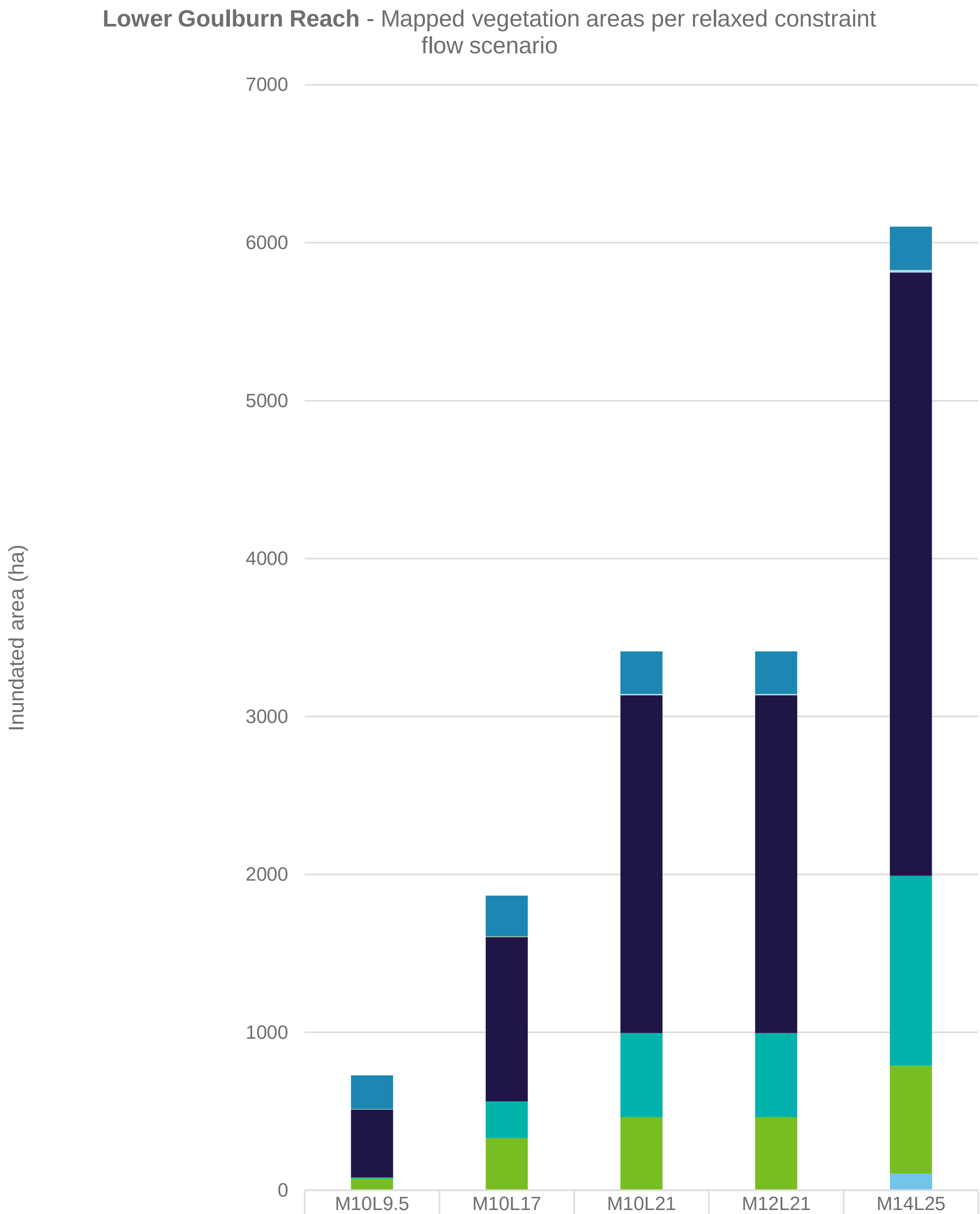
The maximum area of Goulburn River flood adapted native vegetation inundated under each of the relaxed constraints scenarios in the Goulburn River, are shown in Figure 22 through to Figure 24.

83 https://www.environment.vic.gov.au/biodiversity/naturekit/nk-datalists#toc__id_3_vegetation
84 https://www.environment.vic.gov.au/__data/assets/pdf_file/0024/48732/MuF_EVCs_combined.pdf
85 DSE (2012) A Field guide to Victorian Wetland Ecological Vegetation Classes for the Index of Wetland Condition



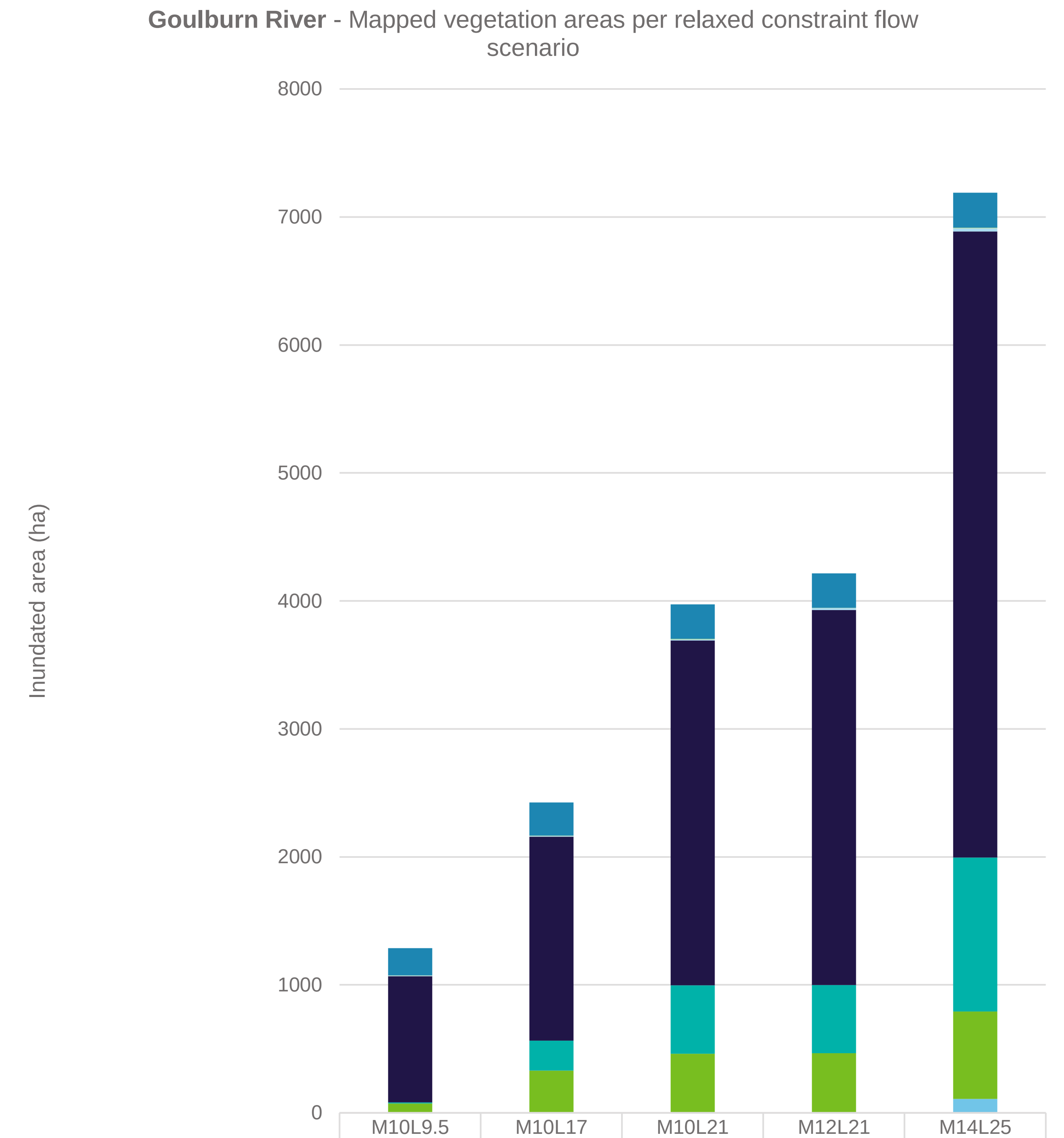
	M10L9.5	M10L17	M10L21	M12L21	M14L25
Terrestrial, not flood-adapted	3	3	3	8	12
Terrestrial, flood-adapted	556	556	556	793	1,071
Aquatic	0	0	0	3	4

Figure 22 – Mapped vegetation areas (ha) for each flow scenario along the Mid Goulburn reach



	M10L9.5	M10L17	M10L21	M12L21	M14L25
Water body	212	259	269	269	275
Bare rock/ground/beach	3	3	3	3	3
Terrestrial, not flood-adapted	1	2	7	7	14
Terrestrial, flood-adapted	430	1,039	2,139	2,139	3,820
Terrestrial, flood-adapted/semi-aquatic	8	233	533	533	1,203
Semi-aquatic	73	330	462	462	683
Aquatic	0	0	0	0	106

Figure 23 – Mapped vegetation areas (ha) for each flow scenario along the Lower Goulburn reach

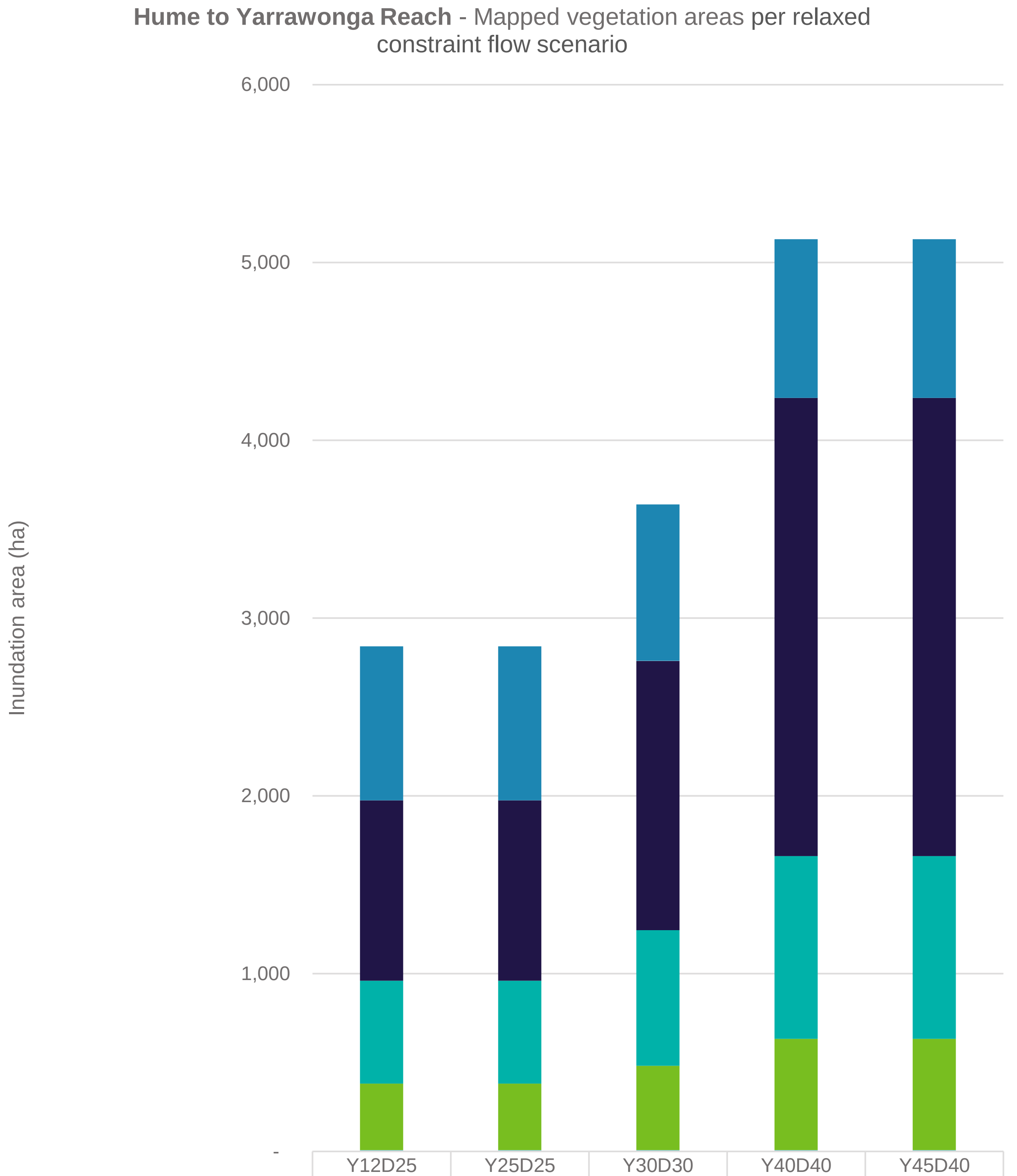


	M10L9.5	M10L17	M10L21	M12L21	M14L25
Water body	212	259	269	269	275
Bare rock/ground/ beach	3	3	3	3	3
Terrestrial, not flood-adapted	4	6	10	15	26
Terrestrial, flood-adapted	986	1,595	2,695	2,931	4,891
Terrestrial, flood-adapted/semi-aquatic	8	233	533	533	1,203
Semi-aquatic	73	330	462	462	683
Aquatic	0	0	0	3	110

Figure 24 – Mapped vegetation areas (ha) for each flow scenario along the entire Goulburn River study area

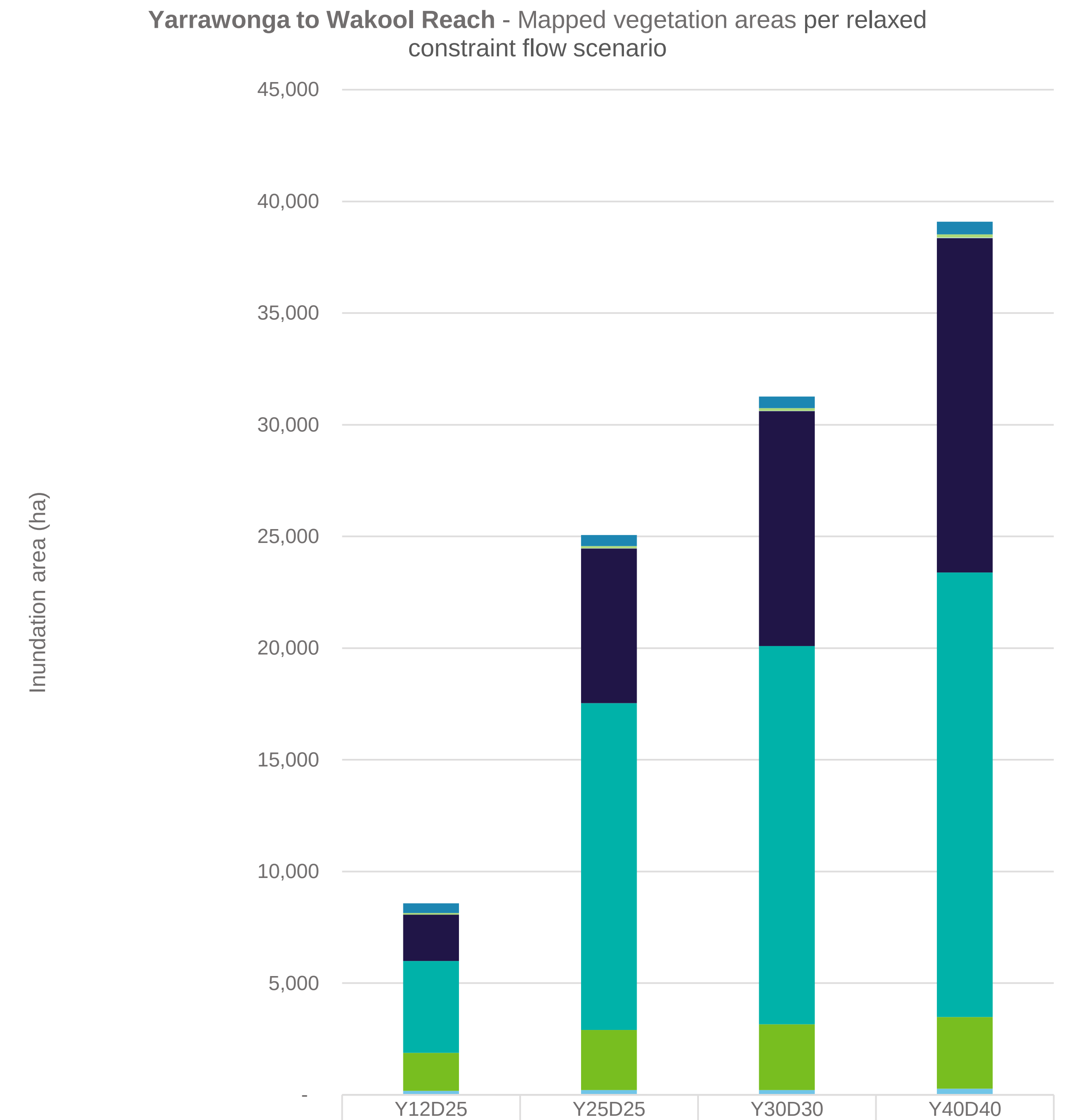
3.4.3.2 Murray River

The potential maximum area of flood adapted native vegetation inundated in the Victorian Murray River under each of the relaxed constraints scenarios in the Murray River, are shown in Figure 25, Figure 26 and Figure 27. Note that the data presented in these charts excludes native vegetation inundation occurring on the New South Wales bank of the Murray River and in the Edward-Wakool anabranch system within New South Wales.



	Y12D25	Y25D25	Y30D30	Y40D40	Y45D40
Water body	866	866	880	892	892
Terrestrial, not flood-adapted	0	0	1	1	1
Terrestrial, flood-adapted	1,015	1,015	1,514	2,577	2,577
Terrestrial, flood-adapted/semi-aquatic	579	579	763	1,027	1,027
Semi-aquatic	374	374	475	627	627
Aquatic	7	7	7	7	7

Figure 25 – Mapped vegetation areas (ha) for each flow scenario along the Hume to Yarrawonga reach



	Y12D25	Y25D25	Y30D30	Y40D40
Water body	441	494	519	566
Bare rock/ground/beach	68	100	125	139
Terrestrial, not flood-adapted	4	12	16	23
Terrestrial, flood-adapted	2,068	6,925	10,512	14,971
Terrestrial, flood-adapted/semi-aquatic	4,110	14,630	16,930	19,902
Semi-aquatic	1,703	2,696	2,952	3,211
Aquatic	182	211	212	274

Figure 26 – Mapped vegetation areas (ha) for each flow scenario along the Yarrawonga to Wakool reach

	Y12D25	Y25D25	Y30D30	Y40D40
Water body	1,306	1,360	1,399	1,458
Bare rock/ground/beach	68	100	125	138
Terrestrial, not flood-adapted	4	12	17	23
Terrestrial, flood-adapted	3,083	7,940	12,026	17,549
Terrestrial, flood-adapted/semi-aquatic	4,690	15,210	17,693	20,929
Semi-aquatic	2,077	3,070	3,427	3,839
Aquatic	189	218	219	281

Figure 27 – Mapped vegetation areas (ha) for each flow scenario along the Murray River

3.4.4 Key Findings

All scenarios with increased flow rates above the base case offer potential benefits to flood dependent vegetation in the subject study reaches. The increase in the area of vegetation inundated via the maximum flows under the Murray River constraints relaxation scenarios assessed from 11,417 ha currently to 44,217 ha under the most relaxed constraints scenario considered in this feasibility study. This represents an estimated 287% increase in the potential area inundated (see Table 11).

Table 11 – Estimated maximum area of flood dependent native vegetation inundated (Victoria only) by relaxed constraint scenarios for the Murray River (ha)

	Base case Y15D25 (ha)	Scenario 1 Y25D25 (ha)	Scenario 2 Y30D30 (ha)	Scenario 3 Y40D40 (ha)
Murray River Total (ha)	11,417	27,910	34,906	44,217
Percentage change on base case (%)	0%	144%	206%	287%

Similarly for the Goulburn River, the increase in the area of vegetation inundated via the maximum flows under the Goulburn River constraints relaxation scenarios assessed from 1,286 ha for the base case to 7,190 ha under the most relaxed constraints scenario considered in this feasibility study. This represents an estimated 459% increase in the potential area inundated (see Table 12).

Table 12 –Estimated maximum area of flood dependent native vegetation inundated (Victoria only) by relaxed constraint scenarios for the Goulburn River (ha)

	Base case M10L9.5 (ha)	Scenario 1 M10L17 (ha)	Scenario 2 M10L21 (ha)	Scenario 3 M12L21 (ha)	Scenario 4 M14L25 (ha)
Goulburn River total (ha)	1,286	2,426	3,973	4,216	7,190
Percentage change on base case (%)	0%	89%	209%	228%	459%

It is noted that the areas being considered are the maximum extents of the hydraulic modelling. This does not incorporate the intended flow regime, and it is not expected that the maximum area would be inundated regularly from controlled flows.

The areas of mapped native vegetation in Victoria are vegetation types that may benefit from inundation. The dominant vegetation type influenced is terrestrial-flood adapted vegetation, particularly in the Goulburn. In the Murray, significant areas of terrestrial-flood adapted-semi-aquatic vegetation are also influenced. Disbenefits, defined as inundation of areas of mapped native terrestrial vegetation that is considered not flood-adapted, are negligible in extent.

It is plausible that additional inundation due to relaxed constraints may favour inundation-tolerant weeds where they are present, suggesting a potential disbenefit. Where terrestrial weeds are a problem, these may be disadvantaged by any additional inundation due to relaxed constraints, suggesting a possible benefit. Such interactions are difficult to predict and are beyond the scope of these analyses.

Overall, the assessment finds that progressive constraint relaxation will increase both the area of healthy floodplain habitat but also the diversity of vegetation types.

3.5 Frequency of late winter/spring bank-full and overbank flow events

3.5.1 Context

Catchment Management Authorities (CMAs) and other relevant agencies have established environmental water requirements (EWRs) for ecological assets in the Goulburn River and Murray River. These EWRs set out the frequency, timing and duration of environmental water flows required to maintain the health of viability of ecosystems.

For floodplain ecosystems, the EWRs have been established specifying a requirement for high bank-full flows that engage flood runners and fill floodplain depressions and overbank flows that spread across the floodplain. A key deliverable from constraints relaxation is the removal of the restrictions on delivering these small overbank events. Removal of the constraints flow limit is expected to result in an increase in the frequency of these events in line with the EWR recommendations.

Current constraints on river flows limit the opportunity to deliver these bank-full and low overbank flows. An objective of the Victorian CMP is to lift constraints to increase the likelihood of being able to deliver these target flow events. Key factors that determine the likelihood of achieving these events include:

- decisions around the use of the environmental water portfolio and the prioritisation of different environmental flow events
- the available volume of environmental water in a given year
- the availability of unregulated flows to augment regulated environmental releases
- river physical capacity and dam storage release capacity
- operational flow constraints.

3.5.2 Approach

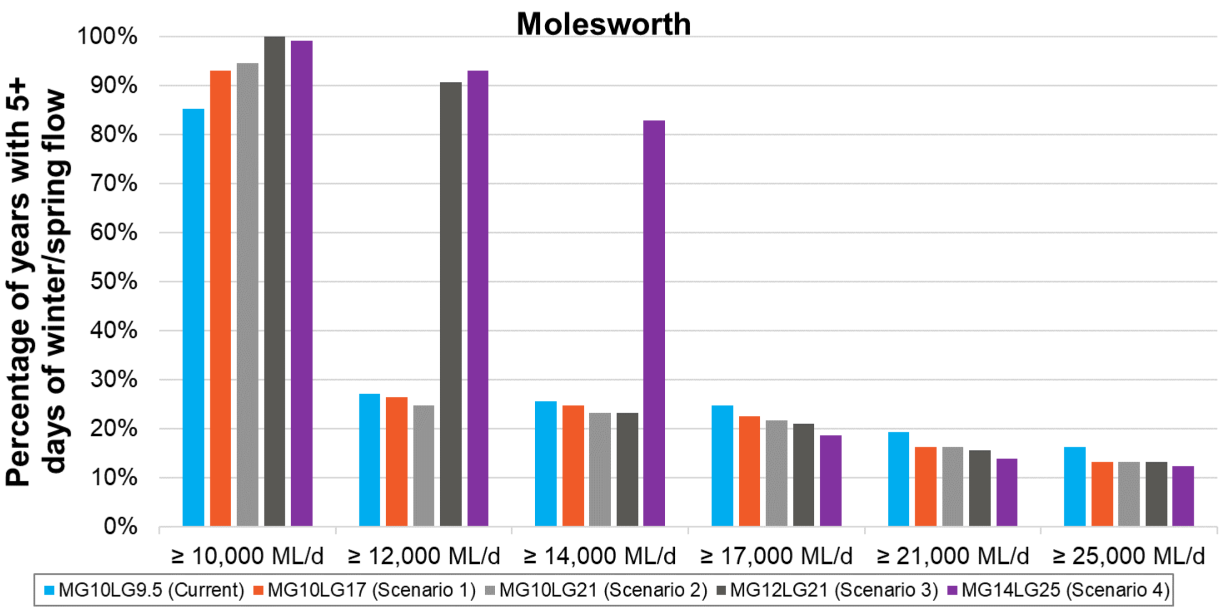
For the Victorian CMP, the MDBA and DEECA have run hydrological models of the Murray River and Goulburn Rivers respectively to model the impacts of different levels of constraints relaxation on environmental flow delivery. Details of the hydrological modelling is provided in Section 14.

To assess the likelihood of achieving the target high bank-full and overbank EWRs, the results of the hydrological models have been analysed to determine how successfully the river can be operated to deliver the desired EWRs. A common metric for assessing the success rate of delivering the target EWRs has been selected. The metric is the percentage of years, with 5+ days of winter/spring flow above specified flow thresholds measured at key gauging sites for the Goulburn and 12+ days in the Murray, aligned with the respective river system EWRs[86]

3.5.3 Results

3.5.3.1 Goulburn River

Figure 28 (Molesworth, Mid Goulburn) and Figure 29 (Shepparton, Lower Goulburn) show the proportion of years with at least five days of winter/spring flow above a range of thresholds for current constraints and the four constraint relaxation scenarios simulated by DEECA for the Goulburn River.



86 GBCMA (2015) Mid Goulburn River Flows Study; UoM (2020) Kaiela (Lower Goulburn River) Environmental Flows Study; and DPIE (2020) Murray -Lower Darling Long Term Water Plan Part A

Figure 28 – Frequency of 5+ days of winter/spring flow exceeding defined flow rates, for different Goulburn flow scenarios, Mid Goulburn

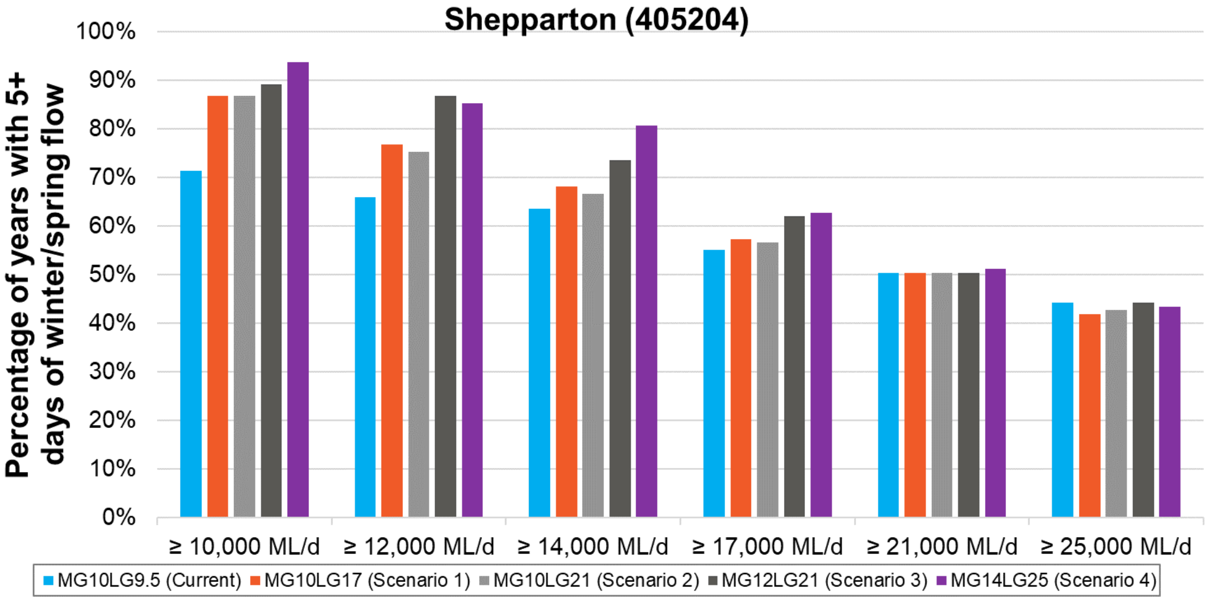


Figure 29 – Frequency of 5+ days of winter/spring flow exceeding defined flow rates, for different Goulburn flow scenarios, Lower Goulburn

3.5.3.2 Murray River

Figure 33 to Figure 33 show the proportion of years with at least 12 days of winter/spring flow above a range of thresholds in the Murray River study area at the four gauging points: Doctors Point, Yarrawonga Weir, Torrumbarry Weir and Wakool Junction.

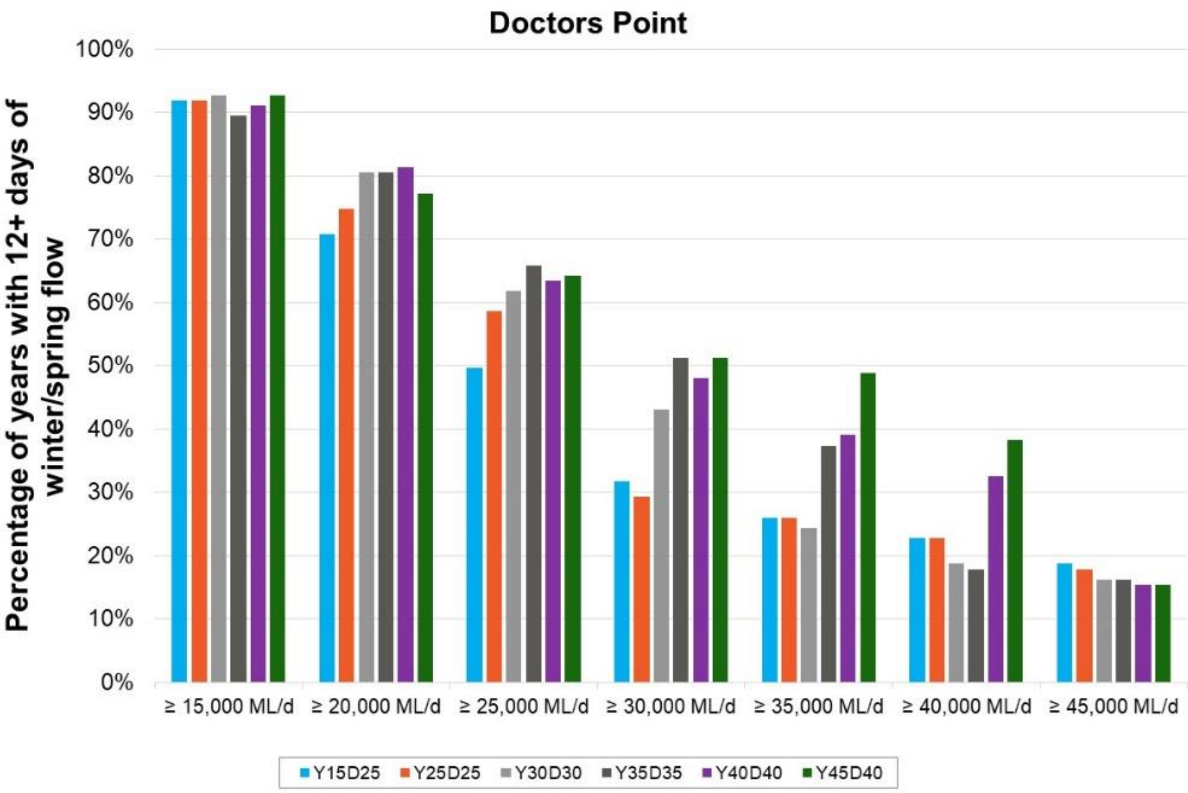


Figure 30 – Frequency of 12+ days of winter/spring flow exceeding defined flow rates, for different Murray flow scenarios, Doctors Point

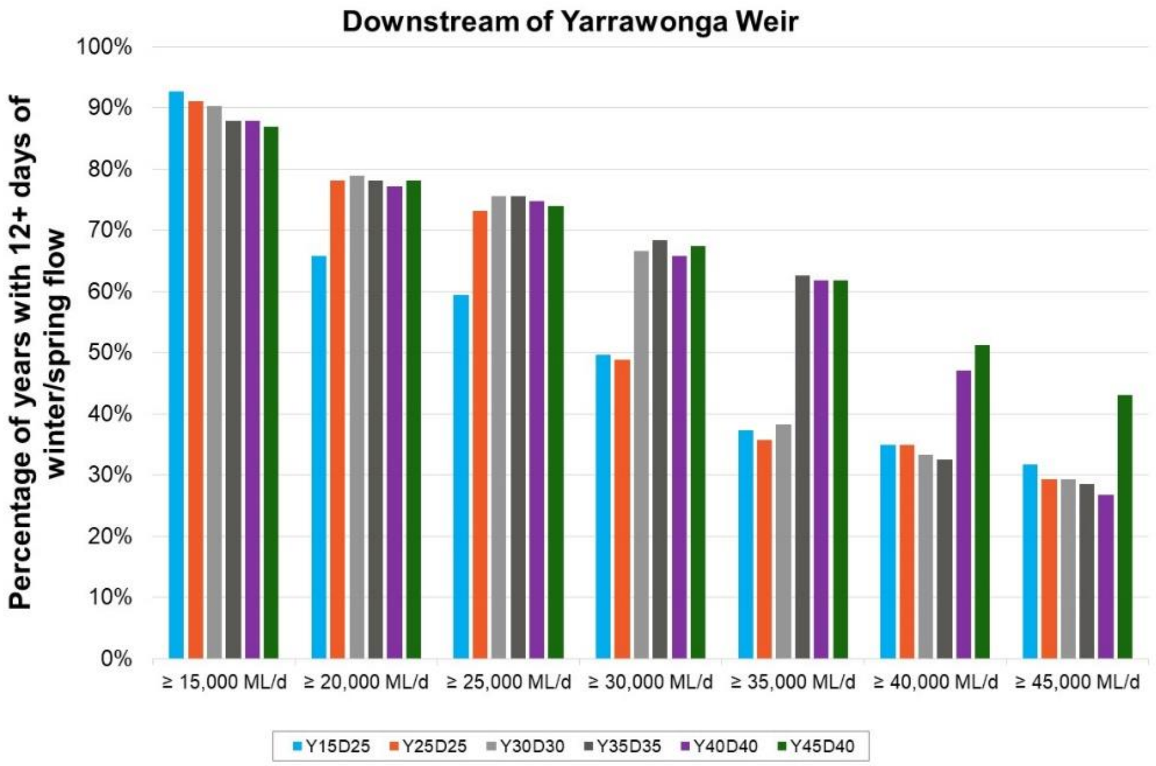


Figure 31 – Frequency of 12+ days of winter/spring flow exceeding defined flow rates, for different Murray flow scenarios, Downstream of Yarrawonga Weir

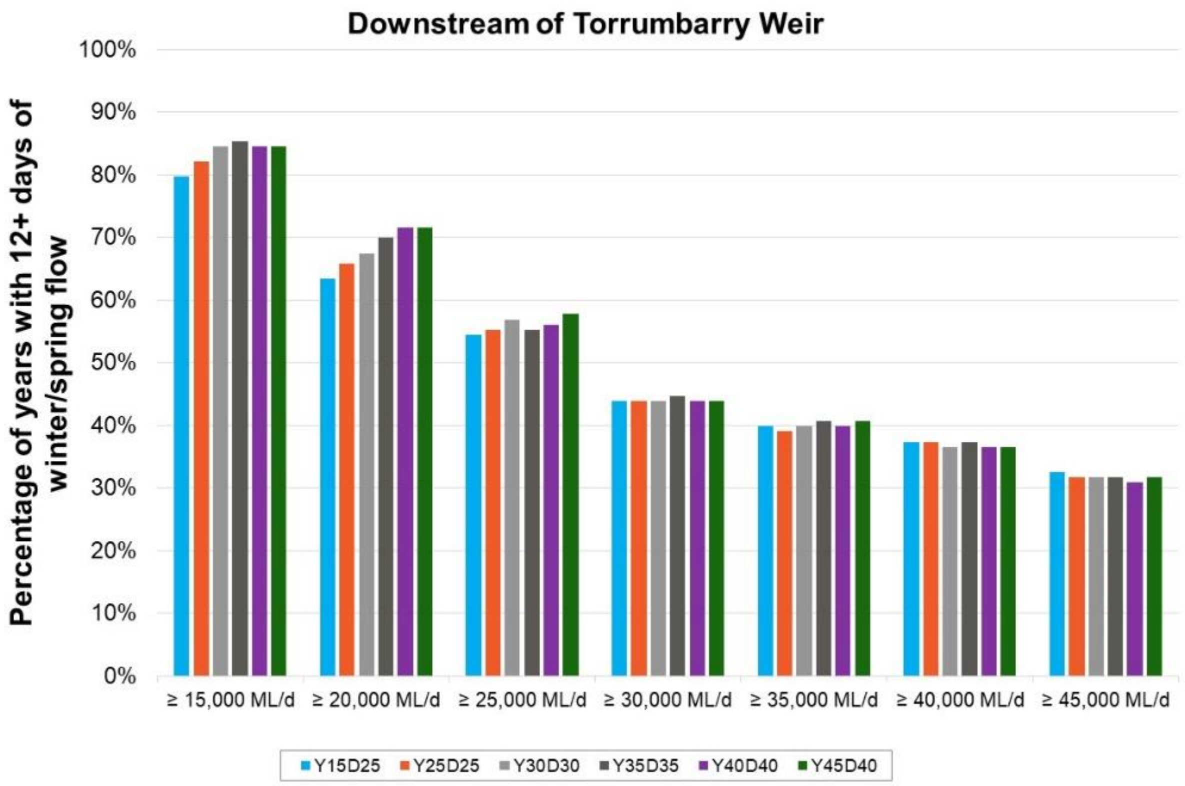


Figure 32 – Frequency of 12+ days of winter/spring flow exceeding defined flow rates, for different Murray flow scenarios, Downstream of Torrumbarry Weir

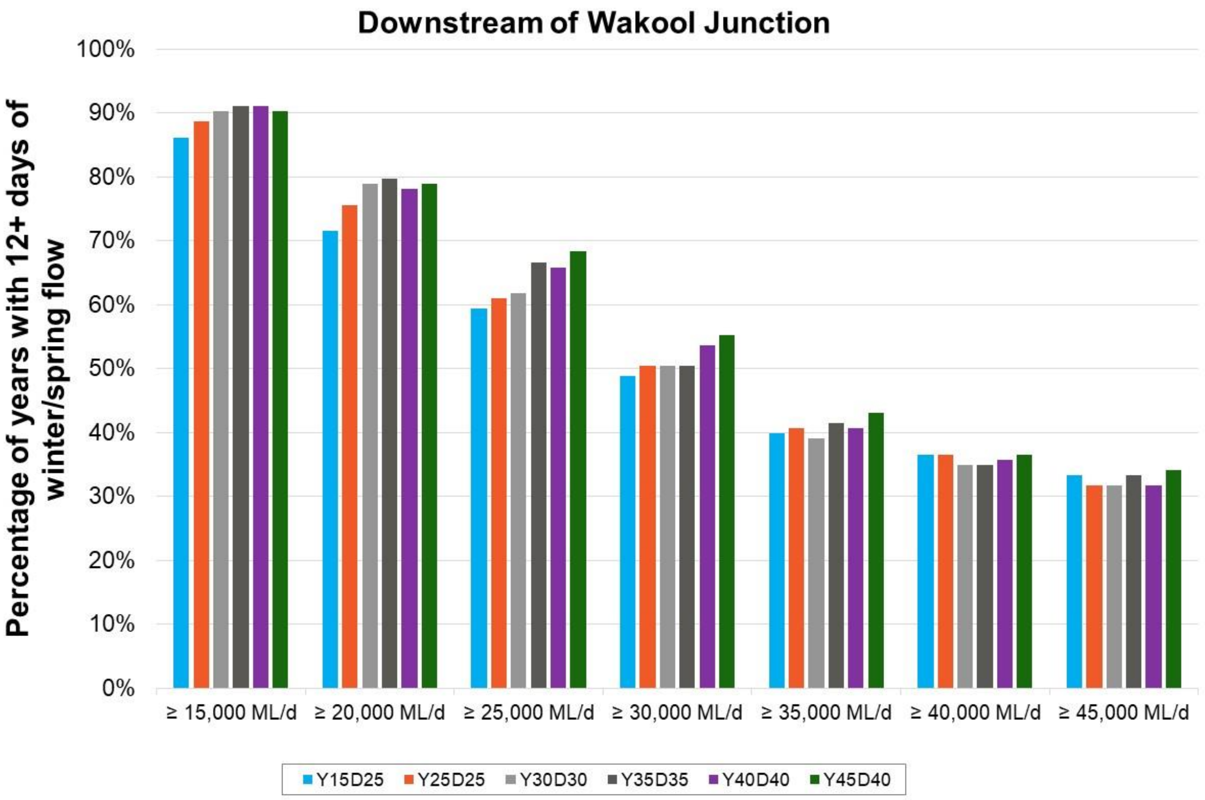


Figure 33 – Frequency of 12+ days of winter/spring flow exceeding defined flow rates, for different Murray flow scenarios, Downstream of Wakool Junction

3.5.4 Key findings

3.5.4.1 Goulburn River

The hydrology modelling for the Goulburn system has shown that it is important to relax the Lower Goulburn constraint to at least 17,000 ML/d – 21,000 ML/d, in order to deliver increased frequency of winter/spring bank-full flows to that river reach. Relaxation of the Mid Goulburn constraint, for example to 12,000 or 14,000 ML/d, is also required to increase the frequency of desirable high flows to the Lower Goulburn.

Modelling suggests the rate of improvement in water delivery of winter/spring high bank-full and overbank events declines once the Mid Goulburn constraint was relaxed beyond 14,000 ML/d and the Lower Goulburn constraint was relaxed beyond 17,000 ML/d – 21,000 ML/d. This is because regulated releases from Lake Eildon are constrained to be below the minor flood level of 13,700 ML/d at Eildon. The results also suggest that the patterns of Goulburn unregulated tributary inflows under current climate conditions are such that relaxing beyond 21,000 – 25,000 ML/d results in minimal increase in targeted winter/spring high bank-full and overbank flows in the Lower Goulburn.

3.5.4.2 Murray River

For the Murray River upstream of Barmah Choke, the relaxation of constraints at Doctors Point and Yarrawonga increases the number of winter/spring days when flows are greater than current constraints. For example, the days per year of winter/spring flow greater than 25,000 ML/d or 35,000 ML/d increases at Doctors Point and Yarrawonga Weir if constraints are relaxed to 35,000 ML/d or 40,000 ML/d at both locations. This increase is most likely to be observed in August, September and October. Once the flow of interest is above the relaxed constraint, the pattern changes. For example, downstream of Yarrawonga Weir the number of days of winter/spring flow above 45,000 ML/d reduces if the constraint is relaxed to 25,000 ML/d – 40,000 ML/d.

The degree of difference in frequency of high bank-full and small overbank flows between current and relaxed constraint scenarios tends to decrease with increasing distance downstream of the Barmah Choke. The benefits are decreased at the mid and lower parts of the Murray as flow regimes are mostly determined by wide and flat geographical characteristics, requiring a large volume of water to increase peaks.

3.5.4.3 General

A key limitation on the above findings is the modelling outcomes are influenced by how environmental water planning and management is represented in the hydrological models. The model contains a range of assumptions regarding the priority of flow events, the triggers events and other factors. These assumptions may underestimate the ability of storage managers to adjust releases in response to weather forecasts or to carryover water to build up the reserves of environmental water to deliver overbank flows in the following years. There is potential therefore that different hydrological outcomes could be generated if a wider range of triggers for environmental water releases and a more realistic representation of inflow forecasts were modelled in future stages of the Victorian CMP.

3.6 Area of river red gum and black box woodland in good or moderate condition

3.6.1 Context

A key outcome sought from increasing the area of floodplain inundation achievable with environmental watering is to generate an improvement in the health of floodplain forests and wetlands. For this feasibility study, a quantitative assessment of the potential benefits to floodplain vegetation condition under relaxed flow constraints has been undertaken to validate that the increased watering will achieve the desired environmental benefits.

The assessment focuses on the condition of floodplain river red gum and black box which are the dominant vegetation communities on the floodplains of the Goulburn River and Murray River, and other most iconic species of floodplain trees. Tree condition refers to the overall health of a tree. This includes factors such as the tree's crown extent and crown density. A tree in good condition will be strong, healthy, and able to withstand short periods of drought conditions with minimal loss of condition. A tree in moderate condition would be expected to have a moderate degree of resilience and be able to withstand a short dry period with minimal loss of condition.

3.6.2 Approach

A state-transition vegetation quality modelling approach developed for the NSW RRCP was applied to identify the potential vegetation quality outcomes from the proposed increased rate of environmental watering. This is the first known application of state-transition models to floodplain vegetation in the Goulburn and Murray although they are widely used in other systems. The models consider a single driver of change, inundation, and the subsequent change in condition given the condition of the tree at the time of inundation. Floodplain trees have been found to utilise rainfall, groundwater and floodwater, however, for this initial assessment, consideration of inundation was believed to be appropriate.

The state-transition model uses five states of vegetation living health, plus dead state, to show the potential condition of vegetation in response to the various constraints relaxation scenarios (see Figure 34). The modelling uses the hydrological modelling results discussed in the section above to determine periods of wet or dry which allow the vegetation to transition to another state. Only inundation events of 30 days or more will improve the condition (state) of black box woodland and river red gum forests and woodland. However, inundation of any duration, within the drying spell time, will prevent a decline in condition of black box woodland and river red gum forests and woodlands to the next state.

It is important to note that the 30-day duration of events necessary to improve condition is longer than the target length of constraints relaxation flow events (5+ and 12+ days). As a result, based on the state transition modelling undertaken, the flow events currently modelled under the constraints relaxation scenarios assessed will be effective at reducing a decline in condition (state) but will have limited role in improving the condition of the vegetation communities.

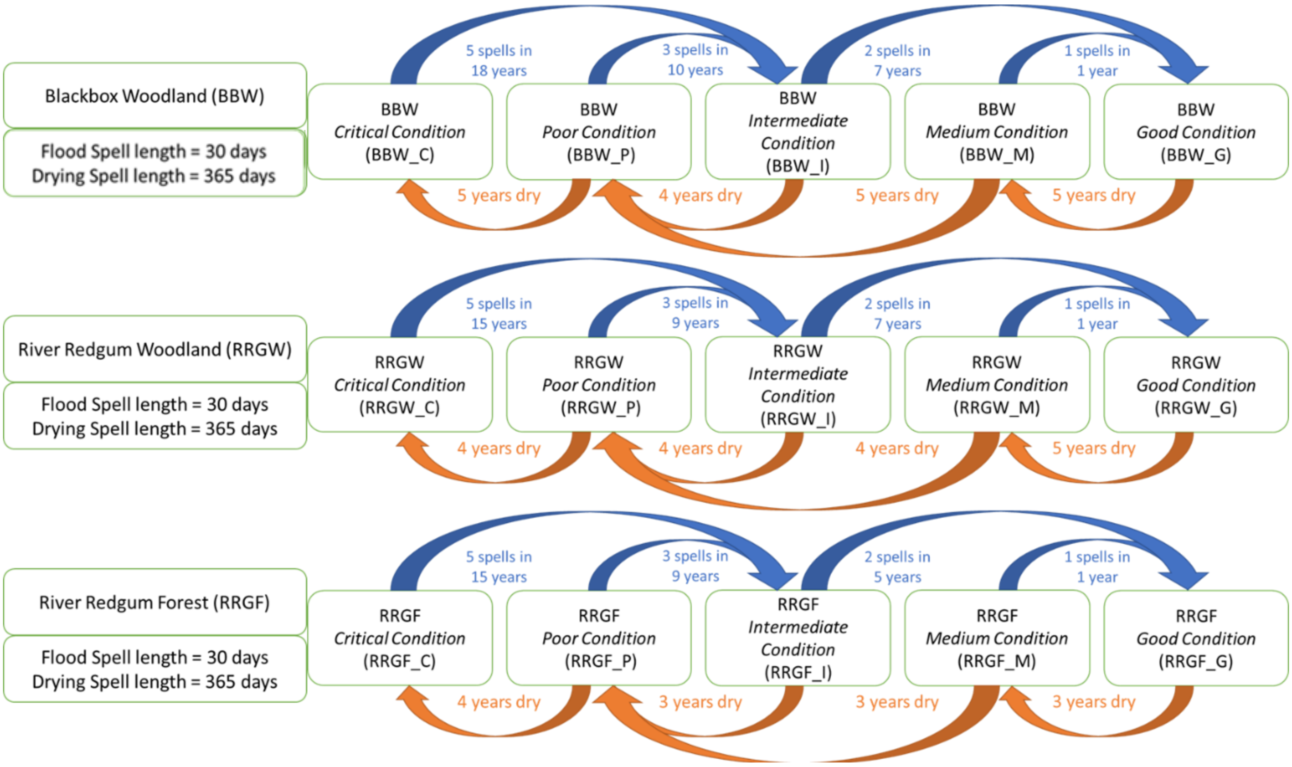
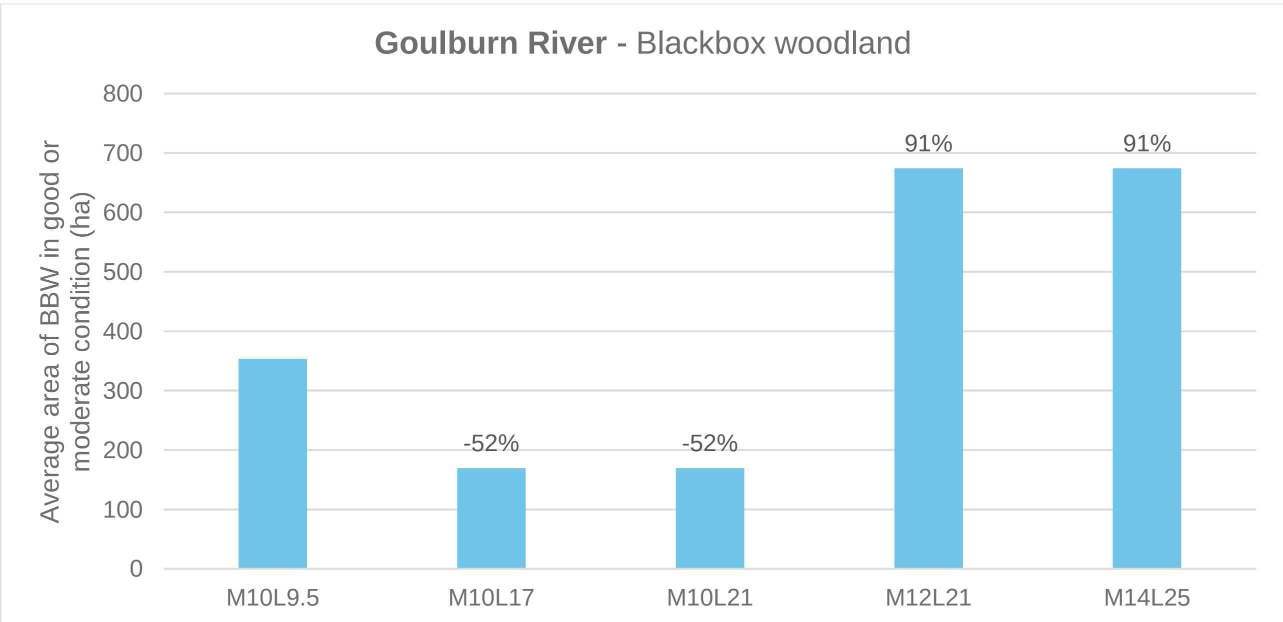


Figure 34 – Visual representation of a subset of transition rules for inundation frequency of broad vegetation categories

3.6.3 Results

3.6.3.1 Goulburn River

Figure 35 and Figure 36 show the modelled area and condition of black box woodland and river red gum along the Goulburn River under the different constraints relaxation scenarios for the river. In total there are approximately 2,000 ha of black box woodland and 20,000 ha of river red gum on the Goulburn River floodplain.



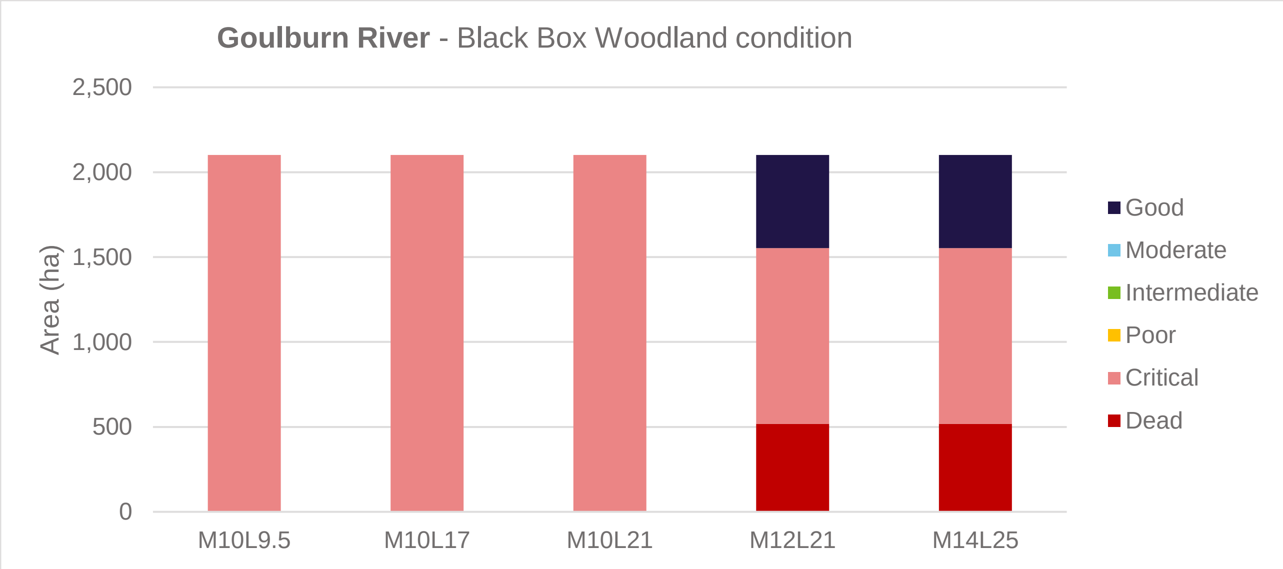


Figure 35 – End state condition of the modelling for Goulburn River black box woodland communities (ha) under modelled relaxed constraint scenarios

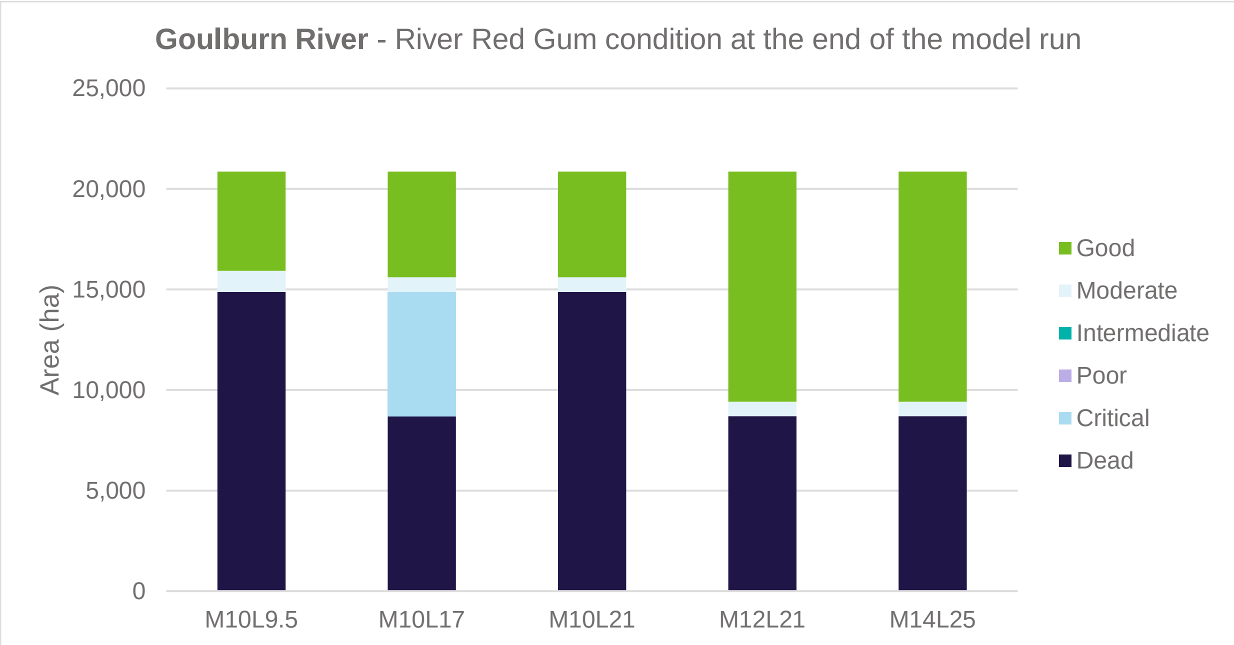


Figure 36 – Modelled area and condition of river red gum along the Goulburn River under each modelled flow scenario

3.6.3.2 Murray River

Figure 37 and Figure 38 show the modelled average area of black box woodland and river red gum in the Victorian Murray River between Hume and Wakool by condition under the different constraints relaxation scenarios for the river. In total there are approximately 10,000 ha of black box woodland and 40,000 ha of river red gum on the Victorian Murray floodplain.

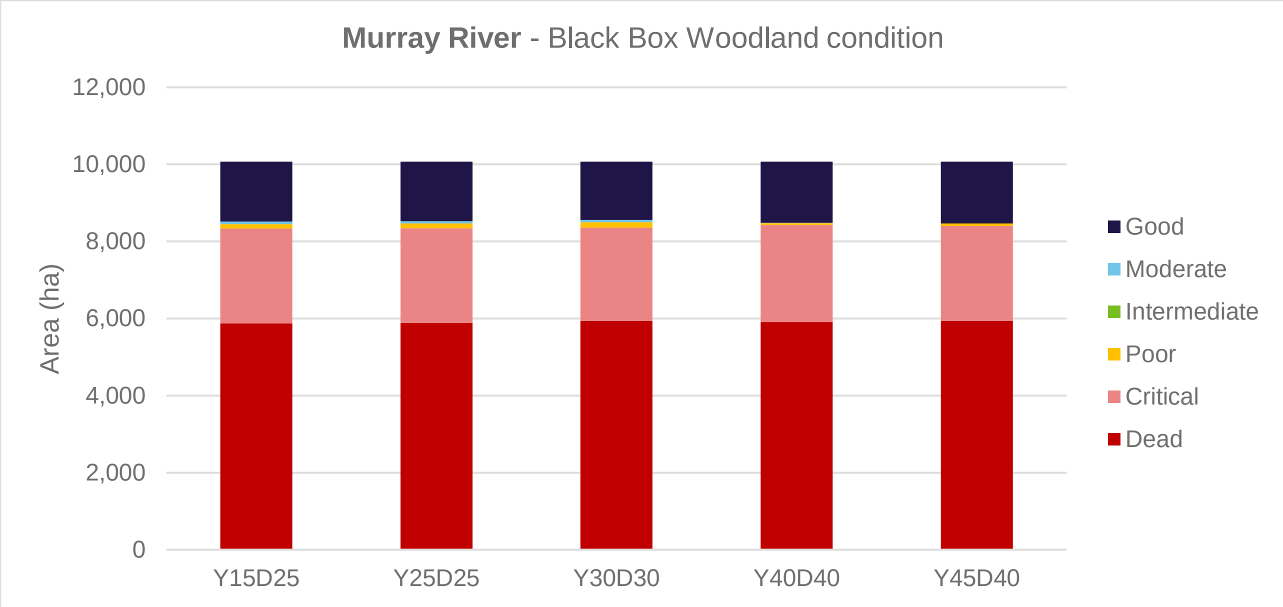


Figure 37 – Modelled area and condition of black box woodland along the Murray River under each modelled flow scenario (Victoria only)

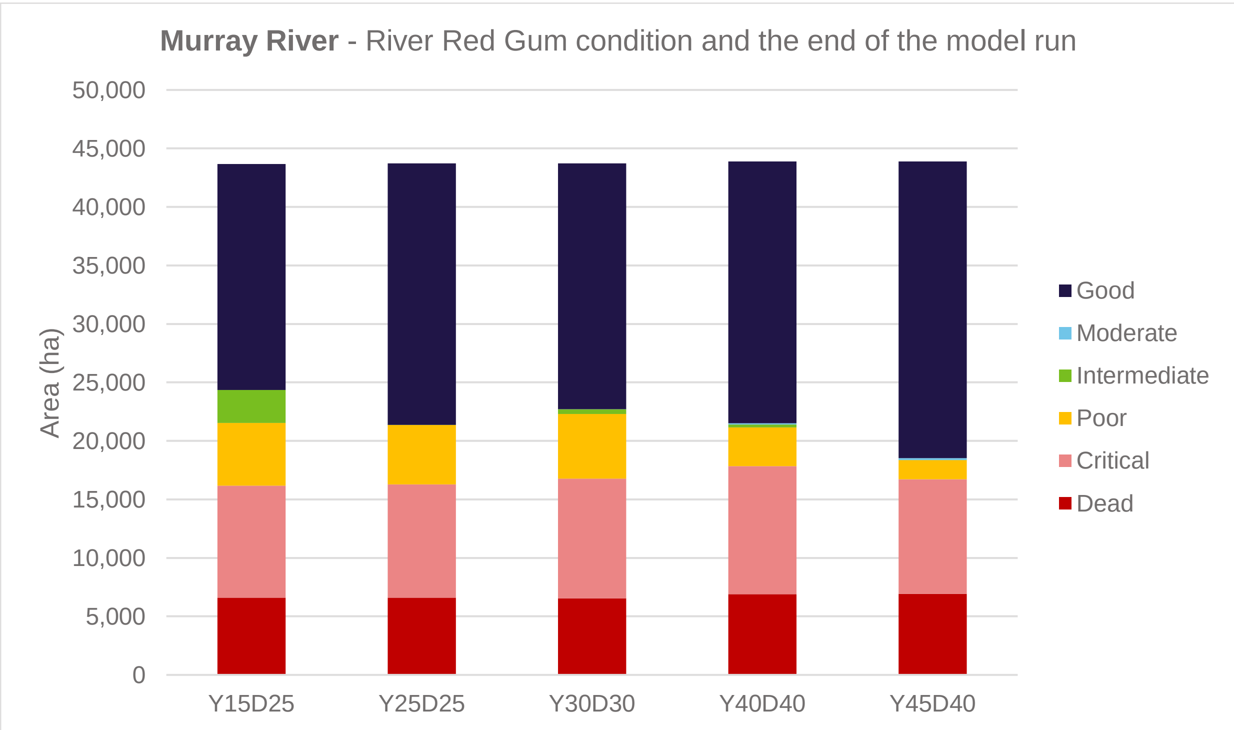


Figure 38 – End state condition of the modelling for Murray River river red gum communities under modelled relaxed constraint scenarios (Victoria only)

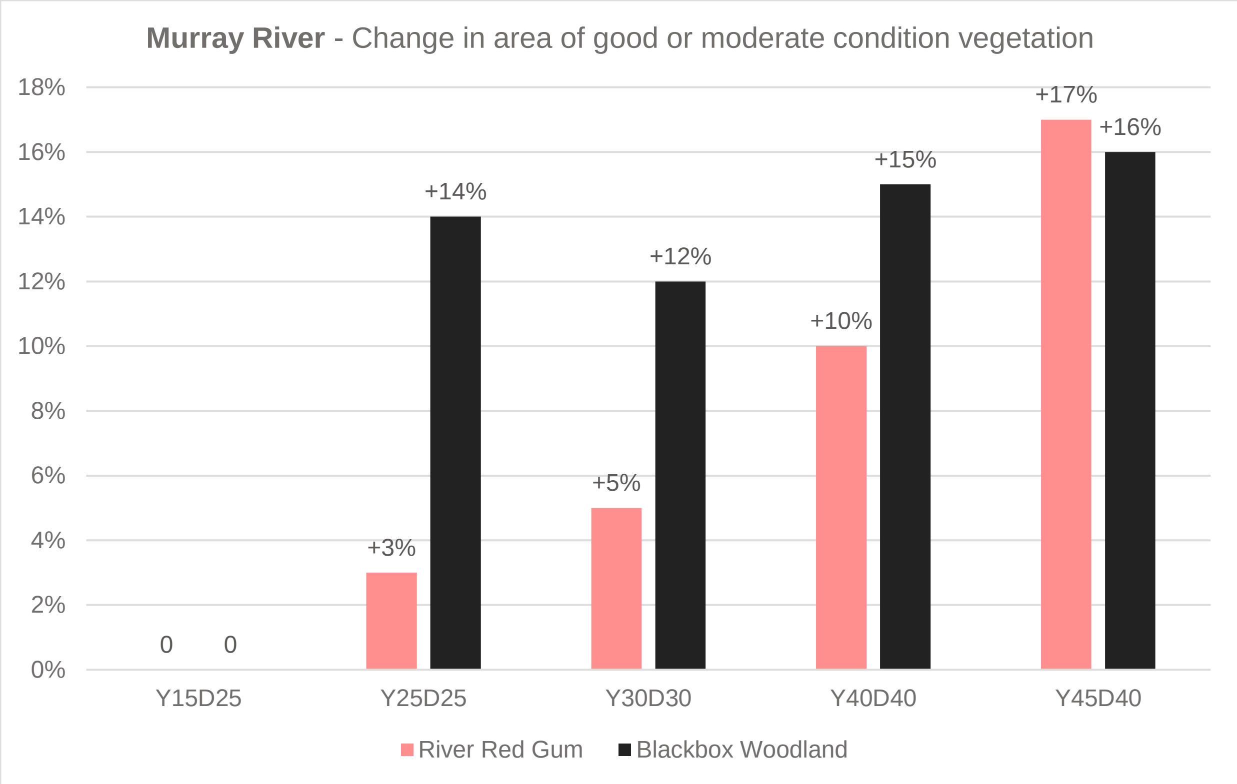


Figure 39 – Vegetation condition change of black box woodland and river red gum along the Murray River under each modelled flow scenario (relative to the base case)

3.6.4 Key findings

3.6.4.1 Goulburn River

The outcomes of this modelling effort revealed that at the end of the model run, under the 'do nothing more' scenario, approximately 75% of the river red gum vegetation community, amounting to around 15,000 ha, in the Goulburn River system would be at risk of loss. However, by relaxing constraints and increasing the connection of the river to the floodplain, it is possible to reduce this loss to less than 9,000 ha, protecting over 6,000 ha of river red gum vegetation. The most significant improvements for river red gum vegetation quality are from the M12L21 and M14L25 scenarios. These scenarios create an 80% increase in the area of river red gum in good and moderate condition.

The responses in black box woodland in the Goulburn show similar responses to the river red gum responses with the most significant benefits associated with the greatest level of constrain relaxation. However, for the M10L17 and M10L21 scenarios during the model run, areas that were in critical condition prior to droughts resulted in a loss of the black box woodland population.

While there are some risks for vegetation at higher elevations on the floodplain, the relaxation of constraints would provide a real and significant benefit to vegetation communities.

Overall, the relaxation of constraints offers a net improvement in the overall condition of floodplain vegetation of the Goulburn River. As the magnitude of constraint relaxation increases, so does the proportion of vegetation that becomes inundated with environmental water. The advantages of higher relaxation scenarios lie in their ability to maintain watered vegetation in a resilient state. However, there is a trade-off to consider – in the outer areas, further from the river channel, environmental water would only reach them during unregulated floods resulting from spills.

Despite some risks posed to vegetation at higher elevations on the floodplain, it is important to underscore that the relaxation of constraints carries substantial and tangible benefits for floodplain vegetation communities that rely on water. These benefits contribute significantly to the overall health and vitality of these ecosystems.

3.6.4.2 Murray River

As with the Goulburn River, the ecological response of vegetation to relaxed constraints in the Murray River is heavily dependent upon not only the extent of inundation, which drives which parts of the floodplain are watered, but also the inundation frequency and duration. The modelled flow, frequency, timing and duration under the different constraint scenarios are driving the ecological response models.

The duration of inundation is a key driver influencing the ecological response. The flows targeted under the environmental flow recommendations and achieved within the modelling are not of a duration for optimal positive vegetation response. Only inundation events of 30 days or more will improve the condition (state) of black box woodland and river red gum forests and woodland. However, inundation of any duration, within the drying spell time, will prevent a decline in condition of these forests and woodlands to the next state.

As seen with the relaxation of constraints in the Goulburn River, the duration of inundation under the modelled Murray River constraints scenario is not sufficient to enhance the condition.

The most significant improvements in River Red Gum occur with the highest relaxed constraint scenarios.

While there are some risks for vegetation at higher elevations on the floodplain, the relaxation of constraints would provide a real and significant benefit to floodplain water dependent vegetation communities.

Overall, the relaxation of constraints offers a net improvement in the overall condition of floodplain vegetation. As the magnitude of constraint relaxation increases, so does the proportion of vegetation that becomes inundated with environmental water. The advantages of higher relaxation scenarios lie in their ability to maintain watered vegetation in a resilient state. However, there is a trade-off to consider – in the outer areas, further from the river channel, environmental water would only reach them during unregulated floods resulting from spills.

Despite some risks posed to vegetation at higher elevations on the floodplain, it is important to underscore that the relaxation of constraints carries tangible benefits for floodplain vegetation communities that rely on water. These benefits contribute to the overall health and vitality of these ecosystems.

3.6.4.3 General

Across the Goulburn and two Murray River reaches, the progressive relaxation of constraints was consistently found to be associated with improvements in the condition of trees influenced by the flows. This was offset to some extent by declines in the condition of trees outside the influence of constraint relaxation.

3.7 Native fish populations

3.7.1 Context

Floodplain habitats provide important foraging, spawning and nursery habitats for many riverine fish species. Existing flow limit constraints mean that environmental water managers are unable to deliver flows that connect wetlands at the scale required to support larger-scale breeding, dispersal and recruitment of native fish species. Nor can they support the recovery of wetland vegetation which provides food and shelter for native fish.

Reduced frequency and duration of wetland-connecting flows isolates floodplain habitat and may result in stranding of native fish and eventual death. The isolation of native fish in wetlands also means that they cannot contribute to maintaining and building the broader native fish community in the Murray River and southern connected basin more broadly.

The removal of constraints on the delivery of water will therefore likely have important benefits for native fish. However, these benefits are likely to vary for different species based on their respective water requirements and how different management approaches change both hydrological conditions, and connections between rivers and floodplains[87].

3.7.2 Approach

Native fish population assessments for this feasibility study have focussed on the outcomes for Murray cod (*Maccullochella peelii*) and golden perch (*Macquaria ambigua*) across the two rivers. Both species are

[87] Arthur Rylah Institute (2022) Population Modelling for Native Fish Outcomes: Golden Perch and Murray Cod

considered highly important, being totemic species to Traditional Owners and for social outcomes of the regions, and Murray cod has a national conservation listing.

Golden perch rely on flow cues for spawning, movement and migration, and their growth and recruitment success is enhanced by increased river productivity and access to off-channel habitat through floodplain inundation. Murray cod prefer deep and fast-flowing habitat with submerged structure (woody debris) and natural rates of water level increase/decrease during breeding season in October/November. Murray cod recruitment can be enhanced through improved river productivity and connectivity with floodplain habitats.

For this feasibility study, the assessment of potential benefits to native fish from the relaxing of constraints used Arthur Rylah Institute ecological response models developed for the NSW RRCP in the Murray River and the University of Melbourne bayesian modelling in the Goulburn River.

3.7.3 Results

3.7.3.1 Goulburn River

Figure 40 shows the modelled stress index values for fish populations in the Goulburn River under different constraint relaxation scenarios. The outcomes are indicated by shading. Positive values (>0) indicate predicted benefits from relaxing constraints and are indicated by blue shading. A stress index value of +1 demonstrates that the relaxed constraints scenario performs wholly better than the base case. A stress index value of 0 indicates that for a given ecological objective the relaxed constraint scenario and base case perform equally (no benefit or disbenefit). Negative values (<0) indicate predicted disbenefits from relaxing constraints and are indicated by red shading. A stress index value of -1 demonstrates that the relaxed constraints scenario performs wholly worse than the base case.

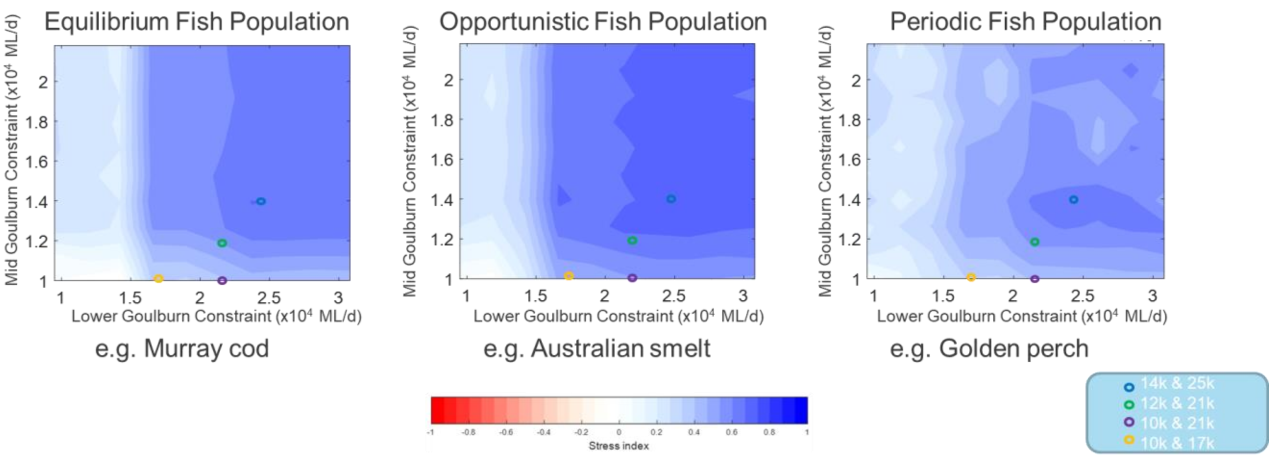


Figure 40 – Ecological model results for fish response in the Goulburn River. Deepening shades of blue represent improvements in the stress index that result in better outcomes for fish, deepening shades of red represent declines in the stress index which offer worse outcomes for fish

3.7.3.2 Murray River

The predicted fish responses to relaxed constraints scenarios in the Murray River are shown in the following figures (Figure 41 and Figure 42). The mean population size refers to the average number of individuals in a population over the hydrological simulation period.

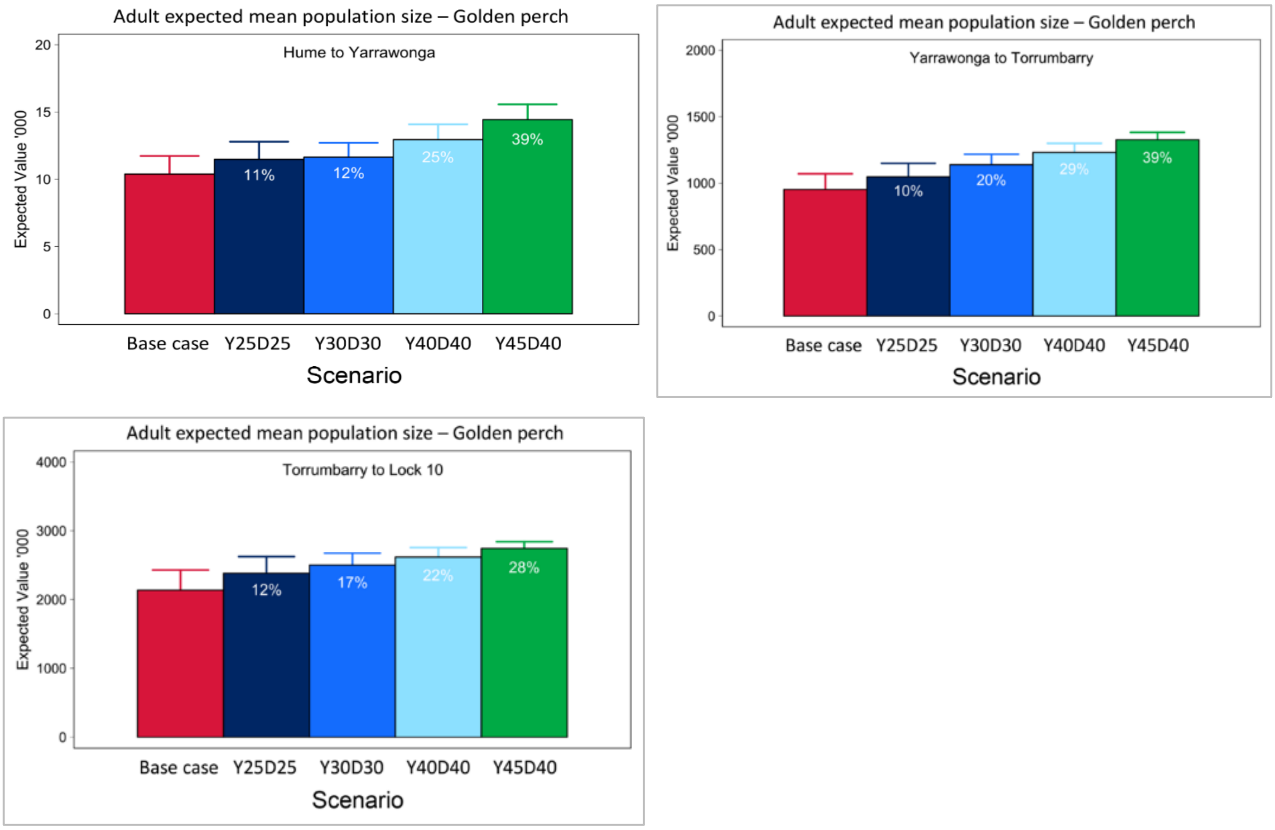


Figure 41 – Modelled golden perch outcomes for population size for the Murray River under each modelled flow scenario

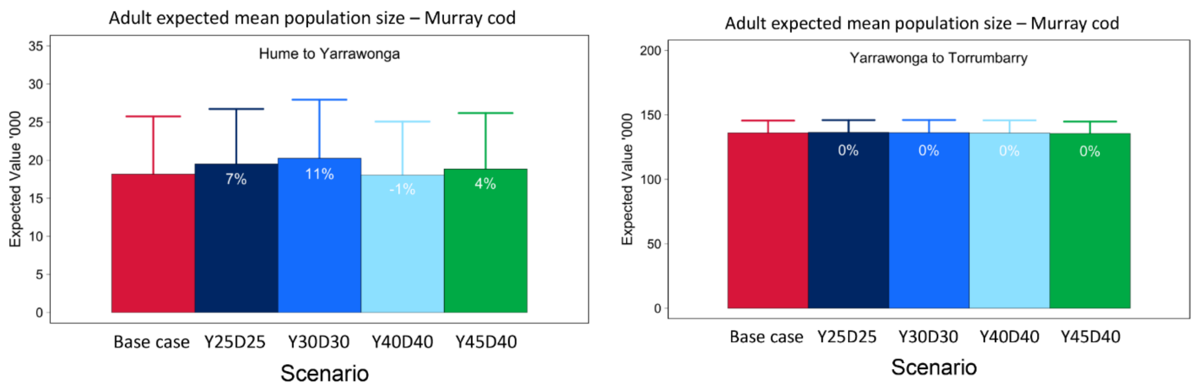


Figure 42 – Modelled Murray cod outcomes for population size for the Murray River study area under each modelled flow scenario

3.7.4 Key Findings

3.7.4.1 Goulburn River

The University of Melbourne stochastic modelling for the Goulburn River identified some benefit to all three guilds of fish assessed – Equilibrium species (e.g., Murray cod), Opportunistic species (e.g., native carp gudgeon and Australian smelt) and Periodic species (e.g., golden perch).

The modelling found minor benefits for equilibrium and opportunistic species could be achieved once flows exceeded 15,000 ML/day on the Lower Goulburn. The benefits of relaxing constraints were greater in opportunistic species compared to equilibrium species. Benefits for periodic species also occur with relaxation of constraints, with improvements starting at flows below 15,000 ML/day and continuing until flows are just over 20,000 ML/day (Figure 40). Higher levels of benefits occur for fish of all three guilds when Lower Goulburn River flows exceed 20,000 ML/day. Together these data suggest that benefits can be achieved by relaxing constraints, particularly under higher flow scenarios, accompanying inundation of the floodplain.

The results show that the benefits for these species increase with the progressive relaxation of constraints up to at least 20,000 ML/d in the Lower Goulburn and around 12,000 ML/d in the Mid Goulburn River. The modelling suggests sustained benefits above these flow levels.

3.7.4.2 Murray River

In the Murray River, the Arthur Rylah Institute ecological response modelling found the periodic flow pulse specialist species golden perch benefited from relaxed constraints, with up to 39% increase in expected mean population size of golden perch in the Hume to Yarrawonga and Yarrawonga to Torrumbarry reaches and up to 28% increase in abundance in the Torrumbarry to Lock 10 reach (Figure 41). The equilibrium species Murray cod showed little, if any, improvement at higher constraint flows in the Hume to Yarrawonga reach and no improvement downstream of Yarrawonga.

3.7.4.3 General

The outcomes of the assessment in the Goulburn River and Murray River differed in that the Murray River modelling found that Murray cod would not benefit, while the Goulburn assessment found that the periodic guild (including Murray cod) would benefit. It is not clear whether the differing predictions are due to the inclusion of multiple species in the Goulburn River assessment or whether the Murray River assessment's use of statistical relationships affected the overall relationship between flow and fish populations. The difference in these results will need to be explored in any subsequent stages of the program.

3.8 Delivery of environmental water

3.8.1 Context

Significant volumes of water have been recovered from consumptive users for the environment over the past decades, with a combined total of approximately 700 GL of high reliability water share and 300 GL of low reliability water share now held as environmental water in the Goulburn River and Victorian Murray[88]. However, due to constraints on environmental flows, a proportion of the held environmental water is not utilised to directly deliver environmental watering events in line with the environmental water requirements and is either carried over, spilled (passed downstream with indirect environmental benefits) or forfeited (returned to all users through increased seasonal determinations). For example, hydrologic modelling undertaken for this feasibility study, indicates that over a long-term historic simulation period (1895-2020) with existing constraints on regulated flow releases, only 58% of the available environmental water portfolio held in the Goulburn system is delivered to meet the specific environmental recommendations[89].

The relaxation of constraints has the potential to increase the extent to which the portfolio of environmental water is used to achieve environmental recommendations and, in particular, high bank-full and small over bank flow targets.

3.8.2 Approach

Hydrological modelling of the Goulburn River and Murray River undertaken by DEECA (Goulburn River) and the MDBA (Murray River) was used to measure the use of environmental water holdings and assess how relaxing constraints might increase the effective rate of utilisation of environmental water.

3.8.3 Results

3.8.3.1 Goulburn River

Figure 43 shows the modelled long-term annual delivery of Goulburn system environmental water holdings under different relaxed constraints scenarios. This chart utilises the results of modelling undertaken by DEECA.

Environmental water delivery is shown as the line graph in the chart with and without Murray environmental water orders. Under the current constraint, the long-term modelled delivery of environmental water (no

[88] DEECA (2023) GBCCL Source Modelling for the Constraints Measures Project pg 5 and MDBA (2022). Murray Constraints Modelling to inform the Victorian CMP Methodology assumptions and Key outcomes pg 3
[89] DEECA (2023) GBCCL Source Modelling for the Constraints Measures Project pg 10

Murray orders) is an approximate 150 GL per year and increases up to approximately 400 GL per year under the most relaxed constraints scenario considered in this feasibility study.

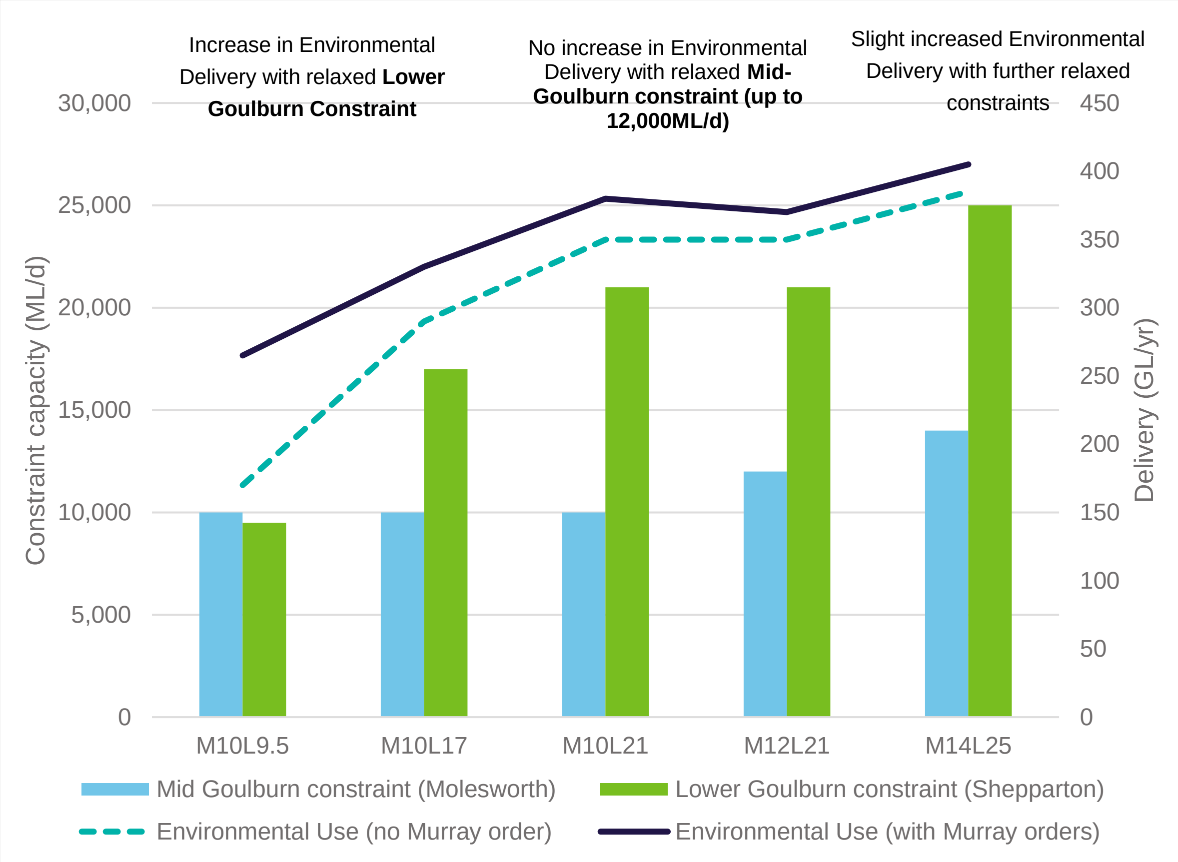


Figure 43 – Modelled annual delivery of environmental water holdings in the Goulburn system – current and with relaxed constraint scenarios

Modelling suggests that relaxing constraints will enable greater delivery of available environmental water during July to October in line with environmental water requirements (Figure 44).

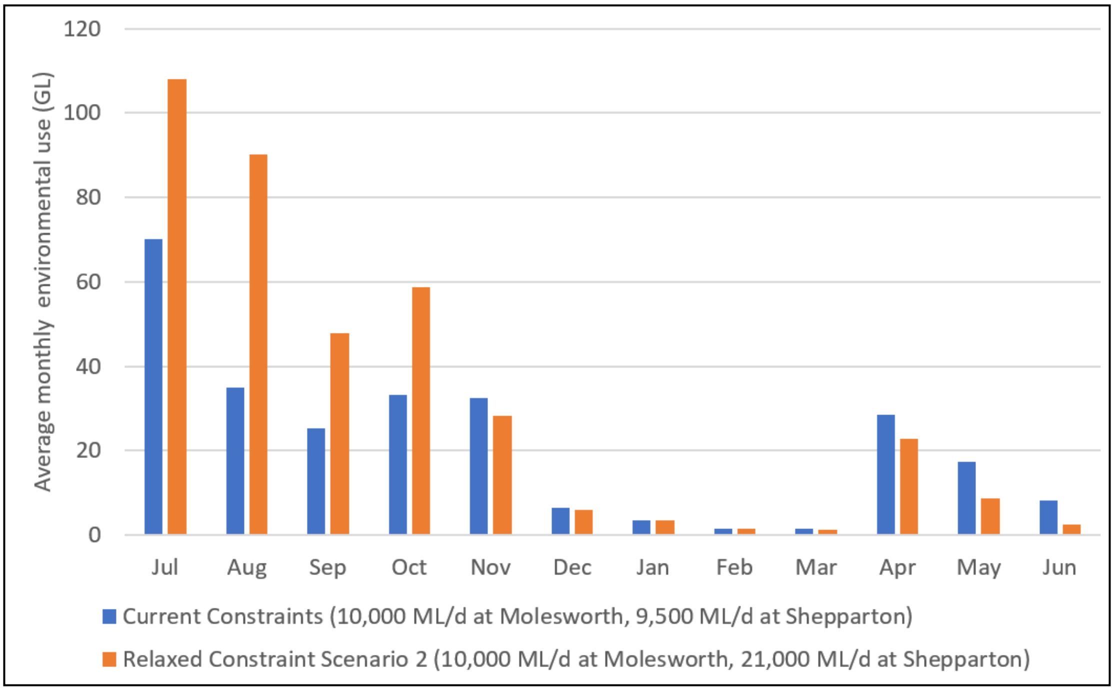


Figure 44 – Modelled average monthly utilisation of environmental water holdings in the Goulburn system – current and with relaxed constraints at Shepparton

3.8.3.2 Murray River

Figure 45 shows the modelled long-term utilisation of Murray system environmental water holdings (combined holdings in New South Wales and Victoria) under different relaxed constraints scenarios. This chart was prepared by the MDBA with the grey shaded part being the average volume allocated over the year from start of year (SOY) to end of year (EOY) and the bars compare the SOY account balance and annual use by environment. Under the current constraints, the average Murray environmental water use is approximately 180 GL and increases to approximately 400 GL under a Y40D40 scenario.

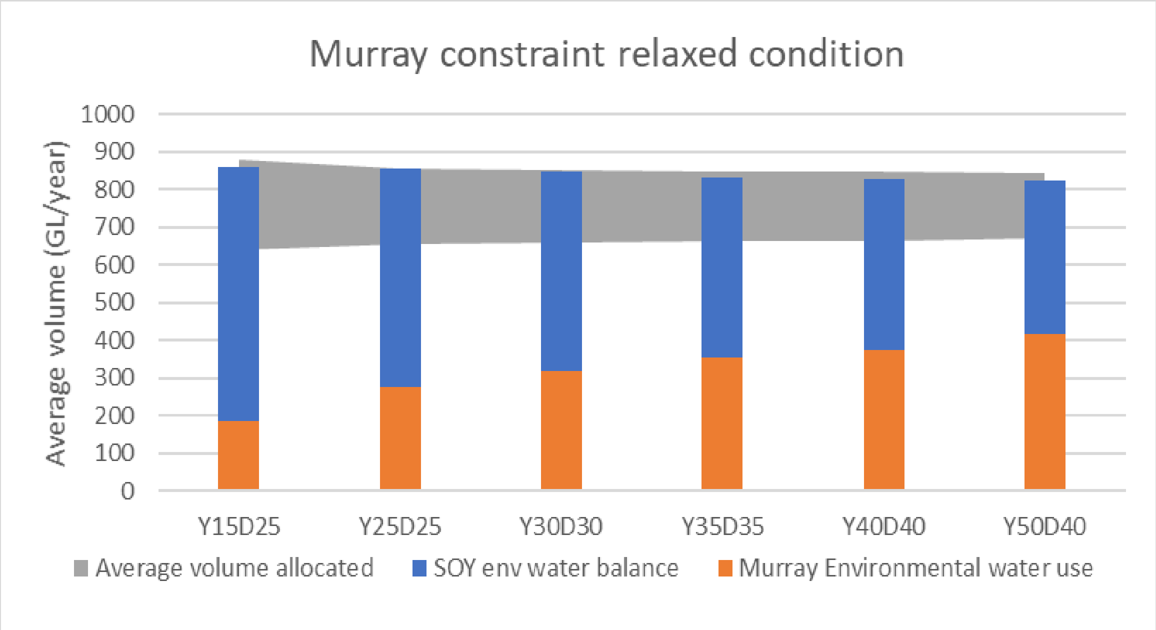


Figure 45 – Modelled delivery of environmental water holdings in the Murray system – current and with relaxed constraints

3.8.4 Key Findings

Relaxing constraints results in substantial improvement in the effective delivery of environmental water, effectively doubling the usage of environmental water in targeted environmental flow actions in line with the environmental flow requirements in both the Murray and Goulburn systems over the long-term.

The MDBA noted, with respect to the hydrologic modelling undertaken for the study, that with relaxing constraints in the Murray, environmental water use increases as the environment gets more opportunity to target higher flow events. As a consequence, the environmental water balance and allocation get reduced due to higher utilisation of the environmental portfolio.

DEECA modellers noted in the hydrologic modelling report that under current constraints and the long-term historical climate sequence, environmental deliveries is limited by channel constraints, timing of water availability and how the environmental demand is ordered. This means a proportion of environmental water is either carried over, traded, spilled (passed downstream with indirect environmental benefits) or forfeited (returned to all users through increased seasonal determinations). As constraints are relaxed, a higher proportion of the environmental water is able to be used to directly target environmental demands with more environmental water to be released from storages than under current rules, increasing dam airspace and reducing the size of moderate floods. Releasing environmental water throughout the year can provide flood mitigation as a secondary benefit, depending on how the entitlement holders chose to use their water. Furthermore, floodplain landowners would benefit from mitigation works up to constraint flow levels and a risk buffer, whereas they are currently directly affected by natural flood impacts.

3.9 Area of private land inundated

3.9.1 Context

Floodplains are the flat land adjacent to a river which experience periodic flooding during periods of high flow in the adjacent river channel.[90] Since European settlement, the floodplains of the Goulburn River and Murray River have been progressively converted to freehold and developed for agriculture and other uses. Currently, approximately 60% of the low-lying floodplain of the Murray River and Goulburn River in Victoria is held as private land. The balance of the land is public or Crown land, used for a range of purposes including nature conservation, recreation and infrastructure.

As a result of historic settlement patterns and more recent efforts to conserve remnant floodplain forests and wetlands, many low-lying parts of the Murray River and Goulburn River floodplains feature a mix of land tenure with private land interspersed amongst public land.

Due to the mix of land uses on the floodplain, relaxing constraints for environmental flows will result in an increase in the area of floodplain land inundated. There will be benefits to land inundated, e.g., within conservation areas, however there will be potentially adverse impacts to both private land (e.g., access to property, private assets inundated) and public land (e.g., access for recreational use such as camping).

3.9.2 Approach

For this feasibility study, modelling has been undertaken to assess the area of private properties impacted under each of the relaxed constraints scenarios within the Murray and Goulburn Rivers. The assessment method used was as follows:

- compilation of spatial data from VicMap property showing the cadastral boundaries of land parcels with associated property details, including land tenure. VicMap property is the Victorian Government's statewide dataset of cadastral boundaries of rateable properties. The cadastral boundaries are based on registered plans of subdivision and local government records.[91]
- title searches of all riparian properties in the Victorian study area to confirm private or public ownership.
- hydraulic modelling of inundation extent from regulated environmental flow events arising from each of the relaxed constraints scenarios.
- queries of the project GIS to identify land located within modelled inundation extents for each relaxed constraint scenario.

One of the outcomes of the relaxed constraints inundation modelling is the prediction that river flows at the existing constraint level result in some amount of private land inundation. The features inundated are primarily identified in the Vicmap Hydrographic database as lakes ('an inland area of standing water on a permanent or intermittent basis'[92]) and water courses. These lakes and water courses are represented in the hydraulic model as connected to the river and which commence to flow (or fill) when the river is at or below the constrained flow rate. It means that private land is already inundated at the current constraint flows due to the configuration of title boundaries.

Generally, across the Goulburn River, it is understood that GMW (the river operator) has no formal rights to inundate private land from regulated dam releases. It is probable that any inundation of natural water features on private land at current constraints is tolerated by landholders due to the configuration of the title boundary and many derive benefits from the inundation, for example through the maintenance of natural water feature and for stock watering.

3.9.3 Results

3.9.3.1 Goulburn River

The area of private land on the Goulburn River floodplain inundated under each of the relaxed constraints scenarios is shown in

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90 Australian Water Information Dictionary
91 https://www.land.vic.gov.au/maps-and-spatial/spatial-data/vicmap-catalogue
92 DELWP (2022) VicMap Hydro Product Data Specification

Figure 46. The data is presented as the mapped area in hectares (bars) and also as the proportion of total floodplain private land area (lines).

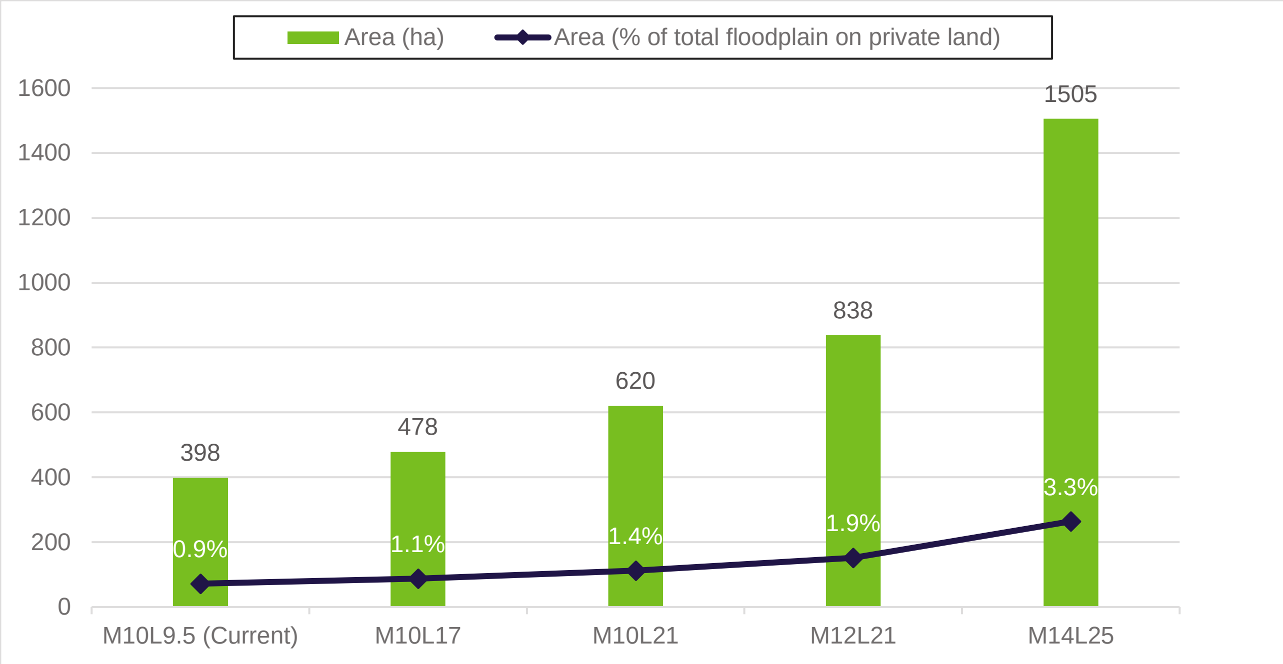


Figure 46 – Goulburn River Floodplain - Estimated maximum area of private land inundated by regulated environmental flow events under modelled relaxed constraint scenarios

3.9.3.2 Murray River

The area of private land on the Victorian side of the Murray River floodplain inundated under each of the relaxed constraints scenarios in the Murray River is shown in Figure 47. The data is presented as the mapped area in hectares (bars) and also as the proportion of total floodplain private land area (lines)

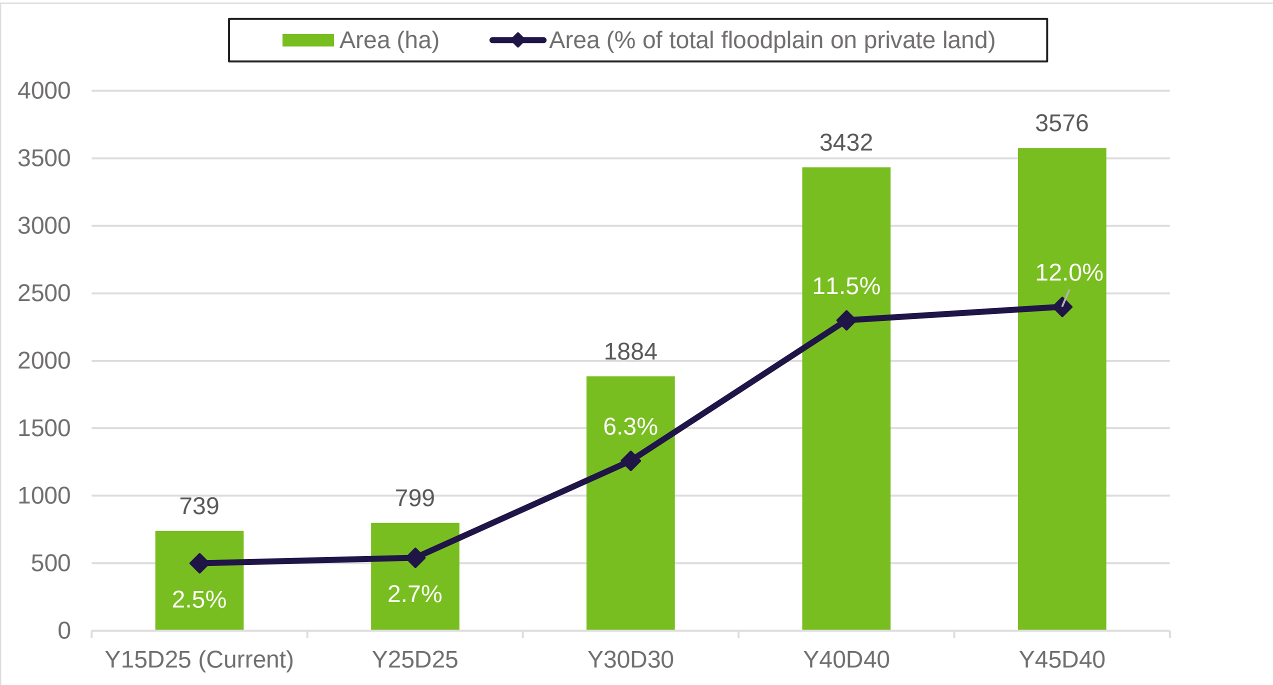


Figure 47 – Murray River Floodplain (Vic Only) - Estimated maximum area of private land inundated by regulated environmental flow events under modelled relaxed constraint scenarios

3.9.3.3 Findings

An assessment of the maximum area of private land inundated by regulated environmental flow events under the different relaxed constraints scenarios found, not unexpectedly, that the area of private land inundated increased as the relaxed constraints flow rate increased. In total, up to 1,505 ha of private land in the Goulburn and 3,576 ha of private land in the Victorian Murray could be inundated with the highest environmental flow event under the most relaxed constraint scenario.

This maximum area inundated represents up to 3.3% of the private land within the declared 100-year ARI floodway in the Goulburn and 12.0% in the Murray River. The impact on private land is most pronounced in the Hume to Yarrawonga reach where the proportion of land inundated is 31.8% under the highest relaxed constraint flow rate. This least impacted reach is the Lower Goulburn where only 2.4% of the private land on the floodplain in the reach is inundated under the highest relaxed constraint flow rate.

The different outcomes across river reaches are a result of a range of factors, including the topography of the river channel and the floodplain, the level of floodplain private land development and the relative size of the proposed relaxed constraint flow rate compared to the current constraint.

The more pronounced impact in the Hume to Yarrawonga reach below Hume Dam is a result of being closely settled and the relatively high incremental change in the relaxed constraint flow proposed in that reach. This results in environmental flows under the high levels of relaxed constraints not only triggering commence to flow/fill in depression features on the floodplain such as billabongs, wetlands and flood runners but to spread out over higher elevation land.

3.10 Number of private properties inundated

3.10.1 Context

Delivery of the constraints measures program will require agreements with impacted landholders to obtain their consent to inundate private land and for the implementation of mitigation works on private land. The number of private properties inundated under each constraints scenario is an approximate indicator of the:

- the number of individual property owners and primary production businesses directly affected by implementation of the project
- size of project implementation task and the deliverability of the project reflects how many landholder agreements will need to be successfully negotiated (and agreed mitigations subsequently delivered).

3.10.2 Approach

For this feasibility study, modelling has been undertaken to assess the number of private properties impacted under each of the relaxed constraints scenarios within the Murray and Goulburn rivers. The assessment method used was as follows:

- compilation of spatial data from VicMap property showing the cadastral boundaries of land parcels with associated property details, including land tenure. Individual parcels have been aggregated up to a property level with many properties built up from multiple parcels
- hydraulic modelling of inundation extent from regulated environmental flow events arising from each of the relaxed constraints scenarios
- queries of the project GIS to identify properties located within modelled inundation extents for each relaxed constraint scenario.

3.10.3 Results

3.10.3.1 Goulburn River

The number of private properties on the Goulburn River floodplain inundated under each of the relaxed constraints scenarios in the Goulburn River is shown in Figure 48. The data is presented as the mapped number of private properties affected by inundation (bars) and also as the average area inundated for affected private property (lines).

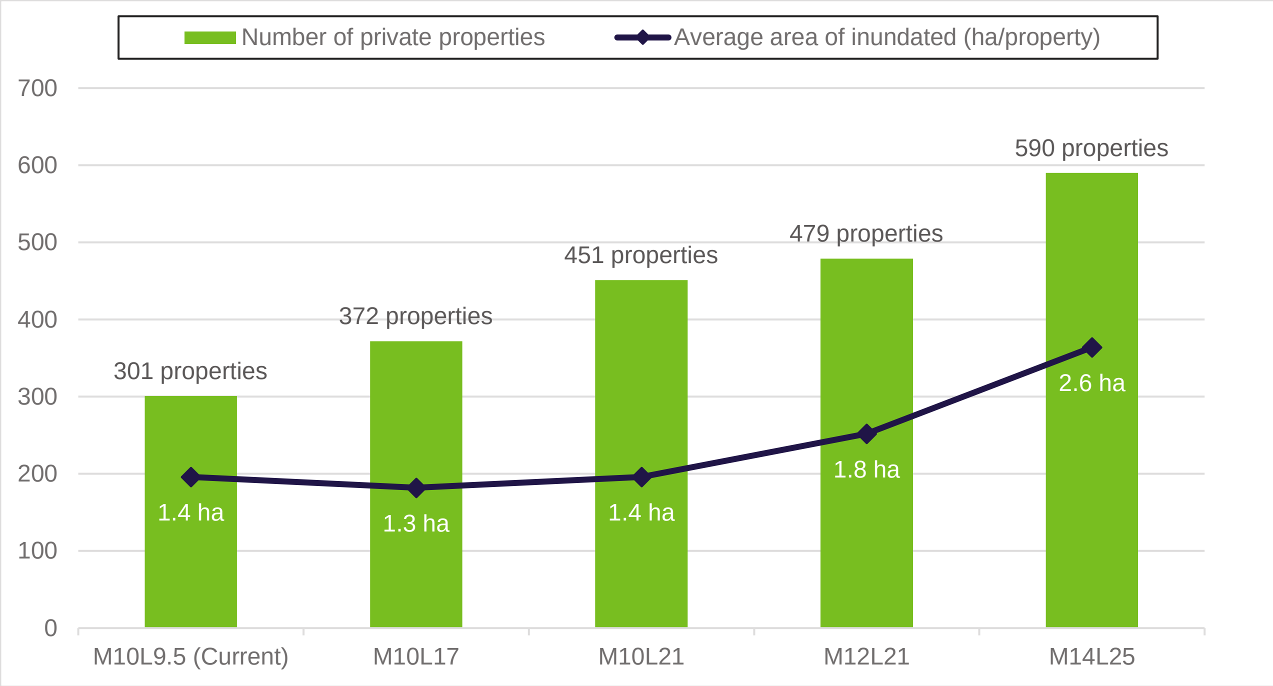


Figure 48 – Goulburn River Floodplain - Estimated number of private properties inundated by regulated environmental flow events under modelled relaxed constraint scenarios

3.10.3.2 Murray River

The number of private properties on the Victorian side of the Murray River floodplain inundated under each of the relaxed constraints scenarios in the Murray River is shown in Figure 49. The data is presented as the mapped number of private properties affected by inundation (bars) and also as the average area inundated for affected private property (lines)

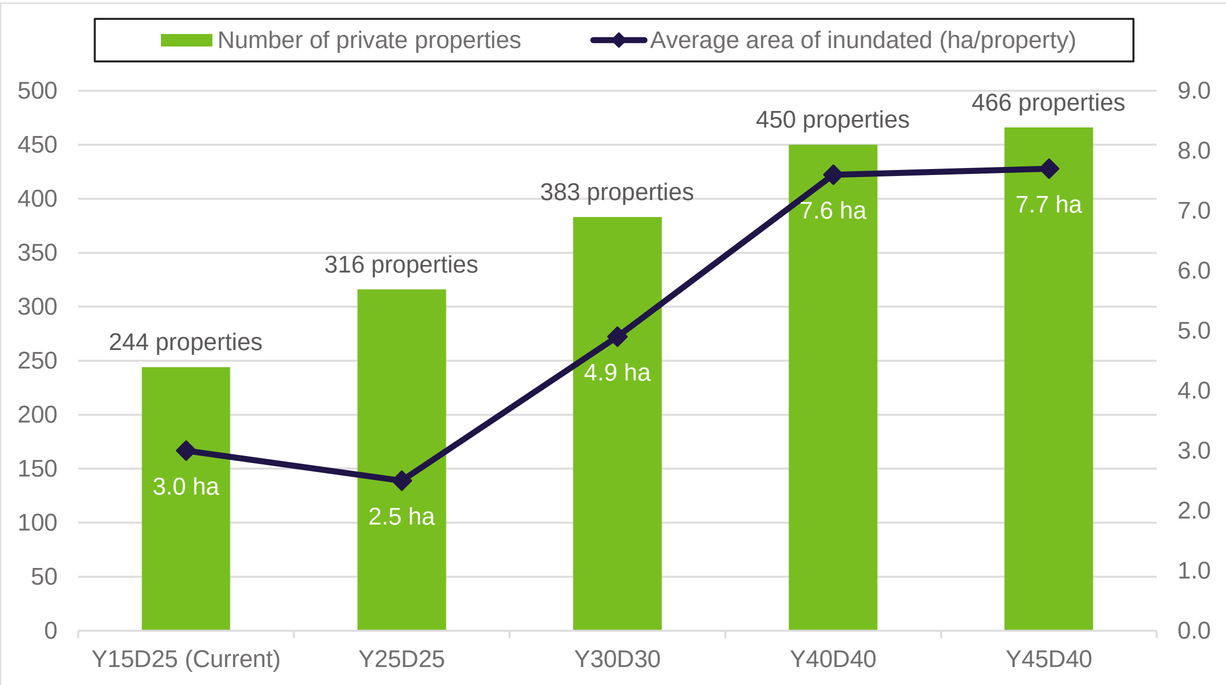


Figure 49 – Murray River Floodplain (Vic Only) - Estimated number of private properties inundated by regulated environmental flow events under modelled relaxed constraint scenarios

3.10.4 Findings

This assessment found that up to 466 individual private properties in the Victorian Murray River and 590 properties in the Goulburn River would be inundated under the highest constraints relaxation scenario considered in this feasibility study. In total, this equates to 1,056 individual properties across the Victorian CMP.

The average area inundated under the most relaxed constraint scenario varied from a low of 2.3 ha per property in the Lower Goulburn reach up to 10 ha per property in the Hume to Yarrawonga reach. This reinforces the previous finding that the extent of impacts on private property of relaxed constraints are likely to be greatest in the Hume to Yarrawonga reach.

The number of private properties impacted also provides an indication of the number of agreements required to implement the project. It is acknowledged that there is not a one-to-one relationship between a count of properties impacted and the number of landholders requiring agreements. For example, one individual could own multiple properties, or one property may have multiple owners that require individual agreements.

As part of the feasibility study, a sample of properties were subject to title searches to determine the alignment between numbers of private properties and number of individual landholders. The sampling exercise found that, in the study area, in general landholders owned only one property. This suggests there is a reasonable correlation between the number of private properties and the number of landholders that need to be engaged by the project.

Further analysis undertaken on the distribution of area inundated on private properties found that a large proportion of private properties have small areas of inundation. The proportion of private parcels inundated by less than 1 ha under the high constraint relaxation scenarios are:

- Mid Goulburn = 61%
- Lower Goulburn = 71%
- Hume to Yarrawonga = 51%
- Yarrawonga to Wakool = 79%.

As part of the future stages of the project, consideration will need to be given to whether there is an area threshold below which an agreement for inundation under relaxed constraints is considered not required by the government and landholder.

3.11 Relaxed constraints flow rate as a proportion of the notified rate

If SDLAM projects are not delivered, an equivalent volume of water may need to be recovered from other means including potentially buying back water entitlements from irrigators with direct and indirect negative impacts on the Victorian community. By implementing constraints relaxation to the levels notified in the Basin Plan, the need for water buyback from Victorian communities may be avoided.

As an indication of the possible implications of different relaxed constraints scenarios for the likelihood or magnitude of water buyback, the relaxed constraint flow rate as a proportion of the notified rate has been calculated as shown Table 13.

Table 13 – Proportion of notified flow rate

Constraint location	Notified relaxed constraint (ML/d)	Relaxed constraint scenarios (ML/d)			
Murray River		**Y25D25**	**Y30D30**	**Y40D40**	**Y45D40**
Doctors Point	40,000	25,000	30,000	40,000	40,000
% of notified constraint flow rate		63%	75%	100%	100%
Yarrawonga	30,000-50,000	25,000	30,000	40,000	45,000
% of notified constraint flow rate (high range)		50%	60%	80%	90%

Constraint location	Notified relaxed constraint (ML/d)	Relaxed constraint scenarios (ML/d)			
Goulburn River		**M10L17**	**M10L21**	**M12L21**	**M14L25**
Shepparton	20,000	17,000	21,000	21,000	25,000
% of notified constraint		85%	105%	105%	125%

As can be seen from the table, the relaxed constraints scenarios generate between 50% to 100% of the notified rate in the Murray River and 85% to 125% in the Goulburn River.

3.12 Summary

Table 14 (Goulburn River) and Table 15 (Murray River) provide a summary of the outcomes from the modelling of project benefits and impacts at different relaxed constraints flow rates focusing on the relaxed constraints flow rates where there are modelling results for all scenarios.

Table 14 – Summary of Benefits and Impacts for different relaxed constraints scenarios in the Goulburn River

Flow rate option	Summary of benefits	Summary of impacts
M10L9.5 (Current Constraint)	Base case	Base case
M10L17	Inundates a maximum of 2,164 ha of native vegetation EVC, an 102% improvement on the base case. Increases the frequency of 5+ days winter/spring bank-full events in the Lower Goulburn by approximately 10% and no impact on mean frequency of overbank events. Increases the area of river red gum in good or moderate condition by 19% compared to the base case Minor levels of benefit for all three guilds of native fish. Increases the utilisation of environmental water by 78% compared to the base case (Goulburn demands only) Delivers 85% of the notified relaxed constraints flow rate	Inundates 478 ha of private land or 1.1% of total private land on the floodplain Inundates 372 private properties (an increase of 71 compared to the Base case) on average 1.3 ha per private property Reduces the area of black box woodland in good or moderate condition by 52%.
M10L21	Inundates a maximum of 3,700 ha of native vegetation EVC a 245% improvement on the base case. Increases the frequency of 5+ days winter/spring bank-full events in the Lower Goulburn by approximately 10% and no impact on the mean frequency of overbank events Has no impact on the area of river red gum in good or moderate condition Higher levels of benefit for all three guilds of native fish Increases the utilisation of environmental water by 108% compared to the base case (Goulburn demands only) Delivers 105% of the notified relaxed constraints flow rate	Inundates 620 ha of private land or 1.4% of total private land on the floodplain Inundates 372 private properties (an increase of 72 compared to the Base case) on average 1.4 ha per private property Reduces the area of black box woodland in good of moderate condition by 52%
M12L21	Inundates a maximum of 3,941 ha of native vegetation EVC a 268% improvement on the base case.	Inundates 838 ha of private land or 1.9% of total private land on the floodplain

Flow rate option	Summary of benefits	Summary of impacts
	Increases the frequency of 5+ days winter/spring bank-full events in the Lower Goulburn by less than 10% and no impact on overbank events Increases the area of river red gum in good or moderate condition by 83% and black box woodland by 91% Higher levels of benefit for all three guilds of native fish Increases the utilisation of environmental water by 108% compared to the base case (Goulburn demands only) Delivers 105% of the notified relaxed constraints flow rate	Inundates 479 private properties (an increase of 178 compared to the Base case) on average 1.8 ha per private property
M14L25	Inundates a maximum of 6,803 ha of native vegetation EVC a 535% improvement on the base case Increases the frequency of 5+ days winter/spring bank-full events in the Lower Goulburn by approximately 20% and no impact on the mean frequency of overbank events Increases the area of river red gum in good or moderate condition by 83% and black box woodland by 91% Higher levels of benefit for all three guilds of native fish Increases the utilisation of environmental water by 131% compared to the base case (Goulburn demands only) Delivers 125% of the notified relaxed constraints flow rate	Inundates 1,505 ha of private land or 3.3% of total private land on the floodplain Inundates 590 private properties (an increase of 289 compared to the Base case) on average 2.6 ha per private property

Table 15 – Summary of Benefits and Impacts for different relaxed constraints scenarios in the Murray River

Flow rate option	Summary of benefits	Summary of impacts
Y15D25 (Current Constraint)	Base case	Base case
Y25D25	Inundates a maximum of 26,450 ha of native vegetation EVC a 163% improvement on the base case Increases the frequency of 12+ days winter/spring bank-full events at Yarrawonga Weir by approximately 5% and no impact on overbank events Increases the area of river red gum in good or moderate condition by 3% and black box woodland by 14% A 10% to 12% increase in the expected mean adult population of golden perch and 0% to 7% increase in mean adult population of Murray cod Increases the utilisation of environmental water by 50% compared to the base case Delivers 50%-63% of the notified relaxed constraints flow rate	Inundates 799 ha of private land or 2.7% of total private land on the floodplain Inundates 316 private properties (an increase of 72 compared to the Base case) 2.5 ha per private property

Flow rate option	Summary of benefits	Summary of impacts
Y30D30	Inundates a maximum of 33,382 ha of native vegetation EVC a 232% improvement on the base case Increases the frequency of 12+ days winter/spring bank-full events at Yarrawonga Weir by approximately 10% and no impact on overbank events Increases the area of river red gum in good or moderate condition by 5% and black box woodland by 12% A 12% to 20% increase in the expected mean adult population of golden perch and 0% to 11% increase in mean adult population of Murray cod Increases the utilisation of environmental water by 73% compared to the base case Delivers 60%-75% of the notified relaxed constraints flow rate	Inundates 1,884 ha of private land or 6.3% of total private land on the floodplain Inundates 383 private properties (an increase of 139 compared to the Base case) on average 4.9 ha per private property
Y40D40	Inundates a maximum of 42,621 ha of native vegetation EVC a 324% improvement on the base case Increases the frequency of 12+ days winter/spring bank-full events at Yarrawonga Weir by approximately 10% and overbank events by 20% Increases the area of river red gum in good of moderate condition by 10% and black box woodland by 15% A 22%-29% increase in the expected mean adult population of golden perch Increases the utilisation of environmental water by 104% compared to the base case Delivers 80%-100% of the notified relaxed constraints flow rate	Inundates 3,432 ha of private land or 11.5% of total private land on the floodplain Inundates 450 private properties (an increase of 206 compared to the Base case) on average 7.6 ha per private property No impact or a 1% decrease in the expected mean adult population of Murray cod
Y45D40	Increases the area of river red gum in good of moderate condition by 17% and black box woodland by 16% A 28%-39% increase in the expected mean adult population of golden perch and 0% to 4% increase in mean adult population of Murray cod Delivers 90%-100% of the notified relaxed constraints flow rate	Inundates 3,576 ha of private land or 11.9% of total private land on the floodplain Inundates 466 private properties (an increase of 222 compared to the Base case)

PART B – FEASIBILITY STUDY INVESTIGATION OUTCOMES

4. Consultative Committee

4.1 Key outcomes

- The Constraints Consultative Committee was established to provide informed advice on the way forward for the Victorian Constraints Measures Program. The Committee consisted of local landowners along the Goulburn and Murray Rivers, environmental water managers, representatives from Traditional Owner groups, local governments and agencies
- Representatives from the MDBA, NSW Reconnecting Country Project and the Australian Government were observers at Committee meetings, associated risk workshops and technical meetings. This ensured transparency in project progress, information, and discussions.
- The matters for consideration within the terms of the Committee's engagement included the approach to community co-design and engagement for any future project phases; changes to physical and operational constraints; impacts, benefits, and cost compensation and mitigation frameworks; and risk management.
- Through open discussions and sharing different perspectives, the Committee fostered an understanding of the project and constraint relaxation requirements. The Committee was pivotal in avoiding unnecessary costs or concerns in engaging the community more extensively, especially if the project was considered unfeasible.
- .While technically feasible and socially challenging, most of the Consultative Committee support further investigations into the benefits, risks, and costs of relaxing constraints to enable overbank flows up to minor flood level on the Goulburn and Murray River.
- Throughout the process the Consultative Committee was very clear – members wanted to see already available water for the environment to be used efficiently to generate local benefits, for people and the environment.
- The majority of Consultative Committee members recommend proceeding to the next phase of the CMP which will involve the development of a detailed business case that includes a full assessment of the costs and benefits of the program.
- The Committee strongly advised that Governments should publish rigorous system level costs and benefits of relaxing constraints and provide further information on how landowners and asset owners would be compensated.
- The Committee recommends that compensation should encompass potential long-term recurring impacts resulting from inundation.
- The majority of the Consultative Committee believe constraints should only be relaxed if the benefits exceed the costs and compensation for inundation impacts is provided in a transparent and fair manner.
- It is the Consultative Committee's view that complementary programs, including grazing management, revegetation, pest control, and monitoring, are necessary to maximise environmental outcomes. Addressing the erosion and deterioration of the riparian zone along the Goulburn and Murray rivers is critical to enhance the benefits of environmental watering.
- Under the Committee's direction, investigations looked beyond in-channel in the Goulburn.
- Most Committee members have strongly voiced concerns about the prospect of further water recovery through buybacks. These concerns stem from the observed adverse effects of previous buybacks within northern Victorian communities.
- The Committee also emphasised the importance of early and extensive engagement with landowners and the community to enhance participation. While there has been some input from various perspectives to inform this study, broader engagement with affected communities is still required.
- Engaging a Consultative Committee is the start of implementing community co-design. Future stages should involve a wider range of stakeholders and further engagement. Broadly engaging with the community is needed to comprehensively understand and document the impacts of the program, before individual landholders are approached.

4.2 Overview

The Victorian CMP is committed to delivering a community-centred approach. Community members and stakeholders potentially impacted by relaxing constraints have been placed at the centre of this stage of the Victorian CMP. The Committee leverages the combined experience, knowledge and opinions of members. It provides the advisory forum for discussion and sharing views to be presented to the Minister as part of the feasibility study.

In line with the MinCo commitment, DEECA established the Constraints Consultative Committee to facilitate this community-centred approach. This places potentially impacted community members and stakeholders at the centre of the program. The Committee was given the task of giving informed advice on the way forward, considering the importance of avoiding unnecessary costs or concerns in engaging the community more extensively, especially if the project was considered unfeasible. Independently chaired by the Hon. Patrick McNamara AM, the Committee leveraged the combined experience, knowledge and opinions of members. The role of the Committee was not to reach a consensus, as decisions about the Victorian CMP are the responsibility of the Victorian Government. The Committee provided an advisory forum for members to provide comments and input on the design and feasibility of the program. They also provided input and views for the Minister.

A diverse range of views and perspectives have been shared through Committee meetings and associated forums, surveys, and correspondence received by the Committee Chair. These perspectives have been gathered to inform the Feasibility Study and this technical report.

4.3 Committee establishment and purpose

While there may be ecological benefits of reinstating environmental water to lower floodplains and wetlands, Basin communities have previously raised valid concerns about the impacts on public and private assets and the scope and accuracy of technical information that exists for the Victorian CMP.

In response, DEECA has adopted a community-centred approach that places the people impacted by change at the centre of providing advice to the Minister. To achieve the community-centred objectives of the CMP, a Consultative Committee was announced by the Minister for Water on 27 April 2022 to provide advice on the benefits and risks of the Victorian CMP. Independently chaired by the Hon Patrick McNamara AM, the Committee is a forum for the members to provide comment and input on the design and feasibility of the program.

The Consultative Committee comprised members from:

- Registered Aboriginal Parties (RAPs)
- local landholders
- irrigators
- community members
- river operators
- council representation
- Catchment Management Authorities
- Victorian Environmental Water Holder
- land managers
- representative bodies and impacted agencies.

DEECA engaged with agencies to identify community members with experience and knowledge of water-based issues who reside in all sections of the Goulburn and Murray Rivers as part of this study, both in the upper and lower reaches

The Committee members have played an advisory role, with decisions about the Victorian CMP being the responsibility of the Victorian Government. Under the terms of their appointment, the Committee members were to consider the range of information for relaxed constraints scenarios and to provide comments on the merit of proceeding to future stages of investigation under the Victorian CMP. The matters for consideration within the terms of engagement included:

- Approach to community co-design for any future project phases
- Changes to physical and operational constraints
- Impacts, benefits, and cost. Compensation and mitigation frameworks
- Risk management
- Any other matters nominated by the Consultative Committee Chair.

The CMP Consultative Committee has provided the opportunity to work with critical stakeholders to re-examine the information in the original concept business cases and inform a strategic pathway toward fit-for-purpose technical investigations and policy frameworks. The Committee has provided a forum for exchanging and testing views, where members have built a shared understanding of the project and constraint relaxation.

Throughout 2022 and 2023, a diverse range of views and perspectives have been shared through Committee meetings and associated forums, surveys, and correspondence received by the Committee Chair. These perspectives have been gathered within the overarching feasibility report with all Committee members agreeing that the feasibility report must fairly represent all Committee members' divergent and shared perspectives.

4.4 Boundary parameters

A range of “boundary parameters” were provided to the Committee to inform their considerations.

- The assessment will be made based on the volumes of the already available and existing environmental water portfolio
- Climate change needs to be considered in the assessment of all scenarios
- The delivery of the program is to be undertaken in a staged approach with defined Ministerial decision points, including following the completion of the feasibility study
- A ‘co-design’ delivery approach is to be undertaken to leverage the expertise and views of the community
- The Victorian CMP is not expected to be completed by the original Basin timeline of 30 June 2024. It is noted that the *Water Amendment (Restoring Our Rivers) Act 2023* was enacted at the end of the Committee’s tenure which extended the completion date of the SDLAM projects to 31 December 2026.
- Flows to be considered are to be generally below the minor flood level in the Murray River
- The Victorian Government’s position is that flows within the Goulburn are to be within the channel only. The Committee has the flexibility to guide technical investigation to look at alternative flows up to minor flood level if it sees it is warranted
- The purpose of relaxing constraints is to maximise the outcomes of already available environmental water, not to create additional opportunities for IVT
- There will be no compulsory acquisition of land or easements
- There will be no inundation of private land without prior consent.

4.5 Developing advice to the Minister

Since commencing its work in April 2022 through to late 2023, the Committee met to consider technical information to inform personal insights into the feasibility of relaxing constraints. The Consultative Committee Chair ran meetings with papers prepared before meeting dates to allow informed discussion. Meetings were held both virtually and face-to-face in venues along the study area of the Goulburn River and Murray River.

Committee meetings were paused in response to the northern Victorian floods in October 2022 as many members were either personally impacted or were involved in community recovery efforts. Meetings resumed in March 2023.

The Committee agreed that the benefits from already available environmental water should be maximised in the context of appropriately considering the identified risks and issues.

A full range of perspectives is outlined in the feasibility study.

4.5.1 What does a successful feasibility study look like?

At an early meeting, Committee members were invited to outline critical aspects that would demonstrate a successful feasibility study. These individual thoughts are captured below:

- Consider options for the best use of available environmental water
- Quantify environmental outcomes/benefits
- Quantify environmental impacts
- Best outcomes for the entire system
- Fair representation of the Consultative Committee views and support for those views
- Least damage to water courses
- Clarity on trade-offs
- Clarity on models
- Clarity on assumptions
- Consider the program in the context of climate change
- Understanding environmental flows with the changed inflows to the system
- Common understanding of issues, information, and gaps
- Shared perspective
- Understanding how it affects people/human stories
- Public/private landholders not impacted
- Improved understanding of cultural aspects
- Improved cultural awareness and ability to water the broader floodplain
- Confirm that the proposal fulfils the Basin Plan objectives
- No theft of water
- Ability to understand the future engagement efforts
- Able to consider interactions with water markets, IVT, and other basin projects
- Operational feasibility – ensure we can deliver what we propose
- Confidence in the data and information used for decisions is fit for purpose for each stage
- Clarifying impacts on private benefits and costs
- Knowing an appropriate way for Traditional Owner inclusion, processes, and governance
- Including review opportunities in the future
- Clarifying social benefits and costs
- Clarify and quantify operational benefits
- No additional water purchased from the consumptive pool.

These thoughts and supporting discussions were grouped into a series of key themes that were used throughout the Committee meetings to support the development of the feasibility study.

Environmental Water: We need to understand the reasons we are not currently getting the greatest benefits from our available environmental water

Technical data and modelling: We must have confidence in the technical data and modelling

Environmental benefits and impacts: We need to understand the environmental benefits and impacts

Impacts on individuals: We need to consider the impacts on individuals

Operational feasibility: We must understand if these flows are operationally feasible

Landowner and community engagement: We need a clear process for engagement with landowners and the wider community

Cultural awareness and values: We need to understand cultural awareness and values

Recreational impacts and benefits: We need to consider the wider impacts and benefits on recreational activities and opportunities

Interfaces: We need to understand the interfaces with other states and what governance of any potential future stages may look like

Representation of views: The feasibility study must fairly represent the views of the Committee

These key themes, areas of interest, and concern drove the Committee meeting agenda. They were explored during the meetings, supported by detailed technical papers and presentations prepared by the project team. Committee members requested particular topics of focus and could contact the Chair and project team members for clarification on any technical aspects at any stage. Some topics, such as hydrological and hydraulic modelling, also included additional optional online Q&A sessions that enabled Committee members the opportunity to have extra time to explore areas of interest or concern directly with the technical specialists.

A vital aspect of the Committee meetings was the opportunity for individual members to present to the broader Committee on areas of critical personal interest or expertise. This was particularly important to highlight the different benefits, risks and issues encountered by the various geographic regions covered by the study.

Although the scope of this stage involves consultation with the Committee, a series of ‘kitchen-table meetings’ were held along the Murray and Goulburn Rivers with community representatives invited by Committee members. This enabled a more comprehensive range of views to be captured and considered by the Committee in preparing this report. Refer to Section 5.1.1 for what was heard from these and other broader forums.

Key outcomes from the Committee discussions are further presented in the Feasibility Report.

4.5.2 Committee surveys

In addition to Committee meetings, two surveys were held to further obtain Committee member insights into the Victorian CMP.

Committee surveys aimed to gauge the members sentiment on:

- Attitudes toward the environment and environmental water
- The scope and remit of the Victorian CMP
- Impacts and benefits of relaxed constraints
- The engagement process and support provided to the Consultative Committee.

Surveys were delivered through a two-stage process. The social benchmark survey, delivered in August 2022, provided informed Committee perspectives on general perceptions and values toward Victorian CMP concepts (e.g., environmental water, Basin Plan obligations, benefits, and risks of constraints relaxation).

A follow-up survey in August 2023 maintained certain questions to assess trends in the Committee sentiment over time. The August 2023 survey questioned in greater detail the Committee members perceptions of certain project aspects and the feasibility and conditions required for the Victorian CMP to proceed to the next stage.

5. Stakeholder and community engagement

Stakeholder and community engagement for this stage focused on the Consultative Committee established as an advisory forum for discussion and sharing views to be presented to the Minister as part of the feasibility study.

To expand on the sentiment, views and concerns of stakeholders and community members external to the Consultative Committee, DEECA endorsed the implementation of ‘kitchen table’ community meetings and ‘focus group’ sessions with representatives of organisations who wished to contribute views.

The outcomes of this additional engagement is provided in the following sections.

5.1 Additional engagement during feasibility study development

5.1.1 Kitchen table community meetings

Community members, primarily riparian landholders or potentially impacted landholders were invited by Committee community members to attend informal ‘kitchen table’ meetings along the Goulburn River and Murray River to seek further insights and sentiment into the issues and benefits of constraints relaxation. This section provides an overview of these discussions and the thoughts and concerns expressed by participants.

In the Mid Goulburn

- The view was expressed that the top of the riverbank was equivalent to 9,700 ML/day flow and concern that at 12,000 ML/day, Molesworth caravan park would be cut off and river flats on two of the participants’ properties would be inundated with significant impact on farm management. The Molesworth caravan park is an important business to the local economy, so any impacts that deter caravan park users would be significant.
- If inundation similar to previous notable flooding events were to occur in seven out of ten years, it was felt it would render some properties worthless from a productive farming perspective. For the two properties considered vulnerable and most potentially affected, it was considered there were no physical mitigations that could offer protection due to the nature of their river frontage. It was queried if the program would offer to purchase properties if the landowners were willing to sell if they felt the impacts were as great as they envisioned.
- The trout farm that operates just downstream of Lake Eildon is not adversely affected by 12,000 ML/day flows. It can operate at flows of up to 17,000-18,000 ML/day without activating its flood mitigation plan. There is a levee around the fishponds and flows can be pumped when necessary. Previous flooding events saw five feet of water on the outside of the levees without flooding the internal ponds. While the trout farm can tolerate higher flows it is a major undertaking to activate the flood mitigation actions. As a member of the community, the trout farm’s position is that the current operational constraint should not be lifted.
- The consensus from local landowners in the meeting was that Mid Goulburn constraints should not be relaxed, with flows above 10,000 ML/day being problematic.
- Some commented that higher flows may be tolerable if:
  - tributary flows were not compounding the impacts
  - events were restricted to certain times of year (before the spring pasture growing period commences in August)
  - were of limited duration (less than 7 days).
- A frequency of one to two times every year would be unacceptable as pasture damage could not be addressed.
- All participants noted the significant increase in land values and stock prices and the consequences on compensation packages.
- River flats are highly productive, potentially double the value of other land and, as such, need to be considered as prime agricultural land.

In the Lower Goulburn

- Participants stated that from the 1960s to 1998, there were only two years where no flooding occurred in the Lower Goulburn up to the levees. Since 1998 there have been only two floods.
- The Lower Goulburn National Park contains the highest biodiversity in the area and is at a crisis point due to lack of inundation. From a personal observation, it is possible that the floodplain only requires decent watering once every five years.
- 25,000 ML/day is not considered sufficient to arrest the decline in floodplain health, however it was agreed to as the maximum flow scenario for investigation as a compromise. Duration is important – GBCMA noted that 25,000 ML/day at Shepparton for five days waters 80% of the floodplain. One participant felt it needed two weeks, and a slow rate of rise and fall from the peak was also important.
- It was noted that it takes years for the community to accept change. Thus, a staged approach was preferable, where between 17,000 ML/day to 25,000 ML/day would be initially investigated. However, it is believed that a higher constraint limit is required.
- Relaxing constraints to 25,000 ML/day or beyond should not be difficult but it would require leadership and the will to make tough decisions.
- There was frustration about delays in the program and a sense that we should “just get on with it”. A need was also expressed to build political support.
- Most landholders protected by the levees do not get concerned about impacts until >40,000 ML/day (or even moderate flood level). Previous experience was such that there were no concerns expressed by landholders with flows up to 40,000 ML/day.
- Some discussion centred on why landholders should be compensated when they own flood-prone land within the flood levees.
- One participant considered VMFRP-type projects in Lower Goulburn to be of low value as he believed any localised works would not deliver sufficient coverage of the floodplain.
- One participant had been a registered valuer and understood that compensation for an easement would be based on an assessment of loss, so he realised compensation would probably be higher for productive river flats in the Mid Goulburn or Murray than in the Lower Goulburn, where much of the inundation was on undeveloped grassy woodland type areas.
- A participant wanted to highlight the risk of not lowering the river sufficiently to allow sunlight onto vegetation at the bottom of the river. This restricted the growth of fauna that depend on that vegetation, onwards and upwards to Murray cod. The GBCMA agreed that maintaining flows at a lower limit was also important to river health.
- The Goulburn has deep sections/holes where Murray cod reside; these silt up without the floods.
- One participant was supportive of improving environmental outcomes in the Lower Goulburn provided it did not conflict with the environmental needs of the Mid Goulburn.
- The same participant noted that platypus populations were healthy now, but he highlighted the risk of high environmental flows at the wrong time of the year in terms of drowning out platypus nests. While he was supportive of environmental flows, he could not support specific events that were poorly planned and likely to endanger the platypus population.
- It was mentioned that landholders in the Mid Goulburn may be comparing ‘apples and pears’ when the program discussed 12,000 ML/day and 14,000 ML/day scenarios. They cited the current high flow situation where GMW may be releasing 9,000 ML/day, but the tributaries may be contributing another 6,000 ML/day. Landholders may perceive this as a 9,000 ML/day event.
- It was noted that by ceasing diversions to Waranga Basin, it was possible to gain another 7,000 ML/day in the Lower Goulburn. This operational intervention could turn a flow with limited environmental benefits into something more beneficial.

On the Hume to Yarrawonga reach of the Murray at Corowa

- Participants in this session were predominantly residents of New South Wales.

- Many properties in this area are larger in size with long river frontages and a combination of river flats and higher ground (some having up to 90% river flats), which is principally used for grazing (cattle) or cropping.
- At 40,000 ML/day, hundreds of acres of river flats are inundated, and access becomes a concern. Higher flows make farming operations problematic, particularly in needing to relocate cattle (especially when calving) and the danger of sometimes having to swim cattle through floodwaters. During higher flows cattle are either agisted or relocated to cropping paddocks.
- River pumps are not a major issue as they are either designed for higher flows or can be relocated.
- While some properties can handle flows higher than 25,000 ML/day, the consensus was that the operational limit on the river should be set at this "lowest common denominator". It was suggested that fewer than 10 of the 100+ landholders affected in this reach would be supportive of relaxing the current constraint.
- While some could cope with higher flows for up to two weeks, there is a level of mistrust of the river operators limiting flows to a more relaxed limit due to risk of unregulated inflows from tributaries such as the Kiewa River etc. during the managed event.
- Inundation mapping provided by the NSW RRCP is considered reasonably accurate, but it is claimed that it does not capture the impact of seepage.
- Most of the landholders at the meeting participated in the previous 25,000/ML easement process and received compensation for the creation of the easement. One participant however did not accept the offer due to not wanting the encumbrance and a lack of trust.
- Three of the properties represented are case study sites for the NSW RRCP. It was noted that they did not want to be involved in NSW RRCP/Constraints engagement as the ongoing uncertainty is stressful, but they feel they have no choice so that they can influence plans.
- Some criticism was made of river operators for allowing current (September 2022) prolonged ~40,000 ML/day flows in lieu of creating more air space in Hume earlier in the winter.
- There was general agreement that high flows in this reach were detrimental to the environment primarily due to erosion (and weed infestation). Photographs of recently fallen mature gum trees due to the saturated ground on the floodplain were shared. Once trees fall, water flows behind them, further eroding banks.
- A comment was made around the government not making the case or presenting any data to demonstrate the environmental benefits of relaxing constraints. There is scepticism that the project is for environmental outcomes, and some are suspicious that the purpose is to allow higher flows to satisfy increased consumptive demand from water traded to properties with permanent plantations downstream of Barmah Choke, South Australia, etc.
- Several participants expressed frustration from having multiple NSW RRCP representatives (three in one case) engage with them over the past 18 months.
- NSW RRCP representatives gained local insights by engaging with landowners but regular turnover in staff means information was often lost.
- Participants shared the feeling that New South Wales is proceeding too fast, and they would prefer the Victorian approach to first verify the feasibility. It was felt NSW RRCP staff had a vested interest in continuing, as they were employees, and their jobs depended on the program continuing.
- The Murray River Action Group engaged a valuer in 2011 to estimate the value of mitigations/easements on three properties in this reach at a 40,000/ML flow. The valuation was $1.5 million. Property prices have potentially tripled since then.
- Participants will be disappointed if Victoria does not estimate the cost of relaxing constraints as there is a concern that the project may proceed without a clear demonstration that benefits exceed the costs or that the program is affordable.
- There is a preference for owning on-farm assets that might need to be upgraded, however there is concern about the maintenance liability for future generations when new bridges/crossings/etc reach their end of life. It is felt that upfront compensation payments do not address this risk. It was agreed that the alternative of government owning these assets was problematic.

On the Hume to Yarrawonga reach of the Murray at Brimin

- Participants from this session were all residents of Victoria.
- They questioned why the current high flows are not being used for environmental purposes. As such higher flows are not needed again any time soon.
- They questioned how the concept of relaxing constraints could save water under the Basin Plan, but this was clarified by explaining that the projects would reduce the amount of water needing to be recovered rather than “saving” water.
- There was some criticism about why airspace in the dams could not have been created earlier to avoid the persistently high flows being experienced now.
- Comment was made that the benefits of relaxing constraints have not been presented and there was some scepticism that the higher flows sought would be purely for environmental purposes.
- All landholders referred to 40,000 ML/day as the constraint relaxation limit (and that this flow caused too much impact). It was communicated that a scenario of 30,000 ML/day was also being investigated.
- ‘Piggybacking’ on top of natural events is considered risky due to unforeseen rainfall events.
- There was agreement that short-duration higher flows could be beneficial during drier periods.
- If environmental water holders could use their entitlement in years like 2022 to create airspace to avoid subsequent high releases, this would be of benefit and landholders would be more willing to entertain relaxed constraints if environmental water could be used in a mutually beneficial way like this.
- The government has sought to cancel grazing licences on Crown land when they expired or the landholder sold the property, but the view was that they did not maintain the land when licences were cancelled. It is considered that the land was best managed where licences were in place, as licence holders managed vegetation, weed growth, fencing, etc.
- Some participants have levees that protect a sizeable portion of their properties however, rainfall-runoff behind the levee cannot drain back to the Murray when it is running high and needs to be pumped over the levee.
- Inundation can have impacts on diversified farm income. For example, one participant offers tourist accommodation, which is inundated at ~40,000 ML/day. With accommodation booked for more than 250 nights per year, the elevated river flows result in cancellations and associated stresses. While they could potentially cope with relaxed constraints even up to 40,000 ML/day, it could only be for short periods (such as a week or less).
- Erosion is a significant concern; one landholder has undertaken progressive re-vegetation along the river frontage and fencing is being used to mitigate erosion. No-wash zones have also been established. The government has also performed several rounds of erosion protection works (rock, hessian matting and tree and native grass planting).
- One participant noted that New South Wales had indicated there was perhaps $200 million available for mitigation in Hume to Yarrawonga but that was believed to be insufficient to deal with the level of compensation required.
- One participant commented hay production was a significant part of his business and the current inundation meant he had lost 12 months of hay production on a significant part of his property. He has an easement for 25,000 ML/day and is opposed to any further relaxation.
- One participant felt that landholders were spoken at, rather than listened to and suggested decision makers should live on the river before deciding whether the program should proceed or not.
- One participant noted their largest issue was loss of access and cost of stock agistment. Their property had the capacity to run more stock, however this was limited when inundation of property occurred.

On the Yarrawonga to Wakool reach of the Murray at Barham

- The river does not rise significantly at Barham during high flows but still can flood. In previous high flow events, a twelve-inch rise at Echuca resulted in a few inches rise at Barham.
- The Goulburn contributes a sizeable portion of the flows received at Barham.

- One participant had levees, but they were in poor condition, with no-one taking responsibility for maintaining them. If it breaches, he risks losing his permanent plantings of avocado trees.
- Another participant had a levee on the point of breaching on the day of the group meeting and had similar issues with levee maintenance. The group inspected this location after the meeting.
- One participant had previously agreed to an inundation easement across some 20% of his property and was paid compensation as part of the Gunbower project. He had an independent valuation, the primary basis of which was the market value of the land. He accepted the initial offer (sensed it was deemed at least fair value) and has subsequently experienced no inundation on the easement.
- One participant discussed community sentiment in relation to relaxed constraints, arguing there was a 'hardcore' group and a 'moderate' group within the community. The 'hardcore' group wanted no change, while the 'moderate' group might be willing to start at a lower relaxation scenario (possibly 25,000 ML/day). The 'moderate' group was becoming frustrated with the 'hardcore' group's inflexible stance. Many people are tired of the politics around water management issues in the area.
- In the discussion about initial observations of inundation extents at different constraint relaxation scenarios, most agreed there would be less overbank flows and breakout on private property on the Victorian side compared to the Hume to Yarrawonga reach. That said, they believed there would be significant impacts on the New South Wales side.
- A range of river management issues not directly related to the program were discussed. These included:
  - Unregulated water trading and the impact on river flows from entitlement moving further downstream
  - Erosion in that stretch of the river as observed to date which was a key local concern. While there was not much conversation as to whether relaxing constraints would have a further impact, it is considered that bank degradation was an underappreciated unintended consequence of delivering environmental water
  - It is believed there were flaws in the design concepts of the Living Murray Projects (Koondrook-Perricoota and Gunbower) resulting in sub-optimal outcomes. Locals advised New South Wales and Victorian Governments that the structures would not operate the way they were intended, which is now being borne out with $30 million of further works at Koondrook-Perricoota and Gunbower Creek being unable to deliver concurrent irrigation and environmental flows, resulting in environmental flows only being able to be delivered during winter irrigation shut down. This is not optimal for ecological outcomes
  - By contrast, Polack Swamp, which has been receiving water for ten years via irrigation infrastructure is seen by the community as highly successful
  - Positive environmental outcomes generated on private land are not being considered by governments when developing the Basin Plan and environmental projects
  - The reality is that community members have contributed a lot of positive outcomes either directly through works/projects, or through unpaid roles on Committees and the like. The outcome of these efforts does not get formally recognised when government measures the outcomes under the Basin Plan. It was felt that it was unfair that community members had to volunteer their time to address/influence issues associated with projects when the project representatives themselves were well paid consultants or employees.

5.1.2 Focus groups

A series of focus groups were also held with representatives of organisations who wished to contribute views to inform the Consultative Committee in their considerations of the Victorian CMP. These discussions and the thoughts represented by these groups are summarised and presented below.

Trust for Nature

Trust for Nature is one of Australia's oldest conservation organisations. Its goal is to protect and restore places in Victoria where wildlife and native plants can thrive.

In 1978, Trust for Nature developed 'on title agreements' known as conservation covenants to protect native plants and wildlife. These legally binding agreements allow private landholders to conserve natural habitat on their properties in perpetuity. This is a unique power that Trust for Nature holds in Victoria.

"We can see large environmental benefits in allowing floodplains to receive appropriate environmental watering and also to enable increased delivery of environmental water further downstream".

Trust for Nature has obtained legal advice about the suitability of its conservation covenant as a tool to allow for overbank flows and believes it should be considered in the suite of mitigation options for constraint relaxation.

"From a pure nature conservation perspective, w"ve identified floodplains as being important areas to target for conservation."

Conservation covenants are entirely voluntary and remain perpetually, even when the land changes ownership. Trust for Nature believes there is an opportunity for the government to enter these agreements through "suitable incentive arrangements", which may open a two-way negotiation with the landowners.

In addition to the conservation covenant being a legal instrument, once the landholder enters into that agreement, the land also enters into a stewardship program with Trust for Nature. As such, it develops a management plan for the land under the covenant, in negotiation with the landholder, and sets out the conservation objectives for that land and agreement on the management for that land.

"We aim to always work with willing landholders and negotiate an agreement that works for those landholders."

Trust for Nature suggests that the constraints mitigation and compensation framework could include a conservation covenant agreement to assist landholders and provide ongoing security over the environmental watering of the floodplain. Moreover, it would also recognise the need to support other land use activities on that land.

"Incentivising the program is important. It would be the way to recognise that there is a financial impact potentially on those landholders."

The covenants have the flexibility to accommodate different land use needs in line with the landowner's wishes. Each area may have a different 'tier', allowing certain land use activities under given conditions. Some sites may be established under the conservation tier, where the primary objective is nature conservation. Other sections will be placed under the sustainable land use tier, where landowners can practice ongoing farming activities such as grazing under certain conditions, which could consider the allowance for intermittent flooding.

"Our conservation covenants have different – we call them tiers – definitions of different land uses allowed under the covenant, rather than just having one black and white contract."

Biodiversity 2037 is Victoria's plan to stop the decline of native plants and animals and improve Victoria's natural environment. The plan sets a target of protecting an additional 20,000 ha of private land.

Trust for Nature believes that due to the flexibility of the conservation covenants of addressing the needs of landholders, the government could achieve a "double benefit" through an agreement with the landowner for intermittent inundation under relaxed constraints, as well as contributing to its efforts toward meeting its biodiversity 2037 plan.

> *"If that land came under a conservation covenant, it contributes directly to targets under the Biodiversity 2037 plan."*

Trust for Nature believes that its covenant provides a suitable alternative to easements through its flexibility and the positive affirmation of landholder'' needs and wishes while also considering the needs of Trust for Nature and the government. This provides a dual benefit of meeting the requirement for relaxed constraints and progressing the government's biodiversity targets.

BirdLife Murray Goulburn

BirdLife Murray Goulburn (BLMG) is a branch of BirdLife Australia. It focuses its activities within the Goulburn Broken catchment. The wetlands of the lower catchment support significant wetland bird diversity and abundance.

BLMG supports the relaxation of constraints in the Goulburn River to efficiently use the available environmental water to protect and enhance habitat in the Lower Goulburn floodplain.

> *"We've got all of this environmental water, but why aren't we using it better: how can we use it better?"*

BLMG notes the Lower Goulburn River floodplain provides a variety of key habitats, including a network of 'flood runner' watercourses and at least 70 separate wetland sites. Both permanent and temporary wetlands are found within the floodplain, such as billabongs, sloughs, marginal swamps, scroll swales, anabranches and cut-off loops. Key wetlands include Gemmill Swamp, Reedy Swamp and Loch Garry. BLMG states it is likely that the actual number of wetlands far exceeds 70 once small ephemeral wetlands are considered. These ecosystems support important species and habitats listed in international agreements such as Ramsar and include vulnerable and endangered species.

This mosaic of different wetlands gets flooded at different times and different river flows. BLMG believes that not only the more extensive wetlands need to be watered but the entire mosaic.

> *"We are keen to see overcoming of constraints; if that is not possible, start watering individual floodplains and floodplain areas so that you get that floodplain mosaic back again."*

The wetlands with varying water requirements should be watered to provide a range of habitats and conditions for birds. There has been a noticeable reduction in floods over the last 30 years, which has noticeably impacted the vegetation and the birds in the region.

> *"The flooding has changed on the river; that's changed the vegetation, and the bird population, and abundance on the river".*

BLMG states that bird data is available from several sources, but no overarching summary has been available until recently. BLMG has reviewed bird records in the Atlas of Living Australia (ALA), which incorporates data from various sources, including Birdata and eBird. Most bird data is from around Shepparton, but all-up, data has been recorded at over 400 locations on the floodplain.

BLGM states that, overall, 271 bird species have been recorded. Compared to other Victorian sites, this suggests the Lower Goulburn floodplain is a very important bird habitat, on par with the water birds at the Western Treatment Plant at Werribee, which is one of the premier sites in Victoria (269 bird species). Of the 271 birds recorded, 19 are listed under the EPBC Act and 36 are listed under the Victorian *Flora and Fauna Guarantee Act 1988*. Of the 51 species listed in BirdLife Australia's Woodland Bird Conservation Action Plan (Howling and Fullagar 2020), 34 can be found on the Lower Goulburn floodplain.

BLMG believes the Lower Goulburn floodplain is one of the hidden jewels of important Victorian bird sites. Since 1997 there have been long periods without high Goulburn River flows and floods, and water delivery to floodplain wetlands has been mostly non-existent or very brief. Consequently, floodplain wetland water regimes have changed from being wet, to almost constantly dry. This is likely to be affecting the birds of the area. Some BLGM members have been studying wetland birds in the region for over 40 years. One long-standing member noted that Gemmill Swamp used to be quite a good ibis rookery; however, this is no longer after the cessation of channel outfall.

> *"You've only got to drive between Shepparton and Mooroopna when it was dry, and half the trees looked as though they were dead or dying and once you got a flood, once it got a bit wet, they came back again".*

BLMG believes environmental water needs to be delivered to as much of the floodplain as possible, not just the river channel. The river channel has received plenty of attention in recent years, and the benefits are well known.

> *"The environment's got a heap of water in Eildon, but they can't really do a great deal with it. Without relaxing constraints you can't make proper use of the environmental water you've got in storage."*

BLMG states that overcoming constraints to the delivery of water to the floodplain is extremely important. BLMG believes a fallback position must be developed and implemented if sufficient environmental water cannot be delivered to the floodplain. BLMG also believes this could involve projects to artificially deliver water to floodplain wetlands, suggesting there is plenty of scope to utilise the irrigation channel network to achieve this.

> *"Hattah is fantastic, but all of those big projects along the Murray require enormous amounts of capital and investigation to make them happen. Huge amounts of work, whereas along the Goulburn, one of the wetlands can be irrigated straight out of the channel or drain system. So it's a much less capital-intensive requirement than anywhere on the Murray."*

BLMG believes that relaxing constraints is required to preserve and enhance the Lower Goulburn floodplain. It recognises that this will not be a short process and will require lengthy consultation with the community.

> *"I think as time goes by, people will become more familiar and a bit more relaxed about overcoming some of these constraints".*

Wentworth Group of Concerned Scientists

The Wentworth Group of Concerned Scientist (WGCS) states that constraints relaxation is about systematically upgrading our management of the rivers to be future-ready to better manage a range of challenges that we face, including greater extreme events such as unregulated floods. They include maximising the benefits that we get from the environmental water that Australian society has recovered in the Murray-Darling Basin for a significant cost and making sure that this water can serve the greatest biodiversity conservation benefit.

WGCS believes there's an immediate urgency for relaxing constraints because there is not enough environmental water available to conserve the wetland ecosystems – from the foot of the major dams all the way to the Lower Lakes. We need these environmental water pulse flows let out of the dams to fill up the river channels and spill out onto the floodplain to sustain things like the floodplain forests, the lakes, the other wetlands, and all the benefits that this provides.

Each tributary requires the flexibility to have those pulse flows move downstream and join up because the further downstream the Murray River, the bigger the river channel gets, and the harder it is to fill it up and spill out over onto the wetlands. Therefore, relaxing constraints on all six reaches of the lower rivers is crucial. Contributions from all six are required and will be crucial in terms of watering directly around 375,000 ha of wetlands.

Research students have tracked all environmental water that the Commonwealth Environmental Water Office has released over four years. This research shows that essentially 80% of those water releases have stayed in river channels because of the existing constraints that limit overbank flow. And only 20% of those environmental water releases have actually reached the floodplain wetlands. The research suggests that these restrictions are resulting in only 2% of the area of floodplain wetlands being watered each year.

Engineering projects through environmental works and measures have been implemented that are trying to mimic the conservation of wetland ecosystems by pumping water out of a river channel at a low flow level and ponding it on the floodplain to try to replicate natural flooding. There are concerns with this approach as it may contribute to blackwater events, increase salinity and cause barriers to fish movement on or off the floodplain. Although there is merit in targeting areas with the greatest diversity of ecosystem types of flora and fauna using these engineering solutions, there are also many areas that don't get water. There is a risk that areas that used to receive water are now de-watered due to the presence of structures impeding natural flows. Other annual costs need to be met by the government such as maintaining the assets and electricity costs for pumping.

"We don't see [engineered solutions] as an alternative to constraints relaxation in which waters are much bigger and sustain a much bigger area of wetlands with fewer resources".

WGCS notes there are 13,000 ha of floodplain wetland ecosystems along the Goulburn River, being primarily red gum forests and other features like billabongs and oxbow lakes which under current constraints will only get wet in extreme flood events because Eildon captures all the small and medium floods.

"[Without constraints relaxation] we're deciding we will only conserve those wetlands by acts of God whenever there's a flood big enough to go over the bank."

They state that the large flooding events do not occur with the required frequency of every two to three years for the red gum forest to stay healthy.

"We're condemning the Black Box forests and a lot of the red gum forests to dry out and transition to some other kind of ecosystem."

As well as the benefit of watering wetlands, WGCS believe there will be a number of benefits for landowners along the river. Overbank flows in late winter and spring would recharge groundwater and increase soil moisture levels which would give pasture a boost going into summer.

WGCS state that high-flow events can also enhance water quality in terms of salt flushing and if these higher flows occur more frequently, it will reduce the likelihood of blackwater events. Under current conditions, the blackwater events occur because the dams capture all the small and medium-sized floods. And therefore, once every ten years during the unregulated high flood event, a blackwater event is more likely due to the enormous amount of leaf litter build-up.

"If under relaxed constraints forests can be inundated every two to three years then blackwater events are much less likely to occur".

WGCS believes that regional communities could become more economically resilient by diversifying the economy through the support of a healthy tourism industry. The bulk of tourists come to regions to see aspects that are associated with rivers, whether it's historic tourism, such as paddle steamers or wineries, that are located close to rivers. There are also opportunities for camping, canoeing, sightseeing, bushwalking and recreational fishing. These tourism activities bring visitor dollars to regional communities that are sustained by having healthy rivers.

There are also benefits to native fish. WGCS states that one way to boost the population of species such as silver perch or Murray cod is to have river flows that mimic natural events. Carp like constant flows that provide ideal breeding conditions so if that flow variability is reintroduced, then that will favour the native fish over the exotic fish.

WGCS believes constraints relaxation also has the potential to reduce the impact of natural floods through federally funded infrastructure upgrades to improve flood resilience up to minor flood levels. It will provide the money that is needed to upgrade assets such as local bridges and roads that will give landowners time to do things like move stock out of lower paddocks. It will mean that at this lower level of flooding, there will be greater access to and from farms but also, in some cases, on farms to improve access between paddocks. This is a one-off opportunity for federal funding for many of these rural communities to upgrade their infrastructure substantially.

WGCS notes that relaxing constraints may also reduce erosion to a minor extent. Due to the current operations of running the rivers at a constant flow within the channel, there is no opportunity for the vegetation to establish on the bank to provide stability. It also means that the soil is constantly saturated, and its structure is weakened. With constraints relaxation, overbank environmental water delivery can occur, meaning that during some periods there would be less water in the channel. If environmental water can be released in a pulse, it varies the water level in the channel and means that there are periods when it would be much lower. This would enable the banks to dry out which allows vegetation to grow on the banks.

Landowners should be given a broad choice when it comes to compensation and easements. WGCS believes an option could be that compensation is paid for a 10-year easement so the landowner can observe how the environmental deliveries have impacted the land over that time and then have a decision point where they review the impact on the property. That would enable landowners to identify if the inundation in practice did not match the modelling and could be further compensated if the inundation was greater than anticipated.

WGCS supports flexibility in the approach so if a landowner wishes to sell any flood-prone land, then they are able to. Other financial mechanisms that are used overseas include a pre-agreed payment every time there is a flood event. There needs to be flexibility in the approach to determine what best suits the individual landowner and there could be review mechanisms after time to readjust and revisit if landowners are impacted more greatly than had been anticipated.

"Rather than a one-size-fits-all, I think flexibility [in terms of compensation approaches] would show much greater faith with the local communities and enable engagement".

Given the large number of properties concerned across all constraints projects, WGCS expects that a small proportion of landowners will not be willing to engage or sign-up for the program. WGCS believes it is in the public interest that after a reasonable period for the government to compulsory acquire either the land or the easement because the greater public good is served by restoring the floodplain up the BoM minor level of flooding.

"I don't think one or two landholders should be allowed to stand in the way of $13 billion worth of water reforms to sustain these rivers in the national interest."

WGCS believes there are opportunities in this program to identify win-win solutions, particularly when individual assets such as roads and bridges can be identified that would be upgraded under this program. These upgrades will be an important incentive in many communities.

WGCS notes the Victorian CMP is not just about delivering environmental water, but it is also about reducing vulnerability to unmanaged floods. Under a climate change future, even if average annual inflows into Eildon and other catchments reduce, there will be large and extreme floods. This program is providing government investment that will help reduce flood risk.

There will always be uncertainty in climate change modelling and WGCS believes our challenge as a society is to start making smart decisions about climate change adaptation for measures that will help us no matter whether the climate changes a little bit or a lot. And constraint relaxation is one of those key measures that WGCS believes is a smart thing to do, regardless of the change in inflows. It believes this is probably one of the smartest things we can do to prepare for the future.

WGCS acknowledges the Victorian CMP is complex and involves a large and systematic decision that affects many people. It's not an easy thing to do.

"Many people resist change and are worried about the unknown and that's entirely understandable."

WGCS states that governments have unwittingly portrayed constraint relaxation as a cost and impost on communities. However, they believe, this should be flipped to consider "what are the benefits from doing this and what can we get out of it that will set up our businesses and our local communities for the future?".

"It's about restoring a key attribute for those of us who live in the Basin; the river systems that we love, that define our community that are the places that we go to fish, canoe, camp, have barbecues, etcetera. And it's about diversifying local economies with things like supporting the tourism industry."

WGCS believes it could be argued that constraint relaxation is one of the best opportunities for communities in the Basin because it is offering federal government investment, and a one-off opportunity to invest in local infrastructure. "What can we get out of this that will benefit us in the future?"

5.2 Future stakeholder and community engagement

The CMP Consultative Committee has provided the opportunity to work with critical stakeholders to re-examine the information in the original concept business cases and inform a strategic pathway toward fit-for-purpose technical investigations and policy frameworks. The Committee has provided a forum for exchanging and testing views, where members have built a shared understanding of the project and constraint relaxation.

The Committee advised that, if the CMP proceeds to the next stage of business case development, wider stakeholder and community engagement should be a core component of program delivery. The Consultative Committee strongly supports meeting with every impacted landowner and occupier in the next stage, supported with clear, concise information on the benefits, potential impacts, and mitigation and compensation options associated with the constraint relaxation scenarios. The Committee recommends that the modelling output be ground-truthed with impacted landowners and occupiers as part of this future engagement.

"I think the issue of ground truthing the model is very important."

Identifying and reaching out to individual property owners may pose challenges. However, it would be essential to conduct one-on-one consultations with all affected landowners to discuss the modelling outputs and evaluate potential impacts on their specific properties. In some instances, this would involve engaging with multiple individuals listed on the title and some land titles would also be held up in probate. Occupiers of affected lands (i.e. leaseholders) as well as landowners would need to be engaged.

The Committee recognised the need to address a potential mismatch between community expectations and the observed outcomes in the rivers, particularly regarding the reason for flows. Committee members highlighted a deficiency in the current communication of river flow information. While real-time data on river heights and flows can be found online, they believe there is a lack of clarity regarding the reasons behind the observed flows and the proportion attributed to environmental water deliveries compared to irrigation and other consumptive uses. There is a common perception among the community that high flows in the rivers are solely due to environmental water, whereas the reality is different.

Addressing this information gap and providing a clearer understanding of the various factors influencing river flows would be important in informing the public and avoiding misconceptions. The Committee suggests that developing tools such as mobile apps could facilitate this communication process. These tools would enable stakeholders to easily access and understand information about water deliveries, irrespective of whether

The imagery captured during the scenario flow rates in Spring 2022 would be instrumental in supporting the engagement activities and ensuring that the modelling accurately represents the areas inundated. This process aims to provide landowners with comprehensive information regarding the potential impacts of the program on their land.

5.2.1 Engagement framework

Community and stakeholder engagement is fundamental to well-informed decisions affecting various community sectors. Effective engagement will allow the Victorian CMP to embrace local insights, share knowledge and experiences, and lead a more rounded program of activities with better outcomes. It means individual landowners and program representatives have discussed and understood any potential impacts on the landowners' property and how those impacts might be mitigated or addressed.

This engagement framework is designed to guide such discussions and ensure transparency and honesty are the core of this approach. This framework aims to shape how the Victorian CMP team engages with landowners and the community should the program proceed past this feasibility stage.

Its purpose is not to prescribe what engagement activities are undertaken but to establish clear expectations around the attitudes and behaviours expected of both the Victorian CMP team and landowners when discussing the program, its potential impacts and how these might be addressed.

At its core, this engagement framework aims to promote genuine, caring, and respectful interaction between landowners and parties interested in land[93] and the program team. The principles guide all interactions between program staff, landowners, community members and other interested stakeholders. Essentially, the framework is an informal pact designed to ensure all the parties involved in discussions are heard and their views shared openly, honestly, and respectfully.

This engagement framework was developed with direct and indirect input from the Consultative Committee. It reflects the Committee's experience and knowledge of the land, the river systems, the broader surrounding areas, and the rich and expansive experience of previous community engagement. It is a custom framework explicitly designed for the Victorian CMP.

[93] The term 'parties interested in land' means a person with a proprietary interest in the land such as a tenant with a leasehold interest in the land or purchaser of land pursuant to a contract of sale

"What is risky is not telling everyone the same thing. Everyone needs to have the same information."

5.2.2 Principles for engagement

The Consultative Committee believes the principles in Table 16 should be inherent in all engagement activities.

Table 16–- Principles for engagement

Principle	Examples of application by the Victorian CMP
Be open and transparent in all interactions. Being open and honest in sharing information and feedback will foster trust and respect among all involved	• Program staff are open and transparent: – with landowners and the broader community – about the program's impacts for landowners as well as the program's benefits – in communicating program approaches or ideas that have been considered and discounted, and the reasons why – about if, where and how landowners and the community can influence the program • Decisions are shared with an explanation of how community input may have influenced the outcome • Everyone engaging with landowners on behalf of the CMP is familiar with the principles in this document
Give people good access to information, empower them to seek more, and provide them with opportunities to connect. Having access to information and opportunities to connect requires ensuring there is more than one 'channel' for communication and identifying and removing any barriers to participation that might exist.	• Program staff: – are readily accessible via phone, email, or face to face – use multiple channels to communicate, which might include online platforms as well as more traditional media channels like radio and print media – readily adapt the mode and method of communication when reasonably requested by the landowner • Communications materials and program information are available online • Information sessions are held face-to-face and online, whichever is most effective Information is provided in different formats and levels of detail to serve those who want a simple program overview or those who want more technical information • Information is provided in a manner that reflects the diversity of the community • Barriers preventing or hindering participation are identified and removed or mitigated • Appointments and activities are scheduled to best suit landowners, wherever possible.
Ensure responses and activities are relevant and timely Requests and enquiries are responded to quickly and communications and connection efforts reflect landowner and	• Landowners are provided with a team member who is considered the principal contact throughout, wherever reasonably possible • Every attempt is made to ensure enquiries or requests for information are responded to within two working days • Unforeseen project issues that affect or interest landowners and the community are communicated promptly

Principle	Examples of application by the Victorian CMP
community needs and commitments.	• One-on-one and wider community engagements are conducted with consideration of landowner circumstances • An 'early as is practicable' policy is adhered to regarding project details, timelines, and key milestones • Project updates and information are provided regularly and as information emerges • Any project delays are communicated openly and promptly.
Be responsible Being responsible for keeping your word and owning up to and apologising for mistakes is key to building trust and respect between the Program team and the community.	• Project staff do what they say they will do and take responsibility for their actions • Landowner and community feedback is genuinely considered and valued • Reasons for decisions – both positive and negative – are communicated • Communications and connection efforts continue to evolve as staff adopt a 'do and review' methodology.
Be clear Communicate clearly without jargon, overly technical language, or unnecessary information.	• Communications materials are easy to understand and written in plain English, without jargon or the over-use of legal language • Graphics and images are used to illustrate points and boost understanding • Communication is tailored to the audience; one size does not fit all • Communications material and project information is accurate and easy to access • Communications and connection efforts include the 'why' behind the decisions • Landowners understand why their input is needed and at what stages of the program.
Communicate regularly Communicating regularly means telling people what is going on and helps build trust. People are not left wondering what is happening or when.	• Communication is provided as early as possible and regularly • There are not long, unexplained gaps in the communication efforts.
Be consistent Aligning all messaging and approaches will ensure all landowners and interested parties are treated in a consistent, equitable and respectful manner.	• Use consistent descriptions of the program, its benefits, impacts, timelines, and how landowners and parties interested in land can be engaged • Work with the individual landowner to determine how their land parcel may be inundated under different flow scenarios and to identify individual property impacts • Provide clear and consistent information about potential compensation and mitigation options • Document all relevant communications regarding impacts with respect to potential mitigation and compensation options and make them available to the landowner in a timely fashion, upon their request • Apply privacy principles to all information collected and only collect and deal with information in accordance with the Australian Privacy Principles as provided in the Privacy Act 1988 (Cth) • Allow individuals the right to correct their personal information if necessary

Principle	Examples of application by the Victorian CMP
	• Publish clear steps –to follow and relevant persons to contact to escalate complaints, for people who have concerns or might be dissatisfied with a Project team member's response or actions.

5.2.3 Expectations of landowners and parties with an interest in impacted land

Landowners and parties interested in the affected land are critical partners in delivering the Victorian CMP. Cooperation and acceptable outcomes are more likely to be achieved when landowners:

- Liaise with the Victorian CMP team in good faith
- Respond to the Victorian CMP requests with minimum delay
- Engage in negotiations with the Victorian CMP team to determine individual property impacts and appropriate mitigation and compensation agreements
- Ensure that those present on their land do not jeopardise the physical or personal safety of any authorised representatives of the Victorian CMP team.

5.2.4 Key stakeholders

The key stakeholders for the Victorian CMP are summarised in Table 17. A communication and engagement plan will be required for all stakeholders if the project is to proceed to the next stage.

Table 17 – Key stakeholders

Stakeholder interest	Representative organisation	Key issues and interest in the project
Victorian Minister for Water	State Parliament	Project decision maker Impact on Victorian communities Cost – time Environmental benefits Compliance with obligations under the Murray-Darling Basin Plan
Consultative Committee	Dedicated forum of community members	Provide input into communication materials Provide input into mitigation and compensation framework
Private landowners and interested parties within the modelled inundation footprint	Individual landowners Leaseholders Business owners and managers within the footprint (e.g., Committees of management) Interested parties in land	Modelled inundation extent Impacts on individual property, private assets and operations Anticipated flow frequency, timing and duration Mitigation and compensation framework Forms of legal agreements and legal support available Project timing and engagement process Wider benefits
Local governments along the river reaches	Campaspe Shire Council	Modelled inundation extent

Stakeholder interest	Representative organisation	Key issues and interest in the project
	Gannawarra Shire Council Greater Shepparton City Council Indigo Shire Council Mildura Rural City Council Mitchell Shire Council Moira Shire Council Murray Group of Councils Murrindindi Shire Council Strathbogie Shire Council Swan Hill Rural City Council Wodonga City Council	Impacts on local government assets Impacts on landowners within the council area Anticipated flow frequency, timing and duration Mitigation and compensation framework Project timing and engagement process
Traditional Owners	Taungurung Land and Waters Council Aboriginal Corporation Yorta Yorta Nation Aboriginal Corporation Barapa Barapa and Wamba Wemba Steering Committee Barapa Country Aboriginal Corporation Wiran/Wamba Wemba Aboriginal Corporation Wadi Wadi Wamba Wemba Barapa Barapa First Nations Aboriginal Corporation Wadi Wadi Land and Water Indigenous Corporation Wadi Wadi Nation Bangerang Aboriginal Corporation Dalka Warra Mittung Aboriginal Corporation Duduroa Dhargal Aboriginal Corporation Dhudhuroa Waywurru Nations Aboriginal Corporation First Peoples of Millewa Mallee Aboriginal Corporation Tati Tati Aboriginal Corporation Tati Tati Land and Water Indigenous Corporation Latji Latji Mumthelang Aboriginal Corporation Gilbie Aboriginal Corporation Munatunga Elders Aboriginal Corporation Dadi Dadi Weki Weki Aboriginal Corporation	Modelled inundation extent Impacts on Country Environmental benefits Anticipated flow frequency, timing and duration Mitigation and compensation framework Project governance Project timing and engagement process Regulatory approvals

Stakeholder interest	Representative organisation	Key issues and interest in the project
	Murray Valley Aboriginal Corporation Dja Dja Wurrung Clans Aboriginal Corporation MLDRIN The Federation	
Land managers	Department of Energy, Environment and Climate Action Parks Victoria Goulburn Broken Catchment Management Authority North East Catchment Management Authority North Central Catchment Management Authority Mallee Catchment Management Authority	Modelled inundation extent Impacts on assets Anticipated flow frequency, timing and duration Mitigation and compensation framework Project timing and engagement process Project benefits Regulatory approvals
Environmental water managers	Goulburn Broken Catchment Management Authority North East Catchment Management Authority North Central Catchment Management Authority Mallee Catchment Management Authority Victorian Environmental Water Holder	Maximising the use of available environmental water Environmental benefits River operations Hydrological and hydraulic modelling Flow frequency, timing and duration
River operators	Goulburn Murray Water Murray-Darling Basin Authority	River operational risks Legal liability for river managers Hydrologic and hydraulic modelling and forecasting tools Communication framework
Local legal representatives	Legal representatives of local landowners	Project information to provide advice to clients Mitigation and compensation framework Project timing and engagement process
Recreational groups	VR Fish Rowing Victoria Boating Industry Association of Victoria Wooden Boat Association Victorian Jet Ski / PWC Association Local recreational groups along the river reaches of the project	Recreational benefits and impacts Hydrological and hydraulic modelling Flow frequency, timing and duration

Stakeholder interest	Representative organisation	Key issues and interest in the project
Wider community	Communities along the river Broader Victorian communities	Project benefits and impacts
Environmental groups	Wentworth Group of concerned scientists Trust for Nature Environment Victoria Birdlife Australia Local environmental groups such as Friends Group Field Naturalists Club of Victoria	Environmental benefits Project timing and engagement process
Elected officials	Elected local government representatives along impacted reaches of river Elected state government representatives along impacted reaches of river (Member for Eildon District; Member for Euroa District: Member for Shepparton District; Member for Benambra District; Member for Ovens Valley District; Member for Murray Plains District; Member for Mildura District; Members for Northern Victoria Region) Elected federal government representatives along impacted reaches of river (Member for Indi, Member for Nicholls, Member for Mallee; Senators for Victoria)	Modelled inundation extent Project cost and timing Environmental benefits Impacts on represented communities Mitigation and compensation framework Engagement process
Federal government	Department of Climate Change, Energy, the Environment and Water Murray Darling Basin Authority	Project cost and timing Environmental benefits Impacts to communities Project compliance under the Murray- Darling Basin Plan
State government	Department of Energy, Environment and Climate Action	Delivering the project on behalf of the State Impact on Victorian communities Environmental benefits Cost – time Compliance with obligations under the Murray-Darling Basin Plan Regulative approvals
	Department of Treasury and Finance Victoria	Cost – benefits Project timing

Stakeholder interest	Representative organisation	Key issues and interest in the project
	Valuer General of Victoria (VGV)	Statutory valuations associated with compensation and mitigation framework
Murray river states	New South Wales Government (via NSW Reconnecting River Country Program) South Australia	Environmental benefits System-wide benefits and impacts Regulatory framework Project timing and delivery method Mitigation and Compensation Framework Engagement Framework and processes Project compliance under the Murray-Darling Basin Plan

6. Traditional Owner contributions

Engagement

- The feasibility study's consultation approach supported Traditional Owner self-determination, enabling Traditional Owners to decide if and how they participated in the project and by enabling them to guide the engagement process, including the place and style of the consultations including meeting on-Country.
- Twenty-one Traditional Owner groups with potential interest in the relaxation of constraints were identified for consultation. Fifteen groups shared their perspectives with the engagement team in seven on-Country workshops. The engagement resulted in five submissions on behalf of twelve groups.
- Engagement extended beyond the project area, downstream of the Murray-Wakool Junction to the Victorian border with South Australia in recognition that floodplain inundation downstream of the Murray-Wakool Junction is anticipated if CMP flows were co-ordinated.
- Although a consolidated viewpoint was not sought, no single summary view on the project was agreed to by all Traditional Owner groups. Each submission has been presented as separate, stand-alone statement to the Victorian Minister for Water as several groups stated it would be inappropriate to merge their statement with that of another group.

Themes

The majority of Traditional Owner groups consulted supported further exploration of relaxing constraints to achieve the broader environmental and cultural outcomes and gave in-principle support to see the project go forward to the next stage of investigation. Some groups requested further information to have a better understanding of the project before they determine their level of support.

From the perspective of the consultant undertaking this investigation (Alluvium), the majority of the representatives from Traditional Owner groups engaged:

- are in favour of the relaxing constraints to achieve the broader environmental and cultural outcomes
- gave in principle support to see the program go on to the next stage of investigation
- want to see significant involvement for Traditional Owner groups in the next stages including in decision making over water use
- Some groups see the need for projects like the Victorian CMP and other infrastructure projects e.g., VMFRP to provide the durations. Some groups don't want to see infrastructure projects
- want the ability to manage the land and water holistically for areas of cultural significance
- have sought further information and engagement if the project continues.

Future Stages

As the CMP progresses, DEECA will continue to partner with Traditional Owners in line with Pupangarli marnmarnepu. DEECA acknowledge Aboriginal Victorians have the right to make choices that best reflect them on their journey to self-determination and are committed to delivering real outcomes by following their lead

From the consultant's (Alluvium) perspective, to inform planning for future stages, the summary of key recommendations for future stages include:

- there is a need to undertake mapping of cultural values for Country and many of the wetlands that would be engaged under relaxed constraints.
- there is a need to increase the role of Traditional Owner Groups in governance and decision-making regarding water allocation, use and management.
- relaxing constraints alone will not deliver positive impacts for Country. Land and water need to be managed holistically.
- future waterways work needs to be led and undertaken by Traditional Owner groups. This will help to address the loss of knowledge about Country due to the dislocation of Traditional Owners from Country, and to provide opportunities for employment and knowledge transfer to future generations.

6.1 Overview

Traditional Owners have an enduring connection to Country and a crucial interest in water resource management. Everything on Country–- the land, water, life, culture, and resources–- is connected. Traditional Owners have moral and cultural obligations to care for, protect and heal Country, and have done so holistically and sustainably for tens of thousands of years. Country connects Traditional Owners to their past, present, and future, and is foundational for identity. Water is an integral part of Country. The management of water by Traditional Owners brings health, wellbeing and economic benefits to individuals and communities, with flow-on benefits to the environment and other water users.

The purpose of engagement during the feasibility study development was to understand Traditional Owner perspectives of the benefits and risks of relaxing constraints for the project area (Murray River from Hume Dam to the Wakool River Junction; Goulburn River from Lake Eildon to the Murray River Junction). The Cultural Values Engagement Report is included in Appendix D for further information. A range of "What we have heard" documents were provided to each group to review and confirm how the conversations were represented. These have been provided directly to the Victorian Minster for Water.

This stage offered the opportunity for dedicated consultation with each of the identified 21 individual Traditional Owner groups.

As a feasibility study, the Victorian CMP does not provide water management responsibilities or cultural water allocations to Traditional Owners. The project does, however, provide an opportunity for Traditional Owners to state concerns and aspirations for the program, and to advise on that nature of future Traditional Owner involvement, roles and responsibilities, should the project proceed to a business case.

Subject to timing of flows, the combination of relaxed constraint flows along the Murray River with tributary inflows could result in floodplain inundation downstream of the study area i.e., below the Wakool River junction. This potential inundation was taken into account within the planning for engagement to ensure conversations with Traditional Owner groups were extended downstream of the project area to the Victoria/South Australia border.

Figure 50 depicts the river reaches both within and outside the project study area, as highlighted in the legend.

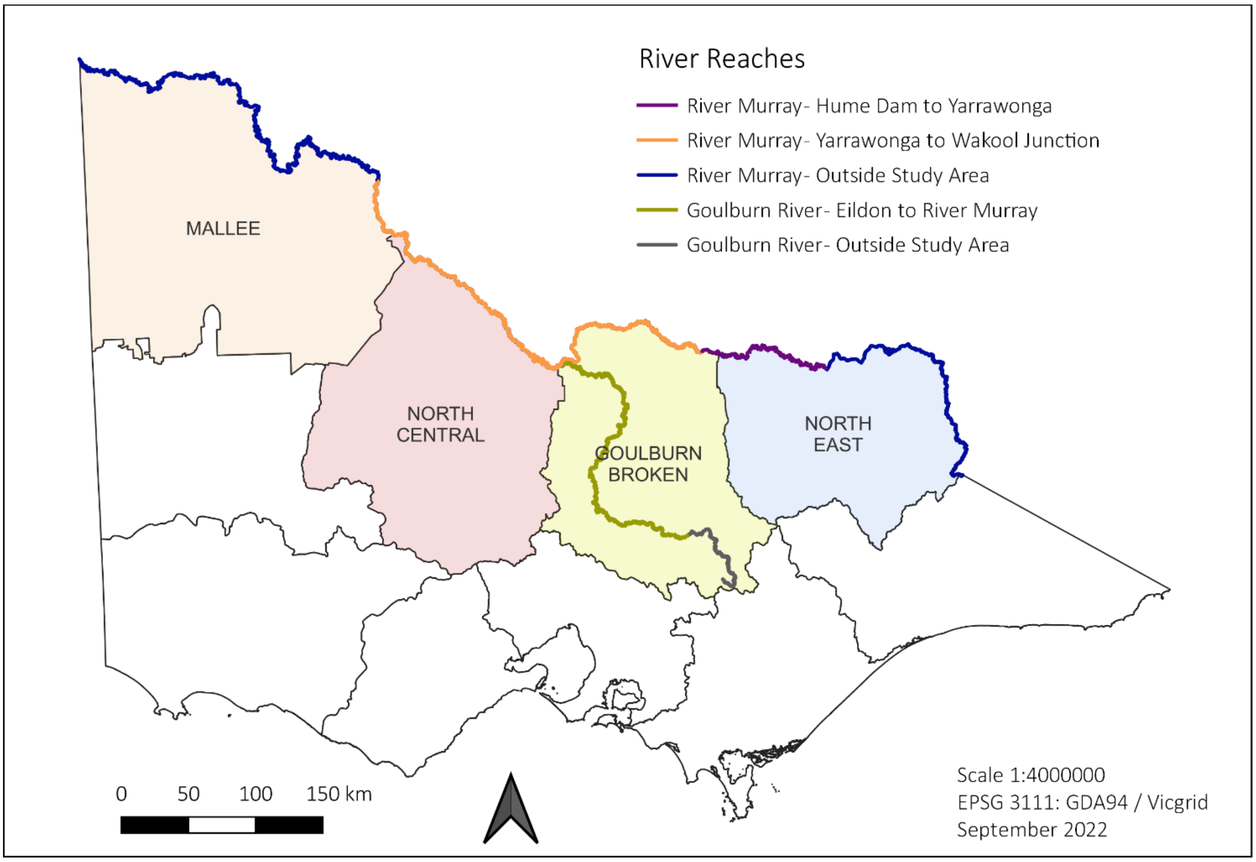


Figure 50 – Key river reaches of the Victorian CMP and CMA boundaries

6.2 Engagement principles

Meaningful consultation with Traditional Owners relied upon demonstrating a shared understanding of Traditional Owner culture and the wants, needs and aspirations of Traditional Owner communities.

Effective engagement with Traditional Owner communities and individuals afforded the opportunity for Traditional Owners to exercise their inherent rights to advance matters of cultural significance where there has been an ongoing connection since time immemorial.

'Culturally appropriate consultation' is an approach that conveys an understanding and respect for Traditional Owner peoples and communities. Traditional Owner people require that consultation be a process that provides for real influence in decision making. During engagement, we ensured that culturally appropriate communication, mechanisms, and good meeting procedures were adhered to. Culturally appropriate consultation with Traditional Owner communities and individuals were recognised in a set of guiding principles to ensure effective recognition and implementation of Traditional Owner initiatives.

The foundational principles for effective Traditional Owner community consultation assisted in an approach that demonstrated respect, established sound working relationships based on transparency, honesty, and the improvement of working relationships with Traditional Owner people and communities. The principles that were adopted under the cultural values engagement for the Victorian CMP are listed below:

- Respect
- Inclusiveness
- Accessibility
- Accountability
- Open and sustained Dialogue.

6.3 Engagement planning

Traditional Owner group identification

A considerable depth of engagement and relationships existed between agencies of the Victorian Government and Traditional Owners within and downstream of the project area prior to commencement of the Victorian CMP cultural assessment workstream. CMAs (GBCMA, NCCMA, MCMA and NECMA) regularly liaise with Traditional Owner groups as part of ongoing CMA activities.

The project team engaged with DEECA and the CMAs to first identify the Traditional Owner groups within and downstream of the project area. The initial discussions confirmed the best approach through existing forums, where appropriate and preferred by Traditional Owner groups, to streamline parallel engagement activities during this stage of the Victorian CMP. The CMAs were instrumental in the identification of Traditional Owner groups for engagement within and downstream of the Victorian CMP project area.

Engagement streams

The team engaged with individual Traditional Owner groups, in accordance with their preferences, to discuss the Victorian CMP, including introducing the program, the rationale, the proposed changes to flows, and the resulting changes to inundation of the river and floodplains.

To assist the project team with planning and logistics, engagement "Streams" (Table 18) were developed based on proximity to the project area and possibility for country to be affected by potential inundation. The streams were:

- Stream 1a: Encompassed twelve Traditional Owner groups who were considered likely to have Country directly impacted by the proposed changes to river flows
- Stream 1b: Included eight Traditional Owner groups with Country directly impacted by the change in inundation regime resulting under relaxed constraints, but whose traditional lands lay outside the constraints project boundary (i.e., downstream of the Murray River and Wakool River junction)
- Stream 2: Comprised Traditional Owner groups within the Murray-Darling Basin whose land would not be directly impacted by the proposed changes.

Table 18 – Traditional Owner groups and engagement streams

Stream	Description	Traditional Owner group	Lead CMA
Stream 1a	Traditional Owner groups that may have Country **directly impacted** by the change in inundation regime resulting under relaxed constraints, and Country is **inside** the project's study area	Taungurung Land and Waters Council Aboriginal Corporation*	GBCMA
		Yorta Yorta Nation Aboriginal Corporation*	GBCMA
		Barapa Barapa and Wamba Wemba Steering Committee	NCCMA
		Barapa Country Aboriginal Corporation	NCCMA
		Wiran/Wamba Wemba Aboriginal Corporation	NCCMA
		Wadi Wadi Wamba Wemba Barapa Barapa First Nations Aboriginal Corporation	MCMA
		Wadi Wadi Land and Water Indigenous Corporation	MCMA
		Wadi Wadi Nation	MCMA
		Bangerang Aboriginal Corporation	NECMA
		Dalka Warra Mittung Aboriginal Corporation	NECMA
		Duduroa Dhargal Aboriginal Corporation	NECMA
		Dhudhuroa Waywurru Nations Aboriginal Corporation	NECMA
Stream 1b	Traditional Owner groups that may have Country directly impacted, by the change in inundation regime resulting under relaxed constraints but are outside the project footprint	First Peoples of Millewa Mallee Aboriginal Corporation*	MCMA
		Tati Tati Aboriginal Corporation	MCMA
		Tati Tati Land and Water Indigenous Corporation	MCMA
		Latji Latji Mumthelang Aboriginal Corporation	MCMA
		Gilbie Aboriginal Corporation	MCMA
		Munatunga Elders Aboriginal Corporation	MCMA
		Dadi Dadi Weki Weki Aboriginal Corporation	MCMA
		Murray Valley Aboriginal Corporation	MCMA
Stream 2	Traditional Owner Groups that are part of the Murray-Darling Basin, whose land will not be directly impacted by the change in inundation regime	Dja Dja Wurrung Clans Aboriginal Corporation*	NCCMA

* Registered Aboriginal Party

6.4 Engagement staging

Engagement with Stream 1a and Stream 1b Traditional Owner groups occurred in three major stages.

- Stage 1 involved virtual introductions and for the Victorian CMP team to develop an understanding of Traditional Owner group preferences for engagement across the lifetime of the program. Face-to-face conversations were arranged with a number of Traditional Owner groups to build relationships and understand potential items for discussion during Stage 2.
- Stage 2 involved on Country meetings, to understand Traditional Owner perspectives of the potential benefits and risks of relaxing constraints. Findings from On Country engagement are assembled into 'what-we-have-heard' documents.
- Stage 3 involved the review of the "what we have heard" documents by Traditional Owner groups. This was to ensure that Traditional Owner perspectives were accurately captured and appropriately conveyed in submissions for the Minister.

For the Stream 2 group, an initial virtual conversation was held to introduce the project, discuss engagement options, and answer any questions. In the initial conversation the Traditional Owner group requested that they be provided updates on the project.

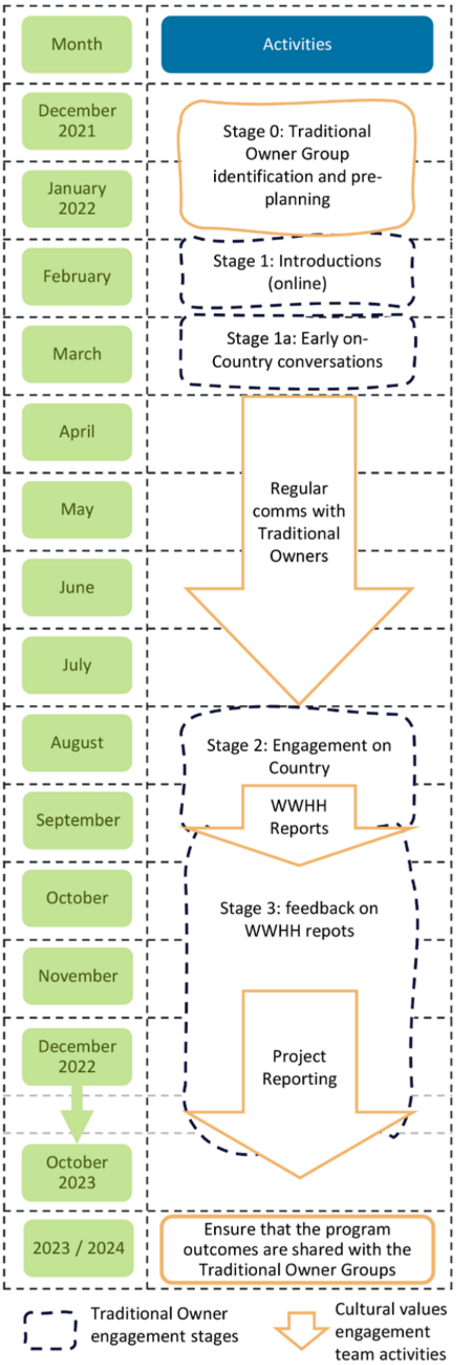


Figure 51 – Traditional Owner group engagement timeline and key activities

6.5 Engagement activities

The approximate timing for key activities during engagement with Traditional Owner groups is shown in Figure 51.

Stage 0 – Traditional Owner group identification and planning

Traditional Owner groups were identified by working with CMAs and DEECA, who have developed long-standing relationships and partnerships with Traditional Owners.

Stage 1: Introductions

Initial engagement consisted of online meetings with Traditional Owner groups to ask to visit them on Country. We discussed why Traditional Owner involvement is critical to the program's success, how each group wanted to engage, and what we could do to make engagement smooth and easy for them.

Stage 1a: Early on Country conversations

We explained the Cultural Values Engagement and the Victorian CMP more broadly and explored the various engagement options with each group and worked with them to identify their preference.

Regular communication with the Traditional Owner groups and CMAs

We maintained contact with the Traditional Owner groups to update them on the progress and confirm planning for engagement in Stage 2.

Stage 2: Engagement on Country

Stage 2 engagement was conducted in person and varied from two-hour meetings to two-day meetings. We shared inundation mapping of sites of interest, visited sites of interest and discussed the positive and negative effects on cultural values.

Stage 3: Feedback on findings

"What we have heard" documents were provided to each Traditional Owner group for review to ensure that Traditional Owner views have been accurately captured and conveyed. The "What we have heard" documents were revised as required based on Traditional Owner feedback, and where permission was granted, have been submitted directly to the Minister.

6.6 Views and considerations expressed

No single summary view on the project was agreed to by all Traditional Owner groups. Each submission, where approved by Traditional Owner groups for inclusion, has been presented as separate, stand-alone statement to the Victorian Minister for Water, as several groups stated it would be inappropriate to merge their messages into one voice.

6.6.1 Key themes

The key themes summarised below are written from the consultant's perspective (Alluvium) rather than being messages agreed by all Traditional Owner groups. Based on the conversations, the majority of the representatives from groups engaged:

- Identified potential benefits of relaxing constraints including: benefits for flora, fauna, and wellbeing benefits to individuals and community of healthy Country.
- Identified potential impacts of relaxing constraints on Country and cultural heritage assets from inappropriate timing of water releases, poor water quality and erosion.
- Identified that the true benefits and risks cannot be assessed without both detailed mapping of cultural assets and detailed knowledge of the flow regimes and implications.
- Emphasised the importance of detailed investigation into the cultural, environmental, and broader community benefits and impact associated with the project.
- Supported further exploration of relaxing constraints to achieve the broader environmental and cultural outcomes and gave in principle support to see the project go forward to the next stage of investigation, although some groups require further information to have a better understanding of the project before they determine their level of support.

Furthermore, the majority of the representatives from Traditional Owner groups engaged expressed the desire to see:

- Significant collaboration with Traditional Owner groups in the next stages, including in decision making over water use.
- Holistic management of land and water, considering the interconnectedness and interdependence of these resources.
- Improved information and engagement if the project continues, to ensure that the information about the project can be understood by the broader community.
- Improved integration between government departments and programs to ensure consistency and continuity in government knowledge.

6.6.2 Future stages

As the CMP progresses, DEECA will continue to partner with Traditional Owners in line with Pupangarli marnmarnepu. DEECA acknowledge Aboriginal Victorians have the right to make choices that best reflect them on their journey to self-determination and are committed to delivering real outcomes by following their lead.

The summary of key recommendations from the consultant's perspective (Alluvium) to inform planning for future stages are:

- There is a need to support Traditional Owners to undertake mapping of cultural values for Country and the many wetlands that would be engaged under relaxed constraints. Traditional Owners want to ensure the protection of current values from any potential negative impacts from relaxing constraints.

- There is a need to increase the role of Traditional Owner groups in governance and decision-making regarding water allocation, use and management. Traditional Owners want to be involved in water governance to ensure that their cultural and economic needs are delivered. Traditional Owners also identified the need for specific actions in relation to many of the wetlands identified, such as the development of cultural management plans and cultural flow requirements for the management of wetlands to inform and guide planning
- Relaxing constraints alone will not deliver positive impacts for Country. Land and water need to be managed holistically. To enable this, Traditional Owner Rangers need to be trained to manage the sites, e.g., to undertake monitoring and land management to care for Country, including the control of weeds, pests, and fire risk
- Future waterways work needs to be led and undertaken by Traditional Owner groups. This will help to address the loss of knowledge about Country due to the dislocation of Traditional Owners from Country, and to provide opportunities for employment and knowledge transfer to future generations.

7. Recreational assessment

7.1 Key outcomes

Key outcomes:

Recreational outcomes assessment

- Impacts to site access from relaxed constraints can be addressed through changes to the operations and management plans and funding pathways
- Improved environmental outcomes arising from relaxed constraints will support the amenity value of recreational land, improved long term visitation rates, enhanced visitor experience and improved community cohesion and appreciation for natural assets.
- Relaxed constraints flows provide conditions for opportunistic recreational pursuits such as bird watching, kayaking etc.
- Strategic collection of visitor data will support ongoing evaluation, reporting and adaptive management.

7.2 Recreational outcomes assessment

Rivers, lakes and floodplains support a wide range of different types of passive and active recreation in Victoria. These experiences are accessible to local communities and tourists that visit these important ecosystems to interact with the forest and waterways. Recreational opportunities are highly valued as they provide enjoyment, support health and wellbeing, social interaction and community cohesion, and contribute to the liveability of rural areas and townships. The recreation outcomes assessment will broadly consider the different social values attributed to, and socio-economic uses of, the Goulburn River and Murray River.

Environmental watering is widely understood to contribute to a range of water-based and riverside recreation e.g., bushwalking, cycling, fishing, camping, swimming, boating and kayaking, and contemplation (VEWH, 2018; MDBA 2017). Relaxing constraints to deliver greater volumes of environmental water to strategically infill billabongs, lagoons, and floodplain depressions, and distribute water across important floodplains supports ecological condition and thereby, the long-term amenity and recreational values of these sites.

The recreation services of Gunbower Forest were estimated to be in the order of $1 million to $4 million per year in 2020[94], based on an estimate of what visitors would be willing to pay if there was a market for this service[95]. Recreation also creates flow on effects to generate important heath, enjoyment, and recuperation benefits for local and out-of-catchment communities. Visitation generates additional economic activity in the local and regional townships for eco-tourism providers, caravan parks, accommodation, pubs, and restaurants, etc.

Important waterway attributes that support nature-based recreation are the proportion and population levels of pre-settlement fish species, number of native waterbirds, length of riverbank with healthy native vegetation, and area of river suitable for recreation without threat to public health[96]. These attributes are some of the primary benefit streams of environmental watering, demonstrating that relaxing constraints would generally be expected to enhance the experience visitors derive from these sites.

Inundating sites traditionally suitable for recreation and impeding site access for periods of time can also generate risks to recreational outcomes. Limiting access for visitors may cause a short-term reduction in tourism, recreation and the flow on economic activity for local townships, tourism operators and businesses. However, while environmental water deliveries may restrict certain types of recreation, it can also provide

[94] Natural Capital Economics (2019). Socio-economic outcomes of environmental watering in Northern Victoria. Project number: 0919023.10

[95] The travel cost method seeks to place a value on non-market environmental goods (such as nature-based recreation activities in river, floodplain, and wetland areas) by using consumption behaviour in related markets. Specifically, the costs of accessing an ecosystem area – such as a river or a national park forest – are used as a proxy for a market price which does not exist.

[96] Bennett, J., Dumsday, R., Howell, G., Lloyd, C., Sturgess, N., Van Raalte, L. (2008). The economic value of improved environmental health in Victorian rivers. Australasian Journal of Environmental Management, 15(3), 138–148. doi:10.1080/14486563.2008.9725196

conditions for other recreational pursuits such as opportunistic kayaking/canoeing, sightseeing, wading and birdwatching.

7.2.1 Consultative Committee drivers

As the VEWH is legislated to consider recreational values in its decision-making under the *Water Act 2007*, a Committee recommendation to consider the recreational values associated with environmental water was proposed. The Consultative Committee supported a desktop assessment of the recreation outcomes of constraints relaxation to be included within the feasibility study.

As initial input to the assessment, the Consultative Committee meeting held in July 2022 provided a workshop discussion on "what are the impacts" of relaxed constraints. Committee members provided useful insights as to the potential impacts to public amenity and how the rivers and adjoining parks and reserves are used by the wider community. Some of these considerations noted by the Committee from this session, and subsequent discussions, have been listed below:

- Pest, plant and animal impacts / weed infestation
- Public infrastructure (tracks, roads, walking trails, boat ramps, Murray River Adventure Trail)
- Future development – long-term local government plans for improvement of tracks and trails
- Site access (public and private).
- Clean up after watering events
- Tourism operators
- Inundation of campsites
- Caravan parks
- Firewood collection
- Sporting groups (e.g., pony clubs)
- Recreational groups.

Committee contributions provided the basis for an initial desktop assessment of the social outcomes and socio-economic components of constraints relaxation.

7.2.2 Victorian recreational values

The 2022 My Victorian Waterways[97] was conducted by Quantum Market Research for DELWP to investigate the Victorian community's connection to our rivers, lakes, floodplains and other waterway features. The survey gathered information about current waterway usage, attitudes and understandings about waterway health, aspirations for the future, and importantly, Victorian recreational values associated with waterways. Conducted in March and April 2022, a total of 5,006 Victorians were recruited to complete the survey through a mix of online and telephone interviews.

Exercise (walking, hiking, etc.) is the most common activity undertaken in proximity to waterways (25%), followed by enjoying the scenery (19%) and dog walking (17%). Of those Victorians surveyed, the recreational activities undertaken the least frequently were horse riding (75%), game hunting (74%) and recreational boating (66%)[98]. A full list of recreation activities prioritised by Victorians can be found in Figure 52 below.

[97] DELWP My Victorian Waterway Survey 2022: https://www.water.vic.gov.au/waterways/my-victorian-waterway-survey
[98] Results presented as a percentage (%) of respondents reporting 'Never' as their answer.

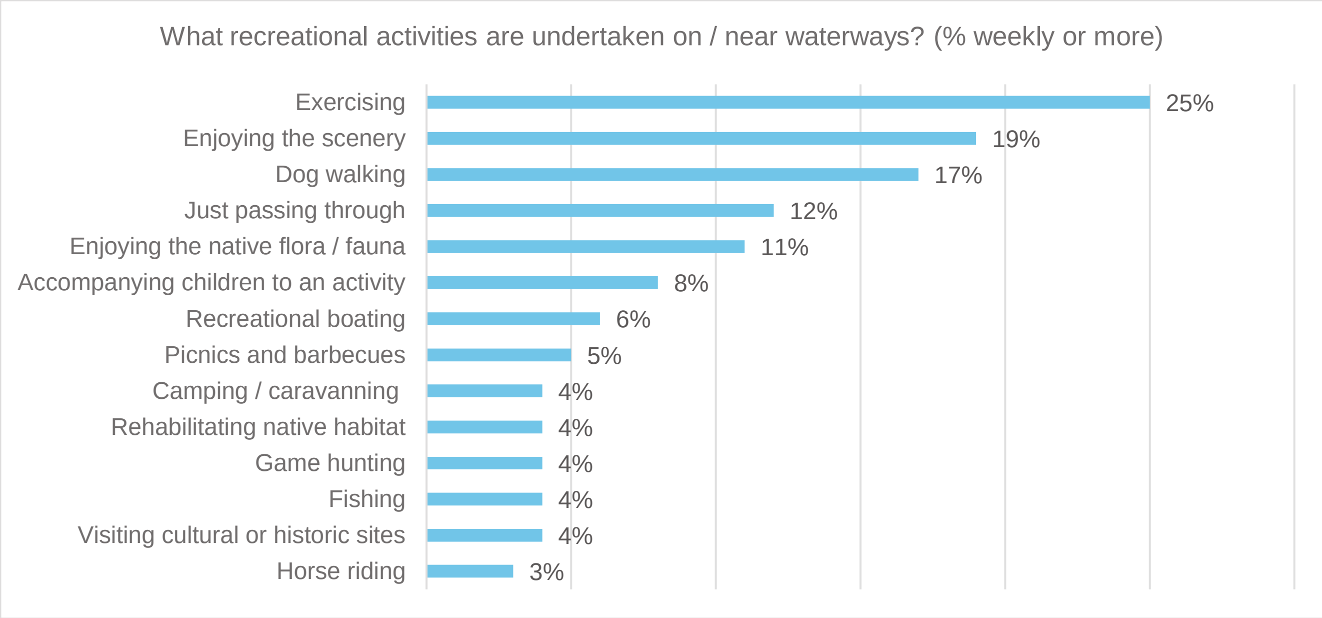


Figure 52 – Victorian recreational activities undertaken on / near waterways (DELWP, 2022)

It is expected that all waterway recreational values supported by Victorians will be impacted to a certain extent by relaxing constraints due to interruption of site access, impacts to recreational groups and decreased tourism during short-term periods of inundation.

Waterways are sought for a variety of experiences with relaxing, as well as activities and fun, being the most common, demonstrating that Victorians use waterways for a range of passive and active recreation. Experience sought vary by age groups and the different types of waterways people like to visit, with slight differences in the experiences sought between catchment management regions. A full outline of all experiences sought by Victorians can be found in Figure 53 below.

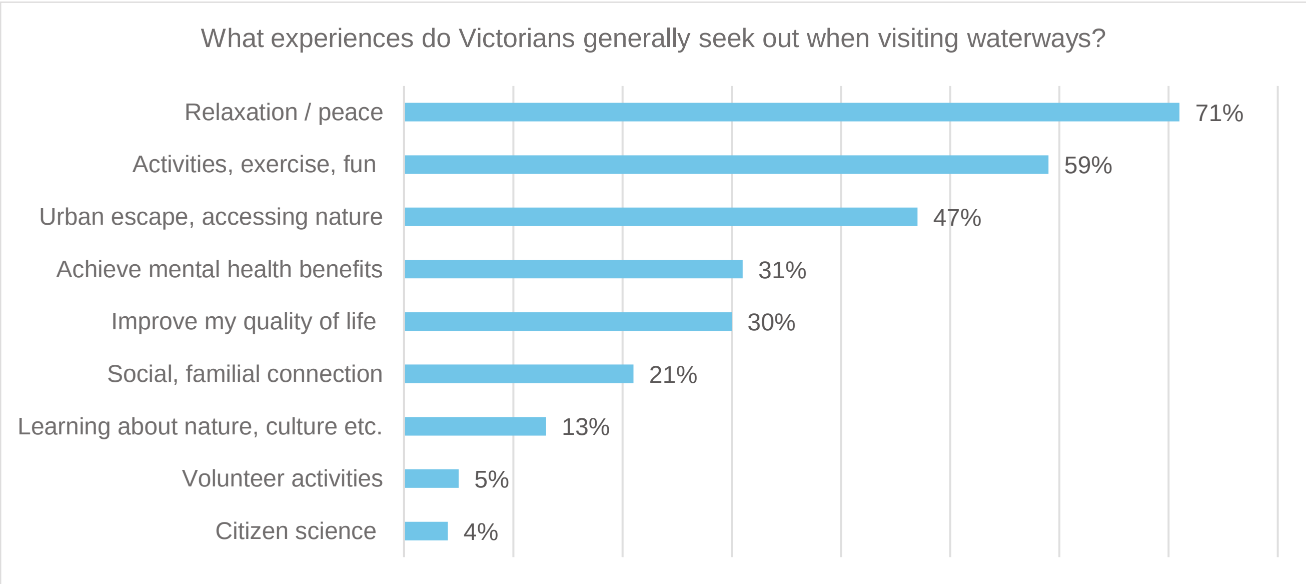


Figure 53 – Waterway experiences sought by Victorians (DELWP, 2022)

The *My Victorian Waterways Survey* provides a significant state and catchment-wide social benchmark. The project has sought to draw detailed information regarding recreational values and aspirations from this data to further develop case study profiles for a selection of high-value sites in the project area. Survey data from catchment management regions has been further discussed for each of the case study sites to further explore the values and pursuits of their local communities.

7.2.3 Recreational assessment

The feasibility study has provided the opportunity for a qualitative analysis of the short and long-term impacts on recreational values of constraints relaxation through preliminary engagement with land and waterway managers, focusing on six case study areas (see Table 19). This approach provides an initial investigation with the aim to support a potential future stage economic evaluation, which would also include private and non-recreational risks and benefits.

Table 19 – Recreation outcomes assessment – Case study sites

Case study site	Victorian CMP river reach	Waterway manager	Land manager	Other relevant organisations
Gunbower Island	Yarrawonga to Wakool	NCCMA	Parks Victoria DEECA Regions[a]	-
Barmah National Park	Yarrawonga to Wakool	GBCMA	Parks Victoria Yorta Yorta Nation Aboriginal Corporation[a]	-
Nyah-Vinifera Park	Yarrawonga to Wakool	MCMA[a]	Parks Victoria	-
Lake Moodemere	Hume to Yarrawonga	NECMA	Parks Victoria	-
Gemmill Swamp	Lower Goulburn	GBCMA	Parks Victoria	Yorta Yorta Nation Aboriginal Corporation[a]
Molesworth	Mid Goulburn	GBCMA	Parks Victoria	Taungurung Land and Waters Council[a]

[a] Stakeholders were unable to attend workshop discussions and may have provided feedback out of session

Dedicated workshops were held for public land and waterway managers. Due to the unforeseeable circumstances of the 2022 Victorian floods in northern Victoria, certain parties were unable to attend workshop discussions to provide their insights to this assessment. As a result, the feasibility study assessment relies on desktop analysis, as well as contributions from those stakeholders who were able to contribute (see Table 19). Further engagement with community, recreational groups, public land and waterway managers and private landholders is anticipated as part of potential futures program stages.

For each case study site, the maximum notified flow rate was selected for discussion as it would present the most significant risks and benefits to recreational values of case study site. Flow rates, timing, frequency and duration for each case study river reach has been outlined below.

Table 20 – Flow scenario information provided to support the assessment

	Yarrawonga to Wakool[1]	Hume to Yarrawonga[1]	Lower Goulburn[2]	Mid Goulburn[2]
Flow rate	45,000 ML/day equivalent release at Yarrawonga Weir	40,000 ML/day equivalent release at Doctor's Point	25,000 ML/day equivalent release at Goulburn Weir	14,000 ML/day equivalent release at Eildon
Timing	Mostly August to October Occasionally earlier (June, July) or later (November)		July to October (winter and spring)	
Frequency	Align with ecological requirements and pre-regulation flow regimes		Overbank event is preferred around 7 years in 10	

	Yarrawonga to Wakool[1]	Hume to Yarrawonga[1]	Lower Goulburn[2]	Mid Goulburn[2]
	Depending on season storage volumes, tributary flows		Managed overbanks events would not be planned if a natural event has achieved the target that year	
Duration	Mostly 7-14 days at target flow Occasionally up to 30 days, for lower-end flows		5 days at peak flow Rise length around 6 days, fall beginning around 11 days	
Recession	Gradual recession to reduce erosion risk and stranding of fish		N/S	
Notification	N/S	Staged notification system to give advice of planned flows		

[1] MDBA, 2022
[2] Hydrological modelling results – HARC, 2023

The case study sites are considered to be popular public land areas. They are also some of the areas most impacted by inundation generally up to minor flood levels and have documented approaches to manage visitor experience and host a range of recreational activities.

An initial desktop review of existing information included:

- Project GIS inundation maps for the maximum notified flow rate for each case study area and other spatial information, e.g., Strava heatmaps, MapShare[99]
- Tracks and trails impacted and the depth of inundation by the maximum notified relaxed constraint flow rate
- Relevant documentation e.g., constraints reach reports, constraints concept business cases, visitor experience strategies and management plans, park notes and plans, etc.
- Social, recreational, and economic values and uses likely to be supported or impacted by relaxed constraints for each of the specified case studies.

Recent observations in 2022 of flows in the Goulburn River and Murray River which are in the range of flows considered under the Victorian CMP, were also incorporated into the assessment.

Information sourced from the desktop assessment was drawn directly into the case study outcomes summaries provided for workshop discussion. Assumptions were consequently tested with stakeholders, who provided valuable insights and details of the anticipated risks and benefits of bringing water onto the floodplain at these sites.

Short-term risks and benefits were defined as occurring during or in the immediate aftermath of inundation such as:

- interrupted site access
- decreased tourism, clean up after watering events or
- supporting conditions for opportunistic floodplain recreation (e.g., birdwatching and kayaking).

Long-term outcomes are the enduring effects of regular inundation of the billabongs, lagoons and floodplain depressions, such as the:

- improved amenity and ecological condition
- increased visitor numbers and
- impacts to planning of future infrastructure (e.g., Murray River Adventure Trail).

Further information on each of the case study sites and the potential impacts and benefits of constraints relaxation is presented in Section 7.2.4 below.

[99] MapshareVic

7.2.4 Case Study Sites

7.2.4.1 Barmah National Park

Background

Barmah National Park, together with the adjoining Murray Valley Regional and National Parks, forms the largest river red gum forest in the world. The Barmah Forest is located within Yorta Yorta's traditional boundaries, the site and its waterways are collaboratively managed by YYNAC, Parks Victoria and GBCMA.

Barmah National Park supports a range of recreational activities. Walking tracks and trails include the Yamyabuc Discovery Trail (1.5km), Lakes Loop Track (4km) and Broken Creek Loop Track (3.5km) that guide visitors through natural assets (river red gum and grey box woodland) and cultural features such as Aboriginal cooking mounds.

Birdwatching, wildlife photography and sightseeing are popular recreational activities, as the site is an important habitat for waterbirds with more than 200 species of birds recorded here. Visitors participate in recreational boating, fishing, and canoeing with swimming available at a number of sandy river bend beaches. Camping is also popular with campsites along the riverbank within the Ghungalla zone and along the sandy beaches at Barmah Lakes in the Gulpa Gaka zone.

Visitors often explore the unique ecology along the Murray River through guided tours with Kingfisher Cruises that travels through the "Barmah Choke", and across the waterways through the lakes and creeks in the area when high water levels support this venture.

Community Recreational Values

The My Victorian Waterways survey (DELWP, 2022) identified residents of the Goulburn-Broken catchment state they actively seek experiences such as exercise / fun (53%) and relaxation (69%) when visiting waterways. The most common recreational activities undertaken by these communities are enjoying the scenery (27%), passing through (17%) and water-based activities (16%). It would be expected that the local visitors to Barmah National Park may prioritise a range of passive and active recreation such as sightseeing, birdwatching, picnicking, as well as canoeing/kayaking, swimming, fishing, boating etc.

Most recreational activities take advantage of the environmental assets of the Ramsar-listed site and therefore wetland health and wildlife are a strong attraction for both locals and visitors alike (DELWP, 2022).

Figure 54 – Camping on the sandy river beaches at Barmah National Park

Source: https://www.visitvictoria.com/

Figure 55 – Kingfisher Cruises, Barmah National Park

Source: https://www.kingfishercruises.com.au/

Table 21 – Modelled percent inundation of Barmah National Park under relaxed constraint scenarios

Flow rate measured downstream of Yarrawonga Weir	Inundated area (ha)	Percent inundated
25,000 ML/day	12,788	45%
30,000 ML/day	14,511	51%
40,000 ML/day	18,138	64%
45,000 ML/day	19,693	69%

Key outcomes

For the notified flow rate of 45,000 ML/day downstream of Yarrawonga, Gulf Track and the park would largely be closed to the public beyond Sandridge track. These tracks are the primary linking tracks that connect to Barmah Lakes camping area and the Gulf camping area. The main constraint was noted to be access across Smiths Creek along the southern boundary of the park.

Sandridge track is currently proposed to be upgraded as part of the Murray River Adventure Trail. Future planning of the trail may need to ensure the proposed upgrade can withstand regular inundation under relaxed constraints.

At the 45,000 ML/day flow rate, access for day visitors and camping would be cut off, and the walking track to Barmah Lakes camping area would be completely inundated. All camping (dispersed or otherwise) would be closed, but not all campsites would be inundated. As the river is a purging system, the high riverbanks in sections of the park would not be inundated potentially providing camp sites for visitors who access by boat. Alternatively, Ulupna Island on the easternmost section of the park provides greater access for camping; however, the beaches would be inundated at the notified flow rate.

Timing of constraints flows would make little difference to the current visitation rates, as they are currently limited by inundation regimes.[100] Apiarists and tourism providers generally seek to access the site from December and may be impacted if the constraints flows recede toward this time with limited time to allow for drying off of tracks.

Relaxing constraints to deliver environmental water was noted to potentially narrow the window of opportunity to run conservation programs in the site. Pest plant and animal control programs have potential to be impacted e.g., fox baiting and weed spraying. This may pose long-term implications for the amenity value of the park and visitor experience.

It was noted that Dharnya Centre becomes inaccessible at approx. 50-55,000 ML/day. Inundation modelling for the notified flow rate showed no access implications to the Dharnya Centre but water pooling in the surrounding landscape. This may have general impacts on how the centre and nearby area is used for activities e.g., by school groups.

Kingfisher Cruises can be adaptable to low-level inundation. It was noted that if the concrete boat ramp at Barmah Lake Day Visitor Centre was inundated, visitors may be boarded from the urban boat ramp at Rices Weir on Broken Creek. Flooding is a popular time for visitors to participate in this commercial tour and other recreational boating and relaxing constraints may provide conditions to enhance these opportunities, so long as the river is not closed due to public safety risks.

The long-term benefits of environmental watering may see a greater extent of improved ecological condition and amenity value for visitors. This would enhance existing riverside and water-based recreation such as boating, birdwatching, camping, bushwalking, picnicking, etc.

There were noted opportunities for new or upgraded infrastructure to enhance visitor experience by allowing visitors to access the site during inundation, e.g., a boardwalk installed near Barmah Lakes over the proposed inundation extent.

[100] Current flooding regimes at approximately 15-20,000ML/day restrict access to the Lakes, Dharnya Centra and Ulupna Island.

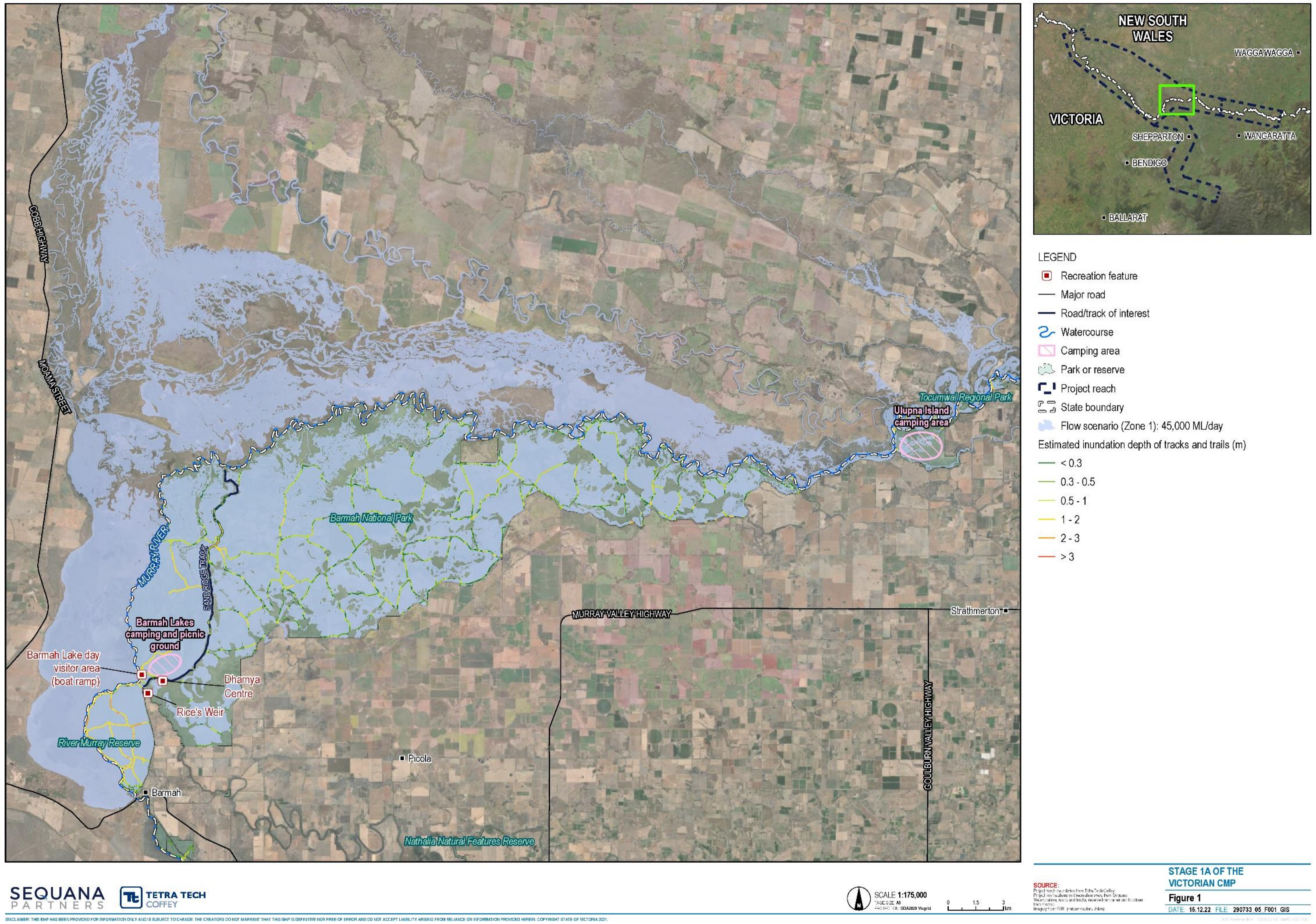


Figure 56 – Inundation extent of Barmah National Park at 45,000 ML/day downstream of Yarrawonga

Table 22 – Outcomes summary for Barmah National Park

Risks	Benefits
Short-term • **Decreased site access to recreation areas, campsites, river beaches** • **Impacts to sites of community importance (e.g., Dharnya Centre)** • **Decreased tourism and visitor activity** • **Inundation of some campsites** • Impacts to recreational groups • Inundation and/or damage to public roads, tracks, walking trails, boat ramps, toilets, bridges – Sandridge Track – Boat ramp (Barmah Lake day Visitor Centre) • Clean up after watering events • Decreased business activity (e.g., general stores, pubs and restaurants, accommodation, caravan parks) • Insect infestation from improved conditions for insect breeding (mosquitos). **Long-term** • Impacts to future planning of public infrastructure (e.g., tracks and trails, **Murray River Adventure Trail)** • **Impacts to park operations (e.g., pest plant and animal control programs)** • Potential pest plant and animal impacts / weed infestation (e.g., carp breeding)	**Short-term** • **Opportunities for recreational floodplain activities (e.g., birdwatching, opportunistic canoeing/kayaking).** **Long-term** • Improved aesthetic and amenity value • **Access to healthier Country** • Improved opportunities for water-based recreation: – **Boating** – Canoeing / kayaking • Improved opportunities for riverside recreation and amenity: – **Fishing** – **Birdwatching** – **Picnicking** – **Photography / Sightseeing** – **Camping** – **Cultural tourism / Ceremony** – 4WD & 2WD driving – General wellbeing benefits / contemplation • **Benefits to apiarists (healthy river red gum forests for general feeding)** • Enhanced community cohesion and events e.g., boat tours, Murray cod fishing season • Increased visitor numbers and enhanced tourism • Enhanced business activity (e.g., Kingfisher Cruises, Barmah Bridge Caravan Park, Moira Gums Guesthouse, etc.).

Note: **Bold** items outline outcomes that were indicated to be of particular importance to this site

7.2.4.2 Gunbower Island

Background

Gunbower Island is a 26,400 ha Ramsar-listed wetland that lies between Gunbower Creek and the Murray River in North Central Victoria. Gunbower Island is home to the second largest river red gum forest in Victoria. Evidence of Aboriginal occupation can be found in the various scar trees, cooking mounds and middens dispersed across the island.

Popular recreational activities at Gunbower include fishing, bushwalking, birdwatching, camping, canoeing, or sightseeing. From Koondrook, walking tracks include Turtle loop (13.2km) and Eagle loop (9.1km) that meander through red gum forests and wetlands. Kayaking and canoeing is popular along sections of Gunbower Creek such as within Cohuna Lagoon, as well as Reedy Lagoon, Yarran Creek, and around Spur Island when the forest is holding water.

The site holds particular importance to the community for hosting large events such as the Cohuna Bridge to Bridge, Massive Murray Paddle, Black Swan Paddling Race, Southern 80 and is a popular location during Murray cod fishing season. Some roads and tracks to recreational areas at the site can be seasonally closed by land managers to protect tracks when the forest is flooded (both unregulated and managed environmental watering events) which generally occurs between winter and early summer. Impacts of track closures are accounted for in planning environmental watering events, with early notification and alternative access routes advertised within the community and where possible ensuring key access tracks are reopened as early as possible to allow access during summer peak visitor activity.

Gunbower island provides economic stimulus through tourism, apiculture (beekeeping) and timber production. In 2021, commercial timber harvesting was estimated to contribute $145,000/yr to local communities such as Gunbower and Cohuna townships via commercial coup harvest income.[101] Gunbower Forest is also a key domestic firewood collection area that is highly valued by local residents.

Community Recreational Values

North Central residents most frequently use waterways for exercise (32%), enjoying scenery (27%), and for water-based recreation activities (16%). Residents of the North Central catchment are most often seeking relaxation / peace (69%) when they access these waterways (DELWP, 2022).

The community may place a particular importance on passive recreational pursuits at Gunbower such as birdwatching, sightseeing and contemplation. Active recreational activities understood to be popular at the site are running / bushwalking, canoeing / kayaking, fishing, and camping.

Figure 57 – Visitor enjoying bird watching in spring, NCCMA

Figure 58 – Visitors canoeing in high flows in October 2022

Credit: Murray River Adventures

Table 23 – Modelled percent inundation of Gunbower Island under relaxed constraint scenarios

Reserve	Flow rate measured downstream of Yarrawonga Weir			
	25,000 ML/day	30,000 ML/day	40,000 ML/day	45,000 ML/day
Gunbower National Park (9335 ha)	14% (1322 ha)	23% (2177 ha)	42% (3888 ha)	48% (4477 ha)
Gunbower State Forest (8391 ha)	44% (3715 ha)	56% (4702 ha)	62% (5197 ha)	69% (5779 ha)

Key outcomes

At the notified flow rate of 40,000 ML/day at Yarrawonga, it was estimated that all tracks leading to the Murray would largely be closed, however some popular camping and fishing areas along the Gunbower Creek below Cohuna will remain accessible. For example, the popular Tree Tops Scout Camp area and Spences Bridge Boat ramp and camping area will remain accessible.

As most tracks in the National Park are clayey soils that are undriveable when wet, they would require adequate drying time to ensure access for visitors in Summer. Certain roads and tracks (e.g., Nursery Track) are maintained as strategic access roads with well-formed gravel tracks that would be less impacted.

There are proposed infrastructure upgrades to River Track to form the Murray River Adventure Trail, which could act as a 'recreational spine' through the park and forest. It was noted that the proposed track upgrades may face long-term impacts from regular inundation.

The short-term impacts to site access would last for approximately 6-8 weeks[102] and would decrease site access, visitation, and tourism to the region during this period. This may be partially offset by visitors coming to see water on the floodplains provided this opportunity is effectively communicated to the public. There is an additional potential benefit for recreation and businesses that provide services for birdwatching, fishing, boating, education, and other floodplain activities. The local cruise boat known as the 'Wetlander' which operates on the Gunbower Creek would not be impacted by the notified flow rates.

Boating visitors to Gunbower Island typically access the lower Gunbower Creek via a boat ramp at Spences Bridge. The Gunbower Creek will remain accessible and safe for recreational boating and fishing at the notified flow rate. Boat access is typically from Shillinglaws regulator, Masters landing and Torrumbarry Weir boat ramps. While all sites are expected to be impacted by the notified flow rate, access tracks to the popular Master Landing camp site and Torrumbarry Weir caravan park will remain open. Camping is dispersed across the Murray River and Gunbower Creek. While certain campsites would be inaccessible or inundated at the notified flow rate, alternative options near Gunbower Creek will be available for visitors.

The improved amenity of the forest and park would support recreation and enhance the experience visitors derive from activities such as birdwatching, photography, sightseeing, fishing, boating, cultural tourism, walking/bushwalking, cycling, paddle boarding, canoeing/kayaking, 2WD/4WD tours, horse and pony rides (where permitted), and camping. The improved amenity value is expected to increase long-term tourism, benefitting regional economies and business activity (e.g., holiday parks and adventure tourism providers).

Gunbower State Forest provides the opportunity for further recreation activities such as duck hunting, shooting, and domestic firewood collection. Supporting healthy red gum communities would provide benefits to recreational firewood collection and timber harvesting businesses. It was noted that logging coupes are planned years in advance, allowing waterway managers and environmental water holders to plan watering events with minimal impact.

[101] MJA. *Gunbower Island Shared Benefits Project*. Prepared for North Central CMA, 14 April 2021.
[102] This includes inundation to recession, plus an additional grace period for drying off and any track maintenance

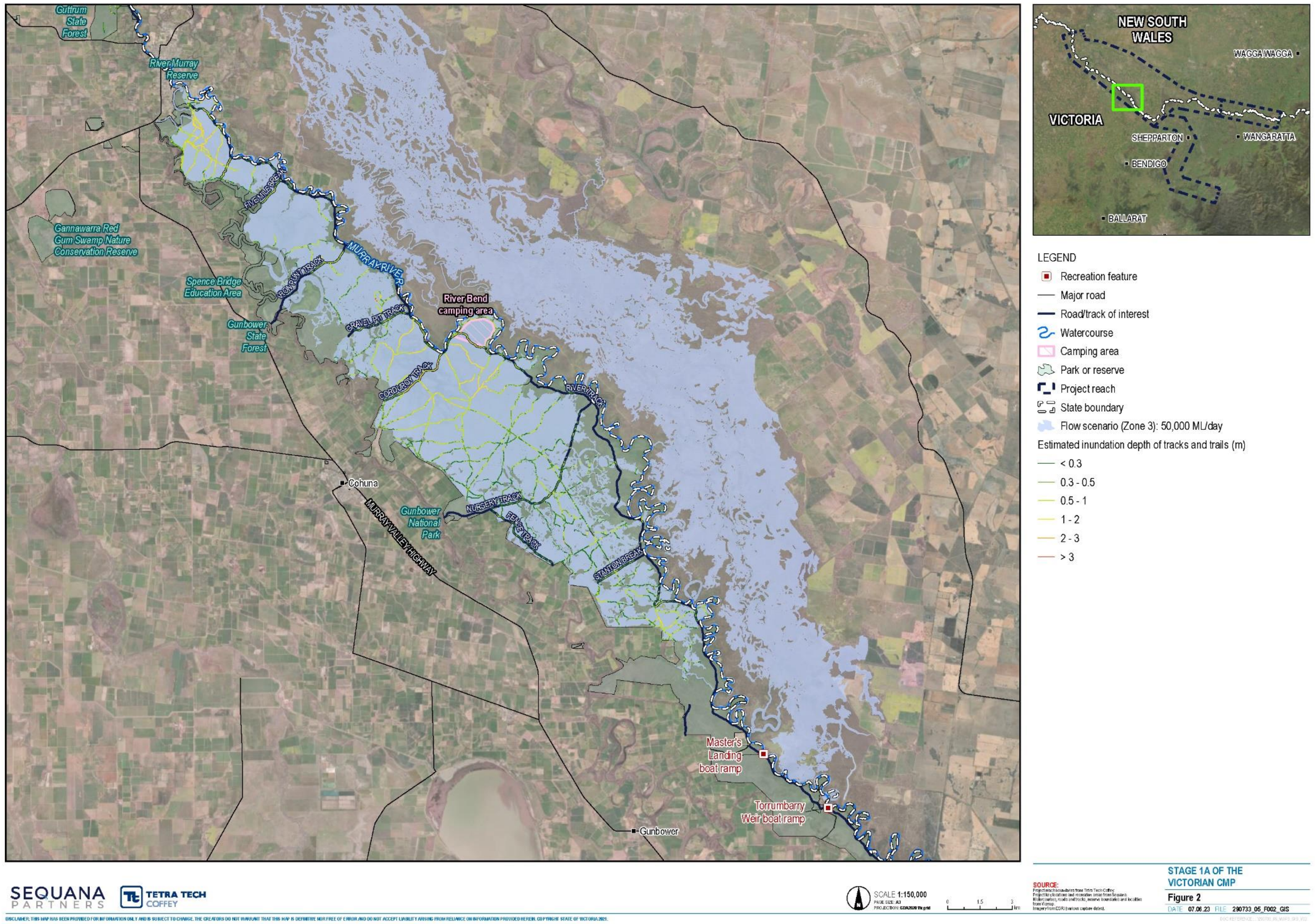


Figure 59 – Inundation extent of Barmah National Park at 45,000 ML/day downstream of Yarrawonga

Table 24 – Outcomes summary for Gunbower Island

Risks	Benefits
Short-term • Decreased site access to recreation sites • Decreased tourism and visitor activity • Inundation of some campsites • Impacts on sites of community importance • Inundation and/or damage to public roads, tracks, walking trails, boat ramps – Nursery Track – Corduroy Track – Stanton Break – Gravel Pit Track – Iron Punt Track – Five Mile Break – Wire Fence Track • **Impacts on firewood collection*** • Clean up after watering events • Decreased business activity (e.g., general stores, timber harvesting, pubs and restaurants, accommodation, caravan parks). **Long-term** • Impacts on future planning of public infrastructure (e.g., tracks and trails, Murray River Adventure Trail) • Impacts on community events (e.g., Massive Murray Paddle) • Pest plant and animal impacts/weed infestation (e.g., carp breeding)	**Short-term** • Supporting conditions for opportunistic water-based recreation (e.g., **canoeing/kayaking, birdwatching**). **Long-term** • Improved aesthetic and amenity value • Improved landscape condition to enable connection to Country • Improved opportunities for water-based recreation: – Fishing – Boating – Canoeing/kayaking – **Duck hunting*** • Improved opportunities for riverside recreation and amenity: – **Birdwatching** – Walking / bushwalking / dog walking* – Cultural tourism – Photography / sightseeing – Camping – 4WD & 2WD driving – General well-being benefits / contemplation • Enhanced community cohesion – i.e., events such as tours, park visitation, activity operators • Improved community events (e.g., Murray cod fishing season, The Black Swan Paddling Race, Cohuna Bridge to Bridge) • Increased visitor numbers and enhanced tourism • Enhanced business activity (e.g., Vic Forests, Riverside caravan parks, general stores, eco-tourism providers, etc.) • Benefits to timber harvesters (healthy river red gums for harvesting)* • Benefits to apiarists (healthy river red gum forests for greater bee productivity).

*State Forest Only

Note: **Bold** items outline outcomes that were indicated to be of particular importance to this site

7.2.4.3 Lake Moodemere

Background

Lake Moodemere is a natural feature along the Hume to Yarrawonga reach of the Murray River. The waterbody is formed by wetlands spanning approximately 62 ha, linking to Sunday Creek through Hells Gate regulator. Water levels in the Lake Moodemere-Sunday Creek complex have been actively managed for around 100 years as a holding lagoon for irrigation.

The site attracts visitors from both within and outside the area, particularly for its nature-based tourism and water-based recreation opportunities. The lake has a long narrow "finger" that stretches north toward the Murray commonly used by water-skiers and boats, that run laps at high speeds. The rest of the lake is used for fishing, boating, rowing / kayaking, and events such as the Rutherglen Regatta, Australia's longest-running regatta which has been held on the 2nd weekend in January each year since 1863.

Camping is dispersed throughout the area in and around a 13 km walking trail around the lake that also provides for bushwalkers and cyclists. A bird-viewing platform and picnic area support passive recreational activities in the area and is used commonly by school groups for excursions and education. Direct expenditure by recreational users at Lake Moodemere was estimated at $278,000/yr in 2019, with majority economic contribution from overnight visitors.[103]

A concurrent reconfiguration project is looking to provide a more water efficient and cost-effective irrigation system by delivering water directly to Sunday Creek. The project would achieve a more natural wetting and drying regime, while still pumping water into the lake to support community and recreational values of the site during summer.[104]

Community Recreational Values

Residents in the North East catchment most frequently use waterways for exercise (38%), enjoying scenery (33%) and for recreational water activities (26%). One of the greatest valued experiences that these communities seek out when visiting waterways is urban escape by accessing nature (39%) (DELWP, 2022).

NECMA has identified the Lake Moodemere-Sunday Creek complex as a priority wetland under the 2014 Waterway Management Strategy. Under relaxed constraint flow scenarios, Lake Moodemere and the Nature Conservation Reserve is the most heavily impacted Parks Victoria reserve along the Hume to Yarrawonga reach.

Figure 60 – 2017 Rutherglen Regatta supported by more than 1000 entries. Border Mail, 15 January 2017

Source: Credit: Mark Jesser

Figure 61 – Picnicking at Lake Moodemere, Warby Range Bushwalkers

Table 25 – Modelled percent inundation of Lake Moodemere under relaxed constraint scenarios

Reserve	Flow rate measured downstream of Doctor's Point		
	25,000 ML/day	30,000 ML/day	40,000 ML/day
Lake Moodemere Lake Reserve (246 ha)	-	80% (211 ha)	90% (237 ha)
Moodemere Nature Conservation Reserve (73 ha)	-	33% (24 ha)	62% (45 ha)

Key outcomes

For the notified flow rate of 40,000 ML/day at Doctor's Point, the southern tracks near Lake Road appeared to be completely inundated, including the boat ramp and toilet block. This area was noted to be lower on the floodplain compared to the rest of the park and is generally a trouble spot for land managers due to regular inundation, with the southernmost track generally unused by visitors. The track beyond McDonald Road would also be inundated at this flow rate, limiting access to the eastern side of the lake.

Tracks and trails in the park are generally gravel and well-formed, but under any inundation they are closed for periods of time. Risks associated with limited site access extend beyond the period of inundation and recession, with land managers required to ensure there is adequate time for tracks to dry prior to peak visitor activity in November/December. Proposed infrastructure for the site includes a walking platform in the lower floodplain, which may provide sightseeing opportunities for walkers and other visitors.

Key events held here include the Lake Moodemere Invitational Water Ski Slalom Classic in February and Rowing Regatta in January of each year. As the constraints flow scenarios do not coincide with this timing and the lake levels are proposed to be maintained for these events as part of the Sunday Creek Reconfiguration project, there are no likely impacts. Relaxed constraint flows may enhance the amenity value and the experience that community derives from the location.

Some of the key user groups of the site are water-skiers, rowers, and campers. Water-skiers and rowers may benefit from deliveries in spring if water levels are sustained through to summer. Camping and group picnicking opportunities will be impacted by the short-term inundation, with general benefits from the improved amenity value in summer.

Generally, it was stated that constraints relaxation to deliver environmental water to the site provide for greater windows where the lake level is high for water-based recreation. A relaxed constraint flow delivered in winter or spring could also reduce the amount of water diverted as part of the reconfiguration project to maintain the water height in summer.

[103] Street Ryan & Associates. (2019). North East Region Socio-Economic Value of Recreational Water: Selected Waterways and Waterbodies. Prepared for NECMA, March 2019
[104] Jacobs. (2020). Sunday Creek Reconfiguration Project: Socio-Economic Impacts. Prepared for NECMA, 9 October 2020

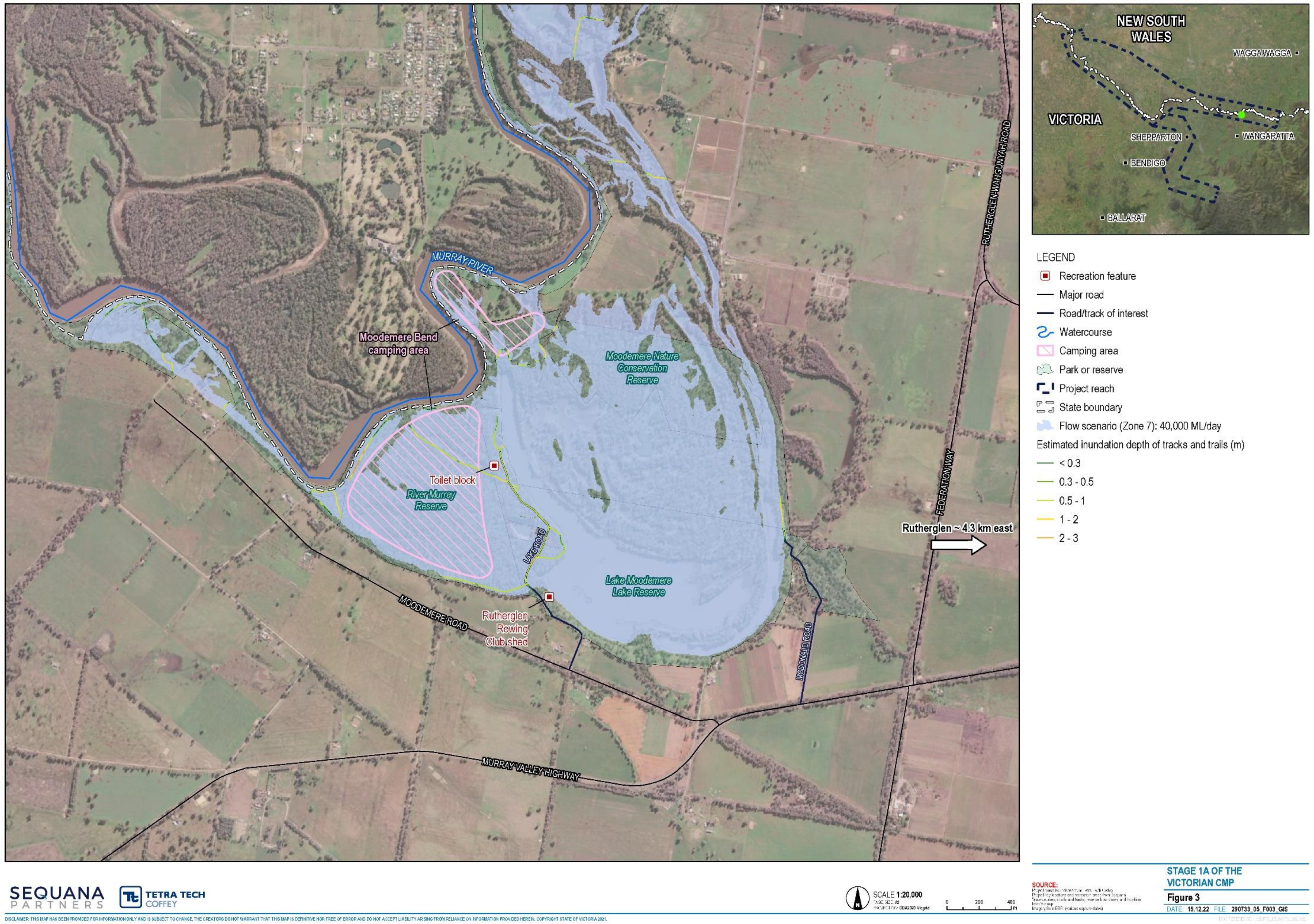


Figure 62 – Inundation extent of Lake Moodemere at 40,000 ML/day downstream of Doctors Point

Table 26 – Outcomes summary for Lake Moodemere

Risks	Benefits
Short-term	**Short-term**
• **Inundation and/or damage to public roads, tracks, walking trails, boat ramps, toilet blocks** – Lake Road – McDonald Road • Decreased site access • Inundation or restricted access to some campsites • Clean up after watering events • Insect infestation from improved conditions for insect breeding (mosquitos).	• **Supporting conditions for opportunistic water-based recreation (e.g., water-skiing, rowing).**
Long-term	**Long-term**
• **Maintenance of tracks, trails, amenities (e.g., toilet blocks) following regular inundation** • Pest plant and animal impacts / weed infestation (e.g., carp breeding).	• Improved environmental condition, aesthetic and amenity value for sites of community importance (e.g., winery estates) • Enhanced community value and appreciation of natural assets • **Potential to maintain existing opportunities** for water-based recreation: – Fishing – **Rowing** / Kayaking / Canoeing – **Water-Skiing** • **Potential to maintain existing opportunities** for riverside recreation and amenity: – **Bike riding** – **Running / walking** – **Picnicking** – Swimming – Bushwalking – Camping – General wellbeing benefits • Access to healthier Country • Potential to support events (e.g., Rutherglen Regatta) • Increased visitor numbers and enhanced tourism.

Note: **Bold** items outline outcomes that were indicated to be of particular importance to this site

7.2.4.4 Nyah-Vinifera Park

Background

Nyah-Vinifera Park is located in the Swan Hill region covering an area of roughly 1,000 ha including Parnee Malloo Creek, river red gum forest and woodland, wetlands and small areas of Blackbox woodland.

Camping is popular at the northern and southern ends of Nyah, with dispersed camping in between along the Murray River off River Track. River Track acts as a spine to the area, with distinct features branching off the track along the way. The features include camping sites, fishing spots, watering holes as well as key Aboriginal historical sites from the Wadi Wadi people such as canoe trees, middens, and burial grounds.

Boat ramps outside the park see visitors launch and travel into the park to fish and camp on the Murray River, including for the Nyah West Fishing Competition held each February.

At Vinifera, camping is very dispersed along the Murray River, with less suitable camping locations than at Nyah and so few campers at most times. In a natural flood, the park is only accessible from the southern end for a small stretch. Bushwalking and picnicking are common through the meandering tracks and picnic tables scattered throughout the site.

Community Recreational Values

Mallee residents have stated they actively seek experiences of relaxation (81%) and exercise / fun (61%) when visiting waterways. Recreational activities primarily undertaken by residents are enjoying the scenery (24%), exercise (22%), passing through (17%) and picnics / barbeques (13%) (DELWP, 2022).

Relaxation was the greatest reason for Victorians to seek out waterways and particularly so for residents in the Mallee catchment. It is expected that local residents of the Mallee catchment may prioritise a suite of recreational activities such as fishing, bike riding, running / walking / bushwalking, and enjoying the scenery.

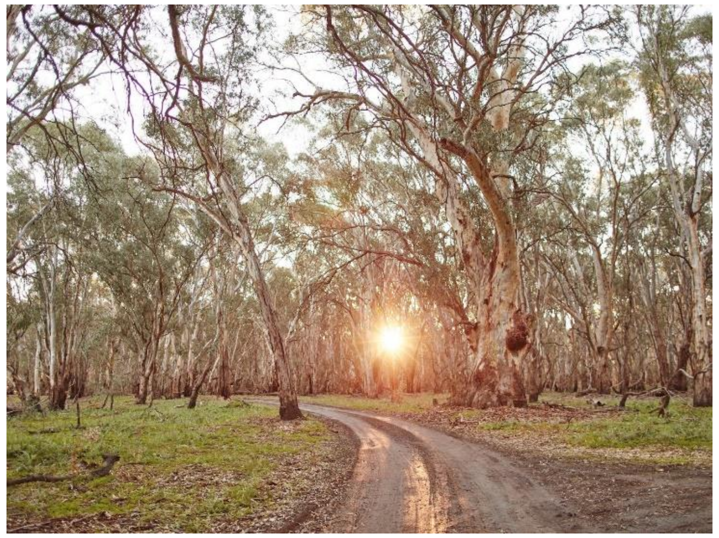


Figure 64 – Nyah Vinifera Park

Source: https://www.visitvictoria.com/

Figure 63 – Nyah Sports Ground Free Campsite. On the Road magazine, 25 August 2016

Table 27 – Modelled percent inundation of Nyah-Vinifera Park under relaxed constraint scenarios

Flow rate measured downstream of Yarrawonga Weir	Nyah-Vinifera Park	
	Inundated area (ha)	Percent inundated
25,000 ML/day	474	35%
30,000 ML/day	597	43%
40,000 ML/day	803	64%
45,000 ML/day	844	61%

Key outcomes

At the notified flow rate of 45,000 ML/day this was estimated as largely a park closure for the limited time of inundation and recession, as the topography of the floodplain is relatively low, inundating the area.

The site would experience a similar impact on camping dispersed along River Track, while the park has relatively few places for people to camp, visitors are tending to not push into new areas. Constraints relaxation may have minor impacts to site access with peak visitor activity generally from November and trailing off by around Easter. This is provided environmental water deliveries are during the winter/spring period with sufficient time for tracks to dry off.

There is proposed infrastructure for a walking platform near Parnee-Malloo creek that would allow visitors to see the inundation anticipated as part of the VMFRP. The VMFRP delivers water to high value sites like Nyah-Vinifera by using works and infrastructure to hold water for a longer duration that the environment needs. Both programs are complementary to each other and central to delivering outcomes for communities.

The improved ecological condition may support fishing, which is very popular in the area, notably the Nyah West fishing competition may benefit from more native fish in the rivers. Floodplain recreation may include canoeing and kayaking provided there is infrastructure to support these activities. The Lower Vinifera pony club may be impacted if the inundation footprint extends through pony jumps installed in Vinifera Park.

It was noted that the site has been used previously for a Wadi Wadi family group gathering. There may be impacts to when this event can occur. Long-term benefits from the enhanced amenity value and ecological condition of the site may provide access to healthier Country to enable cultural practices.

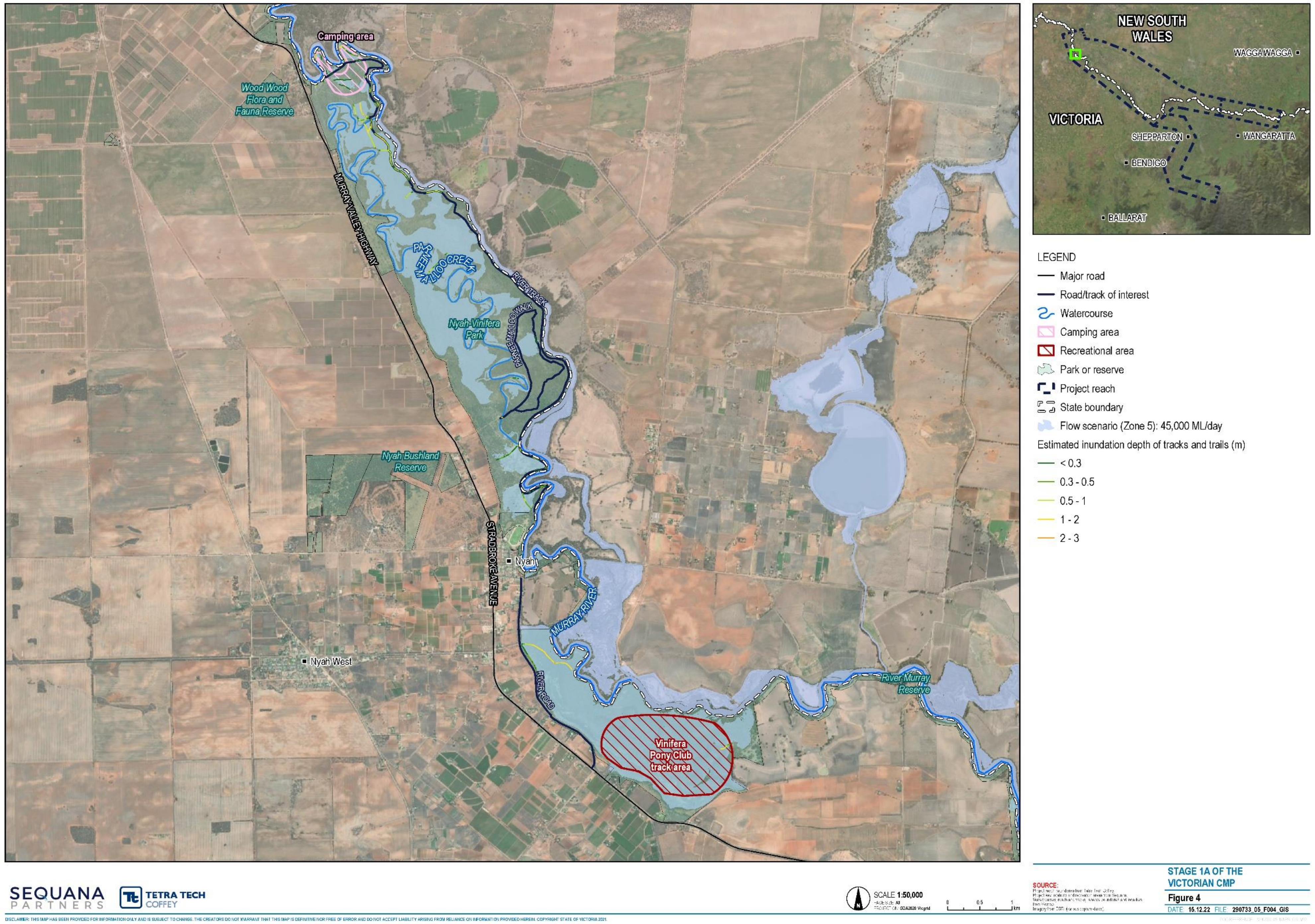


Figure 65 – Inundation extent of Nyah-Vinifera Park at 45,000 ML/day downstream of Yarrawonga

Table 28 – Outcomes summary for Nyah-Vinifera Park

Risks	Benefits
Short-term	**Short-term**
• **Decreased site access to recreation sites** • Inundation and/or damage to public roads, tracks, walking trails, boat ramps – River Track – Parnee Malloo Walk – River Road Track • **Impact to sites and assets of community importance e.g., Horse jumps in Vinifera Pak** • **Inundation or restricted access to some campsites** • **Impacts to recreational groups** • Decreased tourism and visitor activity • Clean up after watering events • Insect infestation from improved conditions for insect breeding (mosquitos)	• **Supporting conditions for opportunistic water-based recreation (e.g., canoeing/kayaking)** • Opportunities for recreational floodplain activities (e.g., birdwatching).
Long-term	**Long-term**
• **Impacts to future planning of public infrastructure (e.g., tracks and trails)** • Pest plant and animal impacts / weed infestation **(e.g., carp breeding).**	• Improved aesthetic and amenity value • Increased visitor numbers and enhanced tourism • Improved opportunities for water-based recreation: – **Fishing** – Canoeing / Kayaking • Improved opportunities for riverside recreation and amenity: – Bike riding – **Birdwatching** – **Walking / bushwalking** – Photography / sightseeing – Camping – General wellbeing benefits / contemplation • **Access to healthier Country to enable cultural practices** • Enhanced community cohesion – i.e., events such as tours, park visitation, activity operators • Improved community events (e.g., Nyah Fishing Competition) • Enhanced business activity (e.g., **Riverside caravan parks**, general stores, etc.).

Note: **Bold** items outline outcomes that were indicated to be of particular importance to this site

7.2.4.5 Molesworth Nature Conservation Reserve

Background

The Molesworth Recreation Reserve and Caravan Park is a popular local attraction between Yea and Alexandra. Next to the caravan park is the Molesworth Conservation Reserve covering approximately 28 ha, with natural features such as river red gums, temporary wetlands and an abundance of flora and fauna. Located on the banks of the Goulburn River between temporary wetlands, the site is jointly managed by the Molesworth Reserve Committee of Management, with live-in caretakers, and Parks Victoria.

Facilities include covered shelters with free electric barbeques and seating, designated fire pits for campfires, a playground and a large sports oval at the centre of the reserve. Popular recreational activities including camping, boating, fishing, bushwalking, sightseeing and birdwatching.

Recent upgrades to the site include a walking track around the wetland (approx. 1.2 km), bird-hide, seats and an information board. The Great Victorian Bike Trail uses the alignment of the old train line and stretches from Tallarook through to Mansfield with a stop off at Molesworth. There is a parking spot for travellers to park their horses, carts, and bikes.

Community Recreational Values

Residents of the Goulburn-Broken catchment state they actively seek experiences such as exercise / fun (53%) and relaxation (69%) when visiting waterways. The most common recreational activities undertaken by these communities are enjoying the scenery (27%), passing through (17%) and water-based activities (16%) (DELWP, 2022).

It would be expected that the local community of Molesworth may prioritise a range of passive and active recreation such as sightseeing, birdwatching, picnicking, as well as bushwalking, fishing, boating etc.

Figure 67 – Molesworth Caravan Park.

Source: Molesworth Recreation Reserve Committee of Management

Figure 66 – Molesworth Caravan Park.

Source: Molesworth Recreation Reserve Committee of Management

Table 29 – Modelled percent inundation of Molesworth Nature Conservation Reserve under relaxed constraint scenarios

Flow rate measured downstream of Eildon	Inundated area (ha)	Percent inundated
10,000 ML/day	-	-
12,000 ML/day	0.1	0.4%
14,000 ML/day	4.0	15%

Key outcomes

At the notified flow rate of 14,000 ML/day from Eildon, land and waterway managers noted the track likely impacted by inundation would be Recreation Reserve Rd, which is the main access to the area.

Impacts to site access will mostly affect visitors of the caravan park, boating, and fishing as site access and all boat ramps in the area were inundated at the 14,000 ML/day flow rate. As one of the key fishing sites on the Goulburn River there is potential risk to recreational fishing during relaxed constraint flows. Fishers and boaters may be able to launch from an alternative concrete boat ramp at Killingsworth during these deliveries.

There are no impacts to the Great Victorian Bike Trail even at the points closest to the Goulburn River. The long-term benefits to the improved environmental condition are expected to enhance the experience cyclists derive from the trail and may increase tourism to the area.

Some of the user groups that are likely to benefit from the relaxed constraints flow scenarios are bushwalkers, cyclists and birdwatchers. Long-term benefits of the ecological condition and enhanced amenity value are expected to benefit all user groups.

As the hotel beer garden backs onto the wetlands, there would be amenity benefits to having the area inundated for periods of visitor activity. This would provide economic benefit to the business and enhance the visitor experience ensuring no impacts to existing visitor infrastructure.

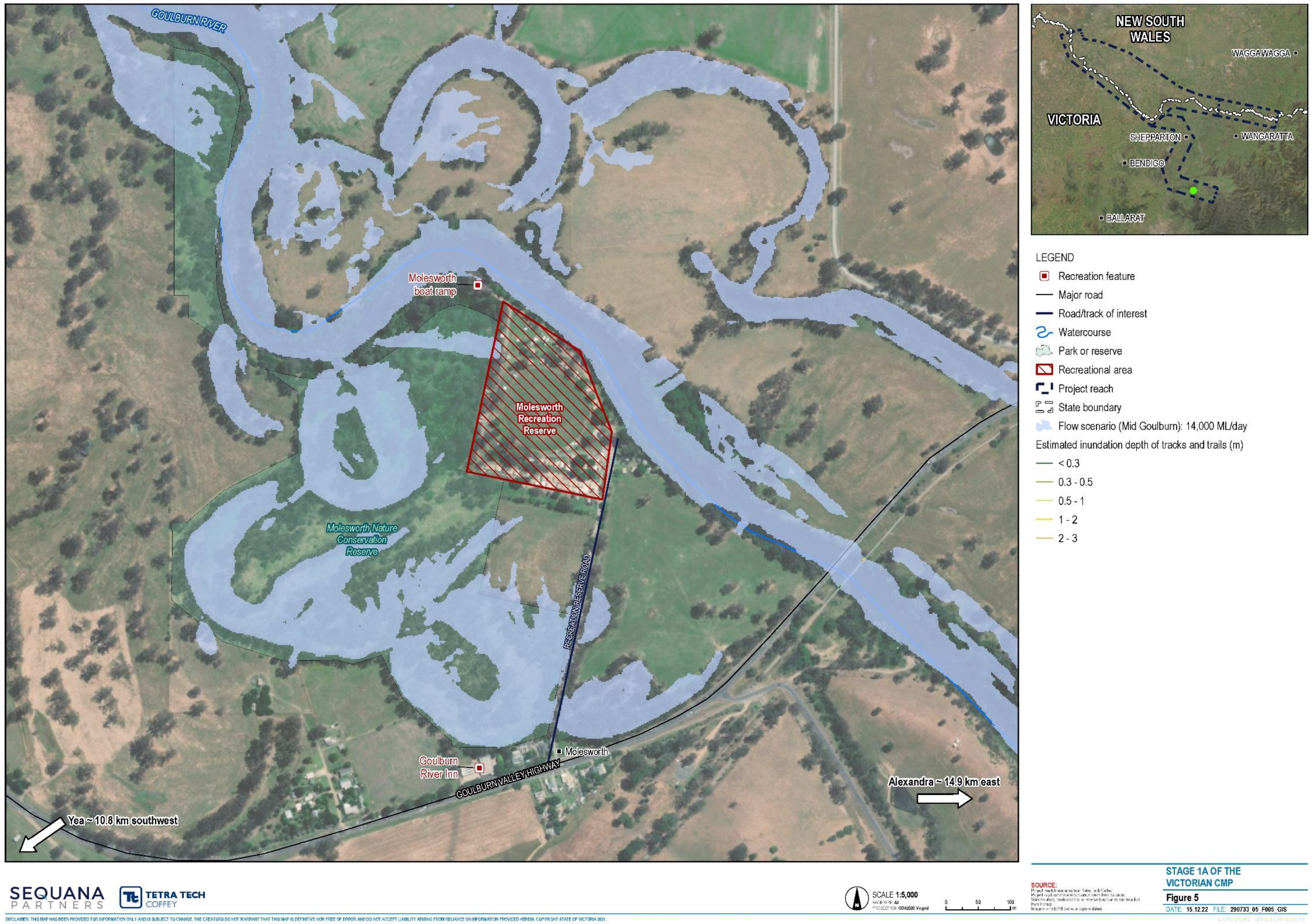


Figure 68 – Inundation extent of Molesworth at 14,000 ML/day equivalent release at Eildon

Table 30 – Outcomes summary for Molesworth

Risks	Benefits

Short-term
• **Decreased site access to recreation sites**
• Decreased tourism and visitor activity
• **Impacts to sites of community importance (e.g., Molesworth Caravan Park and surrounding oval)**
• Inundation or restricted access to campsites
• **Inundation and/or damage to public roads, tracks, walking trails, boat ramps**
  – **Recreation Reserve Rd**
• Potential impact or restricted access to park facilities e.g., BBQs, shelters, fire pits,
• Clean up after watering events
• Insect infestation from improved conditions for insect breeding (mosquitos)
• Decreased business activity (e.g., caravan park, hotel, pub, general stores in the nearby township).
Long-term
• Impacts to future planning of public infrastructure (e.g., tracks and trails)
• Pest plant and animal impacts / weed infestation.
	Short-term
	• **Nil**
	Long-term
	• Improved environmental condition, aesthetic and amenity value
	• Improved opportunities for water-based recreation:
	  – Fishing
	  – Boating
	• Improved opportunities for riverside recreation and amenity:
	  – **Picnicking / BBQs / Campfires**
	  – Birdwatching
	  – **Bushwalking / walking**
	  – **Sightseeing**
	  – Camping
	  – General wellbeing benefits / contemplation
	• Access to healthier Country
	• Enhanced business activity (e.g., Molesworth Caravan Park)
	• Increased visitor numbers and tourism
	• Benefits to local economy (e.g., pubs, general stores, etc.).

Note: **Bold** items outline outcomes that were indicated to be of particular importance to this site

7.2.4.6 Gemmill Swamp Wildlife Reserve

Background

Gemmill Swamp Wildlife Reserve covers an area of approximately 170 ha of Goulburn River floodplain forest and wetland between the urban centres of Mooroopna and Shepparton. Gemmill Swamp is a wetland of state significance surrounded by river red gum forest, supporting wildlife such as squirrel glider, turquoise parrots, and superb parrots. There is a fjord set on the northern end infill point so that as the Goulburn River reaches minor flood level, water spills over and fills the swamp and sits within the area.

This site is highly valued for its birdwatching with flocks of pelicans, ibis, swans, egrets, and ducks often seen in and around the area. Visitors commonly access the site to enjoy recuperation, wildflowers and sightseeing.

Facilities include picnic areas, a viewing platform and walking tracks, with a car park and coach parking. The sight is popular from November through to March for morning and afternoon walks by residents of Mooroopna and Shepparton. The River Connect Program supports night walks and junior ranger activities in the summer school holidays.

Community Recreational Values

Residents of the Goulburn Broken catchment have stated they actively seek experiences such as exercise / fun (53%) and relaxation (69%) when visiting waterways. Recreational activities primarily undertaken by residents are enjoying the scenery (27%), passing through (17%) and water-based activities (16%) (DELWP, 2022).

The local community of Shepparton and Mooroopna and Goulburn Broken catchment residents may prioritise a range of passive and active recreation such as sightseeing, birdwatching, picnicking, as well as walking, cycling, and some wading in the swamp.

It was noted that the communities of the Goulburn River in this area generally request minimal visitor infrastructure to leave the parks and streamside reserves natural and undeveloped. The community generally require roading access and signage, with clean-up for rubbish and weeds.

Figure 69 – Gemmill Swamp

Source: https://www.visitvictoria.com/

Figure 70 – Male Flame Robin at Gemmill Swamp.

Credit: Russ Jones

Table 31 – Modelled percent inundation of Gemmill Swamp Wildlife Reserve under relaxed constraint scenarios

Flow rate measured downstream of Goulburn Weir	Inundated area (ha)	Percent inundated
17,000 ML/day	0.06	0.03%
21,000 ML/day	177	82%
25,000 ML/day	198	91%

Key outcomes

At the notified flow rate of 25,000 ML/day for the Lower Goulburn, access is cut off from the northern end (Government Track) and Cemetery Road. As one of the main access tracks to the site, there would be significant impacts to site access and issues for maintenance. It was noted that the western boundary is inundated when there is water on the floodplain making it impassable. Although residents will often approach from the council land off Echuca Road up to the fence line to look into the site when it's in flood. Track upgrades could provide the opportunity to rationalise tracks and shut down some braiding trails in the area.

Currently, the walking paths program is looking to rework the paths from north on the causeway, wrapping around the swamp to an existing path on the western boundary, then back around across the river toward the Golf club. This proposed upgrade may need to account for regular inundation and the flows considered under the Victorian CMP.

During drying off, a risk to the site currently is keeping 4WDs off the tracks, causing potential damage. There are no gates to the site so limiting illegal access can prove difficult for land managers which may be exacerbated by more regular inundation under relaxed constraint flows. Giant rush is also a problem weed in the area, and restricted access in certain winter/spring periods may impact pest plant control programs during the delivery of relaxed constraint flows.

The southern end access will not be cut off with access available to visitors through McFarlane Road. Visitors will be able to get into the site and venture through limited parts of the area. This is also an important fire access road that is required to be maintained by land managers.

Groups that generally access the swamp are Mooroopna Primary School and the Scout group on the western side, with expected benefits from the improved amenity and potential for floodplain activities such as sightseeing and environmental education.

The primary recreational activities for Gemmill Swamp are birdwatching, walking, cycling, and picnicking for families. Community involvement through the 'Friends of' group has seen general increases in community cohesion and appreciation of the area's natural assets. The improved amenity from constraints relaxation is expected to support and enhance the experiences that visitors derive from these activities.

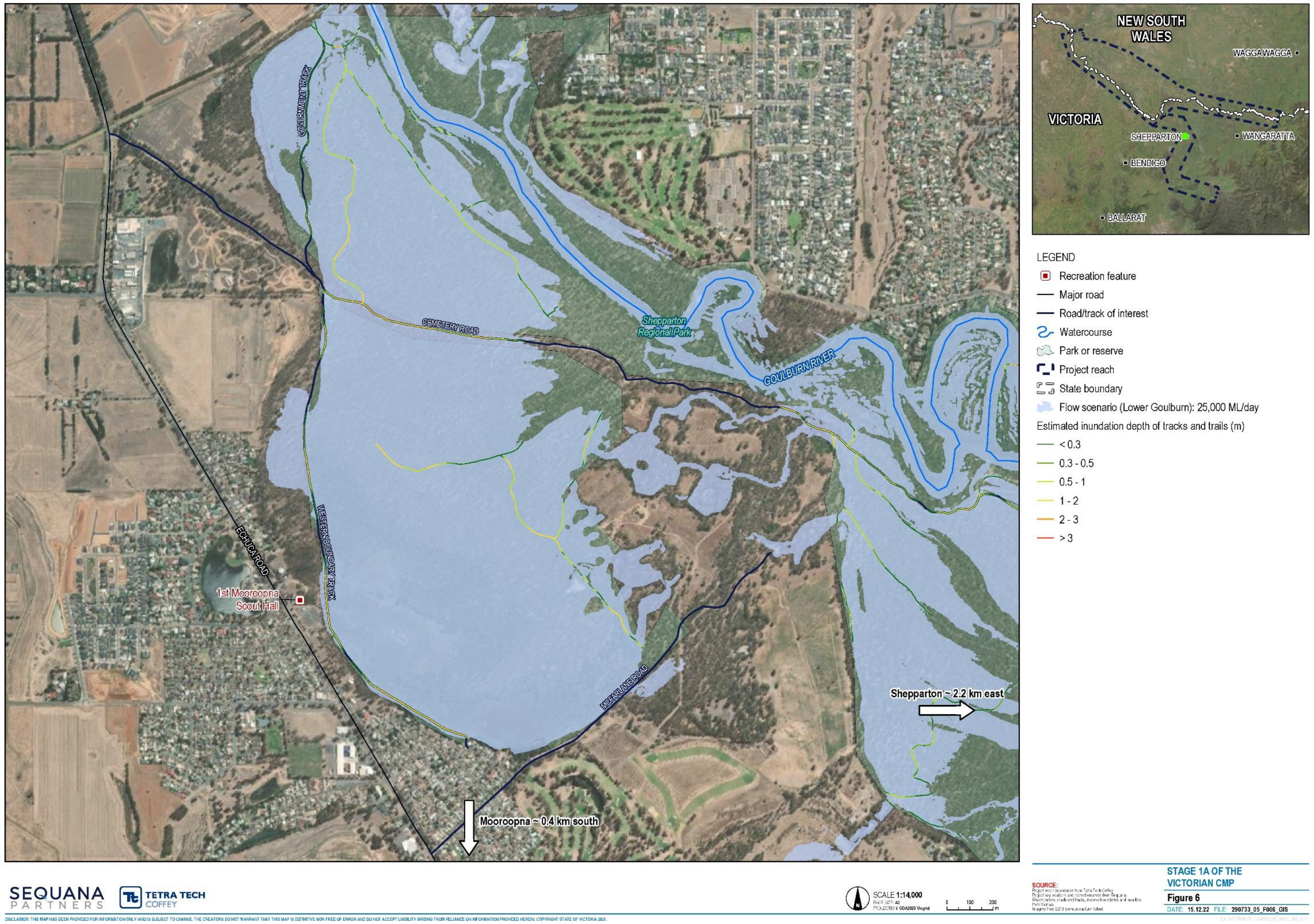


Figure 71 – Inundation extent of Gemmill Swamp at 25,000 ML/day equivalent release at Goulburn Weir

Table 32 – Outcomes summary for Gemmill Swamp

Risks	Benefits
Short-term • **Decreased site access to recreation sites** • **Impacts to recreational groups (e.g., school and scout groups)** • Decreased tourism and visitor activity • Inundation and/or damage to public roads, tracks, walking trails, etc. – Government Road – Cemetery Road – Western Boundary Track • Clean up after watering events e.g., rubbish • Insect infestation from improved conditions for insect breeding (mosquitos) **Long-term** • Impacts to future planning of public infrastructure (e.g., tracks and trails) • Impacts to park/forest operations (e.g., pest plant and animal control programs) • Pest plant and animal impacts / weed infestation (e.g., giant rush)	**Short-term** • **Supporting conditions for opportunistic water-based recreation (e.g., sightseeing, birdwatching, photography).** **Long-term** • Improved aesthetic and amenity value • Improved opportunities for riverside recreation and amenity: – **Birdwatching** – **Walking / bushwalking** – **Cycling** – **Sightseeing / Photography** – **Picnicking** – Wading – Photography / sightseeing – 4WD & 2WD driving – General wellbeing benefits / contemplation • Access to healthier Country • Enhanced community cohesion and appreciation for natural assets • Increased visitor numbers and enhanced tourism • Enhanced business activity (e.g., cafes, pubs and restaurants, general stores in the Shepparton and Mooroopna area).

Note: **Bold** items outline outcomes that were indicated to be of particular importance to this site

7.2.5 Synthesis of outcomes

Through engagement with land and waterway managers, Table 33 below was developed to broadly highlight the key recreational opportunities attributed to each of the case study sites. Recreational activities were aligned with those queried as part of the 2022 My Victorian Waterways survey and assessed as to whether they support this particular pursuit.

For example, recreational game hunting is supported at Gunbower State Forest (assigned 'YES') but is not allowed in other parks or reserves (assigned 'NO'); similarly, Lake Moodemere is not traditionally understood to be a site where visitors use the area for spiritual, cultural, and/or ceremonial uses by may be of particular importance for certain user groups not engaged as part of this assessment (assigned 'MAYBE').

An assessment of the recreational activities supported by each site was supported by engagement with land and waterway managers as part of this study. It is expected that these opportunities and values will be tested with user groups identified in Table 34 as part of potential future stage, on-ground engagement. Further engagement with community, recreational groups, public land and waterway managers and private landholders may seek to quantify wider socio-economic components including non-recreational and private impacts that are not explicitly listed as part of this investigation.

Table 33 – Water-based or riverside recreational opportunities supported by each case study site

Recreational activity[105]	Gunbower Island	Barmah National Park	Lake Moodemere	Nyah-Vinifera Park	Gemmill Swamp	Molesworth
Fishing	YES	YES	YES	YES	NO	YES
Boating (motorised – including water skiing etc.)	YES	YES	YES	YES	NO	YES
Boating (non-motorised – kayak, canoeing, rowing)	YES	YES	YES	YES	NO	NO
Picnics and barbecues	YES	YES	YES	YES	YES	YES
Enjoying the scenery	YES	YES	YES	YES	YES	YES
Spiritual, cultural, traditional and ceremonials uses	YES	YES	MAYBE	YES	MAYBE	MAYBE
Swimming	YES	YES	YES	YES	NO	YES
Enjoying native animals, plans and birds – including photography	YES	YES	YES	YES	YES	YES
Camping / caravanning	YES	YES	YES	YES	NO	YES
Walking, hiking, running, or cycling	YES	YES	YES	YES	YES	YES
Visiting cultural or historical sites	YES	YES	MAYBE	YES	MAYBE	MAYBE
Rehabilitating native habitat or historical sites	YES	YES	MAYBE	MAYBE	YES	MAYBE
Recreational game hunting	YES[1]	NO	NO	NO	NO	NO

105 Adopted from the 2022 My Victorian Waterways survey, Question 10.

Recreational activity[105]	Gunbower Island	Barmah National Park	Lake Moodemere	Nyah-Vinifera Park	Gemmill Swamp	Molesworth
Accompanying children to an activity	YES	YES	YES	YES	YES	YES
Dog walking	YES[1]	NO	NO	NO	NO	NO
Horse riding	MAYBE	MAYBE	NO	YES	NO	NO
Passing through to reach a destination	YES	YES	YES	YES	YES	YES

[1]Gunbower State Forest only

Land and waterway managers provided feedback on the risks and benefits pertaining to the general recreation outcomes of relaxing constraints for environmental water. Sentiment toward the recreation outcomes of parks, forests and streamside reserves accessible to community along the river reaches more generally has been described in relation to key user groups in Table 34.

Table 34 – General recreation outcomes by user group

User group	Benefits	Risks
Community / visitors / interest groups e.g., VRFish, 'Friends of' groups, schools, birdwatching groups, outdoor education, etc.	• Recreational benefits (refer to Table 33 for an indicative list of improved recreational activities) • Aesthetic and amenity benefits • Increased community cohesion, events, and appreciation for natural assets • Access to healthier Country to support connection and ceremony • Increased fish breeding improving whole of river recreational fishing opportunities • Reduction of blackwater events through regular removal of organic matter from the floodplain • Supporting conditions for environmental water eco-tourism opportunities • Reduced bank erosion	• Interrupted access to river-beaches, camping, boat ramps, walking and bicycle paths, wood-gathering areas • Inundation of public spaces, walking tracks, and recreation areas adjacent to the river • Park closures and public event closures during periods of inundation • Carp breeding and vermin, mosquitoes and sandflies • Spread of weeds • Failure of notification system to alert visitors / community / landowners of environmental flow events
Public land Managers / Emergency services	• Recreational, aesthetic and amenity benefits • Improved visitor experience through water in the landscape • Improved floodplain connectivity, ecological condition and site amenity • Improved flood resilience (e.g., capacity to deal with minor floods through infrastructure upgrades) • Addressing flood 'problem areas' (e.g., uncontrolled nuisance flooding) • Potential for new locations and quality visitor infrastructure to support eco-tourism during events – including interpretative signage, promotion	• Impeded site access during periods of inundation • Clean up after inundation • Increases in pest species (requiring complementary pest plant and animal control and monitoring) • Damage to tracks, crossings or access roads, and other infrastructure (requiring repairs, post event grading, cleaning etc.) • Impacts on other operations e.g., proposed environmental programs/works • Reduced performance of drainage infrastructure • Impacts to future development e.g., long-term local government plans for improved tracks and trails

User group	Benefits	Risks
		• Illegal visitor access during periods of site closure (e.g., management of visitor safety and potential damage to visitor infrastructure)
Natural resource businesses (that directly depend on healthy rivers and floodplains)	• Increased nature-based tourism e.g., Licensed Tour Operators • Increased long-term tourism • Honey and forestry production in floodplain forests • Strengthening native fish populations, leading to increased local and regional economic activity from recreational fishing • Opportunistic floodplain activities	• Impeded or reduced site access during periods of inundation • Decreased tourism during periods of inundation • Loss of revenue during inundation periods

7.3 Findings and recommendations

7.3.1 Reduced buyback

Through investigation of the recently observed social and economic changes linked to Basin Plan implementation, the impacts, and costs of different types of water recovery, Frontier Economics found that the benefits of constraints projects include changes to the way the delivery system can be managed, as well as potential regional/localised benefits to water users.

At this stage, the foreseeable socio-economic disbenefits from the Victorian CMP may be able to be adequately managed given the opportunity for addressing these through the mitigation and compensation negotiation process. Affected landholders would be compensated as the government acquires easements which is expected to account potential costs and additional impacts (e.g., reinstatement costs, interrupted access to agricultural land that is not inundated) that are embodied within the cost/value of acquiring easements.

Given the significant financial and socio-economic costs associated with alternatives to recovering the 41.2 GL, the Victorian CMP may achieve in the context of ‘Bridging the Gap’ to SDL and the significant contributions that the Victorian CMP could provide to implementing the Basin Plan, there is potential for significant net benefits.

Furthermore, the recommendation from the majority of the Committee to consider overbank flows in the Goulburn River would lead to an increase in the notified constraint flowrate for the Goulburn River, which could potentially designate the Goulburn Project as a supply measure.

7.3.2 Recreation outcomes

The initial assessment of recreational outcomes demonstrated that the Victorian CMP has the potential to deliver a range of positive outcomes for recreation, particularly in the long-term, as well as some associated negative impacts on recreational values, largely during and immediately following inundation.

The environmental outcomes of relaxing constraints are expected to improve the ecological condition and amenity value of the areas they affect. This is anticipated to enhance the experience visitors derive from these sites in the long-term, support recreation activities, and improve community cohesion and appreciation for natural assets. While environmental watering is noted to restrict access for certain types of recreation during the inundation period, it provides conditions for other recreational pursuits (e.g., canoeing / kayaking, birdwatching, wading, sightseeing).

Many of the negative impacts may be able to be mitigated through site planning and associated works. Moreover, the winter/spring timing of relaxed constraint flows is generally prior to peak visitor activity, with certain sites already enforcing park closures for current inundation regimes (e.g., Gunbower State Forest and National Park, Barmah National Park). Risks to site access are instead generally associated with allowing sufficient time for tracks and trails to dry off and any required track maintenance to occur before peak visitation. Potential mitigation measures may include upgrading or rationalising existing tracks to a standard that can experience regular inundation without degradation. Stakeholders engaged through this stage further noted that the Victorian CMP provides an opportunity for new capital works (e.g., boardwalks and viewing platforms) that would provide visitors the opportunity to interact with and learn about environmental watering events.

Impacts to site access have been described as ‘challenges’ that could be addressed through changes to the operations and management plans of these important assets in consultation with land and waterway managers. Risks to recreation values outside periods of inundation can only be mitigated with adequate funding for land and waterway managers to maintain suitable access and landscape condition to support visitor experiences. Future stages of the project should therefore seek to outline a funding pathway for land and waterway managers to accommodate impacts to support visitor experience. Public land and waterway managers have expressed a willingness to work with the project to further explore the impacts and appropriate mitigation measures.

A lack of longitudinal visitation data and visitor experience surveys available for the case study sites suggests any future analysis will likely rely on expert judgement and conservative assumptions in order to attribute recreational outcomes to constraints relaxation. The strategic collection of visitor data for key sites as part of a priority monitoring program would assist in supporting ongoing evaluation, reporting and adaptive management. This could include surveys designed to benchmark benefit valuation (i.e., travel-cost method applications).

Dedicated on-ground engagement with community and stakeholders is anticipated in future stages of the Victorian CMP. It is expected that the recreational opportunities shown in Table 33 will be further assessed through engagement with the key user groups identified in Table 34 (e.g., recreational groups, community, public land and waterway managers, natural resource businesses). This would aim to substantiate the current qualitative assessment through wider engagement and support a detailed economic assessment accounting for non-market values and wider socio-economic components, including non-recreational and private impacts.

7.3.3 Conclusion

This stage of the Victorian CMP has provided the opportunity for an initial scoping exercise and qualitative assessment of the recreational outcomes and socio-economic context of the Victorian CMP. The analysis has relied heavily on either stakeholder input obtained or recent investigations and exercised a number of expert judgements to determine the indicative socio-economic impacts.

This provides a starting point from which to undertake a detailed economic assessment and further engagement with impacted landowners, communities and stakeholders. Importantly, the socio-economic assessment suggests further investigation may be required to fully consider the merits of the Victorian CMP.

The Committee also supports an assessment of the broader system-level benefits and risks. This includes a detailed system-level cost-benefit analysis to inform future stages of the Victorian CMP and the broader MDBA Constraints Management Strategy.

8. Environmental benefits and risks

8.1 Key outcomes

Key Outcomes

General

- Currently there are a range of environmental flow requirements that cannot be achieved by environmental water managers due to constraints, including higher flows that reconnect rivers to floodplains.
- Environmental benefits to the whole ecosystem are maximised by scenarios that enable the highest overbank flows
- Relaxation of constraints in both the mid and lower Goulburn River were needed to produce an increase in the area of vegetation held in good and average condition.
- Benefits of constraint relaxation are evident under most potential future climate scenarios and therefore can serve as a valuable tool for environmental water managers to adapt to a drying climate. It is only under the 50-year horizon, worst case, where the benefits are shown to be diminished as water availability is the major limiting factor.
- Relaxing constraints will increase the proportion of water-dependent vegetation communities held in good condition between dry spells. This helps to keep the vegetation communities out of the critical condition status (i.e., 'near death') and increases the likelihood of surviving extended dry periods.
- Relaxing constraints to the notified flow rates would not benefit the large areas of higher floodplain red gum and black box forests that need moderate and major flood events to be watered.

Area of vegetation inundated

- Between 30,300 ha and 51,400 ha in total (net: 17,000 ha to 38,700 ha increment from the base case) of native vegetation communities in Victoria would potentially benefit from the relaxation of constraints to the highest levels explored in this assessment across the three river reaches. By way of comparison, this approximately equates to the area of Wilsons Promontory National Park
- Relaxed constraints deliver a 144% to 287% increase in the maximum area of flood dependent native vegetation inundated (Victoria Only) for the Murray River from the base case (Y25D25: 27,910 ha & Y40D40: 44,218 ha. Base Case: 11,420 ha)
- Relaxed constraints deliver an 83% to 330% increase in the maximum area of flood dependent native vegetation inundated (Victoria Only) for the Goulburn River from the base case (M10L17: 4,871 ha & M14L25: 11,465 ha. Base case: 2,669 ha)
- The inundation areas assessed are the maximum extents of the hydraulic modelling. Achieving these maximum extents will depend on decisions about how environmental water is used with relaxed constraints.

Quality of native vegetation

- **Goulburn River RRG condition:** improvement in condition ranges from +19% (M10L17) to +83% (M12L21 & M14L25) from the base case
- **Goulburn River BBW condition:** improvement in condition ranges from -52% (M10L17) to +91% (M12L21 & M14L25) from the base case
- **Murray River (Hume to Wakool) RRG condition:** improvement in condition ranges from +3% (Y25D25) to +17% (Y45D40) from the base case
- **Murray River (Hume to Wakool) BBW condition:** improvement in condition ranges from +14% (Y25D25)

Key Outcomes Cont.:

Erosion: It is the Consultative Committee's view that complementary programs, including grazing management, revegetation, pest control, and monitoring, are necessary to maximise environmental outcomes. A program to address erosion of the Murray River is required even if constraints relaxation is not implemented. Addressing the deterioration of the riparian zone along the Goulburn and Murray rivers is critical to enhance the benefits of environmental watering.

Carp: there is some risk that an increase in overbank inundation will provide the conditions to support carp breeding. Further investigations and learnings from other environmental watering programs are to be undertaken in any future program stages to manage carp.

Platypus and Turtles: Careful management of environmental water delivery timing is required to minimise risk of impacts to platypus and turtle nesting periods.

8.2 Overview

River regulation and consumptive use of water have interrupted many of the natural river and wetland processes needed by native plants and animals to grow, reproduce, move and ultimately survive. River regulation has significantly modified natural river flow regimes, including the timing, duration, rates, and variability of flows. This modification has adversely impacted the condition of river systems, and the flora and fauna that depend on the system for survival. Overbank flows, a component of the flow regime, have been significantly modified with reductions in their frequency, extent, and duration, severing the connection between the river channel and the floodplains and wetlands.

The Basin Plan was developed to improve the health of the river systems of the basin and its floodplains. Such improvements include efforts to reduce the impact of river regulation and consumptive water use on the frequency, duration and extent of overbank events.

Since implementation of the Basin Plan, environmental flows within the Goulburn River have been delivered in channel to enhance native fish spawning, reduce the extent of bank erosion, and enhance productivity and littoral vegetation. Floodplain watering with environmental water has been limited to icon sites. The provision of in-channel and icon site environmental water has been associated with movements and breeding of golden and silver perch. While improvements in vegetation and productivity and fish spawning have been observed, these have not translated into changes in the macroinvertebrate community or increases in young-of-year fish.

In the Murray River channel, similar outcomes have been observed to those in the Goulburn River, with large variations in fish numbers from year to year, but no clear improvement in populations and increases in the proportion of invasive species (Brown and Whiterod, 2021; Raymond et al. 2018).

The Victorian CMP has potential to improve the environmental outcomes from environmental water delivery by 'relaxing' these constraints on environmental water delivery and enabling improved inundation of floodplain and wetland ecosystems.

The environmental benefits and risk report prepared for this stage of the Victorian CMP is included in Appendix C for further information.

8.2.1 A conceptual model of the river system

A conceptual model of the river system has been adopted to aid this investigation to explore the environmental benefits and environmental risks of each of the modelled relaxed constraint scenarios.

The conceptual model describes the landscape scale connectivity of the river systems and how these processes have been modified by historical river regulation and development. More specifically, the model helps to explain the modification of longitudinal connectivity characteristics (such as the timing and contributing flow types) in the subject river systems, as well as the way that important lateral connectivity with the floodplain has been lost as a result of river regulation and constraints on the delivery of overbank events.

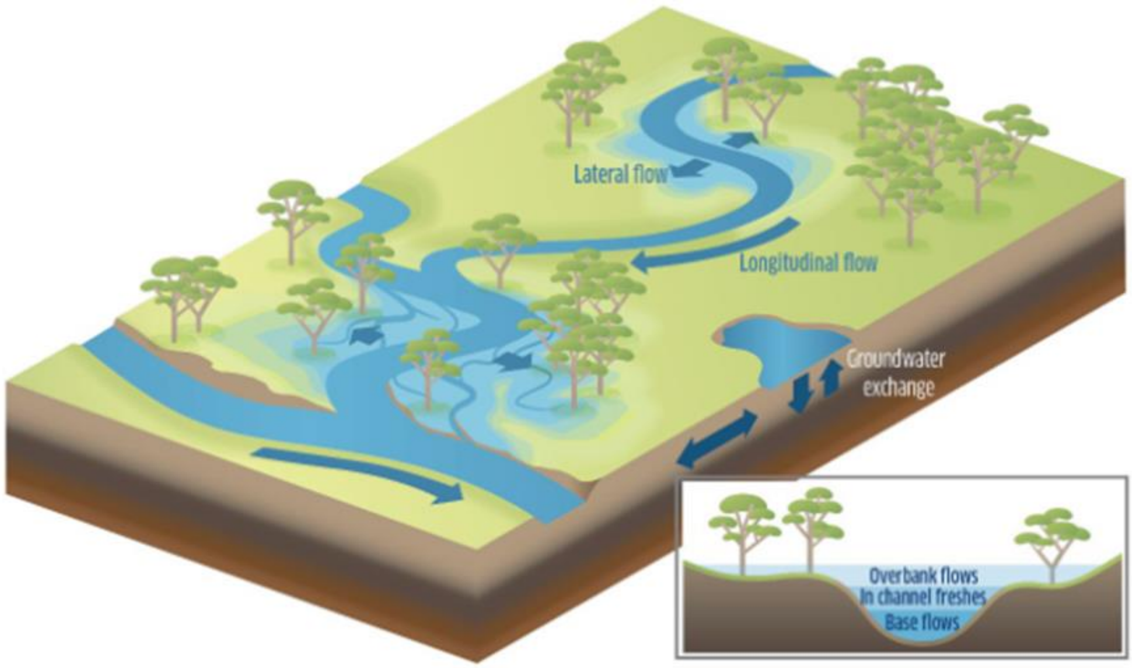


Figure 72 – Hydrological connectivity and flows (MDBA, 2020)

8.2.2 The importance of connectivity

Floodplain river ecosystems are a system with critical interdependencies between floodplain, wetland and channel components. For example, flood-dependent vegetation communities such as floodplain wetlands, redgum forests, and redgum and black box woodlands all depend on overbank inundation. The vegetation community in turn, influences critical nutrient, carbon and sediment movements between terrestrial and aquatic environments, and provides critical habitat and food resources for fish, bird and invertebrate communities and species of reptiles, amphibians and mammals (rakali, platypus).

Floodplain river ecosystems provide a range of other ecosystem services including soil formation, water purification, climate regulation and a range of cultural, educational and recreational opportunities. Recent work on carbon sequestration has found that healthy wetlands can store more carbon per hectare than forest ecosystems.

There is growing evidence of the linkages between floodplains and main channels. Water, sediment and particulate carbon transported in the channel, is critical to floodplain productivity. Conversely, floodplain carbon becomes available to the channel during overbank inundation. When transported back into the river, this floodplain carbon becomes a major source of instream carbon that drives instream productivity. This instream productivity includes benthic algae, phytoplankton, and instream submerged vegetation. The products of this instream production become the food source for other life forms including macro invertebrates, fish, turtles, and platypus. There is also a range of species whose life cycles require access to both main channel and wetland habitats. One example is the native catfish that spends its early life stages in wetlands before moving into the river channel and dispersing.

River regulation has profoundly impacted these natural characteristics of lateral and longitudinal connectivity in the subject rivers. River regulation captures floods (overbank events) and converts these flows into a flow regime that supports the needs of predominantly consumptive users. The reduction in overbank inundation increases the discharge of water in the river channel and this increases the expenditure of energy on riverbanks, increasing rates of streambank erosion. River regulation has also impacted individual habitats, such as river channels.

Without human intervention, hydrological connectivity is driven by gravity and so changes in flow manifest downhill as changes in connectivity. As a consequence, sequential changes accumulate as one moves downstream meaning that some of the greatest impacts on connectivity manifest at end of the system. The Coorong being a stark example.

Broadly, connectivity is important for three reasons. First and most obvious is that it would not be possible to deliver water to water dependent ecosystems without transferring water from one part of the system to another. What is less obvious is that, in some areas, achieving appropriate connectivity requires coordinated delivery across multiple parts of the system. The Murray River in South Australia is a clear example of this where delivery of water to representative ecosystems is not possible without coordinated management of longitudinal connectivity through the southern connected basin.

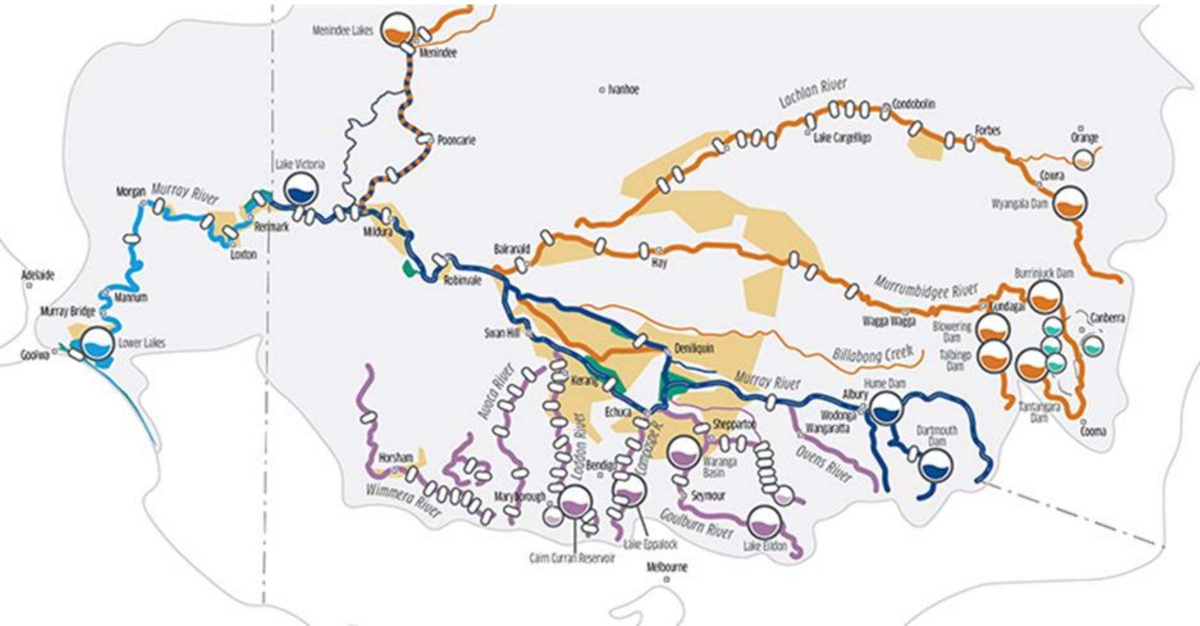


Figure 73 – Schematic of the Southern Connected Basin showing the importance of tributary flows (MDBA, 2020d)

Hydrological connectivity is also important because of the processes it supports. Among these processes is the erosion, transport and deposition of sediment. These processes are heavily influenced by flow and contribute to the availability of habitat within channels and the floodplain mosaic. The erosion and deposition of sediment on floodplains drives soil formation which is one of the main reasons that much of Australia's most productive agriculture is located on floodplains. Hydrological connectivity is also important for nutrient and carbon cycles with ecosystems dependent on the subsidy that is carried into the ecosystem.

Finally, hydrological connectivity is important to the movement of biota through the system. Water-dependent ecosystems in Australia are characterised by cycles of boom and bust or disturbance and opportunity. Many species are dependent on the booms associated with flooding to maintain condition or reproduce. Connectivity is also important to resilience with biota dependent on flows to recolonise areas. Many plant species rely on flows to disperse their seeds, while flows are important for the dispersal of both adult and larval native fish.

From a system perspective hydrological connectivity provides the foundation for delivery of flows and the maintenance of key ecosystem functions that ultimately link all the water dependent ecosystems into a system that is a cohesive group of interdependent components.

8.2.3 Reaches and scenarios assessed

The reaches and scenarios assessed are described in Section 3.2.

The frequency, timing, and duration of overbank events included in the daily hydrologic modelling of the environmental delivery scenarios are set out in Table 35.

Table 35 – Frequency, timing and duration targets

River	Frequency	Timing	Duration of overbank flows
Goulburn	• Overbank environmental flow deliveries preferred once a year • In dry/drought years (around 1 in 4) this changes to in channel only • Therefore, one overbank event is preferred around 7 years in 10 • Managed overbank events would not be planned if a natural event has achieved the target that year	• July to October (winter and spring)	• 5 days at peak flow • Rise length around 6 days, fall beginning around 11 days
Murray	• Align with ecological requirements and pre-regulation flow patterns • Depends on season, storage volumes, tributary flows	• Mostly August to October, though occasionally earlier or later	• Will vary depending on flow size, water availability, river operations and environmental needs but mostly around 7 to 14 days at target flows • Occasionally up to 30 days for flows • Gradual recession to reduce erosion risk and stranding of fish

8.2.4 Investigation approach

The environmental assessment sought to identify the environmental benefits and risks associated with the different relaxed constraint flow scenarios proposed and the resultant related hydrologic regimes.

A limited set of ecological values or themes were assessed in this investigation. The investigations into the benefits and risks of relaxed constraints considered the following themes:

- Floodplain vegetation
- Instream productivity
- Instream water quality
- Instream macroinvertebrates
- River and floodplain dependent fish
- Waterbirds
- Platypus and turtles
- Channel geomorphology / erosion rates.

The approach estimated the likely reach scale and system-wide environmental outcomes of relaxing constraints. The assessment methods used a bottom-up approach based on specialists understanding of the environmental water requirements of individual species and processes contained within the themes.

The assessment approach was based on the use of existing available ecological response modelling if and as available. No new ecological response modelling approaches were developed, although some existing approaches were adapted to suit the requirements of the Victorian CMP.

The assessment process included quantitative modelling originally developed for the NSW RRCP. The investigation included:

- a review of the NSW RRCP assessments methods and results for Victoria's purposes on the Murray River and
- the application of the NSW RRCP approach to assess impacts on vegetation and birds in the Goulburn River.

The Goulburn River assessment also included stochastic ecological modelling developed by the University of Melbourne. The Goulburn River assessment therefore comprises multiple lines of evidence.

The investigations applied a suite of separate ecological response models that represent the best science currently available. This quantitative modelling involved the integration of:

- Daily time step (hydrologic) water balance modelling for the 'without development', 'base case (current constraints)' and individual scenarios. The water balance modelling was based on the demands for all water users and included environmental water demands (i.e., the timing, duration and frequency of these demands), including those sought for overbank inundation
- Hydraulic modelling of inundation extents. Two-dimensional hydrodynamic hydraulic modelling has been undertaken to identify the extent of inundation under alternative levels of relaxed constraint
- Ecological response modelling. Ecological response models developed by specialists for each of the values assessed, were applied to the modelled hydrologic regime arising from the proposed constraint relaxation scenarios. These ecological response models had been developed by the subject matter specialists, for previous related projects including Environmental Flow Assessment for the Goulburn River (University of Melbourne stochastic models) and the NSW Reconnecting River Country Program. The ecological response models are based on research and monitoring into the behaviour and response of Australian ecosystems to flood events, the delivery of environmental water and to spells between events including droughts.

Where gaps were identified, the modelling was supplemented by semi quantitative and qualitative assessments by experts in that that field of science.

The environmental risk and benefit outcomes were reviewed by a panel of ecological experts who agree that the environmental benefits of relaxing constraints outweigh any potential environmental risks.

8.3 Summary of outcomes

The assessment found that substantial environmental benefits can be expected from the relaxation of constraints. These benefits are spread widely across the landscape and across the themes assessed. These benefits occur within each reach assessed but also cumulatively across the whole system.

The assessment also identified some ecological risks (potential disbenefits) associated with the relaxation of constraints. These risks include the potential for carp breeding and a potential reduction in spill events that would otherwise provide watering to the outer extents of floodplain vegetation communities.

- Carp: There is some risk that an increase in the occurrence of overbank inundation provides increased opportunity for carp breeding. The Committee supports further investigation of the impacts of constraints relaxation on carp populations. This should include potential impacts on wetland habitat, including impacts on native vegetation and fish, the waterbird benefits, and the potential flow management options that benefit native fish without exacerbating carp risks.
- Reduction in the size of moderate floods: Relaxing constraints would enable more environmental water to be released from storages than under current rules, increasing dam airspace and reducing the size of moderate floods. Higher unregulated flow events have been identified to provide benefits to the outer edges of floodplain vegetation communities that will not be serviced by the relaxed constraint scenarios assessed. Some loss of this outer lying vegetation is expected. However, this impact (disbenefit) is more than offset by the benefits to larger areas of floodplain vegetation watered as a result of relaxed constraints.

On balance, the ecological benefits identified from the investigations have been identified to overwhelmingly outweigh the identified disbenefits.

Importantly the benefits of relaxed constraints are contingent on achieving overbank inundation. Indeed, the assessments reveal that the more constraints are relaxed, the greater the benefit. Conversely, relaxation of constraints without achieving overbank inundation is unlikely to achieve significant ecological benefit. In the scenarios where constraints are relaxed to the level that allows significant inundation of the floodplain, the benefits to the whole ecosystem are maximised.

The role that the floodplain has in sustaining habitat, ecosystem functions and resilience is critical to achieving Basin Plan objectives. From an ecosystem functions perspective, floodplains are an important influence on food-webs which affect floodplain, riparian and downstream river reaches.

The expected environmental outcomes from relaxed constraints is summarised in Figure 74, showing ongoing degradation if the base case (current constraints) is maintained, and increasing improvement of environmental benefits the further constraints are relaxed.

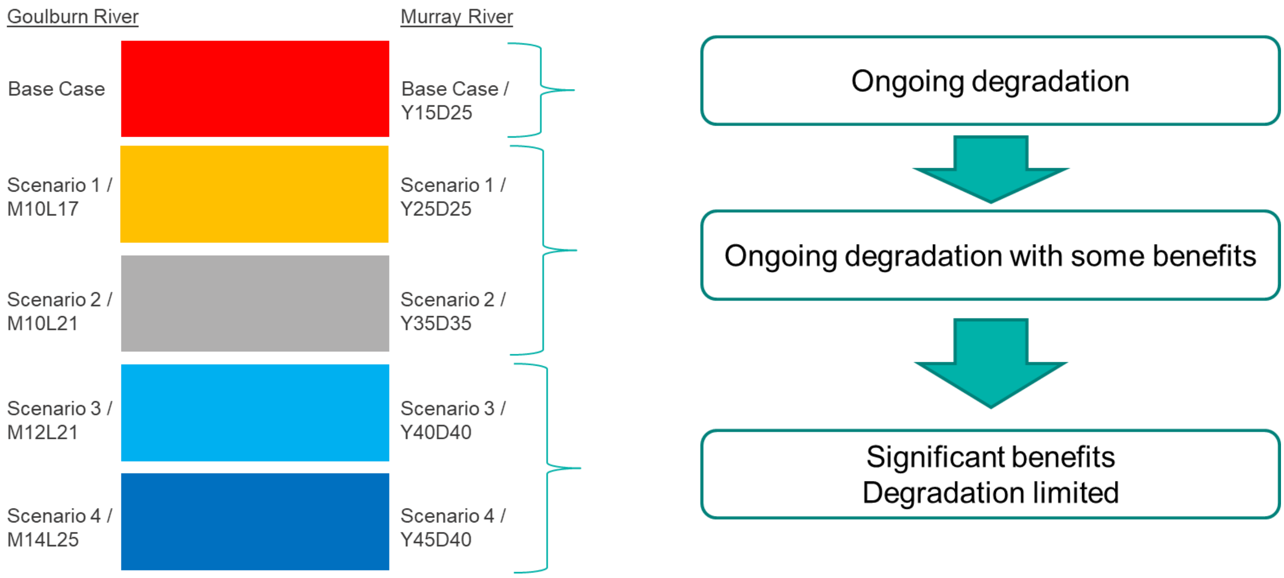


Figure 74 – Summary of expected outcomes from relaxed constraints

Following the theme-based assessments (ecological values and processes) and the synthesis of the interactions, the assessment of constraints scenarios has been collated to document the benefits and risks within each of the study reaches. These are summarised in the following sections.

8.3.1 Goulburn River

For the Goulburn River (Table 36), the assessments showed that the base case scenario, where no change to constraints is made, provides the highest risk scenario for the environmental themes assessed. The condition of vegetation, the instream ecosystem led by production and fish, and the erosion risk in the base case scenario shows a high likelihood of degradation (in line with the observed decline of the system). The scenario assessments have revealed ‘step changes’ as constraints are relaxed. Some benefits can be expected in the lower relaxation scenarios, but it is only once significant floodplain engagement occurs, via constraints relaxation, that ecosystem recovery is possible.

The lower relaxation scenarios (e.g., M10L17 and M10L21) have the capacity to slow some of this decline, though still pose some risk. These lower constraint relaxation scenarios in the Goulburn River pose risks for black box communities. Some of the elements within the system, such as native fish, would see improvement against the base case, with other benefits such as river red gum vegetation mainly benefiting from uncontrolled spills from storage rather than controlled delivery. It is not until the higher scenarios with greater inundation of the floodplain that a reversal of the decline is possible and benefits for black box communities are achieved. These higher constrain relaxation scenarios allow a more resilient ecosystem to be maintained, providing opportunity for the mosaic of native species to endure future drought events and climate change pressures.

Table 36 - Summary of environmental outcomes: Goulburn River

Theme	Summary of outcomes of relaxing constraints, compared to base case
Hydrologic connectivity	Improved longitudinal connectivity with up to 9% increase in August flows at Shepparton. Up to 4% increase in flows in July and October. Changes in lateral connectivity assessed via themes below.

Theme	Summary of outcomes of relaxing constraints, compared to base case
Vegetation quality	Relaxation of constraint to low levels (less than 22,000 ML/day) likely to provide some support to native vegetation but likely to remain vulnerable. High relaxation will allow targeted vegetation to be held in good condition, though some sacrifice of fringe areas as a result of reduced spills. Significant improvements in black box and river red gum will require relaxation of constraints in both the mid and Lower Goulburn.
Vegetation quantity	Increased inundation of semi-aquatic, terrestrial flood-adapted/semi-aquatic, and terrestrial flood-adapted ecological vegetation classes in the Mid Goulburn and Lower Goulburn River. Negligible inundation of terrestrial (not flood-adapted) vegetation.
Production	Negative impacts on production (compared to base case) if constraints are relaxed below 22,000 ML/day. Increased production (compared to base case) above 22,000 ML/day, as floodplains are engaged.
Water quality	Relaxation of constraints as proposed and assessed is unlikely to adversely impact on any water quality parameters in this reach.
Macroinvertebrates	Benefits to macroinvertebrate biomass and diversity are predicted if constraints in Mid Goulburn are relaxed above 11,000 ML/day and Lower Goulburn constraints are relaxed above 21,000 ML/day.
Native fish	Benefits for equilibrium, periodic and opportunistic fish increase with progressive relaxation of constraints up to ~20,000 ML/day in the Lower Goulburn River and ~12,000 ML/day in the Mid Goulburn River. Sustained benefits above these flows. Benefits to large fish such as Murray cod are limited, however floodplain specialists are expected to significantly benefit from relaxed constraints that increases the frequency of floodplain inundation.
Waterbirds	Mixed outcomes are predicted for waterbirds. Increased median probability of waterbird breeding (up to +5%), +12% overall probability of waterbird breeding with relaxation of constraints. Decreased chance of large breeding events by up to 11%, but an increased chance of small breeding events by 11%. Overall reduction of long-term breeding occurrence by 3% with relaxation of constraints. Declines in long-term average waterbird abundances with relaxation of constraints, particularly for Large Waders (13% decline in 9^{0t}h percentile, increased 2^{5t}h percentile by 14%).
Platypus	Disbenefits have been identified if Lower Goulburn constraints are relaxed above 22,000 ML/day during nesting periods. Platypus have evolved and adapted to winter and spring overbank inundation. Potential disbenefits are unlikely if inundation events occur outside nesting season. The timing of environmental flow delivery is important. Nesting is expected to improve with reduced bank erosion.
Turtles	Negative impacts on turtle populations are predicted if overbank events occur during critical nesting periods. The timing of environmental flow delivery is important.
Geomorphology	Decreased erosion is predicted as constraints are relaxed in the Lower Goulburn. Relaxation of constraints at above 12,000 ML/day (creating overbank flows) in the Mid Goulburn is also expected to decrease erosion potential.

8.3.2 Murray River

The results for the Murray River (Table 37 and Table 38) were very similar to those in Goulburn. The base case scenario with no change to constraints poses the highest risk to the Murray River ecosystem. The relaxation of constraints has potential to mitigate some of this risk for floodplain and river vegetation, particularly in the Hume to Yarrawonga reach. The investigations reveal that the higher relaxation scenarios provide the greatest benefits.

The current condition of the subject waterways and related ecological values is poor, with indications of ongoing decline. The assessments undertaken for this assessment reveals that the base case scenario (no change to constraints) will lead to ongoing decline in condition and potential for accelerated loss under expected climate change. The base case (do nothing more) scenario has the greatest level of ecological risk (disbenefit) of the scenarios assessed.

Hume to Yarrawonga

Table 37 provides a summary of the environmental assessment outcomes for the Murray River, Hume to Yarrawonga, for each environmental theme.

Table 37 - Summary of environmental outcomes: Murray River, Hume to Yarrawonga

Theme	Summary of outcomes of relaxing constraints, compared to base case
Hydrologic connectivity	No adverse impacts to longitudinal connectivity. Lateral connectivity assessed through the themes below.
Vegetation quality	Both black box woodland and river red gum forests/woodlands were responsive to the relaxation of flow constraints. Broad benefits of constraint relaxation to higher flow scenarios were representative of greater areas of woody species in good condition and reduced areas in critical condition.
Vegetation quantity	Over 2,289 ha of additional vegetation (81% increase) inundated through relaxation of constraints compared to base case, including 1,562 ha terrestrial flood-adapted vegetation (154% increase), and 447 ha terrestrial flood-adapted semi-aquatic vegetation (77% increase). A negligible (1 ha) of terrestrial not flood-adapted vegetation inundated at the highest constraint relaxation scenario.
Production	Up to 2% increase in mean annual production potential.
Water quality	Relaxation of constraints as proposed and modelled is unlikely to adversely impact on any water quality parameters in this reach.
Macroinvertebrates	Not directly assessed. Macroinvertebrate production is expected increase in response to constraint relaxation.
Native fish	Up to 39% increase in expected mean population of golden perch. No change to Murray cod population size with relaxation of constraints. Floodplain specialists are expected to significantly benefit from relaxed constraints that enable the proposed frequency of floodplain inundation.
Waterbirds	Not assessed – significant waterbird sites in Murray River are located downstream of Yarrawonga.
Platypus	Not assessed
Turtles	Not assessed
Geomorphology	Decreased erosion potential expected when constraints are relaxed to 30,000 ML/day and higher.

Yarrawonga to Wakool

Table 38 provides a summary of the environmental assessment outcomes for the Murray River, Yarrawonga to Wakool, for each environmental theme.

Table 38 - Summary of environmental outcomes: Murray River, Yarrawonga to Wakool

Theme	Summary of outcomes of relaxing constraints, compared to base case
Hydrologic connectivity	No adverse impacts to longitudinal connectivity. Lateral connectivity assessed through the themes below.
Vegetation quality	Similar results as seen in the Goulburn, however the rate of decline may not be as rapid due to tributary flows supporting vegetation communities.
Vegetation quantity	An additional 30,000 ha of vegetation will benefit, including 15,000 ha of terrestrial flood-adapted/semi-aquatic vegetation and 13,000 ha of terrestrial flood-adapted vegetation. A potential disbenefit of a relatively negligible 19 ha of additional not flood-adapted terrestrial vegetation may be inundated.
Production	Up to 15% increased mean annual production potential.
Water quality	Relaxation of constraints as proposed and assessed is unlikely to adversely impact on any water quality parameters in this reach.
Macroinvertebrates	Not directly assessed. Macroinvertebrate production is expected increase in response to constraint relaxation.
Native fish	Up to 39% increase in expected mean population size of golden perch from Yarrawonga to Torrumbarry. Up to 28% increase in golden perch population between Torrumbarry and Lock 10. No change to Murray cod population size with relaxation of constraints. Floodplain specialists are expected to significantly benefit from relaxed constraints that enable the proposed frequency of floodplain inundation.
Waterbirds	4-5% increases in median waterbird species richness and 10-13% increase in waterbird density in Barmah-Millewa Forest. Up to 11% increase in probability of colonial waterbird breeding in Barmah-Millewa Forest with relaxation of constraints. 1-4% increase in the median number of species, and 8-48% increase in median waterbird abundance in Gunbower Koondrook-Perricoota Forest with relaxation of constraints.
Platypus	Not assessed
Turtles	Not assessed
Geomorphology	Decreases in erosion potential are expected as constraints are progressively relaxed beyond 25,000 ML/day.

8.4 Environmental assessment outcomes

The outcomes from assessment of the ecological themes are described in this section or referenced if extensively covered in another section of this feasibility study.

8.4.1 Vegetation benefits and risks

This is explored in Section 3.4- Area of flood adapted native vegetation potentially inundated and in Section 3.6- Area of river red gum and black box woodland in good or moderate condition.

8.4.2 Fish benefits and risks

This is explored in Section 3.7- Native fish populations.

8.4.3 Water quality benefits and risks

The assessment did not identify any additional disbenefits associated with relaxing constraints. There are existing and potential water quality risks associated with the return of carbon and nutrients from the floodplain into the river systems in the peak of summer. The management scenarios considered here seek the delivery of environmental water in winter and spring and include the return of organic matter and nutrients to the channel which will influence productivity in downstream reaches and assets. Management of environmental water does not involve the inappropriate inundation of floodplains during summer. As a consequence, any risks arising from summer inundation of floodplains is not linked to the management of environmental flows.

Within this context, relaxing constraints will provide regional biodiversity and productivity outcomes through effects on habitat and connectivity and system scale outcomes in terms of the movement of nutrients and organic matter in ways that will not pose a risk to downstream systems.

8.4.4 Instream production and macroinvertebrate benefits and risks

The assessments revealed improvements in instream productivity associated with increasing levels of constraint relaxation. This benefit reflects the increased, timely, carbon input to the stream system. The expected productivity increase on floodplains was not assessed but is expected to be significant due to its effects on the growth of algae, understory plants and trees.

The University of Melbourne Stochastic modelling explored the outcome for macroinvertebrates. This assessment identified improvements in macroinvertebrate populations associated with the relaxation of constraints in both the Mid- and Lower Goulburn River. Similar outcomes could be inferred for the Murray River reaches. No significant risks were identified. Like the instream production assessment, the University of Melbourne stochastic macroinvertebrate modelling for the Goulburn River only assessed in-channel macroinvertebrate communities, and so, this is also likely to under-estimate the benefit of relaxed constraints given that large areas of macroinvertebrate habitat would be created in wetlands and floodplains and that these invertebrates provide a food resource for bush and waterbirds. There is abundant data from around the world to suggest that delivery of flows to floodplain and wetland ecosystems is associated with a boom in productivity that supports a range of predatory bats, birds, frogs and reptiles.

The assessment has found that that the restoration of lateral connectivity will lead to benefits for food webs locally and regionally with increases in the amount and quality of habitat and increased productivity. The regional outcomes will also contribute to system scale outcomes through the contribution of organic matter and nutrients to downstream systems and also in supporting bird populations whose health is influenced by large scale habitat availability.

8.4.5 Waterbird benefits and risks

The waterbird assessment found that relaxing constraints favours some species but results in some decline in others. The assessment found that while waterbird abundance would significantly improve in dry years, there was no overall improvement in waterbird abundance.

Perhaps most importantly, the modelling revealed that the minimum population size would increase, and this has a number of population implications. First, when breeding opportunities arise, there will be better population responses. Second, modelling of egret populations found high mortality rates suggesting they are vulnerable to changes in the frequency of breeding events. Improvements in foraging habitats on floodplains may reduce mortality rates and act as a buffer to declines in breeding in the southern basin.

The change in risks associated with waterbird breeding and abundance are difficult to link to a specific location given the migratory patterns of many bird species, however the more locations that the waterbirds are able to use as habitat, the greater chance that species have of avoiding irreparable decline. This is shown in the modelling results, with the greatest impact of relaxed constraints being a reduced likelihood of poor outcomes for birds. By providing more waterbird species with greater areas for habitation, the better chances they have of maintaining or growing species numbers.

The relaxation of constraints in the Goulburn River needs to be considered within the context of the whole system because waterbird populations respond to large (basin or continental) scale changes in habitat availability. The investigation revealed that the Goulburn River floodplain may play an important role in sustaining waterbirds during dry periods. This finding and outcome may be important for the attainment of Basin Plan targets and meeting national treaty obligations. The Murray River reach from Yarrawonga to

Wakool is acknowledged as supporting waterbird populations and the assessment confirmed that relaxation of constraints appears to be appropriate and beneficial for waterbird populations.

8.4.6 Platypus and turtle benefits and risks

Platypus and turtle benefits and risks were only modelled in the Goulburn River. The results were mixed, possibly reflecting the greater uncertainty around the flow requirements of platypus and turtles and comparatively low data availability. Increases in productivity and invertebrates are expected to improve conditions for platypus and turtles. However, the modelling identified risks for both platypus and turtles related to the influence of high flows on nest success.

In the case of platypus, high flows over the breeding season have the potential to inundate nesting burrows. However, there remains considerable uncertainty around this hypothesis. Firstly, these species have evolved and or adapted in this region to annual winter and spring flood events. While platypus monitoring programs have identified breeding may start as early as August (and therefore impacted by winter/spring inundation), there are observations from Tasmania and Victorian high country of breeding starting in October (and therefore not impacted by winter and early spring inundation). The hypothesis also appears inconsistent with observations that platypus populations have dramatically decreased over the last three decades at the same time that river regulation has reduced winter/spring flow events. This raises questions about how platypus respond to changes in flow. It is possible that platypus take cues from winter flows when locating and constructing their burrows. Environmental flow managers may need to consider antecedent flows (e.g., bank-full events) when planning overbank inundation events to mitigate the risk of impacting nesting burrows.

The University of Melbourne models made similar predictions for turtles[106]. All three species of turtle were modelled together which may increase uncertainty around the modelled forecasts, given that each species has different breeding habitats. There is also evidence that some species of turtle use flows as a cue for nest site selection.

For both platypus and turtles, managing the timing of flow events and the quality of bank habitat may be the most effective ways a constraints relaxation program can influence the availability of suitable nesting sites and success of breeding.

Overall, the modelling provides a cautionary message about potential risks to these two important values. This risk needs to be considered within the broader context of how these species have evolved and persisted in these systems for millennia, including the way they have adapted to late winter and spring events. Further investigations including the identification of the risk triggers and responses through ongoing research, monitoring and adaption of environmental water delivery programs is recommended, rather than using these risks as a basis to not proceed with the further development of relaxed constraints.

8.4.7 Geomorphology benefits and risks

River regulation has been identified as a major factor in stream related erosion in the Goulburn River and Murray River systems. River regulation stores high flow events, that may have created overbank events, in winter and spring, and delivers this water in-channel over the summer irrigation season. Stream flows apply force to (or ‘work’ on) the bed and banks of the river and on the floodplain. The process of river regulation decreases the occurrence of overbank events and associated expenditure of the energy on the floodplain with a complementary increase in energy expenditure in the river channel. By increasing the occurrence and duration of in-channel flow events, river regulation has increased the potential for energy expenditure in the river channel including the riverbank. This can lead to increased rates of channel erosion in regulated rivers. Returning or increasing the occurrence of overbank events, redistributes this energy to the floodplain and can reduce the rate and extent of bank erosion.

There is evidence of accelerated rates of erosion in both the Goulburn River and Murray River. The Committee was also concerned about erosion, a critical issue affecting both current and potential river operations under relaxed constraints. The Committee shared numerous examples of erosion currently occurring in the Goulburn and Murray catchments and expressed fears that relaxing constraints may exacerbate erosion rates. They observed that erosion rates have seemingly increased over the past two decades, likely due to prolonged periods of high-water flows. The observed erosion has been linked to river regulation and changed water delivery patterns to meet evolving water use for both the environment and irrigation. Examples were cited such as the increased water requirement for permanent plantings in Sunraysia and reduced demands down the National Channel have altered flows patterns down the rivers.

[106] UOM Stage 1A Victorian Constraints Measures Program – SGEFM updates, Goulburn range-finding exercise, and climate change vulnerability analysis, August 2022

Other factors specific to some reaches like boat wake and sediment deprivation downstream of Lake Hume due to the dam's operation were also highlighted.

The investigations undertaken for this assessment sought to assess the amount of excess energy in the river system to 'do work' on the banks of the Lower Goulburn River. The assessment found that the current flow regime has increased the erosion potential compared to the 'without development' flow regime. Relaxing constraints to increase the occurrence of overbank events was found to reduce the bank erosion potential. The investigations were limited in extent and further work on the erosion potential is warranted.

An assessment of erosion potential in the Murray River system was beyond the scope of the investigation. However, a review of the occurrence of overbank events in the Murray River under current and alternative levels of relaxed constraints revealed the potential to reduce erosion in the Hume to Yarrawonga Reach. The benefits in the Yarrawonga to Wakool reach of the Murray River are more limited but may be significant in reaches such as the Barmah-Millewa Forest.

Constraints relaxation has some potential to indirectly increase erosion risk from boat wake. It has been noted that during the Millennium drought low water levels in lakes and high levels in rivers (due to irrigation flows) led boater/skiers transitioning their boating activities from lakes to rivers. High river levels arising from relaxed constraints also has the potential to encourage increased boat use and resultant boat wake. The issue of boat wake and its management is discussed under complementary measures.

In terms of benefits and risks, the assessment found no evidence to suggest that the relaxation of constraints would increase erosion risk in the Lower Goulburn and Murray Rivers. To the contrary, the investigations revealed that relaxing constraints may reduce erosion potential. However, the assessments were limited in scope and further investigations should be undertaken to explore the implications of relaxed constraints on bank erosion and anabranch development in the subject reaches and river systems.

8.4.8 Climate change and constraints

All constraints study reaches are predicted to experience a warmer and drier future climate, with increased likelihood of extreme droughts and floods. Such changes are predicted to negatively impact on hydrological metrics in both rivers, causing substantial decreases in mean annual flows, overbank events, and freshes and increases in cease-to-flow events. Climate change represents significant risks for ecological outcomes with the condition of ecological values expected to decline as the climate warms and dries. Environmental water shortfall volumes (as well as water for other entitlement holders) are also expected to increase under climate change as tributary flows and entitlements decrease. The investigations, except for the most severe climate scenario where water availability is the major limiting factor, relaxing constraints can serve as a valuable tool for environmental water managers to adapt to a drying climate. It's important to recognise that in such an environment, river management would need to significantly differ from what we are familiar with today. The relaxation of constraints will be particularly important for supporting the resilience and climate adaptation of ecological values to future climate impacts.

8.5 Future considerations

The feasibility study environmental benefits and risks assessment has identified knowledge gaps that have potential to impact on the scale of beneficial outcomes sought and identified. Further investigations that would improve the confidence in the assessments and the benefits are set out below.

8.5.1 System scale implications

The river system conceptual model includes both the mosaic of ecosystems within a reach and their influence on the functioning of the whole system, facilitated or moderated by hydrological connectivity. Due to limited capacity to model system scale interdependencies, this assessment has focussed on modelled ecosystem responses within the reaches, and a qualitative assessment of outcomes across the system. Improving our system scale understanding of interdependencies and responses to environmental flow management will be increasingly important to the implementation of the Basin Plan as managers apply adaptive management approaches to the provision and delivery of environmental flows.

The Committee recommends that such system-level modelling should be undertaken to provide a complete picture of what may be achievable with relaxed constraints across all study areas. Further work may determine whether the notified flow rates can be achieved through the system or whether lower levels may be more appropriate.

8.5.2 Invasive carp

Carp are an existing threat across the Murray Darling Basin and readily respond to overbank flows. This is an existing threat across the study reaches. Relaxation of constraints will benefit targeted native species but may also favour carp. Limits on the duration of floodplain events may limit the benefits to carp and related risks to the river system.

While carp pose a risk to the health of the river system, this risk does not warrant a cessation in further investigation into and development of a constraints relaxation program.

It is noted here though that the potential response of carp has not been included in the modelling for this feasibility stage assessment as no functional ecological response model was available for the investigations. The Committee supports further investigation of the impacts of constraints relaxation on carp populations. This should include potential impacts on wetland habitat, including impacts on native vegetation and fish, the waterbird benefits, and the potential flow management options that benefit native fish without exacerbating carp risks.

8.5.3 Platypus and turtle models

The investigations have revealed uncertainties in the platypus and turtle models. Further work is required to refine and update these ecological response models to reflect:

- the requirements of individual species (turtles)
- research into platypus response to antecedent conditions and overbank inundation in winter and early spring.

8.5.4 Geomorphic impacts, including bank erosion

The scope of the study limited the extent of investigations that could be undertaken into geomorphic processes such as bed and bank erosion and anabranch development. Further investigations are required to confirm the preliminary outcomes identified in this report and to pursue issues not examined such as the potential for anabranch development e.g., in the Hume to Yarrawonga reach of the Murray River.

8.5.5 Complementary measures

There are ongoing issues beyond the scope of this investigation, within the subject stream systems that have the potential to limit or risk the environmental outcomes sought via relaxed constraints. These issues are discussed below and should form a part of a program of work to complement a constraint relaxation program.

Grazing risks

Riparian areas are vulnerable to grazing pressures as they are often fertile and provide easy access to drinking water. Grazing is one of the major causes of riparian degradation and has significant impacts on riparian function and biodiversity.

Grazing stock causes reductions in vegetation cover, biodiversity loss, streambank erosion, water eutrophication and degradation of instream processes (Lunt et al. 2007). It can also contribute to increased sediment loads delivering to the waterways when livestock access the riverbanks and accelerate instream and bank erosion. Grazing of riparian lands has the potential to undermine some of the outcomes sought from constraints relaxation. Measures aimed at expanding existing efforts to control stock access to riparian frontages on the Goulburn River and Murray River systems should be explored to complement the outcomes sought through a constraints relaxation program.

Invasive vegetation

Invasive vegetation has the potential to undermine the expected benefits of relaxed constraints. Flow pulses have the potential to disperse invasive vegetation seeds to a wider area and provide water to support the germination and establishment of such species. With riparian areas already subject to pressures from anthropogenic activity such as vegetation clearing, erosion from flow regulation and river activity and biodiversity loss, invasive vegetation can further disrupt the system, particularly in riparian areas.

Managing weeds across the rivers is a complex issue that is likely to be influenced by multiple sources. It is expected to require a holistic approach that considered riparian areas and the adjacent floodplain. Weed management is vital to river system health and should be considered as a complementary measure to a constraints relaxation program.

Boat wake

Boat wake has been identified as contributing to streambank erosion in some of the river reaches assessed for this investigation. Ongoing erosion through boat wake has potential to limit any erosion benefits sought from a constraints relaxation program. Further effort will be required to address boat wake in order to realise the erosion reduction benefits of constraint relaxation.

9. Mitigation Selection and Compensation Framework

9.1 Key outcomes

Key outcomes:

- A Victorian CMP mitigation selection and compensation framework is required to provide a reasonable, consistent and transparent method for negotiation of mitigation measures and compensation payments.
- There must be consistency in compensation and mitigation approaches across state borders to ensure that landowners on both sides of the river are treated fairly.
- Inundation impacts may extend beyond the land directly affected, including causing farm access issues, impacting property management and impeding stock movement.
- Compensation and mitigation approaches should consider all impacted assets and recurring impacts, such as loss of production, restoration, clean-up, impeded access and maintenance.
- Any future compensation must consider the potential impacts up to not only the target flow rate, but a higher level that includes an additional risk buffer for river operations. The extent of the risk buffer will depend on developing appropriate forecasting and associated tools as part of the Enhancing Environmental Water Delivery (EEWD) project.
- Unless otherwise advised by governments, any future implementation must adhere to the *Victorian Government Land Transaction Policy 2022* for compensating against impacts.
- Relaxing constraints should not result in a material increase in local government rates.
- The framework was developed in the context of the Victorian Government's stated position that **Victoria will not inundate land without prior landowner consent nor compulsorily acquire land or easements** for the purposes of relaxing constraints
- The framework has been developed in consultation with the Consultative Committee
- Where agreement cannot be reached, there are options for voluntary resolution included in the framework:
  - **mitigations involving land transactions (easement or land purchase):** disputed valuations are resolved in accordance with the *Victorian Government Land Transactions Policy (2022).* The parties will be referred to a **valuers' conference** to resolve any difference in valuations
  - **other mitigations:** landowners can choose to enter into a **mediation process** with the program
- The Victorian CMP considers voluntary opt-in arbitration an unsuitable mechanism for seeking agreements as it forces binding outcomes on both parties and is expensive and a protracted process
- Governments (State and Commonwealth) should agree to reserve the right to use compulsory powers. This should only be where inundation of private land has been avoided as far as practical, and where transparent compensation approaches are in place, all voluntary options have been exhausted, and there are overwhelming environmental outcomes (greater public good).

Available agreements for mitigations

- **Option agreement:** The agreement only comes into effect as such time that the program is satisfied that a sufficient level of agreement with affected landholders has been secured
- **Agreement for inundation:** Through either easement (preferred mechanism), licence, deed, or overlay
- **Land purchase agreement:** While expected to be rare, this would be available if situations arise where the purchase of freehold may be the most appropriate and agreeable to landholder(s)

9.3 Introduction

The Mitigation Selection and Compensation Framework provides a consistent and transparent method for:

- The Victorian CMP and affected parties to negotiate appropriate measures to mitigate inundation impacts
- Identify legal agreements required to formalise those mitigations
- Identify compensation payments that would accompany mitigations and ensure compensation is consistent with relevant government legislation and guidelines for public procurement, land acquisition and public grants.

The Consultative Committee discussed key aspects that should be considered when assessing impacts and mitigation approaches. These have been used to inform the development of the Mitigation Selection & Compensation Framework that will guide the selection of appropriate mitigation measures including any associated compensation if the Program was to proceed. The framework has been developed in the context of the Victorian Government's stated position that Victoria will not inundate land without prior landowner consent nor compulsorily acquire land or easements for the purposes of relaxing constraints.

The framework contains the elements shown in Figure 75 with each element detailed in subsequent sections.

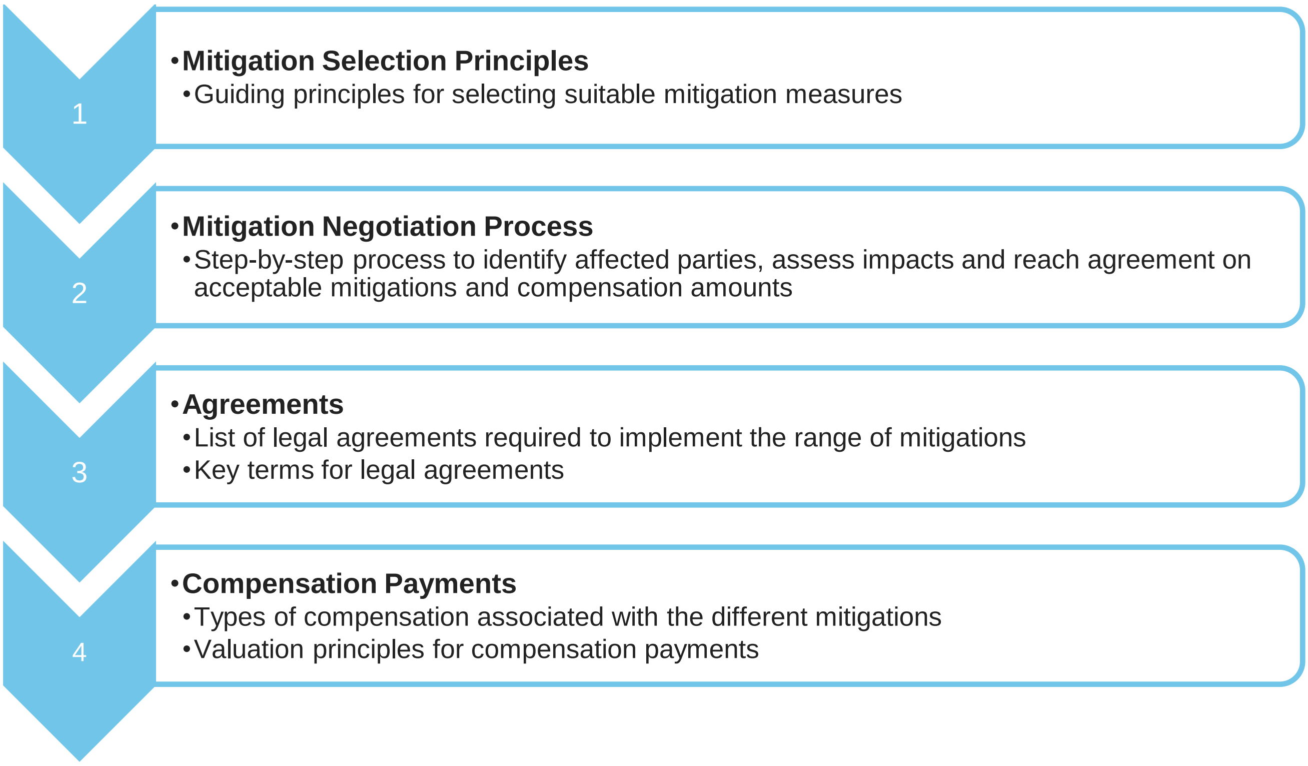


Figure 75 – Framework elements

9.4 Mitigation selection principles

The following principles have been developed in consultation with the Consultative Committee and are intended to guide the selection of suitable mitigations for different circumstances and provide consistency in approach for certain mitigation types.

1. Affected parties shall be provided with sufficient information on inundation extent/duration/frequency/timing, mitigation options and compensation so they can make informed decisions regarding measures that could satisfactorily mitigate impacts.
2. Affected parties would be best placed to identify measures that could mitigate impacts on their property/business/assets.
3. Where opportunities exist, mitigations should aim to deliver benefits to the affected party to complement the broader environmental benefits associated with constraint relaxation.

4. Where an affected party elects to upgrade infrastructure beyond the standard required to mitigate the relaxed constraint, that party would fund the marginal cost difference
5. Mitigations for impacted private or public land or assets shall be the lowest whole-of-life cost solution.
6. Where assets are constructed or upgraded, asset ownership must be agreed upon and documented prior to works commencing.
7. Where easements are the agreed mitigation, easement boundaries shall be based on the inundation extent and an additional buffer area to provide a margin of safety for river operators.
8. Inundation easements would not be acquired over public land.
9. Mitigations must be enduring

9.5 Mitigation negotiation process

The following process provides a consistent and transparent method of engaging with affected parties so they can understand impacts and make an informed decision regarding mitigations. Step-by-step process to identify affected parties, assess impacts and agree on acceptable mitigations and compensation amounts.

9.5.1 Step 1 – Identify affected parties

Affected parties include landowners, land managers, Traditional Owners, and occupiers (including leaseholders). While stakeholders of affected public land will be identified and consulted with (e.g., recreational users, emergency services, etc), they will not participate in the mitigation negotiation process.

Inundation maps shall be used to identify parties whose land may be inundated or whose access may be impeded. Identified parties would be invited to engage in voluntary negotiations to reach agreement on measures that could adequately mitigate impacts.

Landholders whose properties are not modelled to be impacted can advise the project that they anticipate being impacted and wish to enter negotiations to consider potential mitigations.

9.5.2 Step 2 – Impact assessment

The process to assess impacts on individual properties or public assets shall involve:

1. Understanding baseline conditions (i.e., how the property/business/asset is operated and impacted under current river operations)
2. Provide affected parties with the following information for the proposed constraint flow rate:
    a. Property map showing modelled inundation extent at the proposed relaxed constraint flow rate. Where possible, aerial imagery of actual inundation from similar river flows in 2022 shall be provided to increase landowner understanding of the flows being considered and confidence in the modelled inundation extents
    b. Intended timing, duration, and frequency of managed releases up to the proposed relaxed constraint.
3. Seek agreement and document how the property/business/asset is likely to be impacted under the contemplated constraint relaxation scenario.

9.5.3 Step 3 – Mitigation selection

Once probable impacts are established, the parties shall identify measures which could mitigate inundation impacts. The following information shall be provided to affected parties:

1. Mitigation options available, including the ability of landowners to contribute towards the cost of mitigations to further enhance new or existing assets. Mitigation options would include works to protect or relocate assets, works to maintain access, creation of easements or land purchase (or a combination of measures)
2. Compensation payments associated with different mitigation types and the process of determining the value of compensation.

Landholders would be encouraged to identify mitigations that best suit their operations and would be provided with examples of typical works and associated design standards, plus eligibility and basis of any compensation payments.

9.5.4 Step 4 – Mitigation offer

Where in-principle agreement to mitigation is achieved, the landholders would be presented with a Mitigation Offer which specified the mitigation(s), compensation and agreement documentation.

Landholders would be provided with appropriate support through the negotiation process to ensure they can make an informed decision to accept or not accept a Mitigation Offer. This would include reimbursement of reasonable costs for independent legal, valuation or other professional advice.

9.5.5 Step 5 – Agreement

Where a landholder verbally accepts the Mitigation Offer, an Option Deed would be provided for execution by the parties to formalise the agreement (refer to Agreement section for Option Deed details).

In-principle agreement on public asset mitigation would be appropriately documented between the relevant agencies/authorities and progress to execution of an appropriate agreement (i.e. Funding Deed).

9.5.6 Step 6 – Options where agreement not reached

Where an affected party does not accept the mitigation offer, the affected party could voluntarily enter into the following agreement resolution options.

- **Land transactions**: Easement acquisition or land purchases will be governed by the *Victorian Government Land Transactions Policy (2022)* and valued by the VGV. Refer to Section 9.6.1.2 for details about this policy. The policy prescribes how disputed valuations are resolved. If a landowner does not accept an offer of compensation based on VGV valuation, the parties will be referred to a valuers' conference to resolve any differences in the valuations. Following the valuers' conference, the VGV will determine whether it is appropriate to increase its valuation, based on the evidence put forward by the landowner's valuer, for the landowner's reconsideration.
- **Mediation:** For mitigations that don't involve land transactions (i.e., works or compensation for operational responses), the landowner and Victorian CMP could seek to reach agreement on selection of mitigations and the value of associated compensation via mediation. The parties, with the assistance of an appointed dispute resolution practitioner (the mediator), would identify the disputed issues in the mitigation offer, develop options, consider alternatives and endeavour to reach an agreement on a revised offer. The mediator acts as a facilitator and makes no determinations that binds the parties. Either party can withdraw from mediation at any time. Relevant legislation and guidelines on public procurement, easement or land acquisition would continue to govern the relevant authorities' ability to accept a mediated outcome during this process.

The Victorian CMP considers voluntary opt-in arbitration an unsuitable mechanism for seeking agreements as it forces binding outcomes on both parties and is expensive and a protracted process.

Governments (State and Commonwealth) should agree to reserve the right to use compulsory powers. This should only be where inundation of private land has been avoided as far as practical, and where transparent compensation approaches are in place, all voluntary options have been exhausted, and there are overwhelming environmental outcomes (greater public good).

9.6 Agreements

9.6.1 Regulatory framework

Given mitigations will include easements (and potentially land purchases), a summary of the regulatory framework for government land transactions is presented to ensure the Framework complies with relevant legislative requirements.

9.6.1.1 Power to acquire easements

The *Water Act 1989* (Act) grants Victorian water authorities the power to acquire an easement if it is required "for or in connection with or as incidental to, the performance of its functions or the achievement of its objects". Easements need to be acquired in accordance with the Land Acquisition and Compensation Act 1986 (Vic), which specifies procedural requirements that need to be followed (such as notices, time limits and compensation).

9.6.1.2 Victorian Government Land Transactions Policy (2022)

The *Victorian Government Land Transactions Policy (2022)* (Policy) is designed to ensure consistency and transparency in government land transactions and would apply to the following land dealings:

- entering into an option agreement to acquire an easement or freehold land at a future date
- acquiring an easement
- purchase of land.

The Policy would not apply to entering into licences for temporary access to perform works and would not extend to the procurement of works to upgrade, replace, or install assets. Nevertheless, the Victorian CMP would need to comply with applicable Victorian Government procurement requirements in respect of any works (such as competitive tendering, managing conflicts of interest).

Relevantly for Constraints, under the Policy, the Victorian CMP must:

- obtain a current market valuation of the interest in land to be acquired from the VGV
- **not acquire an interest in land at a price which exceeds market value** as determined by the VGV.

A VGV valuation must be current when the parties enter into an agreement. The VGV will advise the period of currency when issuing the report (generally between three to six months).

If entering into an option to purchase an interest in land at a future date, a VGV valuation must be obtained prior to entering into the option agreement and before the authority exercises its option to acquire the interest in land. Payment of an option fee (to be deducted from the compensation offer) is permitted by the Policy.

9.6.2 Valuations

Landowners will be entitled to compensation for the reduction in the market value of their landholding as a result of the easement being created. This will involve an assessment of the restriction placed on the landowner's use and enjoyment of their land as a result of the easement. The CMP will need to provide the valuer with the easement terms together with instructions regarding the expected frequency, duration and timing of managed inundation events as well as specific inundation impacts on business operations and infrastructure that was identified during consultation with individual landowners.

The valuation methodology will be a matter for the valuer to determine, however, it is noted that:

- a 'before and after' approach is generally adopted by valuers in accordance with the Land Acquisition and Compensation Act 1986 (whereby the 'before' value disregards the proposed easement and the 'after' value recognises the reduction in market value of the land associated with the easement).
- it is common for valuers to utilise a 'direct comparison' method (such as adjusting comparable sales evidence with regard to specific characteristics of each property) in assessing the market value of the land in question.

Where relevant, the compensation offer to landowners will include a component for future loss or damages associated with inundation impacts in **perpetuity** (such as loss of production, pasture restoration, reinstatement of fencing, agistment costs etc). The payment of an upfront lump sum which incorporates compensation for future losses creates an inevitable issue of whether financial benefit is transferred to future owners when land is sold. Conditions may be included in the Deed or easement terms which obligate the landowner to disclose the compensation received so the purchaser can make an informed decision when making an offer to purchase.

A landowner is entitled to obtain its own, independent valuation of the interest in the land being acquired. The Policy lists certain administrative requirements the CMP would need to have in place to cover these costs.

If a landowner does not accept an offer of compensation based on VGV valuation, the parties will be referred to a valuers' conference to resolve any differences in the valuations. Following the valuers' conference, the VGV will determine whether it is appropriate to increase its valuation based on the evidence put forward by the landowner's valuer.

The fact that the acquisition of easements for this Program is dependent on the CMP reaching agreement with landowners, creates a significant challenge for the CMP because the landowner is under no obligation to:

- agree to an offer of compensation put forward by the CMP even if the offer is a fair assessment of market value
- is not required to make a fair and reasonable decision when considering an offer of compensation.

9.6.3 Agreements for mitigation

The following types of agreements are proposed to implement the various mitigations.

Inundation easement

The following options for establishing a right to inundate private land are discussed in Figure 76 (over).

- Inundation easement
- Inundation overlay.
- Licence or deed

Easements are proposed as the preferred mechanism as they provide ongoing certainty of the authorities' right to inundate privately owned land as they are registered on title, and are binding on future landowners.

Under the easement terms, the landowner would grant the relevant authority (GMW for the Goulburn River and GMW & MDBA for the Murray River) the right to inundate an area of land shown on an attached plan in exchange for compensation for the inundation effects. The landowner would also release and indemnify the relevant authority from any claim it may have for the effects of the inundation up to the specified levels

Land dealing options: Inundation and flooding

DESCRIPTION	OPTIONS	BENEFITS	COMMENTS
Right to inundate or flood land	**Inundation easement** Right to flood or inundate private land In favour of (and enforceable by) water authority Tailored easement terms specific to Project	• Registered on title • Proprietary interest • Binds future owners • No expiry date	• Must comply with Policy • Difficult to remove from title • Requires payment of compensation
	Land Subject to Inundation Overlay Property control applied to land by way of a planning scheme amendment Aimed at reducing potential damages and costs associated with flooding Administered by responsible authority (e.g. local council)	• Flexible • Shifts onus to landowner • Triggers need for permit for future works or development	• Not recorded on title • No proprietary interest • Not enforceable by water authority
	Licence or deed Contractual agreement with landowner to inundate land Does not bind future owners Not preferred option for this Project	• Attractive to owners • Temporary alternative where owner is not prepared to grant easement	• May be terminated for minor default • Not registered on title • No proprietary interest • Fixed term

Figure 76 – Options for creating a right to inundate land

Purchase land agreement

While expected to be rare, there may be limited situations where purchasing freehold land may be the most appropriate means of mitigating inundation impacts.

Option Deeds

A mechanism is required to avoid creating easements on title or purchasing land until the government is satisfied that a sufficient level of agreement from affected landowners has been secured such that relaxing constraints is feasible. Option agreements (in the form of a Deed) can provide this flexibility and are being used on similar projects such as the Victorian Murray Floodplain Restoration Project (VMFRP).

An option deed may also incorporate the grant of an access licence for works (to avoid the need for two separate agreements). The deed would specify the right for the authority to acquire the interest in the land at a later date (by exercising its option). As discussed earlier, an updated VGV valuation would need to be obtained prior to the option being exercised.

Works agreement – private works

Experience on similar projects shows most landowners prefer works on private infrastructure to be delivered by the CMP. A minority of landowners prefer to manage the works themselves with the CMP covering those costs. Some landowners may also take the opportunity to upgrade affected infrastructure beyond the standard required by the program. The following agreements would be required to provide this flexibility:

- Works Agreement – Program Delivered Works
- Works Agreement – Landowner Delivered Works
- Works Agreement – Mitigation Cost Share.

Figure 77 (over) outlines options for the CMP to obtain temporary access rights to undertake mitigation works. The preferred mechanism for documenting such access rights is either within the option deed (if the land is also affected by an easement acquisition) or a stand-alone, short-term construction licence (if an easement is not being acquired).

Land dealing options: Access for works

DESCRIPTION	OPTIONS	BENEFITS	COMMENTS
Right to access land to carry out works	**Short-term licence** Temporary right to enter property Frequent access over fixed period (e.g. 6 months) to complete Useful where works are likely to cause disruption to landower	• Policy does not apply • Ability to gain access to land quickly (subject to agreement)	• Option to pay nominal or market licence fee • Not recorded on title • No proprietary interest
	Deed Grant of ongoing rights of entry by agreement to carry out works Capable of documenting a range of rights (e.g. construct, inspect, relocate, replace) Capable of documenting ownership or transfer of ownership of assets	• Similar to a licence with broader scope	• Not recorded on title • No proprietary interest • Contractual right only
	Lease Grants exclusive possession to Authority Not suitable where land continues to be used by landowner Not suitable for this Project	• Proprietary interest • Binds future owners	• Policy applies • Exclusive possession • Lengthy negotiations
	Statutory right of entry S 133 Water Act Right of entry in absence of easement or other agreement Limited application	• Notice required but not consent • Refer to water authority's functions and powers under Water Act	• Limited application - e.g. repair & maintenance of existing assets owned by Authority

Figure 77 – Options for creating a right to access land to carry out works

Funding Deed – public works

Where works are required to protect public assets from inundation, those works would be undertaken via a Funding Deed. Funding Deeds are well established agreements for public authorities to undertake works with the use of government funds. The Funding Deed would be executed by the asset owner and the State or Federal department providing the funding.

9.7 Compensation payments

The following payments in Table 39 are proposed for the various mitigations The payment types each party would receive would depend on the mitigations agreed during the negotiation process. Payments that are highlighted would be governed by the Victorian Government Land Transaction Policy (2022) and therefore valued by the VGV.

Table 39 – Compensation payment types

Compensation Payment Type	Details
Reimbursement of Landowner's professional and other expenses	Reimbursement of landowners' reasonable costs to obtain independent legal, valuation or other professional advice in order to make an informed decision before entering into an agreement or deed. The Project authority could either offer to pay each landowner a fixed amount across the Project or reimburse each landowner for their actual costs incurred up to a reasonable capped limit. Other reimbursements may include fees charged by mortgagees or caveators to provide consent to the registration of the easement on title (once the option is exercised).
Option Fee*	Payment of a non-refundable fee to the landowner made upon executing the Option Deed. The fee would form part of the overall compensation amount and therefore deducted from the amount due at final settlement.
Easement Consideration*	Consideration for acquisition of the easement (minus the Option Fee). While the easement valuation methodology would be a matter for the valuer to determine, given the quantity of valuations involved, the CMP would likely proactively engage with the VGV to provide advice on expected inundation regime and impacts so the VGV could establish a consistent valuation methodology for the program.
Land purchase*	Payment for purchase of the land (minus the Option Fee), payable on settlement.
Private Mitigation Works	Where a landowner elects to undertake their own mitigation works, the CMP would make payment of an amount to cover the agreed market value of those works (or series of payments upon the landowner achieving certain milestones).
Construction Licence Fee	Payment of a licence fee for temporary occupation of private land to perform mitigation works.
Public Mitigation Works	Program funding contribution towards works on public assets as detailed in the Funding Deed.

** These items are valued by the VGV*

9.7.1 Other considerations

The following circumstances may result in additional compensation considerations:

- **Leaseholders on private land.** Where a lease on private land exists, the tenant may potentially seek compensation from the landowner or the CMP for the effects of inundation on its use of the land. A landowner may require the CMP to compensate a tenant as a condition of its consent to the grant of an easement (to protect the landowner from such a claim). Where the CMP determines that it will compensate a tenant, the CMP would need to enter into separate agreements with the landowner and tenant and pay separate compensation as part of the land transaction. However, only the landowner's agreement is required to create the easement on title.
- **Crown land licences.** There is no statutory requirement for the CMP to directly compensate Crown land licence holders for effects of inundation. The CMP would engage with the Crown and licence holders to explain the program and its expected impacts; however, it would fall upon the parties to the licence to negotiate a reduction in licence fee (or change in licence conditions) if inundation were to materially limit the use of land for the purpose stated in the licence. This would be a commercial negotiation between the parties.

10. Land and asset impact assessment

10.1 Key outcomes

General

- Upgraded hydraulic modelling has been completed for the relaxed constraint scenarios to enable the areas that could be inundated by each scenario to be estimated.
- As constraints are further relaxed, the downstream reaches of the Goulburn River and Murray River would see significant areas of public land inundated relative to private land. In the Yarrawonga to Wakool reach, 30 times more public land is inundated than private land at flow rates of 45,000 ML/day. At 25,000ML/day in the Lower Goulburn, nearly 8 times as much public land is inundated than private land.
- The challenge is, in order to capitalise on those beneficial downstream outcomes, more private land may be inundated in the upstream reaches than the downstream reaches, namely:
  - In the Goulburn River, hydrological modelling shows the constraint in the mid-Goulburn to be the key limitation on achieving lower-Goulburn flows of 25,000 ML/day.
  - In the Murray River, more modelling work is required to determine whether the significant downstream public land inundation can be achieved without needing to significantly relax constraints in the Hume to Yarrawonga reach.
- The Hume to Yarrawonga reach experiences the most private land inundation. However, there is not a significant corresponding increase in public land inundated in that reach. The same situation is evident in the mid-Goulburn, albeit with a lower total area of private inundation than Hume to Yarrawonga. The area of land impacted, and number of landholders affected increases as flow rates enabled by constraints relaxation increases.
- Much more public land in total is inundated than private land.
- Majority of private land inundated has less than 1 ha of inundation. The private land inundated is predominately agricultural with pasture grazing, making up 70-85% of impacted land. Cropping represents a further 5-10% of impacted private land. There are no residential houses, farm dwellings or built-up areas inundated in any reach.
- Other private land impacts include:
  - impeded access to parts of properties resulting in loss of production (e.g., loss of pasture or grazing)
  - required agistment of stock where property has insufficient high ground to relocate stock
  - private infrastructure impacts such as creek crossings, bridges, fencing, tanks/troughs, hay sheds etc.
  - increased uncertainty for farm planning due to lack of certainty about timing of environmental flows.

Goulburn River

- Under the minimum (M10L17) and maximum (M14L25) relaxed constraint scenario on the Goulburn River there are:
  - 478 ha to 1,505 ha of private land inundated
  - 1.1% to 3.3% of the area of private land inundated within the declared 100-year ARI floodway
  - 2,064 ha to 6,064 ha of public land inundated
  - 99 to 289 additional private properties inundated (301 ‘inundated’ under current constraints)
  - 2.3km* to 10.5km of roads impacted
  - 11km* to 56 km of 2WD and 4WD tracks impacted (note: the extensive track networks within public land are currently the subject of rationalisation by Parks Victoria)
  - 452* to 499 crown land licences held on inundated public land.

*NB: lower value is for M12L17

Key Outcomes Cont.:

Murray River

- Under the minimum (Y25D25) and maximum (Y45D40) relaxed constraint scenario on the Murray River there are:
  - 799 ha to 3,576 ha of private land inundated (739 ha 'inundated' under current constraints)
  - 2.7% to 12% of the area of private land inundated within the declared 100-year ARI floodway
  - 27,623 ha to 45,741 ha of public land inundated
  - 72 to 222 additional private properties inundated (244 'inundated' under current constraints)
  - 8.5km* to 43km of roads impacted
  - 163.8km* to 636km of 2WD and 4WD tracks impacted (note: the extensive track networks within public land are currently the subject of rationalisation by Parks Victoria)
  - 402* to 450 crown land licences held on inundated public land.

*NB: lower value is for Y30D30

10.2 Introduction

Restoring flows to below minor flood levels will impact private land, agricultural production, stock, assets, private access roads and other public infrastructure such as roads, bridges, and culverts.

This Land and Asset Impact Assessment identifies the number of affected parties that may require mitigations under different constraint relaxation scenarios and the likely nature of impacts.

The assessment method was as follows:

- Desktop queries of the project GIS to identify Victorian land and assets located within modelled inundation extents. The project GIS imported numerous land and asset datasets, together with hydraulic model shape files (showing lateral extent and inundation depth) for each constraint relaxation scenario
- Title searches for inundated private properties to determine the number of unique property owners to increase confidence in the number of legal agreements likely required, and identify encumbrances that may complicate creating inundation easements on titles
- When quantifying inundation impacts, the area of land occupied by rivers were excluded from query results. The following method and data was used to define and exclude river areas:
  - Goulburn River: The VicMap Hydro - Water Area (polygon) 1:25,000 dataset informed the river extent.
  - Murray River: The Victorian state boundary is the southern edge of the Murray River
- Site visits were undertaken to ground-truth desktop assessment results where impacts to infrastructure (particularly public assets) were inconclusive
- "Kitchen table" meetings held in each river reach with Consultative Committee members and local landowners. These meetings provided valuable insights into the probable impacts on private property based on local experience.
- During the period of this study, the Murray and Goulburn rivers experienced flows of the magnitude of those being investigated. This enabled the capture of aerial photography of the inundation extents to compare against asset location information, as well as field visits to understand the flow impacts on various assets, especially tracks, roads and bridges.

The impact assessment at this stage of the Constraints Measures Program is currently limited by:

- Any gaps or inaccuracies in land and assets datasets imported into the project GIS
- Inherent accuracy limits of the hydraulic modelling, although aerial imagery of inundation on the Goulburn and Murray rivers was obtained during the September 2022 river high river flows which may assist to communicate and validate modelled inundation extents during any future stages of the program

- Limited GIS data for infrastructure on private land. This limitation could be addressed via engagement with potentially affected parties during a subsequent stage of the Victorian CMP
- The steady state nature of the hydraulic model, compared to the dynamic reality of a river system. The inundation layers show the corresponding water level for a flow of that magnitude at any location along the river reach. The dynamic reality of the system is that the flow will vary along the river. The amount of land and assets assessed as impacted are based on steady state inundation footprints
- Consideration of cultural heritage impacts are being discussed with individual Traditional Owner groups and therefore are not included in this impact assessment.

Land and asset impact assessment outcomes are presented per individual river reach in the following sections. This highlights the degree to which impacts in each reach increase as constraints are further relaxed. However, the relaxation of constraints between reaches are hydrologically related (i.e., relaxing the constraint in the Mid Goulburn is necessary to deliver higher flows to the Lower Goulburn). The combined impact on land for the hydrological scenarios in Table 40 and Table 41 are presented in the following section. Asset impacts are generally only provided for the lower and upper constraint relaxation flow rates in each reach, as this is generally sufficient to draw conclusions about the feasibility of mitigating asset impacts.

Table 40 – Goulburn constraint relaxation scenarios assessed

Goulburn River reach	Current constraint M10L9.5 ML/d	M10L17 ML/d	M10L21 ML/d	M12L21 ML/d	M14L25 ML/d
Mid Goulburn (at Molesworth)	10,000	10,000	10,000	12,000	14,000
Lower Goulburn (at Shepparton)	9,500	17,000	21,000	21,000	25,000

The ‘Lower constraint scenario’ and ‘Upper constraint scenario’ for the Goulburn River as referenced in the land and asset impact assessment results is represented by:

- Lower constraint scenario:M12L17
- Upper constraint scenario: M14L25.

Table 41 – Murray constraint relaxation scenarios assessed

Murray River reach	Current constraint Y15D25	Y25D25	Y30D30	Y40D40	Y45D40[1]
Hume to Yarrawonga (at Doctors Point)	25,000	25,000	30,000	40,000	40,000
Yarrawonga to Wakool (at Yarrawonga Weir downstream)	15,000	25,000	30,000	40,000	45,000

[1]45,000 ML/day has not been modelled in Zone 3 of the Hume to Yarrawonga reach. Modelling for 50,000 ML/day for Zone 3 was used for assessment purposes for this scenario.

The ‘Lower constraint scenario’ and ‘Upper constraint scenario’ for the Murray River as referenced in the land and asset impact results is represented by:

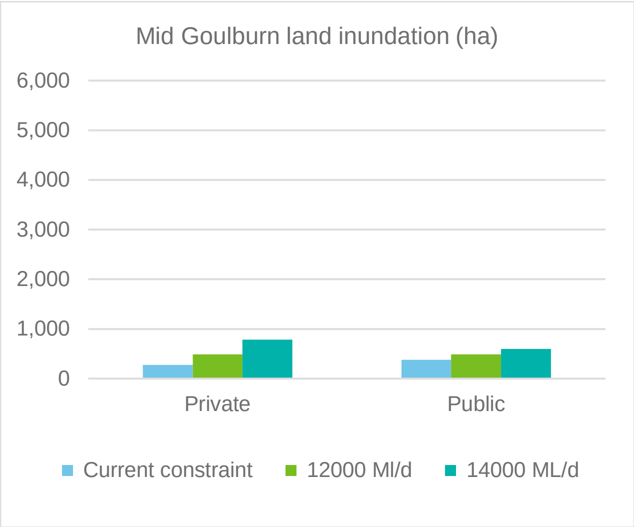
- Lower constraint scenario: Y30D30
- Upper constraint scenario: Y45D40.

10.3 Land

10.3.1 Area inundated

Figure 78 and Figure 79 show the area of private and public land inundated at different flow rates in the Goulburn and Murray rivers respectively. Vertical scales are the same within each river to help visualise the relative amount of inundation between reaches. The same information is provided in Table 42 to Table 47.

Figure 78 – Goulburn River land inundated (ha)



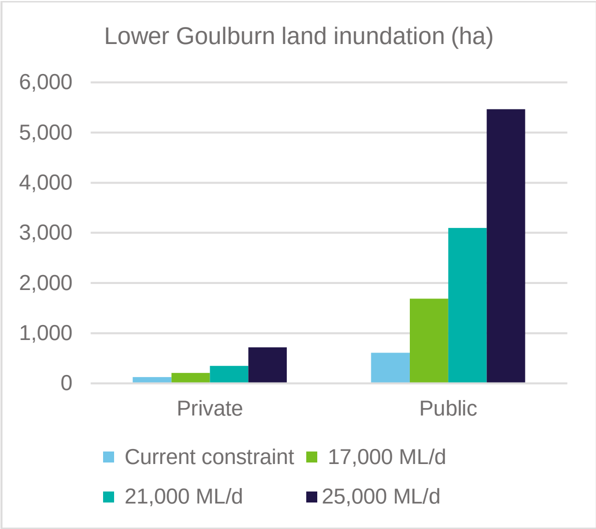


Table 42 – Mid Goulburn River land inundated per reach (ha)

Mid Goulburn	Current constraint 10,000 ML/day	12,000 ML/day	14,000 ML/day
Private land	273	491	787
Public land	376	488	596

Table 43 – Lower Goulburn River land inundated per reach (ha)

Lower Goulburn	Current constraint 9,500 ML/day	17,000 ML/day	21,000 ML/day	25,000 ML/day
Private land	125	205	347	718
Public land	613	1,688	3,100	5,468

Table 44 – Total Goulburn River land inundated per scenario (ha)

Land tenure	Current constraint M10L9.5	Scenario 1 M10L17	Scenario 2 M10L21	Scenario 3 M12L21	Scenario 4 M14L25
Private land	398	478	620	838	1,505
Public land	989	2,064	3,476	3,588	6,064

Figure 79 – Murray River land inundated (ha)

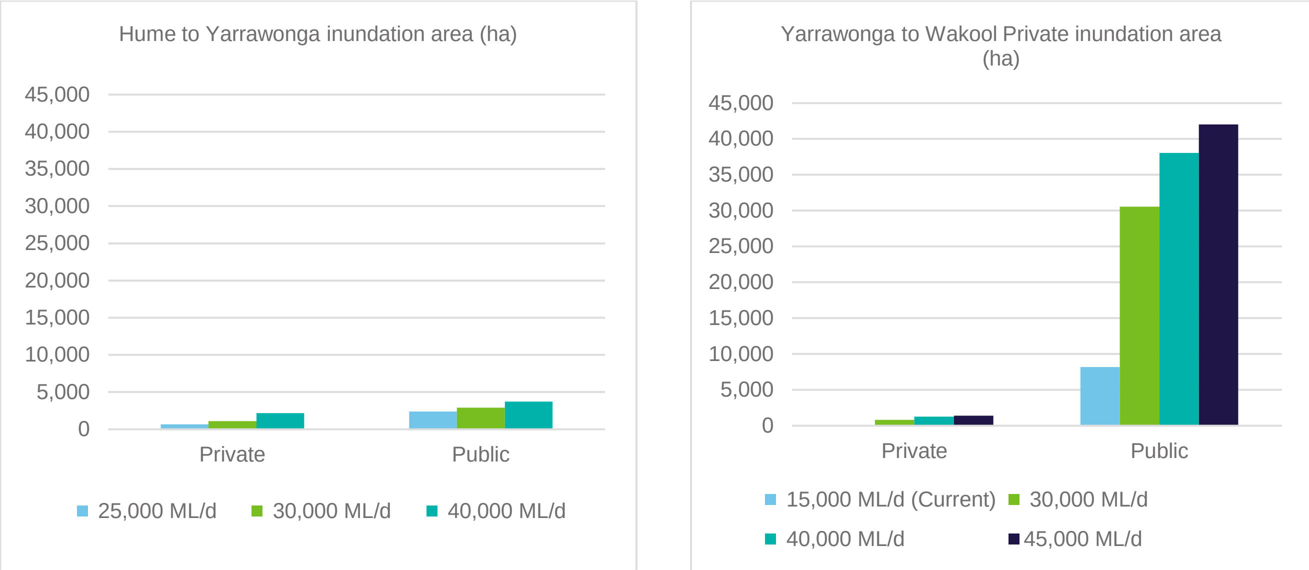


Table 45 – Murray River Hume to Yarrawonga land inundated per reach (ha)

Hume to Yarrawonga	Current constraint 25,000 ML/day	30,000 ML/day	40,000 ML/day
Private land	685	1,082	2,161
Public land	2,381	2,908	3,715

Table 46 – Murray River Yarrawonga to Wakool land inundated per reach (ha)

Yarrawonga to Wakool	Current constraint 15,000 ML/day	25,000 ML/day	30,000 ML/day	40,000 ML/day	45,000 ML/day
Private land	54	114	802	1,271	1,415
Public land	8,179	25,242	30,574	38,039	42,026

Table 47 – Total Murray River land inundated per scenario (ha)

Land tenure	Current constraint Y15D25	Scenario 1 Y25D25	Scenario 2 Y30D30	Scenario 4 Y40D40	Scenario 5 Y45D40
Private land	739	799	1,884	3,432	3,576
Public land	10,560	27,623	33,482	41,754	45,741

The following conclusions can be drawn from the information above:

- As constraints are further relaxed, the downstream reaches of the Goulburn River and Murray River would see significant areas of public land inundated relative to private land. In the Yarrawonga to Wakool reach, 30 times more public land is inundated than private land at flow rates of 45,000 ML/day. Nearly eight times as much public land is inundated than private land in the Lower Goulburn at 25,000 ML/day

- The challenge is, in order to capitalise on those beneficial downstream outcomes, more private land may need to be inundated in the upstream reaches than the downstream reaches
  - In the Goulburn River, hydrological modelling is showing that the constraint in the Mid Goulburn is the key limitation on achieving Lower Goulburn flows of 25,000 ML/day. This flow level is where the highest ratio of public versus private land inundation occurs, hence the highest trade-off of ecological benefit versus adverse impact.
  - In the Murray River, more modelling work is required to determine whether the significant downstream public land inundation (and therefore ecological benefits) can be achieved without needing to significantly relax constraints in the Hume to Yarrawonga reach. This is due to significant landowner concern about increasing target flows, particularly at 40,000ML/d at Doctors Point.
- The Hume to Yarrawonga reach experiences the most private land inundation. However, there is not a significant corresponding increase in public land inundated in that reach. The same situation is evident in the Mid Goulburn, albeit with a lower absolute area of private inundation than Hume to Yarrawonga.

10.3.2 Private land

Properties inundated

The number of private properties inundated is a key indicator of the deliverability of a future Victorian CMP as it reflects how many agreements will need to be successfully negotiated with landowners (and agreed mitigations subsequently delivered).

Figure 80 shows the number of private properties inundated under current and relaxed constraint scenarios. This is based on title searches along all study reaches. It shows a significant number of private properties are modelled to experience some inundation at current constraint limits. The following section outlines potential reasons for this finding.

The spatial information suggests that a large number of properties already are inundated at the current constraint flow rates. This is generally a function of property boundaries and how titles have been established over time. For completeness, all properties that fall within the inundation extent, even under the current constraint, are shown in the analysis. It is the impacts **beyond current constraint conditions** that will be the key focus of any future stages. The number of additional private properties inundated beyond current constraints are those above the red lines in Figure 80 and are also shown in the following tables.

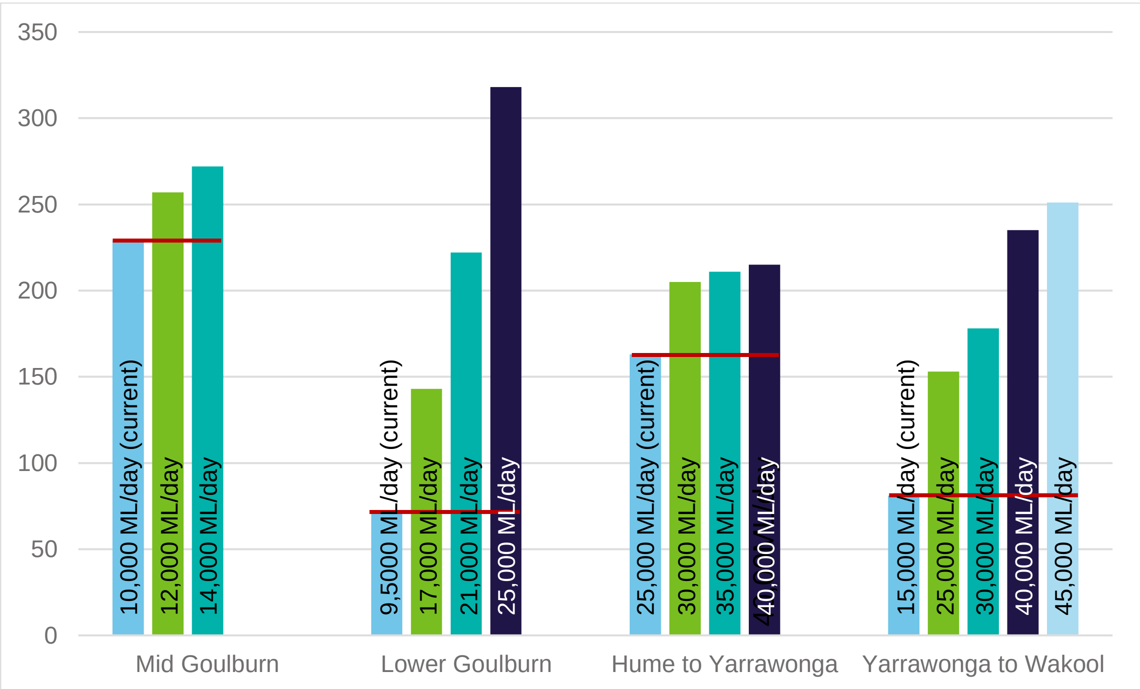


Figure 80 – Number of private properties within the modelled inundation footprint

Table 48 – Private properties inundated on Mid Goulburn River

Mid Goulburn	Current constraint 10,000 ML/day	12,000 ML/day	14,000 ML/day
Private properties inundated	229	257	272
Additional private properties	0	28	43

Table 49 – Private properties inundated on Lower Goulburn River

Lower Goulburn	Current constraint 9,500 ML/day	17,000 ML/day	21,000 ML/day	25,000 ML/day
Private properties inundated	72	143	222	318
Additional private properties	0	71	150	246

Table 50 – Private properties inundated on Goulburn River per scenario

Land tenure	Current constraint M10L9.5	M10L17	M10L21	M12L21	M14L25
Private properties inundated	301	372	451	479	590
Additional private properties	0	71	150	178	289

Table 51 – Private properties inundated on Murray River Hume to Yarrawonga

Hume to Yarrawonga	Current constraint 25,000 ML/day	30,000 ML/day	40,000 ML/day
Private properties inundated	163	206	215
Additional private properties	0	43	52

Table 52 – Private properties inundated on Murray River Yarrawonga to Wakool

Yarrawonga to Wakool	Current constraint 15,000 ML/day	25,000 ML/day	30,000 ML/day	40,000 ML/day	45,000 ML/day
Private properties inundated	81	153	178	235	251
Additional private properties	0	72	97	154	170

Table 53 – Private properties inundated on Murray River per scenario

Land tenure	Current constraint Y15D25	Y25D25	Y30D30	Y40D40	Y45D40
Private properties inundated	244	316	383	450	466
Additional private properties	0	72	139	206	222

The following circumstances are significant drivers for the number of inundated private properties.

1. **Minor inundation**: A large proportion of private land parcels have small areas of inundation (noting that a property may have one or multiple parcels). As an example, Figure 81 shows inundated private parcels on Mid Goulburn at 14,000 ML/day in increasing order of inundated area from left to right. It shows 58% of the private parcels are inundated by less than 1 ha. The proportion of private parcels inundated by less than 1 ha under the high constraint relaxation scenarios are:
   - Mid Goulburn = 58%
   - Lower Goulburn = 63%
   - Hume to Yarrawonga = 55%
   - Yarrawonga to Wakool = 51%.

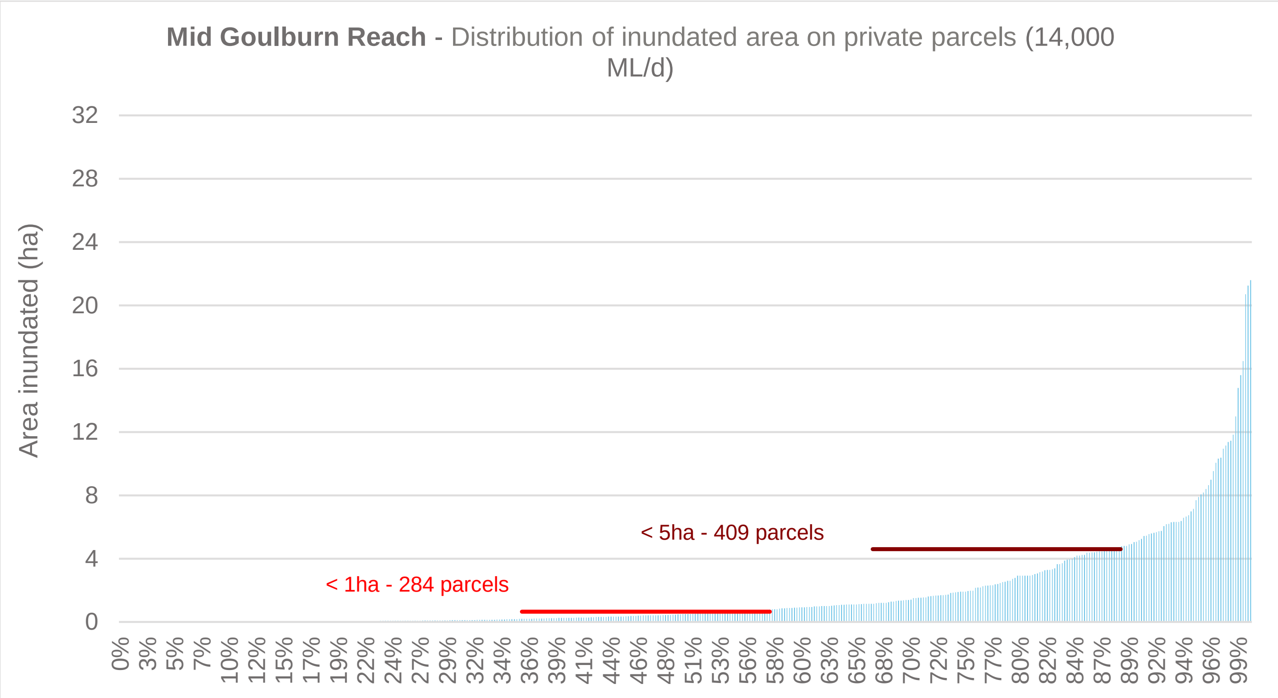


Figure 81 – Area of inundation of private parcels in MId Goulburn at 14,000 ML/day

2. Tributaries: Due to the flat terrain, modelling indicates relaxed constraints could inundate a large number of private properties on Lower Goulburn tributaries due to tail water effects. Of the 318 private properties inundated on the Lower Goulburn, 134 (or 42%) are located on tributaries. As an example,
3. Figure 82 shows in pink polygons the inundated private land on the Broken River immediately upstream of the Goulburn River confluence at Shepparton. While there are a large number of private properties modelled as inundated on tributaries, the area of inundation on each property is generally very small.
4. **River edge effects**: Some private properties show minor inundation along river edges. This inundation could be due to river boundaries adopted in the GIS not aligning with the top of riverbank. In essence, some apparent property inundation may still be contained within the river. An example of this “edge effect” in the Mid Goulburn is shown in Figure 83.

Pragmatic policies could be developed to identify modelling outcomes like those above which may not result in inundation or impacts that are significant enough to be in the interests of landowners and government to seek to mitigate.

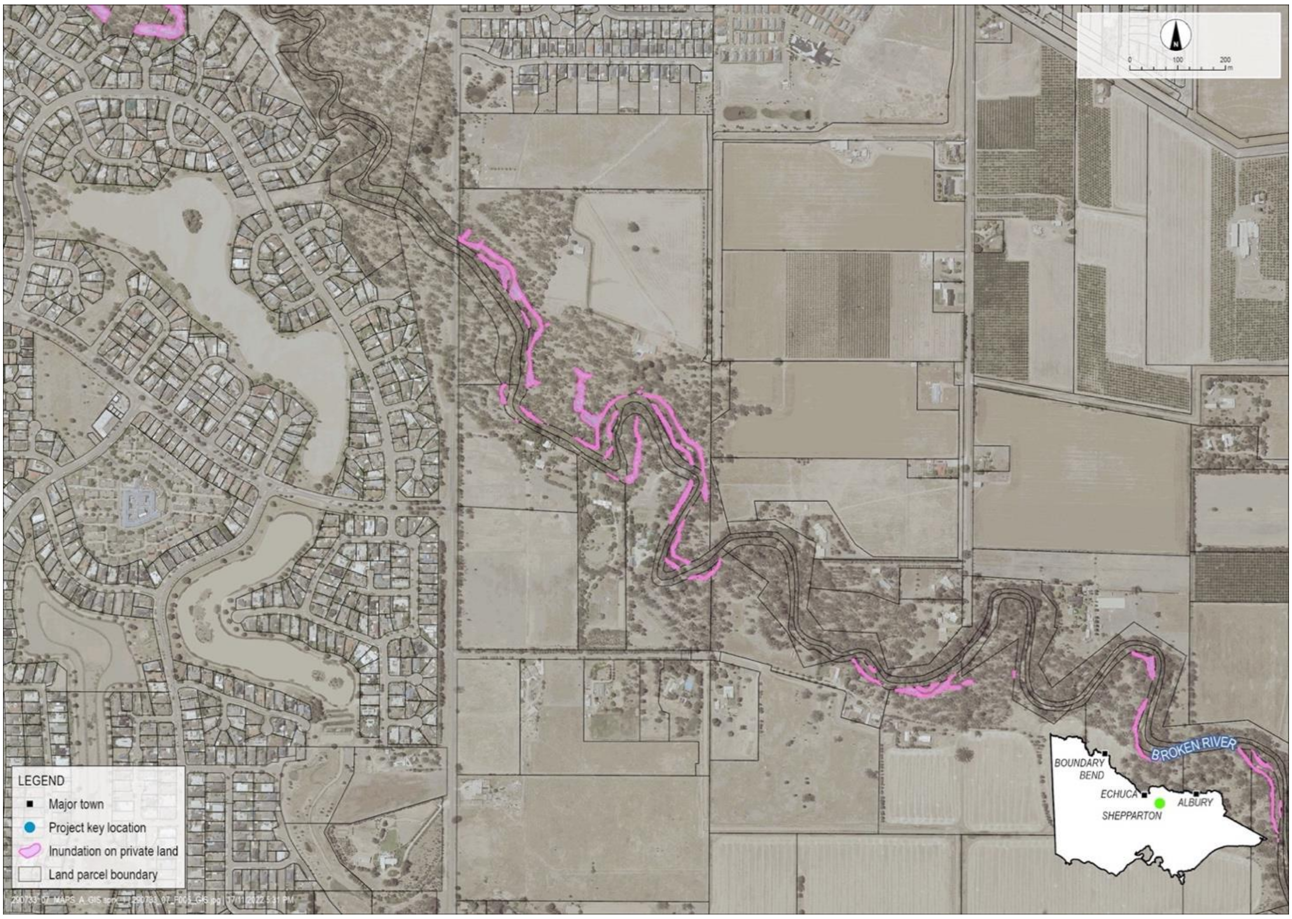


Figure 82 – Inundated private land on Broken River near Goulburn River confluence, Shepparton (25,000 ML/day)

Figure 83 – "Edge effect" examples in Mid Goulburn (pink areas show private land inundation GIS query results)

Title searches

Certificates of title were obtained to increase confidence in the number individual private landowners that may require mitigation agreements to be negotiated and identify caveats or encumbrances which may complicate registering inundation easements on title. Title searches were limited to private properties where any parcel within the property was inundated by more than 1 ha under the maximum constraint relaxation scenario. Table 54 and Table 55 summarise the outcomes of the title searches.

The title search exercise revealed the following:

- Datasets from landata.vic.gov.au incorrectly assigned 8% of publicly owned properties on the Goulburn River and Murray River respectively as “private” tenure. While the Project GIS has been updated to correct identified errors:
  - The Feasibility Study may still overstate the number of private landowners impacted as title searches were limited to inundation > 1 ha
  - Any future stage should not rely solely on Landata to quantify private versus public impacts
- Few private landowners owned multiple properties. Consequently, the engagement effort will not be significantly reduced by there being less affected parties to negotiate with
- Private land ownership was 64% sole proprietor, 27% joint proprietors and 9% tenants in common. Reaching agreement with some joint proprietors or tenants in common may be more complex than negotiating with sole proprietors
- Engagement and negotiation will likely be required with a small number of legal representatives of deceased landowners
- 46 properties had caveats, covenants, or Section 173 Planning & Environment Act / Section 234 Water Act / etc registered on title. The project would need to obtain copies of these instruments to understand the implications for reaching agreement on mitigations or registering easements on titles
- Trust for Nature own one property and may have covenants on other properties. Negotiation may be required with Trust for Nature to ensure inundation easement conditions don’t place landowners in breach of the terms of those covenants
- 124 property titles included a reference to a water frontage licence. This instrument may document an access arrangement between adjoining owners. The project would need to obtain the instruments to review agreement conditions to confirm any implications for reaching agreement on mitigations or registering easements on titles.
- As mortgagees need to consent to the registration of easements on title (and may charge a fee), an efficient process will need to be established to engage with each financial institution to obtain these consents. 139 properties had mortgages with 22 lending institutions or entities identified as mortgagees.

There may be further easements or encumbrances registered on title, but only shown on property plans. Property plans were not obtained as part of the title search; therefore, the project would need to obtain and review these plans to identify further implications for reaching agreement on mitigations or registering easements on titles.

Table 54 – Title search outcomes for private properties inundated >1ha (individual private landowners)

	Private properties inundated >1ha (per Landata)	Private Properties confirmed as publicly owned	Confirmed private properties inundated >1ha	Individual private landowners inundated >1ha
Mid Goulburn	122	4	118	107
Lower Goulburn	77	13	64	63
GOULBURN TOTAL	**199**	**17 (8%)**	**182**	**170**
Murray – Hume to Yarrawonga	133	11	126	113
Murray – Yarrawonga to Wakool	56	5	51	45
MURRAY TOTAL	**189**	**16 (8%)**	**177**	**158**

Table 55 – Title search outcomes for private properties inundated > 1ha (caveats, encumbrances, etc)

	Deceased landowners	Mortgages	Caveat, covenant or agreement	Water frontage licence
Mid Goulburn	4	31	6	68
Lower Goulburn	2	29	16	2
GOULBURN TOTAL	**6**	**60**	**22**	**70**
Murray – Hume to Yarrawonga	0	53	8	39
Murray – Yarrawonga to Wakool	2	26	16	15
MURRAY TOTAL	**2**	**79**	**24**	**54**

Land use

As an example indicated in Figure 84, of the private land inundated, the predominant land use type is typically pasture grazing which makes up 70%-85% of the impacted land. Cropping represents a further 5%-10% of impacted private land.

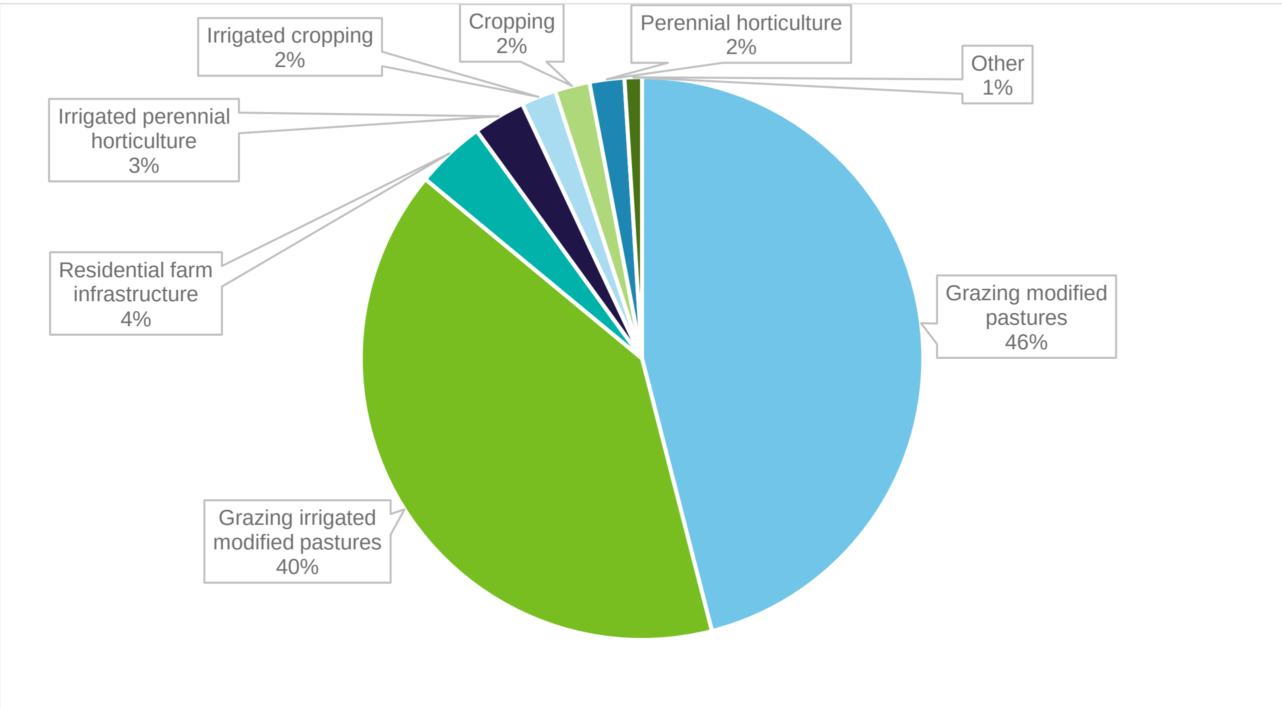


Figure 84 – Land use for inundated private land in Hume to Yarrawonga reach at 40,000 ML/day

Impeded access

Feedback from the Consultative Committee and “kitchen table” meetings highlighted that impeded access to parts of private properties will be a significant burden to many landowners. This impact is particularly prevalent on the Hume to Yarrawonga reach due to the large number of flood runners, oxbows, etc. Hydraulic modelling shows many situations where flows into flood runners and oxbows create inaccessible “islands” of productive private land.

The impact assessment has not sought to estimate the amount of land which will have impeded access as a result of relaxing constraints. Quantifying this impact would require direct input from landowners to confirm which productive areas of land are cut-off and what options exist to maintain access.

In 2011, the Murray River Action Group engaged GHD to assess impacts on private land if the operational constraint at Doctors Point was further relaxed from 25,000 ML/day to 40,000 ML/day. GHD conducted a survey of 63 of 112 landowners potentially affected by these flows and inferred from survey responses that 8,433ha of private land may become inaccessible at 40,000 ML/day. Earlier surveys conducted in 2001 indicated the inaccessible area may be closer to 6,000ha. These survey results indicate 3-4 times as much land could become inaccessible in this reach than is inundated.

Other private land impacts

Consultative Committee members and attendees at "kitchen table" meetings articulated a range of other impacts that would be experienced on private land. These impacts can't be quantified in this current stage and would need to be assessed via direct engagement with landowners in future stages. Impacts identified included:

- Loss or damage to pasture from extended inundation
- Restoration of lost pasture which can take up to a year to recover
- Loss of production to due loss of access to areas for grazing and loss of pasture or crops
- Riverbank erosion
- Agistment of stock where property has insufficient high ground to relocate the stock
- Animal health and welfare issues
- Weed infestation and subsequent weed control
- Increase in large trees falling, which in turn can exacerbate bank erosion
- Occupational health and safety risks associated with moving stock through inundation or retrieving pumps from riverbanks as rivers are rising
- Clean up following inundation events including debris removal, log removal, cleaning troughs, repair or replacement of fences, access tracks, river crossings, bridge repairs, etc.
- Low-lying river frontage businesses such as the Molesworth Caravan Park may experience inundation or interrupted access
- Infrastructure impacts. The 2011 survey commissioned by the Murray River Action Group estimated 85 bridges, 222 crossings, 30km of fencing, 79 tanks/troughs and 10 hay sheds may be impacted on both sides of the Murray River in the Hume to Yarrawonga Reach at 40,000 ML/day. Other private infrastructure which could be impacted includes pivot irrigators, holiday accommodation, stock yards and jetties
- Increased uncertainty for farm planning due to lack of certainty about timing of environmental flows.

10.3.3 Public land

Land use

Table 56 to Table 59 show the extent of inundation of public reserves managed by Parks Victoria at upper and lower constraint relaxation scenarios. This shows how sensitive each reserve is to increases in river flow rates and provides a high-level indication of the likely ecological benefits and potential positive or detrimental recreational impacts for each reserve. It also provides an indication of the trade-off between ecological benefits on public land versus impacts on private landowners.

Table 56 – Inundation of Parks Victoria managed land (Mid Goulburn)

Location	Reserve area (ha)	% Inundated at 12,000 ML/day	% Inundated at 14,000 ML/day
Horseshoe Lagoon Flora and Fauna Reserve	46	20%	22%
Homewood Nature Conservation Reserve	27	31%	32%
Molesworth Nature Conservation Reserve	26	13%	53%
Wyndham Streamside Reserve	13	2%	2%

Table 57 – Inundation of Parks Victoria managed land (Lower Goulburn)

Location	Reserve area (ha)	% Inundated at 17,000 ML/day	% Inundated at 25,000 ML/day
Lower Goulburn National Park	9,321	17%	39%
Shepparton Regional Park	2,798	11%	36%
Arcadia Streamside Reserve	1,060	23%	39%
Loch Gary Wildlife Reserve	557	0%	90%
Wakiti Creek Streamside Reserve	313	27%	38%
Gemmill Swamp Wildlife Reserve	216	0.03%	91%
Wyuna Nature Conservation Reserve	18	0%	15%
Echuca & Waranga Trust Historic Reserve	11	30%	56%
Murchison Lagoon Wildlife Reserve	6	0%	80%
Murchison Waterworks Trust Historic Reserve	6	13%	22%
Goulburn River K49 Streamside Reserve	3	27%	71%
Wahring Streamside Reserve	2	96%	96%
Dargalong Streamside Reserve	1	98%	98%

Table 58 – Inundation of Parks Victoria managed land (Hume to Yarrawonga)

Location	Reserve area (ha)	% Inundated at 30,000 ML/day	% Inundated at 40,000 ML/day
Proposed Murray River Park	21,846	1%	1%
Murray River Reserve	15,042	4%	6%
Warby-Ovens National Park	14,706	0%	0%
Lower Ovens Wildlife Reserve	1,258	62%	78%
Lake Moodemere Lake Reserve	264	80%	90%
Moodemere Nature Conservation Reserve	73	33%	62%
Murray River K16 Streamside Reserve	17	51%	66%
Carlyle H115 Bushland Reserve	5	48%	89%
Murray River K15 Streamside Reserve	4	12%	17%

Table 59 – Inundation of Parks Victoria managed land (Yarrawonga to Wakool)

Location	Reserve area (ha)	% Inundated at 25,000 ML/day	% Inundated at 45,000 ML/day
Barmah National Park	28,537	45%	69%
Proposed Murray River Park	21,846	13%	24%
Murray River Reserve	15,041	9%	20%
Gunbower National Park	9,333	14%	48%

Location	Reserve area (ha)	% Inundated at 25,000 ML/day	% Inundated at 45,000 ML/day
Nyah-Vinifera Park	1,373	34%	61%
Cobram Regional Park	474	13%	30%
Echuca Regional Park	458	23%	44%
Spence Bridge Education Area	387	8%	20%
Yarrawonga Regional Park	310	8%	24%
Big Reedy Lagoon Wildlife Reserve	274	0.01%	59%
Baillieu Lagoon Wildlife Reserve	249	0.5%	2%
Tocumwal Regional Park	224	11%	37%
Passage Camp Nature Conservation Reserve	21	30%	60%
Major Mitchell Lagoon Historic Reserve	13	55%	73%
Koondrook Historic Reserve	7	33%	41%

Recreational land

The Recreational Outcomes Assessment presents the likely impacts and benefits on recreational uses of public land. Case study sites across the Goulburn River and Murray River were discussed with Traditional Owners, and land and waterway managers to qualitatively assess the risks and benefits to recreation. Refer to Section 7.2.

Crown land licences

Table 60 lists the number of Crown land licences on inundated public land. Most of the licences are for water frontage, grazing or riparian management with a smaller number of reserves managed by public utilities or COM.

There are a large number of impacted licences at low constraint relaxation scenarios, with the number of impacted licences not increasing significantly as constraints are further relaxed. Therefore, there is likely to be considerable engagement effort with licence holders regardless of which scenario is contemplated. Given most licence holders need to own adjoining private land, many affected parties are likely to require engagement due to inundation of their privately owned adjoining land.

Table 60 – Number of Crown land licences held on inundated public land

Name / location	Lower constraint scenario	Upper constraint scenario
Goulburn River		
Mid Goulburn	344	361
Lower Goulburn	108	138
Murray River		
Hume to Yarrawonga	180	195
Yarrawonga to Wakool	222	255

10.4 Roads and tracks

Figure 85 and Table 61 show the length of inundated road and 2WD/4WD tracks under lower and upper constraint relaxation scenarios. This is based on available spatial information and as such is generally limited to public assets. Further stages of the program will require quantification of modelled inundation on private access tracks.

The standout impact is the significant length of 2WD/4WD tracks inundated as constraints are further relaxed in the downstream reaches of each river (Lower Goulburn and Yarrawonga to Wakool). These tracks are predominantly contained within low-lying national parks, state forests and public reserves.

Figure 86 and Figure 87 visually highlight the increase in inundated tracks around Shepparton and in the Gunbower National Park as constraints are further relaxed. Colours reflect track inundation depth, with cooler colours (greens) showing shallower inundation and warmer colours showing increasing inundation depth (yellow, orange and red).

As part of engagement with stakeholder to identify potential mitigation options, it was identified that Parks Victoria is already working to rationalise under-utilised 2WD and 4WD access tracks in the Lower Goulburn as part of business as usual improvements in an effort to reduce the extent and cost of ongoing track maintenance.

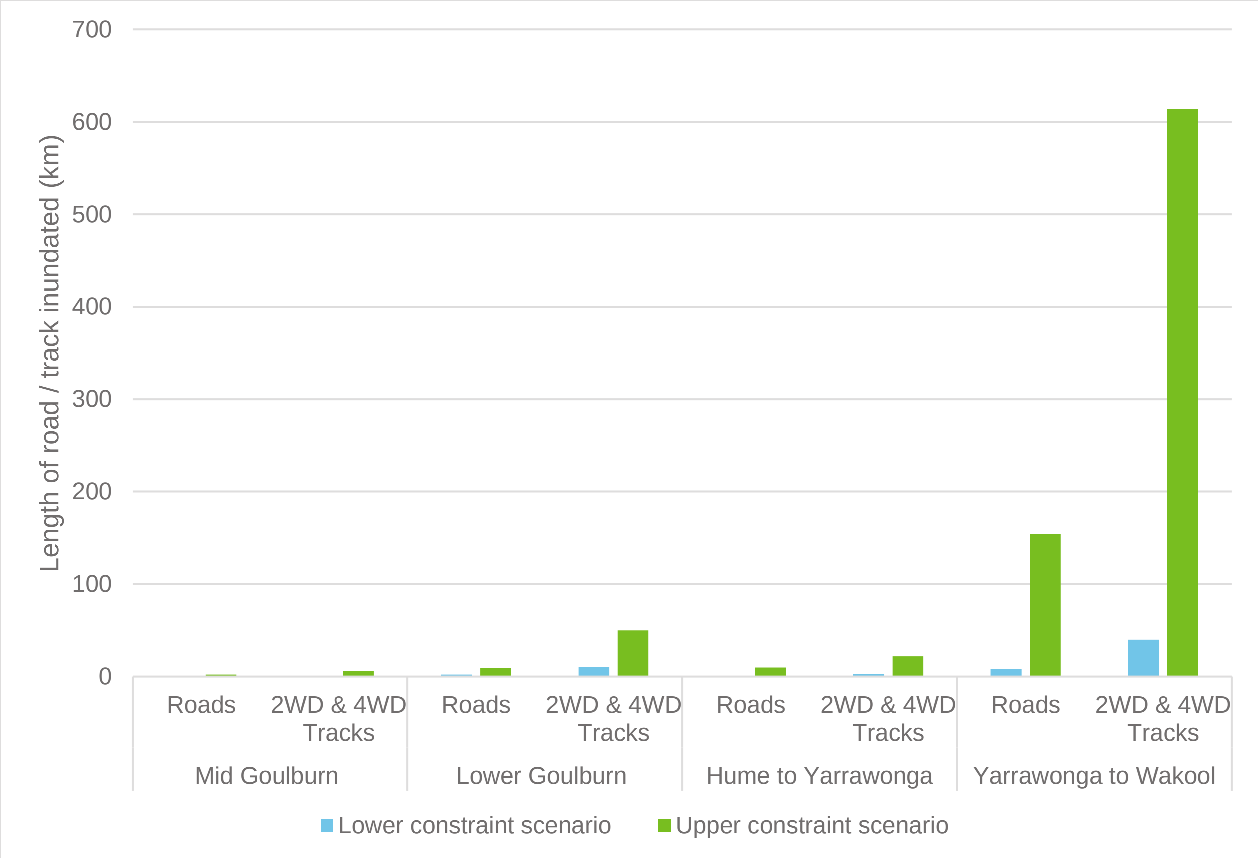


Figure 85 – Length of public roads and tracks inundated at the lower and upper constraint scenarios

Table 61 – Roads or tracks inundated (km)

Location	**Lower constraint scenario**		**Upper constraint scenario**	
	Roads	**2WD & 4WD Tracks**	**Roads**	**2WD & 4WD Tracks**
Goulburn River				
Mid Goulburn	0.3	2	0.5	6
Lower Goulburn	2	9	10	50
Murray River				
Hume to Yarrawonga	0.5	9.8	3	22
Yarrawonga to Wakool	8	154	40	614

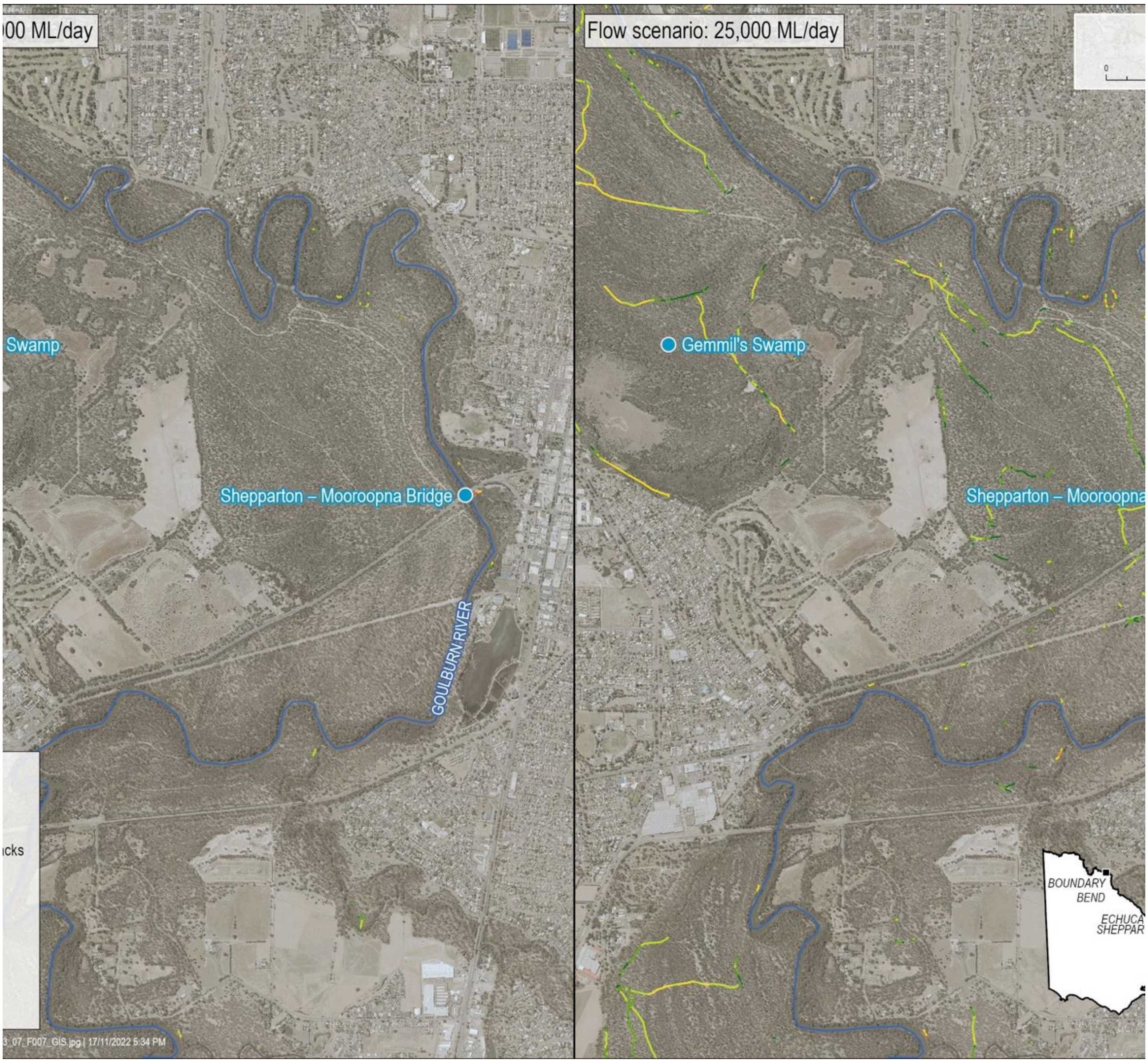


Figure 86 – Tracks inundated at 17,000 ML/day (left) and 25,000 ML/day (right) in Lower Goulburn, Shepparton

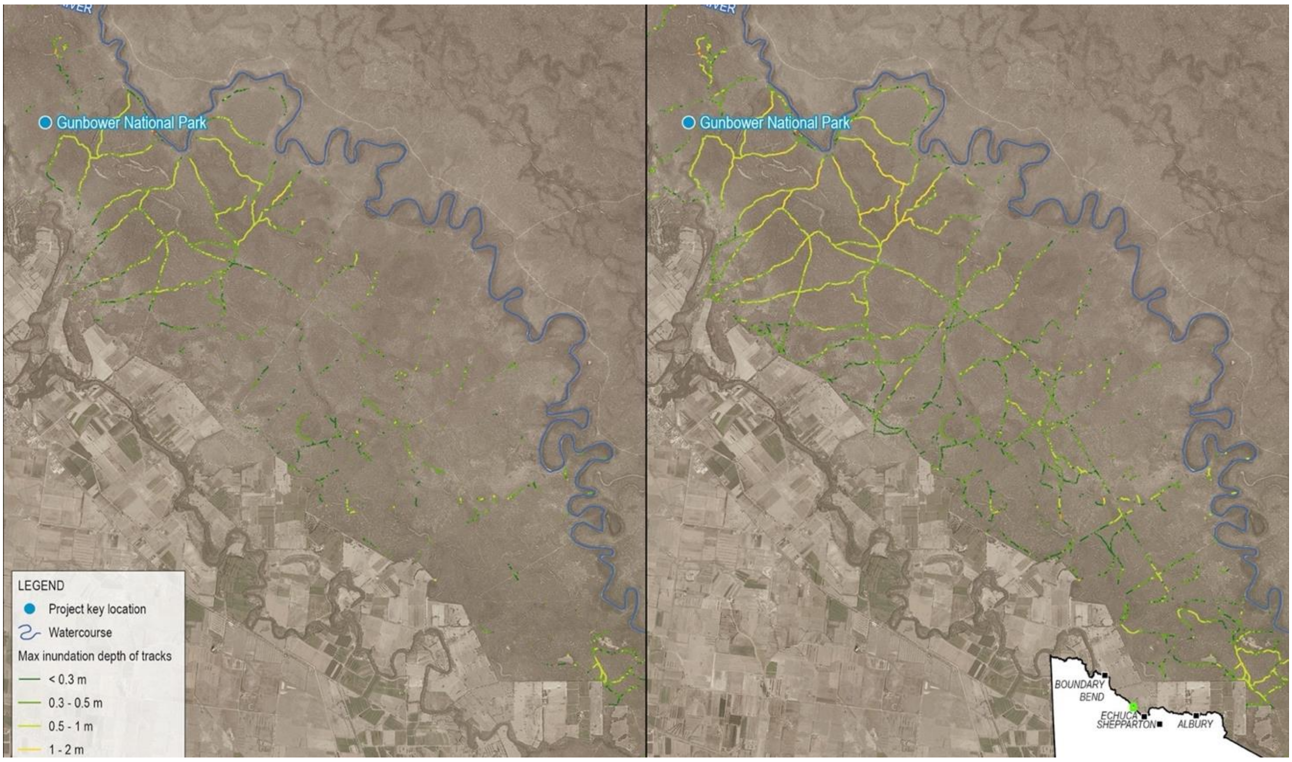


Figure 87 – Tracks inundated at 30,000 ML/day (left) and 45,000 ML/day (right) in Gunbower National Park

Site visits were undertaken to ground-truth desktop inundation results for roads in Mid Goulburn, Lower Goulburn south of Shepparton and Hume to Yarrawonga reaches while flows in both rivers were of the magnitude of the relaxed constraint scenarios. The impact assessment for roads has found:

- No public bridges are inundated under any scenario. This is not unexpected given bridges are typically designed above minor flood level (and all constraint relaxation scenarios are generally below minor flood level). The approaches to Carrolls Lane Bridge, Wodonga and Raftery Road Bridge, Shepparton are modelled to be inundated under high constraint relaxation scenarios. These bridges are shown in Figure 88 and Figure 89. Site visits during similar river flow rates confirmed inundation of the approaches occurs and Shepparton City Council has installed boom gates on Raftery Road bridge to facilitate its closure. Carrolls Lane would be a candidate for mitigation works to raise the approach road to avoid interrupted access to a quarry on the north side of the bridge
- Inundation of the modest length of road in the Mid Goulburn, Lower Goulburn and Hume to Yarrawonga reaches could be readily mitigated via raising works or temporary road closures and alternate routes. The 40km of modelled road inundation in Yarrawonga to Wakool reach requires further investigation to understand the significance of these impacts
- Inundation of tracks on private property is expected to be significant and require mitigation works to avoid impeded access. Engagement with landowners will be required to confirm impacts and suitable mitigations. As an indicator of the potential impact, the 2011 GHD survey commissioned by the Murray River Action Group estimated 85 bridges and 222 crossings on private land may be impacted on both sides of the Murray River in the Hume to Yarrawonga Reach at 40,000 ML/day
- Walking and bicycle tracks are expected to be impacted, particularly around townships. Some trails in Wodonga and Shepparton were partially inundated during site visits during August and September 2022. The location and length of walking/bicycle trail inundation is difficult to model accurately due to limited trail information in datasets imported to the project GIS
- Parks Victoria sought confirmation of any inundation of the Great Victorian Rail Trail which follows and crosses the Mid Goulburn. The assessment concluded there would be no inundation of the rail trail
- Consultative Committee representatives highlighted the Murray River Adventure Trail as a project currently in planning and design that will likely be impacted. Parks Victoria anticipate that the adventure trail would be impacted by relaxed constraints, and it would not be feasible to raise the trail sufficiently to fully mitigate impacts.

Figure 88 – Raftery Road bridge over Sevens Creek, Shepparton

Figure 89 – Inundation of approach to Carrolls Lane Bridge, Wodonga

10.5 Buildings

Buildings or permanent structures that may be at risk of inundation have been identified by querying public building GIS datasets and scanning of aerial imagery. Table 62 lists the number of dwellings or other permanent structures that were identified as potentially inundated via this process. The assessment indicates it is unlikely that any dwellings will be inundated under any of the constraint relaxation scenarios.

Since the assessment relied upon aerial imagery, there may be smaller items of farm infrastructure that will be inundated that are not identifiable from aerial imagery. As an indicator of the potential impact, the 2011 GHD survey commissioned by the Murray River Action Group estimated 30km of fencing, 79 tanks/troughs and 10 hay sheds may be impacted on both sides of the Murray River in the Hume to Yarrawonga Reach at 40,000 ML/day.

Table 62 – Buildings or permanent structures located within inundation extent

Location	Lower constraint relaxation scenario	Upper constraint relaxation scenario
Goulburn River		
Mid Goulburn	Dwellings = 0 Other structures = 4	Dwellings = 0 Other structures = 5
Lower Goulburn	Dwellings = 0 Other structures = 0	Dwellings = 0 Other structures = 4
Murray River		
Hume to Yarrawonga	Dwellings = 0 Other structures = 2	Dwellings = 0 Other structures = 5
Yarrawonga to Wakool	Dwellings = 0 Other structures = 2	Dwellings = 0 Other structures = 13

10.6 Diversion pumps

GMW diversion customers own a wide range of pump installation types which extract water for irrigation or stock and domestic (S&D) use (see Figure 91 for examples of diversion pumps for irrigation). Some installations will be designed to handle high river levels, however many will not and will typically be relocated to higher ground by the landowner during high flows.

Figure 90 and Table 63 lists the number of pumps within modelled inundation extents.

Given some pumps are designed to be inundated, and some diversion licences will have inactive works, Figure 90 and Table 63 will overstate the number of pumps that may require mitigation works. Each pump would need to be visited to assess mitigation works required.

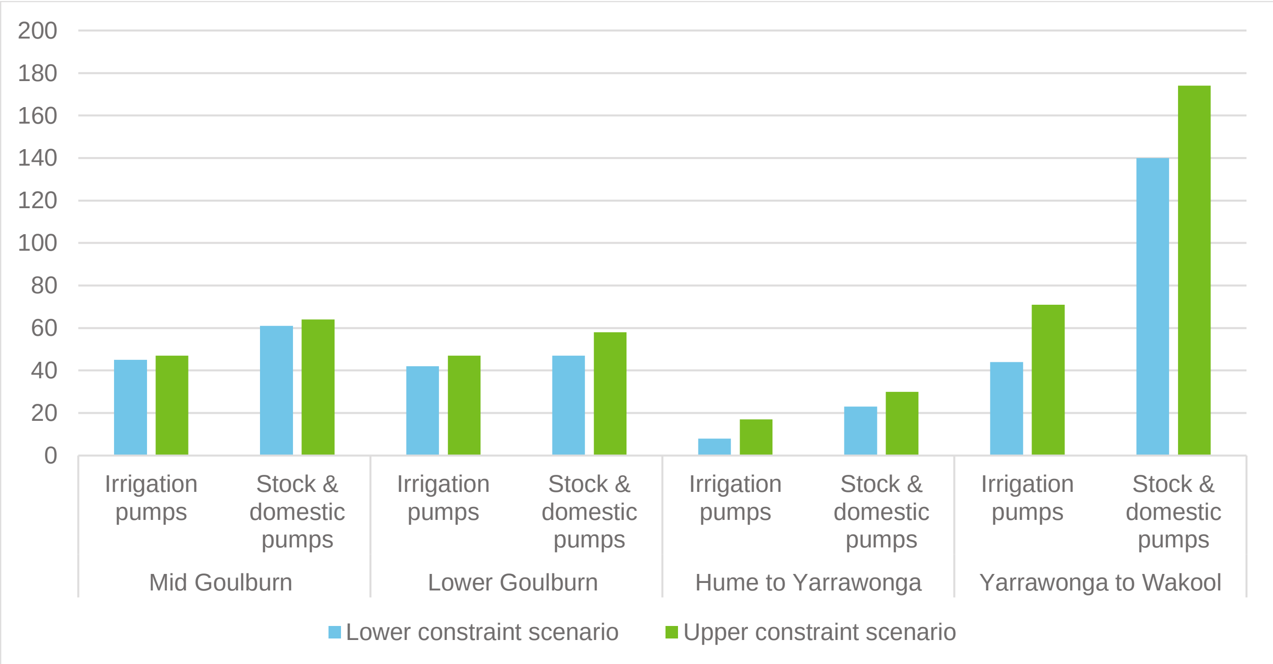


Figure 90 – Diversion pumps located within inundation extents

Table 63 – Diversion pumps located within inundation extents

Location	Irrigation pumps		Stock & domestic pumps	
	Lower constraint scenario	Upper constraint scenario	Lower constraint scenario	Upper constraint scenario
Goulburn River				
Mid Goulburn	45	47	61	64
Lower Goulburn	42	47	47	58
Murray River				
Hume to Yarrawonga	8	17	23	30
Yarrawonga to Wakool	44	71	140	174

Figure 91 – Irrigation diversion pump stations (Left = Little Murray River, Right = Lower Goulburn)

Figure 90 and Table 63 indicates the following:

- A higher constraint relaxation scenario does not significantly increase the number of inundated pumps
- S&D pumps are typically more resilient to higher flow rates as they are often located on higher ground, and in any case would be a lower cost to relocate due to their smaller size and complexity. Where irrigation pumps need to be rebuilt or modified, costs will be significant and several statutory and environmental approvals will be required.

Separate to the Victorian CMP, DEECA and GMW engaged Jacobs to assess the feasibility of mitigating impacts to diversion pumps on the Lower Goulburn at flows up to 6,000 ML/day to facilitate delivery of inter-valley traded water.

Jacobs identified 43 pumps impacted by flows up to 6,000 ML/day, with only 6 of these remaining operational when relocated to the top of bank. As part of the study, Parks Victoria indicated all pumps located on Parks Victoria managed land will need to comply with Guidelines for infrastructure and works on or across Parks Victoria managed land (April 2022). The most relevant elements of the guidelines are that pumping infrastructure should be located on private land wherever practical and the delivery pipe from pumps must be placed underground and section pipes should be under-bored.

These conditions would impose significant limitations on the type of pump that could be utilised as end-suction pumps relocated to distant private land which may have insufficient suction head available (e.g., those in Figure 91). In order to comply with the Parks Victoria requirement, Jacobs adopted a concept design of submersible borehole pumps discharging through a sleeved discharge pipe. Pump drives and electrical equipment would be located remotely on private land. Figure 92 and Figure 93 show this concept arrangement.

The cost of this concept arrangement will be significant, with Jacobs estimating each pump to cost several hundred thousand dollars.

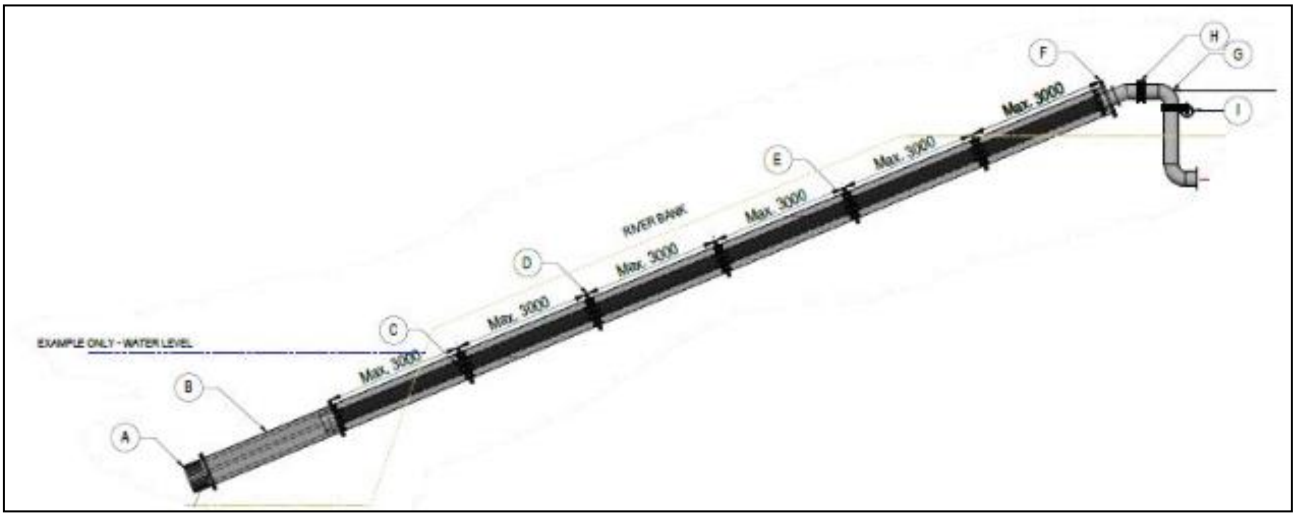


Figure 92 – Schematic of sleeved submersible pump design

Figure 93 – Examples of Parks Victoria compliant pump arrangements

10.7 Levees

In 2016, GBCMA and MDBA commissioned levee risk / impact assessments for the Lower Goulburn and Murray River respectively as part of Constraint business case development. The constraint relaxation scenarios considered were higher than this feasibility study, namely:

- Lower Goulburn: 40,000 and 55,000 ML/day
- Yarrawonga to Wakool: 35,000 to 65,000 ML/day.

Studies were not undertaken for the Mid Goulburn or Hume to Yarrawonga due to limited formal levees in these reaches.

The Lower Goulburn study found 0.8km of the 144km levee system had crest heights below the design standard for a 40,000 ML/day event. Points of weakness in levees were identified with 98% assessed as low or medium risks and 2% as high or extreme risks (see Figure 94).

To mitigate risks at 40,000 ML/day, the study recommended levee realignment and crest raising works at 10 locations, plus repairs to address high-risk points of weakness. The project team queried the GIS and identified 6 of these 10 levees being potentially overtopped at 25,000 ML/day.

In Yarrawonga to Wakool, no levees around Victorian towns overtopped under any scenario, while 8km and 12km of other levees were modelled to overtop at 35,000 ML/day and 50,000 ML/day respectively. The project GIS identified less levee length modelled as inundated than the previous MDBA study, however this current assessment is based on publicly available levee data and is likely to be less accurate than field assessments used in the MDBA study.

This impact assessment identified, via GIS queries, the following levees that could be at risk of inundation at the maximum constraint relaxation scenario:

- Hume to Yarrawonga: Three relatively short levees near Lake Moodemere, Brimin and Bundalong
- Yarrawonga to Wakool: 2.5km of 308km of levees.

While the above-mentioned investigations largely focussed on overtopping risk, attendees at "kitchen table" meetings discussed certain levees being in poor condition that were at risk of being breached with water level below crest height. One such levee was visited at Barham where the levee on the bank of the Murray River had breached and inundated adjacent private property.

Initial findings for levee impacts are:

- Levee mitigation works may be moderate in extent and not technically complex
- The more significant challenges for any levee works may be confirming asset ownership arrangements, Operations and Maintenance (O&M) responsibility and obtaining permits and access rights.

If managed environmental watering requires the use of this infrastructure as a containment bank to prevent inundation of private land, then environmental water holders should pay for these services in line with existing government policy.

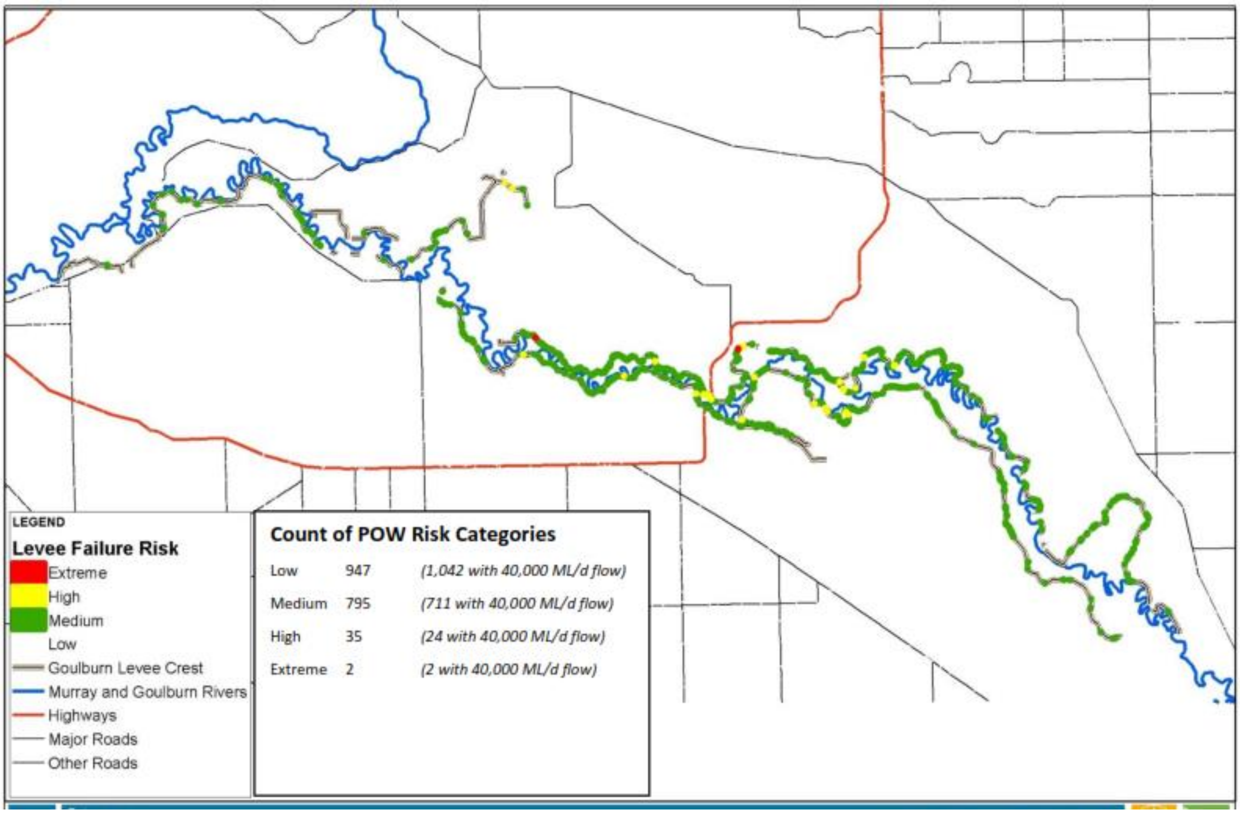


Figure 94 – Lower Goulburn levee failure risk at 55,000 ML/day (Water Technology 2016)

10.8 Historic European sites

Table 64 and Figure 95 and Figure 96 show the European historic sites that would be inundated under relaxed constraints. These sites are registered on the Victorian Heritage Database. Both are routinely inundated by fluctuating river levels.

There are additional locations from the Historic Places Dataset that are within modelled inundation footprints. All places on the Goulburn River and Hume to Yarrawonga reach were visited or investigated and found to be historic bridges whose decks would be above the maximum river height or the site of historic buildings or structures that no longer exist.

The Yarrawonga to Wakool reach has 21 places from the Historic Places Dataset within the inundation footprint (15 are within the Barmah Forest). They are the location of historic sawmills, landings, shipwrecks, wells or cuttings and were not confirmed by field inspection. It is recommended that if the program proceeds that these sites be further investigated to determine they exist and whether mitigation works are required.

Table 64 – Inundated heritage sites

Name / location	Description
Goulburn River	
Haulage Track. 200m south of Shepparton Cemetery	Metal rail tracks on riverbank for water transport
Murray River	
Echuca Wharf	Timber wharf built in 1865-67 from red gum timber

Figure 95 – Haulage Track

Figure 96 – Echuca Wharf

The impact assessment for historic sites found:

- Impacts on registered historic sites are limited and are unlikely to require mitigations, for example the Echuca Wharf would only have an increased water level (generally below minor flood level) on the piers which have endured much higher flows
- 21 historic places within the inundation extent of the Yarrawonga to Wakool reach need to be visited to confirm if any buildings or structures exist that may require mitigation works.

10.9 Mitigations

The following measures could mitigate inundation effects discussed in the Land and Asset Impact Assessment. The most suitable mitigation for each affected party, and any associated compensation, would need to be identified and agreed per the Mitigation Selection Framework (refer Section 9).

10.9.1 Land

The following works could mitigate some land impacts:

- **Levee repair**: Previous levee investigations highlighted some risks to levee integrity, in the form of overtopping risk and levee condition. Two landholders at the Yarrawonga to Wakool "kitchen table" meeting identified insufficient levee height or poor condition as a risk to their private properties. This was verified via a site visit to one of the properties at Barham where a levee was overtopped and was inundating private land
- **Block bank**: Inundation modelling shows occasional situations where inundation of a private property commences via flow through localised narrow low spots. There may be situations where a modest block bank could protect sections of those properties. A site visit as part of the Hume to Yarrawonga "kitchen table" meeting, demonstrated where modest a modest block bank would maintain access to holiday cabins at the upper constraint relaxation flow rate
- **Access works:** The following assets could be constructed or upgraded to maintain access to key sections of private property during higher river flows:
  - Bridges
  - Raised access tracks
  - Raise or enhance low level crossings
- **Permanent structure relocation**: Relocation of agricultural structures or equipment such as stock yards, tanks, troughs, etc.

- **Land use changes**: Modify the use of land subject to more frequent inundation to timber plantation / harvesting. This practice was demonstrated and suggested as a potential mitigation option at a Hume to Yarrawonga “kitchen table” meeting
- **Inundation easements**: Create an easement on title whereby the landowner grants river operators the right to inundate the portion of land reflecting the modelled inundation extent with an appropriate risk management buffer
- **Land purchase**: There may be rare situations where it may be mutually beneficial to transfer ownership of affected private land to the government.

There may be opportunities to deliver works that enhance recreational outcomes associated with increased river flows. Public land managers indicated that works such as boardwalks, viewing platforms, boat ramp improvements, etc. could be undertaken at key locations in public reserves to allow the public to view and access areas benefiting from enhanced environmental flows.

10.9.2 Buildings

The following works could mitigate some building impacts:

- **Levee repair**: As discussed above
- **Block bank**: As discussed above
- **Permanent structure relocation**: Site visits identified potentially affected horse shelters and smaller sheds that could feasibly be relocated to higher ground.

10.9.3 Roads and tracks

The following works could mitigate impacts to roads and tracks:

- **Road raising**: While there were limited circumstances of public roads being inundated without viable alternate routes, some situations may warrant sections of road being raised above the river level associated with the adopted relaxed constraint
- **Temporary road or track closures**: This temporary operational measure is likely to be a more appropriate mitigation for most road or 2WD / 4WD inundation
- **Rationalise under-utilised tracks**: Parks Victoria have been rationalising under-utilised 2WD and 4WD tracks along the Lower Goulburn in order to concentrate traffic, and therefore track maintenance effort, on fewer key access routes through public reserves. This measure, if adopted more broadly along the Goulburn River and Murray River, has the potential to reduce the effect of track inundation when coupled with the following mitigation
- **Upgrade key access tracks**: Parks Victoria acknowledge that it will not be feasible to raise all key 2WD / 4WD access tracks above modelled water levels. A more realistic approach would be to upgrade key access routes in reserves so the public and Parks Victoria staff can travel on those tracks after waters recede without causing significant damage. Upgrade works to establish sound road bases with adequate crushed rock cover would reduce track damage and vehicle bogging once reopened.

10.9.4 Diversion pumps

The following works could mitigate impacts to diversion pumps:

- Landowners agreeing to relinquish diversion licences where there are inactive pump works. Given the potential cost to relocate/upgrade irrigation pumps to be compliant with current requirements, it may be mutually beneficial for a landowner to rationalise underutilised licences in exchange for an incentive payment (funded by the avoided cost of the pump upgrade works)
- New submersible or end suction pump stations like those shown in Figure 91 and Figure 93
- Given the potential cost of constructing compliant fixed pump stations higher on the riverbank, mobile trailer-mounted pumps may be a more economical option for some sites. Trailer-mounted AS4747 compliant non-urban flow meters with telemetry were successfully trialled on the WaterNSW NSW Metering Project.

10.9.5 Historic European sites

While the impact assessment didn't identify any specific sites that clearly required mitigation, permanent structure relocation would likely be the most practical mitigation if, during detailed investigations, an historic site was assessed to be exposed to an unacceptable risk from inundation.

11. Asset ownership and maintenance considerations

11.1 Key outcomes

Key outcomes:

- It is not expected that there will be a large number of new assets created.
- There is no proposed change in ownership or responsibilities for private and public assets that are upgraded.
- The Victorian CMP will fund the capital cost of upgrading of assets where required.
- It is essential to have a clear and consistent approach to asset ownership and maintenance considerations for works delivered by the Victorian CMP. There is a need to provide clarity around who owns the asset(s) delivered by the project, who is responsible for O&M and who pays for O&M
- It is proposed that existing Commonwealth and Victorian Government policies will apply to asset ownership and management arrangements for water sector assets built in Victoria

This stage of the Victorian CMP has highlighted the following key policy position considerations:

Existing Commonwealth Government policy and practice

- The Commonwealth will not own or be responsible for the ongoing costs of any class of proposed assets

Existing Victorian Government policy and practice

- Assets providing private benefits (services) will be owned and maintained privately
- Assets providing services that are the responsibility of public entities will be owned and maintained by the public entity
- The program will only invest in new assets where asset ownership and ongoing O&M arrangements are clear

Assets servicing public land

- The current public land manager will be the owner and manager of measures implemented to protect recreational facilities on public land they are responsible for
- The Victorian CMP would fund the capital cost of mitigating impacts on public land
- There should be no material impact on local government rates as a result of constraints mitigation works

Levees

- The relaxed constraints scenarios consider flows up to the minor flood level, and therefore, are not expected to significantly engage the existing levees that offer flood protection for much higher flow rates.
- If managed environmental watering requires the use of this infrastructure as a containment bank to prevent inundation of private land, then environmental water holders should pay for these services in line with existing government policy

Private access tracks and private water supply systems

- The Victorian CMP would fund the Capital costs of mitigation works (e.g., relocation of pump above minor flood level) – but not the ongoing O&M costs
- A framework will be developed to ensure consistent application of private asset relocation principles
- It is important to strive for consistency in implementing mitigation measures for impacted landowners across both Victorian and New South Wales.

11.2 Overview

As highlighted in the Land and Asset Impact Assessment, restoring flows generally to below minor flood levels will have an impact on private land, agricultural production, stock, assets, private access roads and other public infrastructure such as roads, bridges, and culverts.

The mitigations required to address impacts will need to consider and confirm policies and arrangements for asset ownership and maintenance responsibilities prior to implementation should the program proceed.

As part of this stage, an assessment has been completed to highlight key policy position considerations for asset ownership and maintenance arrangements.

The policies ultimately adopted by the government will influence the level of support, and hence feasibility of the program, from the various asset owners for relaxing constraints.

This section:

- Lists the type of existing and new assets that may be affected by the Victorian CMP
- Describes the current relevant Victorian Government policies and practices regarding asset management
- Proposes policies to determine the ownership of assets that would be built or upgraded by the Victorian CMP
- Proposes policies to determine who will be responsible for maintaining and refurbishing the assets
- Proposes policies to determine who will fund operating and maintenance costs of the assets.

11.3 Approach and requirements

The assessment completed for this stage has leveraged existing government policies and the 'boundary parameters' confirmed by DEECA, which were presented at the first Consultative Committee meeting (Section 4.4). It also assumed that the effects of inundation on private land (except for impeded access and built assets such as sheds) are addressed through easements.

To shape the design of the recommended policies, two important aspects were considered. These were:

1. Consideration of whether asset owner consent is required to be obtained prior to the delivery of relaxed constraint flows. Consent would be required if:
    a. the river operator was legally liable for any damage caused by managed inundation of land and assets owned by government entities and municipalities
    b. asset owner agreement is required before the program could undertake works on assets needed to mitigate the impacts of managed inundation from delivering a relaxed constraint scenario
2. Policies need to manage the risk of asset owners using their strong negotiating position to their advantage to:
    a. require asset upgrades to unreasonably high standards
    b. require payments well in excess of actual costs
    c. attempt to shift 'business as usual' costs to the program
    d. refuse to participate because of their opposition to the Project, the Basin Plan, or other unrelated matters.

These risks, if not actively managed, have the potential to cause a significant increase in the cost of implementing relaxed constraints and could impact on community perceptions should the program proceed.

As part of this feasibility study, policy considerations include:

- Consistency with existing Victorian Government policies
- Development of an incentive framework for asset owners to support investment
- Avoiding unreasonable incentives
- Providing value for money
- Being affordable.

11.4 Further considerations

Additional considerations relating to asset ownership, ongoing funding arrangements and broader asset management frameworks are outlined below. Each of these will require a detailed approach to be developed to address these items if the program is to proceed to the next phase (business case).

Enduring easements

The program would result in enduring inundation easements and various mitigations works during implementation. From a planning perspective, the easements (in addition to securing the right to inundate an area of land) would also prevent particular types of development occurring without appropriate approvals.

Taking measures, as part of developing the landowner agreements, to ensure future activities and assets in the program footprint take into account the agreed managed environmental flows may also be necessary to avoid future damage claims.

Asset resilience

The program may provide opportunities to improve general resilience to natural flood events that are not associated with environmental water deliveries. There will need to be a clear framework for when the program would fund or partially fund activities that improve assets' resilience to natural flooding.

Existing unauthorised assets

The program is likely to encounter assets that have been built without proper authorisation (e.g., private levees). A clear policy or rule will be required to guide how unauthorised assets will be managed. For example, the project may only consider mitigation works for authorised assets (i.e., those with the necessary approvals and permits) or the program may determine all assets will be provided with the appropriate mitigation works.

The approach taken may significantly affect the complexity and therefore the cost of implementation.

Opportunistic asset enhancements

The Victorian CMP may provide the opportunity to address the condition of assets that do not meet current standards.

For example, the condition of some existing irrigation diversion pumps, some of which were installed many years ago, would not meet the contemporary ‘Siting and Design Guidelines for Works Licences’ developed as part of the Northern Victoria Irrigation Development Guidelines.

In recent years, Lower Murray Water (LMW) delivered a successful program, as part of the S67 Works Licence Renewal process to require that Irrigation diversion pumps were upgraded to meet the standard of the day. The project provided multiple benefits including supporting the protection of the aesthetic, archaeological and conservation values of the riverine environment and other Crown Land areas.

11.5 Consent to inundate or undertake works

As highlighted in Section 11.3, to shape the design of recommended policies, legal experts will be required to consider whether asset owner consent is required to be obtained prior to the delivery of constraints.

This section briefly explores if the program would need to gain the consent of asset owners to either inundate their assets or do works to mitigate the effects of inundation.

Clause 157 of the *Water Act,1989 (Vic)* says that:

> Liability of Authorities arising out of flow of water
>
> 1. If—
>
> a. as a result of intentional or negligent conduct on the part of an Authority in the exercise of a function under Part 8, Part 9, Division 2, 3 or 5 of Part 10, or Part 11 or any corresponding previous enactment, a flow of water occurs from its works **onto any land**; and
>
> b. the water causes —
>
>   i. injury to any other person; or
>
>   ii. damage to the property (whether real or personal) of any other person; or
>
>   iii. any other person to suffer economic loss—the Authority is liable to pay damages to that other person in respect of that injury, damage or loss.

Therefore, it is likely that a water authority would be liable for damage caused by managed inundation flows on both private land and land managed by municipalities, Parks Victoria and DEECA.

The private irrigation customers who extract water from the Goulburn and (Victorian) Murray Rivers are required to hold a Works Licence under Section 67 of the *Water Act 1989*. The licence issued (for a defined duration) by the relevant Water Authority includes the following statement ‘The Authority does not accept any responsibility or liability for any suits or actions arising from injury, loss, damage or death to person or property which may arise from the maintenance, existence or use of the works.’ This inclusion would appear to provide water authorities legal protection from damage to private infrastructure included in the Work Licence. It is however recommended that further assessment and legal advice be obtained to confirm this provides sufficient protection to the Water Authority in the context of relaxed constraints.

Section 157(4) of the Act sets out the basis for assessing damages caused by intentional or negligent inundation.

> 157 (4) The following provisions apply with respect to a proceeding brought under subsection (1)—
>
> b. the proportion (if any) of the responsibility of the Authority for the injury, damage or loss must be assessed and only that proportion of the assessed damages must be awarded against the Authority;
>
> c. in assessing damages in respect of damage to property or economic loss the measure of damages is the direct pecuniary injury to the person bringing the proceeding by the loss of something of substantial benefit accrued or accruing and does not include remote, indirect or speculative damage;
>
> d. if damages are assessed in the proceeding in respect of any continuing cause of action, they may, in addition to being assessed down to the time of assessment, be assessed in respect of all future injury, damage or loss and, if so, the Authority is not liable to pay any further damages in respect of that injury, damage or loss;

It is possible that Section 157(4)(d) of the Act could be used to provide incentives by giving land managers the choice of agreeing to terms offered by the project or taking proceedings against river operators and applying section 157(4)(d).

The feasibility study is based on the assumption that the consent of asset owners will be required for works to be done on their assets.

11.6 Types of actions affecting assets

The relaxed constraint scenarios assessed to date highlight that there will be impacts to both public and private assets as identified in the Land and Asset Impact Assessment. The mitigation works proposed include scenarios that will:

- Require existing assets with clear ownership to be either upgraded or protected
- Require existing assets with unknown ownership to be upgraded (e.g., unmanaged levees)

- Change the ongoing operating and/or maintenance costs of existing assets
- Require new assets to be built.

The assets may be located on public or private land.

For each type of mitigation actions listed above, the feasibility study has proposed polices to determine the:

- Asset ownership
- Responsibility for asset operation and maintenance
- How operation and maintenance activities will be funded.

11.7 Types of assets that may be impacted

The Land and Asset Impact Assessment has identified and quantified impacted assets where possible via desktop methods to inform the feasibility study. Table 65 provides a broader list of assets that may be impacted by the Victorian CMP, with further assessment required in any future program stages.

Table 65 – Types of assets that may be impacted

Asset categorisation	Types of assets	Existing asset owners
Assets providing public benefits		
Gauging	Rainfall gauges	DEECA[1]
	Stream gauges	DEECA[1]
Public water infrastructure assets	Pumps, regulators, channels	GMW
	Drainage assets	GMW, Municipalities
Levees	Urban levees	Municipalities
	Rural levees	Private/unknown
Public Access tracks	Public access tracks including culverts and crossings in Crown land (i.e., state forests and national parks)	Parks Victoria, DEECA
Recreational facilities	Access tracks and trails (walking, cycling, 2WD/4WD, etc.) including culverts and crossings Picnic facilities (barbecues, tables, seating, shelters, toilets, car parks, etc.) Grounds / public spaces / recreational areas Boat ramps	Parks Victoria, DEECA, Municipalities
Road networks	Roads including culverts and crossings	Municipalities
Fencing	Fences (e.g., to protect vegetation, direct visitors, etc.)	Parks Victoria, DEECA, Municipalities
Assets providing private benefits		
Fencing	Fencing	Private[2]
Access	Farm tracks including culverts, bridges and crossings on private property	Private
Levees	Private unmanaged levees	Private
Water supply	Pumps for domestic and stock supply	Private
	Farm pumps for irrigation	Private

Asset categorisation	Types of assets	Existing asset owners
Agriculture	Irrigators, tanks, troughs, cattle yards, sheds, etc	Private
Other	Holiday accommodation buildings, jetties	Private

[1]A component of the feasibility study scope of works is the investigation of additional hydrometric network assets in the Mid Goulburn to improve streamflow and rainfall gauging within the catchment. Agreement has been reached that these assets will be added to the State Observation network with their ongoing O&M being funded by DEECA.

[2]The mitigation of possible costs to farmland (including to farm fencing) that may be caused by the Victorian CMP will be considered as part of terms and conditions within landholder agreements.

The level of understanding of the types of assets, and their expected impacts, are broadly understood. Further work is required to describe how all asset classes would be affected by the change in river operations from the perspective of:

- Frequency
- Magnitude
- Duration
- Time of year.

11.8 Policy Considerations

Existing Commonwealth and Victorian Government policies apply to asset ownership and management arrangements for water sector assets built in Victoria.

11.8.1 Commonwealth Government policy and practice

The consistent position of the Commonwealth Government when funding assets in Australia's water sector is to contribute to the costs of building new assets on the terms specified in funding agreements with the state but not to fund ongoing operation and maintenance costs.

The longstanding Murray-Darling Basin Agreement, that is now Schedule 1 of the *Water Act 2007*, establishes the Joint Venture for Murray River Operations works (RMO works)[107]. The MDBA is responsible for maintaining, operating, and repairing the designated RMO works in accordance with Part VIII of the Murray-Darling Basin Agreement.

Under this Part of the Schedule the RMO assets are controlled jointly by the Commonwealth Government and the Governments of South Australia, New South Wales, and Victoria. MDBA manages the RMO assets. The capital costs of these assets are shared equally by the Commonwealth, Victoria, New South Wales, and South Australia. The ongoing operating and maintenance costs are shared by the States one third each or by other agreed proportions.

Schedule 1 sets out detailed processes for creating and funding new RMO assets. The ultimate decision maker is the Murray-Darling Basin Ministerial Council. Decisions must be unanimous.

The Commonwealth Government decided not to deliver SDLAM projects including the Constraints programs via the MDBA using the provisions of the MDBA. Instead, the Commonwealth and Victoria have entered into a bilateral agreement whereby the Commonwealth funds Victoria to build the works with the expectation that Victoria funds the ongoing operation and maintenance costs. Similar agreements exist with New South Wales.

It is noted that under the Water Amendment (Restoring Our Rivers) Act 2023, enacted at the end of the Committee's tenure, the MDBA is required to develop a Constraints relaxation implementation roadmap. At the time of writing it is unknown if this roadmap will include a change in delivery arrangements and as such this report considers the current state-based delivery mechanism will continue.

[107] RMO assets means Murray River operations assets, being transitional RMO assets; and works constructed under clause 56 of the MDB Agreement

The MDBA has funded a River Works Program to mitigate the detrimental geomorphic and ecological impacts of flow regulation[108] through erosion control works along the Murray in accordance with Clause 57 Ancillary, Preventative and Remedial Works of the Murray-Darling Basin Agreement.

For example, the Commonwealth, New South Wales, Victorian and South Australian Governments contribute funding to implement this River Works Program.

Since 2000, more than $25 million has been spent to implement physical bank protection works and to enhance the environmental values of the Hume to Yarrawonga reach.

The MDBA is continuing the River Works program, but it is outside the scope of the Victorian CMP.

Policy position considerations

It is proposed that the Victorian CMP should align with the current practice that:

- the Commonwealth will not own or be responsible for the ongoing costs of any class of assets proposed
- Victorian CMP assets will not be designated as Joint Venture assets under Part VIII of the MDB Agreement
- the MDBA continue to fund its River Works program to manage River erosion.

11.8.2 Victorian Government policy and practice

The Victorian DTF Asset Management Accountability Framework (AMAF) [109] details mandatory asset management requirements as well as general guidance for state agencies responsible for managing assets. The framework includes the following principles that apply to the Victorian CMP assets:

1. Accountability for service delivery and asset management are mutually dependent
2. Ownership, control, accountability, responsibility, and reporting requirements for assets are established, relevant, clearly communicated and implemented, including for outsourced services.

Note that the above guidance does not cover arrangements for funding the ongoing operating and maintenance costs of the assets.

The outcome of the first guideline is that the entity or person responsible for or receiving the service from the asset (i.e., benefit) should manage (own) the asset.

The outcome of the second guideline is that the Victorian CMP is required to establish the ownership of any assets it upgrades or builds.

Policy position considerations

It is proposed that:

- assets providing private benefits (services) will be owned and maintained privately
- assets providing services that are the responsibility of public entities will be owned and maintained by the public entity
- the program will only invest in new assets where asset ownership and ongoing management arrangements are clear.

11.9 Ownership of assets providing public benefits

11.9.1 Assets servicing public land

The majority of assets that provide public benefits are located on Crown land managed by either Parks Victoria, DEECA or Committees of management established under the Crown Lands Reserve Act, 1978. Municipalities are often the designated Committee of management (COM) or oversee the established COM.

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108 https://roads-waterways.transport.nsw.gov.au/projects/01documents/river-murray-erosion-management-plan/murray-river-erosion-management-plan-draft-december-2017.pdf

109 Department of Treasury and Finance Asset Management accountability framework. https://www.dtf.vic.gov.au/infrastructure-investment/asset-management-accountability-framework

The ownership of existing assets that may need upgrading is generally clear, in that the asset ownership is to remain with the public entity responsible for managing the land serviced by the asset.

For example, Parks Victoria owns and manages the access tracks and recreational facilities servicing the land they are responsible for. The same arrangement applies to the State Forests managed by DEECA.

Any future stage of the Victorian CMP may require mitigation works to access tracks and recreation facilities on public land in response to the increased frequency of managed inundation. Where this is the case, the project would fund the capital cost of the upgrades, but not the ongoing O&M costs.

A small number of local government roads may be impacted by the increased frequency of managed inundation. Where this is the case, and where the municipality agrees, the Victorian CMP would meet the capital cost of mitigation works associated with these local government roads. Ownership of the roads would not change.

It is possible local municipalities will request the program fund the incremental O&M costs of their assets that are subject to increased inundation. It will be difficult to calculate incremental O&M costs and the municipalities will be incentivised to maximise payments.

There are three broad approaches:

1. Estimate capitalised incremental O&M costs of each asset and offer to fund these costs
2. Offer to fund the capital cost of improvements on a time bound take it or leave it basis
3. Offer to fund the capital cost of improvements on a take it or leave it basis (no O&M) but also establish a grants program (say $15 million - $20 million) available to participating public land managers or other stakeholders for projects that either improve flood resilience, recreational and/or cultural experiences associated with the Murray and Goulburn River.

Option 3 would avoid the need for the Commonwealth to fund capitalised O&M costs, however it would require an administrative process to be established to manage the grants program.

Policy position considerations

It is proposed that:

- There be no change in ownership or responsibilities for public assets that are upgraded
- The current public land manager will be the owner and manager of new measures implemented to protect recreational facilities on public land they are responsible for
- The Victorian CMP would fund the capital cost of mitigating impacts on public land and assets on a take it or leave it basis but not the ongoing operating and maintenance costs
- A time bound grants program be established instead of funding ongoing O&M costs.

11.9.2 Assets owned and operated by GMW

Bulk water delivery assets are managed by GMW. It is anticipated that the Victorian CMP will have no effect on these assets. The VMFRP will deliver new assets, including permanent pump stations located on the Murray River, for delivery of environmental water to icon sites. The majority of the VMFRP assets to be delivered will be owned by GMW. The operating and maintenance costs of these assets are expected to be funded by the state government.

11.9.3 Flood mitigation infrastructure

Victorian Government policies about the accountability, management and funding of flood mitigation infrastructure are set out in the Victorian Flood Management Strategy[110]. Flood mitigation infrastructure includes levees, channel modifications, bypass floodways, retention basins, dams, and floodgates.

There are detailed policies in the Victorian Flood Management Strategy for unmanaged levees which need to be considered in the feasibility study. Unmanaged levees are mainly old levees in rural areas, that were not built to contemporary engineering standards, are not regularly maintained, and have no formal owner. Often,

[110] Victorian Flood Management Strategy. https://www.water.vic.gov.au/managing-floodplains/new-victorian-floodplain-management-strategy

they were formed by farmers to mitigate the flooding of their farm before there were planning controls in place. Sometimes these unmanaged levees provide broader community protection.

It is noted that the relaxation of constraints, which will be generally below the minor flood level, is not expected to have a significant impact on existing levees protecting private property. Should impacts to levee be identified in any subsequent stages of the program, the ownership, management and funding of levees will be a key consideration.

11.9.4 Formal accountabilities for ongoing management

The Victorian and Commonwealth Governments have recognised the public benefits of flood infrastructure and have shared the construction costs with Local Government Authorities (LGAs), and the LGAs took responsibility for ongoing maintenance. This approach has been applied successfully for levees protecting towns. However, there are flood mitigation infrastructure that has not been adequately maintained and there is no clear accountable owner for others.

The Victorian Flood Management Strategy includes actions to remove uncertainty and inconsistency in the management of flood mitigation infrastructure. It includes the principle that the three tiers of government will only invest in building or upgrading flood mitigation infrastructure if the accountability arrangements for ongoing management, maintenance and assurance are agreed and clearly documented.

Policy position considerations

It is proposed that:

a. The Victorian CMP will require agreed management accountabilities before investing in the enhancement or building of any new public levees if required.

11.9.5 Flood infrastructure for environmental watering

The Victorian Flood Management Strategy establishes the following policies for investing and managing flood infrastructure required for environmental watering. As the purpose of relaxing constraints is to enable the most effective use of environmental water, it is considered that the polices below are applicable within the context of the Victorian CMP.

a. If a new or existing levee is required solely to protect against managed floods[111], the Victorian or Commonwealth Government, as environmental water managers, will bear all capital costs (construction or upgrade) and all ongoing maintenance costs.

b. If a formally managed levee[112] is also used for managed inundation, the Victorian or Commonwealth Governments, as environmental water managers, will negotiate to pay an appropriate share of the maintenance costs. Consistent with the criteria for government investment, the cost of building or upgrading the levee to bring it into formal management arrangements would already have been shared between the Australian and Victorian Governments and the LGA, so the environmental water manager would not need to contribute to capital costs.

c. If an unmanaged levee on Crown land is required for managed inundation, the environmental water manager could upgrade any section of the levee through the CMA licensing framework.

d. If an unmanaged levee on private land is required for managed inundation, the environmental water manager will negotiate with the landholder to obtain the permission necessary to carry out maintenance works.

e. There is no need for anyone to own an existing unmanaged levee. But, if it were currently being used for managed floods, the environmental water managers would need to be assured that it was fit-for-purpose in terms of risk management.

Policy position considerations

The relaxed constraints scenarios consider flows up to the minor flood level, and therefore, are not expected to significantly engage the existing levees that offer flood protection for much higher flow rates. Where levees

[111] This principle applies to infrastructure build specifically to control environmental watering
[112] These are levees that were built to protect assists from natural floods but also provide protection for managed environmental flows managed

may be engaged, it is proposed that the Victorian CMP would fund the following incremental costs as a result of the increased frequency of inundation created by relaxing constraints.

a. Incremental O&M costs of existing managed town levees

b. The capital costs of:

   – strengthening existing town levees

   – strengthening or moving unmanaged levees

   – ensuring unmanaged levees are fit for purpose

c. Environmental water managers (CMAs) would be responsible for ensuring unmanaged levees required for environmental watering enabled by relaxing constraints are fit-for-purpose in terms of risk management. The CMAs are funded by the Victorian Government.

11.10 Ownership of assets providing private benefits

11.10.1 Private access tracks

The feasibility study includes possible mitigation actions to ensure that private landholders have access to parts of their property that may be inaccessible more often by the increase in inundation area from overbank flows, generally up to the minor flood level, resulting from relaxed constraints.

Policy position considerations

It is proposed that:

a. private access tracks remain in private ownership

b. the Victorian CMP would fund the capital cost of mitigation works to private access tracks (and other privately built assets) but not the ongoing operating and maintenance costs.

Private water supply systems

The Victorian Water Act requires a person who pumps water from waterways, including the Goulburn River and Murray River, to hold:

- A Section 51 take and use licence that is a fixed term entitlement to take and use water from a waterway that is subject to conditions set by the Minister, and
- A Section 67 works licence that is a fixed term entitlement to construct, operate, alter, decommission, or remove works associated with the extraction of water (i.e., pumps that is subject to conditions set by the Minister and specified on the licence).

All pumps on the Goulburn and the Victoria side of the Murray require Section 67 works licence that set out the conditions for siting and operating pumps. The costs of complying with the conditions are paid by the licence holder. Penalties apply for non-compliance to the conditions.

The licence conditions may be amended when the licence is renewed in accordance with *Section 71 – Conditions on which licence may be issued.*

Section 71(b)(viii) of the Act is:

> 71(b) any other conditions that the Minister thinks fit relating to –
>
> (viii) in the case of works on a waterway, additional works or measures to be undertaken for—
>
> a. the protection and enhancement of in-stream uses of water; or
>
> b. the protection of the waterway and its surrounds; or
>
> c. the maintenance of flow in the waterway; or
>
> d. the maintenance of the drainage regime within the meaning of section 12(1);

It is likely that the above clause enables the Minister to set conditions associated with pumps on waterways to support the Victorian CMP.

Works licencing provisions have been used in the past to upgrade pumps. In about 2009 Lower Murray Water (LMW) commenced an audit of domestic and stock and irrigation pumps along the Murray River from Nyah to the South Australian Border. The pumpers were given five years to 'clean-up' their pumps at their cost where pumping arrangements were substandard with the understanding that the works licences would not be renewed if 'clean-up' action was not taken.

The MCMA worked with LMW and funded works to decommission abandoned pumps and rationalise access tracks and power supplies crossing public land.

The learnings from this program were incorporated into the Ministerial Policies for Works Licences (2016)[113]. These policies apply statewide and are applied by Victoria's Water Corporations that have delegated licencing functions, including GMW.

The works licence policies apply to issuing, renewing, and amending licences. Schedule 2 of the Policies set out the requirements for the preparation of a Work Plan for the proposed works (i.e., pumps and associated works).

Section 5 of Schedule 2 sets out matters to be included in the construction plan:

> 5. A construction plan must be prepared by the applicant which clearly identifies how the applicant will –
>
> (a) liaise with relevant Aboriginal and cultural heritage authorities to avoid or minimise the impacts on any relevant sites or objects;
>
> …
>
> (k) minimise disturbance to the floodplain and waterway by, where practical, –
>
> (i) consolidating the works sites and access tracks;
>
> (ii) making use of existing works, access tracks and powerlines;
>
> (iii) placing new powerlines and delivery pipes underground;
>
> (iv) ensuring any pumphouses are as small as practicable;
>
> (v) colouring and screening any pumphouses to be compatible with the surrounding environment.
>
> (l) where practical, fix power authority-approved electrical fittings above the Nominal Flood Protection Level (300 mm above the 100-year ARI flood level).
>
> (m) where practical, raise and secure suction pipes above bank slopes to minimise the collection of flood debris;

Note that the policies require liaison with Traditional Owners and cultural heritage to avoid or minimise the impacts on aboriginal sites and objects.

Currently there are some private stock and domestic and irrigation systems that have pumps on the banks or within the channel of the Goulburn River and Murray River. The owners of these systems move the pumps when high river flows and overbank flows are forecast to avoid damage to their pumps or have installations that can cope with fluctuating river levels such as pontoon mounted pumps.

These private water supply systems are exposed to damage caused by natural floods. The costs to address this type of damage are met by the landholders. Many irrigation systems on the Murray have been located above minor flood levels and have been designed to operate over a wide range of river levels.

It is likely that the siting of many of the pumps are inconsistent with the requirements of the Ministerial Policies and that the asset owners would be required to upgrade their pumps at their expense when their works licences are renewed assuming that GMW are applying the Ministerial Policies.

Some of the relaxed constraint scenarios considered may increase the frequency of inundation generally below the minor flood level. An increase in the frequency of high flows may require landholders to move their water supply systems more frequently. Irrigation may also be interrupted if the high flows are released during the irrigation season.

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113 https://www.waterregister.vic.gov.au/images/documents/Policies%20for%20Managing%20Works%20Licences_SIGNED_20160902.pdf

There are a range of options for these private water supply systems:

a. Do nothing: the landholders would continue to move their pumps to avoid damage when high flows are forecast
b. Amend works licence conditions to require pumps to be located above minor flood levels at the landholders cost when works licences are renewed
c. Provide grants to part fund landholder costs when they agree to voluntarily locate active pumps above minor flood levels
d. Meet the full capital costs when landholders agree to locate their active pumps above minor flood levels with the works to be performed or overseen by the Project
e. Meet the full capital costs and incremental operating costs when landholders agree to locate their active pumps above minor flood levels

If there is no agreement, Option b) is the recommended default position.

The landholder or a delivery entity could be responsible overseeing the delivery of the works for option c), d) and e).

Policy position considerations

It is proposed that:

a. The pumps would remain in private ownership
b. When landholders agree to relocate their active pumps above minor flood levels, the Victorian CMP would meet the full capital costs (but not operating costs) and the works licence would be updated
c. The delivery program for option c) would be designed to:
    i. size pumps to reflect recent historic use but allow for co-investment for upgrades
    ii. only invest in active pumps below minor flood level
    iii. provide incentive to remove rather than move inactive or rarely used pumps
    iv. streamline approval processes
d. Conditions on all works licences for pumps would be amended in accordance with current licencing policies (to require pumps to be located above minor flood levels) when works licences are renewed
e. There would be a moratorium to licence illegal pumps
f. Detailed rules and arrangements would be developed to implement these policies if the program moves to the next stage.

12. River operations

1.1 Key Outcomes

- River operators and environmental water managers have developed detailed arrangements and have extensive experience in delivering environmental water. This includes coordinating flows and 'piggy backing' to a lower level than under the proposed relaxed constraint scenarios.
- All relaxed constraint scenarios were considered operationally feasible from a river operations perspective with the use of appropriate mitigations to address identified risks
- The most appropriate responsible lead and support has been identified for each mitigation measure identified during stakeholder workshops. These will require further investigation as part of any future program stages
- Further work is required to provide clarity around the concept of river operators acting in good faith to deliver environmental flows under relaxed constraints and to resolve concerns associated with ongoing liability.

Key risks identified include:

- Implementation of higher environmental flows under relaxed constraints will require greater cooperation and coordination across a number of organisations and jurisdictions. Clearly defined roles and responsibilities are an important element of any coordinated approach.
- Uncertainty about the management of potential liability from overbank environmental flows, and unclear bounds for roles and responsibilities to manage this.
- A greater need for system-wide and "landscape-scale" environmental water planning. It is unclear under current arrangements who would manage this expanded scale of environmental water planning.
- A greater need for investment in resourcing capacity and capability implementing landscape planning and coordination
- Concerns that risk-based flow forecasting may not be well understood particularly by landholders and the public. In particular, there was concern that public expectations around the precision of flow forecasts may be unrealistic.
- Notifying landholders and the public about current and forecast flows.

Key mitigations identified include:

- Creating a clear statutory responsibility or function for river operator organisations to deliver overbank environmental flows enabling river operators to undertake relaxed constraint releases within agreed limits with the legal certainty that they require.
- Addressing statutory responsibility may require changes to Victorian legislation and consideration of MDBA powers and MDB Agreement provisions.
- Incorporation of an additional area or "buffer" zone when determining primary mitigation measures such as easements and other works, recognising that, despite proposed work to improve river flow forecasting tools, there will still be residual forecasting uncertainty for river operations.
- Implementing arrangements to provide compensation in the unlikely event that, despite river operator organisations complying with any agreed procedures and arrangements, river flows still exceed agreed limits. This would provide a back-up or "fail-safe" mechanism for stakeholders and river operators.
- Appropriate policies and procedures will be important for river operators and environmental water managers to ensure best practice and quality assurance of new activities required to deliver higher environmental flows, and to build understanding and confidence with stakeholders that risks are being managed appropriately.
- Staging the implementation of higher environmental flows and the use of trials is important, and this is recognised as an important mitigation measure.
- Investment in capacity and capability of human resources, development of operations tools to improve flow forecasting and better information to support improved flow forecasting.

12.1 Overview

The ability to effectively manage the River Operations associated with the delivery of proposed flows under relaxed constraints requires adjustment to the existing arrangements of planning and operation in the Goulburn and Murray systems. This section summarises the outputs from a process used to identify and mitigate risks associated with the delivery of environmental flows under relaxed constraints proposals. It includes two key outputs:

1. A set of guiding principles for River Operations
2. Risks and Mitigation Measures.

The notable changes to flow targets, to which the risks and mitigation measures were considered, are summarised in Table 66.

Table 66 - Notable changes to flow targets

Site	Existing operations	Victorian CMP	Comment
Goulburn – Shepparton	9,500 ML/day	20,000 ML/day (17,000 ML/day with a 3,000 ML/day unregulated flow risk buffer)	At the request of the Consultative Committee flows up to 25,000 ML/day were also considered.
Murray – Doctors Point	25,000 ML/day	40,000 ML/day	Site located 15km downstream of Hume dam.

In order to effectively manage the River Operations to achieve these flows, the following aspects of environmental flow planning and delivery, were carefully considered and the associated risks and mitigation measures identified:

- Roles and Responsibilities
- Planning for the environmental delivery
- Ordering and delivering environmental water.

In certain circumstances, achievement of these flows will also require changes to the existing operational practices of the river operator. For example, the manner in which Eildon releases are currently managed by GMW to reduce flows when downstream tributary inflows are expected would require change. Such changes have been captured as part of the risks review and development of mitigation measures.

Risks were identified using a three-step approach that included:

- a literature review of existing risk assessment work on relaxing flow constraints
- initial interviews with river operators
- a river operations risk assessment workshop involving multiple agencies.

The identified risks were assessed using a consistent Risk Management Framework that aligns with the Australian Standard for Risk Management (AS/NZS ISO 31000: 2018, Risk Management: Principles and Guidelines) and the Victorian Government Risk Management Framework (VGRMF).

At the conclusion of the process a total of 21 risks were identified across the three aspects of Environmental watering planning and delivery. Of these, all have identified mitigation measures that if successfully implemented would result in the assessment of risk reducing to within tolerable levels.

The risk assessment indicates that managing higher environmental flows across the proposed flow ranges is feasible with the identified mitigation measures in place. The risk assessment also found that there was no significant change in feasibility across the range of flows up to the flow limits proposed for assessment in the Murray and Goulburn systems as part of the Victorian CMP feasibility study.

12.2 Consultation and engagement

A risk workshop was held on 8 June 2022 to discuss and identify key river operations risks and mitigations that need to be considered if operational flow constraints on environmental water are to be relaxed. The workshop included representatives from river operator organisations (GMW, MDBA, and WaterNSW), Victorian CMAs, DEECA, the VEWH and the NSW RRCP.

The workshop focussed on the ongoing "dynamic" risks and mitigations that will vary over time and typically arise as part of river operations, rather than the "static" risks and mitigations that do not change over time (e.g., establishment of easements or modifications to infrastructure), and would be addressed via other workstreams as part of any future implementation of the Victorian CMP.

The workshop program covered the following key areas:

- Consideration of the draft principles for operational delivery of relaxed constraints developed by NSW RRCP, from a Victorian perspective
- Potential risks and mitigations for delivering higher environmental flows, based on the existing VEWH Operating Arrangements. The Operating Arrangements are an established arrangement amongst the key Victorian stakeholders for the planning, ordering and delivery of environmental water, which formed the basis for structuring the risk workshop. The key sections within the Operating Arrangement guideline that were tested and explored at the workshop included:
  - Roles and responsibilities
  - Planning for environmental water delivery
  - Ordering and delivering environmental water.

A discussion paper was developed detailing the set of risks and issues to be managed to enable river operation under relaxed constraints and the likely range of mitigation measures or options.

The options were validated with river operators and environmental water managers at a workshop held in October 2022. The River Operators and Environmental Water Managers that attended the workshop agreed the key risks and mitigations from their perspectives have been captured. These risks and mitigation measures were shared with the Consultative Committee for discussion.

12.3 River Operations principles

The implementation of higher environmental flows requires a coordinated approach across a number of organisations which have different objectives. Agreeing a set of guiding principles can assist management of higher flows and the risks involved, by providing consistency in decision-making, including where there may be unexpected operational circumstances that can arise. Guiding principles for operational delivery of higher flows are also likely to provide clarity and reassurance for stakeholders, and therefore are of importance for the program implementation more broadly.

The feedback on the draft principles from participants provided broad support for agreeing a set of principles, and the draft principles (presented below) were generally considered reasonable. A key theme not directly addressed in the draft principles was the importance of coordination to the CMP, and the high degree of coordination at multiple levels that will be required. The concept of good faith was also unclear, with feedback indicating that further work was required to provide clarity about what this concept means in practice.

Based on this feedback, the following guiding principles were developed for the purposes of this stage of the Victorian CMP:

1. River operators will apply and demonstrate good faith in the planning and delivery of Program flows to meet the flow, timing and duration specified by environmental water managers and holders
2. Delivery of Program flows will have appropriate regard for protection of human safety and property
3. Risks associated with delivery of program flows should be identified, assessed and mitigated. Documentation of the risk assessment and mitigation will be publicly available and transparent
4. Delivery of program flows should be based on accepted good practice for river operations, which will include repeatable, auditable and defensible processes and procedures supported by suitable quality assurance processes, forecasting and observations. Documentation of these procedures and processes should be made publicly available to the extent that is reasonable and efficient to do so

5. Impacted or interested stakeholders should be able to easily access or receive timely and relevant notification of planned, forecast or actual program flows. Notifications should be available in a range of delivery channels and should be communicated in a manner that is meaningful to stakeholders. Effectiveness of notification approaches and experience from implementation should be reviewed at a reasonable frequency and continuous improvement implemented
6. Delivery of program flows involves the use of valuable public land and water assets, and a high degree of transparency and accountability should be provided to the community in relation to river operations actions undertaken, outcomes achieved, and issues experienced (noting that broader outcomes are a matter for broader monitoring and evaluation rather than river operations).

12.4 Roles and responsibilities – Risks and mitigations

Delivering the environmental flows envisioned by the CMP requires river operators to release water from storages at flow rates that will inundate low-lying areas of the floodplain including private property. River operators traditionally aim to control river flows within the banks of the rivers and avoid overbank flows to avoid inundating private property.

To assist in understanding the identified risks and mitigations associated with Roles and Responsibilities it is prudent to firstly understand the existing roles and responsibilities as it relates to the delivery of Environmental flows in the Goulburn and Murray (Victoria) systems.

Environmental water is already being managed and delivered through existing operating arrangements within the Goulburn and Victorian Murray Systems. Environmental water managers and river operators currently coordinate the delivery of environmental water while managing delivery risks within the system. The *Operating Arrangements (September 2020)* are an established arrangement amongst the key Victorian stakeholders for the planning, ordering and delivery of environmental water in the Goulburn and Victorian Murray Systems

12.4.1 Existing Goulburn operating arrangements

Goulburn-Murray Water (GMW) operates the Goulburn system to meet demands for water from entitlement holders in accordance with the Bulk Entitlement Order. Planning for the release of water from Lake Eildon requires information about tributary inflows in the mid-Goulburn catchment which can contribute to meeting the total flow requirements for diversion and downstream flows at Goulburn Weir.

Estimates of tributary hydrographs and the response of the total catchment is required. This is currently done by monitoring data from the hydrometric network and through the operators’ understanding of the catchment behaviour for the prevailing and forecast weather conditions.

GMW, Goulburn Broken Catchment Management Authority (GBCMA) and Victorian Environmental Water Holder (VEWH) are signatories to the Goulburn Operating Arrangements document, which sets out the roles and responsibilities of the parties for operating and risk management arrangements.

- the VEWH has primary responsibility for mitigating actions that relate to the demonstration of outcomes from environmental water delivery and portfolio management.
- GBCMA has primary responsibility for mitigating actions relating to engaging with the community in relation to environmental watering, adequate planning and monitoring of environmental water delivery and incorporating learnings into improved environmental water management.
- GMW has primary responsibility for mitigating actions relating to system operations associated with the delivery of environmental water.

12.4.2 Existing Murray operating arrangements

The operating arrangements for the River Murray system are governed by the *Water Act 2007* (Commonwealth) and the Murray Darling Basin Agreement. The Agreement sets out the water sharing arrangements for the River Murray system, and also provides for key water accounting and operational arrangements. The Agreement also empowers the Basin Officials Committee to set arrangements for the operation of the River Murray system.

The primary way this is done is through the approval of the Objectives and Outcomes for River Operations in the River Murray System (the O&O document). The O&O document sets out the operational limits and practices and any detailed water accounting procedures for all key points in the River Murray system. It has recently been extended to include arrangements for a range of environmental water delivery procedures (including accounting treatments). These arrangements also cover the measures necessary to implement the Prerequisite Policy Measures such as arrangements to allow 'piggybacking' storage releases onto unregulated or natural events in the River Murray.

River operators have also developed a range of detailed procedures, manuals, and guidance material to assist in applying the O&O provisions in day-to-day operations.

Victorian Murray Operating Arrangements

- The VEWH has primary responsibility for mitigating actions that relate to the demonstration of outcomes from environmental water delivery and portfolio management.
- The relevant CMAs (Goulburn Broken, Mallee, North East and North Central) in their role as Waterway Managers have primary responsibility for mitigating actions relating to engaging with the community in relation to environmental watering within Victoria, adequate planning and monitoring of environmental water delivery and incorporating learnings into improved environmental water management.
- The Murray-Darling Basin Authority (MDBA) has primary responsibility for mitigating actions relating to system operations associated with the delivery of environmental water. The River Operator (MDBA) has the authority to reject or cease delivery of an order immediately if it reasonably believes it will create unacceptable risks to public safety or may expose the storage manager to liability for payments of claims for loss or damage to property.

12.4.3 Risk identification

Implementation of higher environmental flows will require cooperation and coordination across a number of organisations and jurisdictions. The current Operating Agreements between delivery partners - VEWH, CMAs and storage managers/system operators set out roles and responsibilities for each organisation for current watering activities. The roles and responsibilities of each organisation under the proposed operating arrangements will need to be considered to ensure that any risks from delivery of higher environmental flows are appropriately managed.

The following questions were posed to workshop participants:

- Will the roles and responsibilities identified in the existing Operating Arrangements need to change under a relaxed constraints environment?
- What are the risks/gaps to your organization's roles and responsibilities under a relaxed constraints environment?
- The identified risks and the associated mitigation measures associated with 'Roles and Responsibilities' are summarised in the Table 67. Note some risks have multiple consequence categories.

Table 67 – 'Roles and responsibilities' - summary risks and mitigations

Risk description	Mitigation measures	Risk category
Insufficient or uncoordinated consultation and engagement results in environmental flow actions that do not match community and landholder expectations	• Coordinated landscape-scale environmental water planning and consultation process • Program communications • Develop relevant policies and procedures and provide appropriate public visibility / transparency.	Public communication and education
Lack of existing/clear agency roles and/or procedures leads to missed environmental watering opportunities.	• Statutory powers and roles for overbank environmental flows • Develop relevant policies and procedures and provide appropriate public visibility / transparency.	Governance and coordination
Lack of existing/clear agency roles and/or procedures leads to unintended/unmanaged inundation.	• Statutory powers and roles for overbank environmental flows	Governance and coordination

	• Coordinated landscape-scale environmental water planning and consultation process • Develop relevant policies and procedures and provide appropriate public visibility / transparency.	

12.5 Planning for environmental water delivery – Risks and mitigations

Planning for environmental water delivery involves preparation of seasonal watering proposals and planning at environmental sites to identify the desired environmental water use under a range of climate and water availability scenarios. This planning takes into account relevant information, including long term watering plans, technical reports, any site monitoring data, and consultation with key stakeholders.

Environmental water delivery planning includes the following key functions:

- Timing, duration, magnitude and frequency of releases
- Consulting and coordinating consent for watering private land where existing agreements are not already in place
- Consulting public land managers regarding planned releases and attaining formal approval from the public land manager for site access and works associated with watering
- Preparing a delivery plan for diversions of water onto land such as wetlands and floodplains, to provide information such as the delivery mechanism, confirmation of landholder approvals, delivery costs and evaluation of any risks
- Consulting the delivery infrastructure operator to ensure there are no planned maintenance activities that may impact ability to deliver environmental flows
- Providing information and advice regarding system operations and third-party impacts
- coordination and/or participation in operational advisory groups (OAGs) to coordinate operational delivery planning risk management among partner agencies throughout the season.

The following questions were posed to workshop participants:

1. What are the risks associated with the planning function under relaxed constraints – will community or other stakeholder engagement/acceptance be more time consuming or difficult to achieve?
2. Is there a risk that Environmental Water Advisory Groups will not support the proposed higher environmental flows?
3. Will any of the existing flow delivery planning functions be riskier under higher proposed flows?

The identified risks and the associated mitigation measures associated with 'Planning for environmental water delivery' are summarised in Table 68. Notes some risks have multiple consequence categories.

Table 68 – 'Planning for environmental water delivery' – summary risks and mitigations

Risk description	Mitigation measures	Comments
Inability to quickly plan complex events over one or more river systems results in missed opportunities for environmental watering events	• Staged implementation and trials • Coordinated landscape-scale environmental water planning and consultation process • Investment in capacity and capability of human resources • More efficient/effective e-water ordering. Links to EEWD.	Flow forecasting and delivery

Risk description	Mitigation measures	Comments
Lack of coordination between agencies results in missed environmental watering opportunities.	• Coordinated landscape-scale environmental water planning and consultation process • More efficient/effective e-water ordering	Environmental flow planning
Lack of resourcing and capability to undertake landscape planning and coordination.	• Coordinated landscape-scale environmental water planning and consultation process • Investment in capacity and capability of human resources	Environmental flow planning
Lack of resourcing leads to missed opportunities for environmental releases at higher flows.	• Investment in capacity and capability of human resources	Environmental flow planning

12.6 Ordering and Delivering Environmental Water – Risks and Mitigations

The process of ordering and delivering higher environmental flows will be significantly more complex than for the existing environmental and consumptive demands. This will include the prior development of orders for releases to be targeted under a range of potential climatic conditions, the arrangements for approving the commencement of those releases, and the procedures for managing the delivery as climatic conditions unfold during the releases. Accordingly, ordering and delivery of higher environmental flows is the activity that generate the most public interest and is likely to carry the higher risks. Managing these is the focus of most of the static mitigation measures for the program.

The following potential areas of risk were posed to workshop participants:

1. Pre-ordering communication - Does this change under relaxed Constraints?
2. Enhanced notification/information services:
    a. Landholders and communities need to be able to receive timely info on proposed flow events
    b. Annual plans, proposed events advice, actual event info
    c. Provision of effective and timely information enables people to avoid risk – move stock, portable assets, put any preparations in place
3. Are the notification systems and processes adequate under relaxed constraints?
4. Ordering and Confirmation
    a. Is the existing system and processes adequate given the larger flows and possible scrutiny of this activity?
    b. Should there be an ultimate group of decision makers (authorisation) for go/no go for bigger riskier events?
    c. Overshooting or falling short - Are there adequate tools and techniques to manage and/or monitor this and what are the impacts?

The identified risks and the associated mitigation measures associated with ‘Ordering and Delivering Environmental Water’ are summarised in Table 69. Note some risks have multiple consequence categories.

Table 69 – 'Ordering and delivering environmental water' - summary risks and mitigations

Risk description	Mitigation measures	Risk category
Higher environmental flows increase impacts during subsequent natural flow events	• Develop operations tools to improve flow forecasting • Better information to support improved flow forecasting • Investment in capacity and capability of human resources	Flow forecasting and delivery
Insufficient or ineffective flow notifications during relaxed constraints flow events results in public or private impacts (includes various consequence categories)	• Development and implementation of an effective event notification system to alert downstream stakeholders	Public communication and education
Insufficient understanding of flow forecasts by landholders and public	• Development and implementation of effective event notification system to alert downstream stakeholders • Staged implementation and trials	Public communication and education.
Uncertainty in flow forecasting leads to lack of inundation and reduced environmental outcomes	• Develop operations tools to improve flow forecasting • Better information to support improved flow forecasting • Staged implementation and trials • Investment in capacity and capability of human resources	Flow forecasting and delivery
Uncertainty in flow forecasting leads to unintended/unmanaged inundation.	• Appropriate buffers included in easements. • Redress pathway if flows exceed limits	Flow forecasting and delivery
Water ordering and delivery process inefficient or ineffective	• More efficient/effective e-water ordering	Flow forecasting and delivery

12.7 Further development of mitigation measures

Having identified a range of mitigation measures to reduce the identified risks, the project team have also identified a proposed responsibility lead and support for each mitigation measure. This recognises that, should the Victorian CMP proceed, each of the proposed mitigation measures associated with higher environmental flow limits will require further investigation and development as part of subsequent stages of the Victorian CMP.

The detail of the allocated responsibility lead and support is included in Appendix E.

12.8 Conclusion

In general, risks tended to increase with higher flow rates. However, there was no particular flow rate identified within the range of flows under consideration where risks were thought to increase significantly. The risk assessment indicates that managing higher environmental flows across the proposed flow ranges is feasible with the identified mitigation measures in place. The risk assessment also found that there was no significant change in feasibility across the range of flows up to the flow limits proposed for assessment in the Murray and Goulburn systems as part of the Victorian CMP feasibility study.

13. Goulburn River hydrometric network upgrades

13.1 Key outcomes

Key outcomes:

- The project is installing and commissioning 3 streamflow, 10 rainfall gauges and adding telemetry to one existing streamflow site in the Mid Goulburn.
- Extensive engagement was completed for initial site identification, short-listing and final site selection with key stakeholders GMW, GBCMA, BoM and DELWP Water Resources Information Modelling Division and interested Consultative Committee members
- The hydrometric network upgrades to be installed as part of the Victorian CMP will enhance the Mid Goulburn streamflow and rainfall gauge network to support future and current river operations models.
- It is anticipated that installation and commissioning will be completed in 2023 subject to the necessary approvals.

13.2 Overview

The objective of installing new gauging and rainfall sites is to assist both in the operation of relaxed constraints environmental watering actions in the Goulburn system, as well as normal river operations by providing an improved level of information for rainfall and streamflow data and forecasting.

Within the Mid Goulburn catchment there are some gaps in the unregulated stream flow and rainfall monitoring network, with approximately 57% of the catchment and long sections of the mainstem of the Goulburn River not gauged with streamflow monitoring. This stage of the Victorian CMP is installing and commissioning new streamflow and rainfall gauges to reduce the gaps in the Mid Goulburn hydrometric network system.

A shortlist of potential streamflow and rainfall gauging sites was identified through consultation with the key stakeholders - GMW, GBCMA, DEECA Water Resources Information and Modelling Division and the BoM. The shortlist of sites was then subject to field investigations to confirm the suitability of the proposed sites and to identify the site particulars.

Following detailed field investigations and stakeholder engagement, including consultation with Consultative Committee members, the streamflow and rainfall gauging sites were confirmed.

Following identification of the final sites for installation, the funding source for the O&M costs associated with the new sites was confirmed. As the new gauges are required for planning and managing environmental flows in the Goulburn River (under relaxed constraints scenarios), it is confirmed that ongoing O&M costs are funded by the DEECA Environmental Water Team through existing funding arrangements with the GBCMA for environmental water management functions.

Appendix F provides a comprehensive report of the site identification process and justification for the final sites selected.

13.3 Consultation and engagement

During a review of available information at the commencement of this feasibility study, it was identified that while there was a general appreciation that additional gauging was required in the Goulburn to support operational decisions for environmental water deliveries, there was no study that has identified the location and specification of the proposed upgrade works.

During this stage of the Victorian CMP, extensive consultation and engagement with key stakeholders including GMW, GBCMA, BoM and DEECA's Water Resources Information and Modelling Division. A range of options papers were provided, and feedback was sought. This information was used to identify a shortlist of potential sites based on desktop investigations. Field visits were then conducted to confirm the viability of establishing sites in the preferred locations. In addition to engagement with key agencies, the proposed hydrometric upgrades were provided to the Consultative Committee. As a result, a Committee member raised concerns about the coverage and availability of streamflow gauging data in the Murrindindi and Yea systems. This resulted in additional gauges being included for construction.

"A new gauge at Yea will make a big difference."

The stakeholders and their relevant interest in the hydrometric network is described below.

- **GMW**: is the storage manager for the Goulburn System with responsibilities for operating and managing the headworks storages and delivering consumptive and environmental water entitlements. GMW owns and operates a number of streamflow gauges in the Mid Goulburn catchment and tributaries to monitor storage inflows and releases and to manage the delivery of water entitlements.
- **GBCMA**: is the waterway manager for the Goulburn System and is responsible for developing and implementing environmental watering actions in the river system. The CMA solely or jointly owns and operates a number of streamflow gauges in the Goulburn catchment to assist in monitoring river health and the delivery of environmental watering actions.
- **BoM**: the BoM provides flood forecasting and warning nationally and operates a number of rainfall gauging stations in the Mid Goulburn catchment. The BoM utilises the streamflow gauging networks owned and operated by other organisations to identify long-term trends in stream favourability and predict the effects of climate change on water availability across Australia. Additionally, the Bureau prepares 7-day streamflow forecasts at two sites in Mid Goulburn catchment (Yea River, 405217 and Acheron River, 405209)
- **DEECA**: the Department manages the Victorian Regional Water Monitoring Partnership which has been established to coordinate data collection on water flows and quality across the State. The monitoring partnership coordinates the procurement of gauging sites and the contract for the maintenance of the network on behalf of the partner agencies. The Department owns a subset of the streamflow gauging network.

Key deficiencies in the existing network that were identified during the initial review of available information, and used to inform site selection, included:

- The ungauged section of the Goulburn River between Eildon and Trawool: there is approximately 110 km of the Mid Goulburn mainstem that is ungauged between the Eildon gauge and the gauge at Trawool. This compares against industry-standard recommendations of one streamflow gauge every 20-25 km
- Significant sections of tributary catchment below existing streamflow gauging stations and therefore are ungauged. For example, existing gauging stations on the Major Creek, Yea River and King Parrot Creek were in the order of 20 to 40 km upstream of the confluence with the Goulburn River
- Lack of streamflow gauging on a number of tributaries in the Mid Goulburn catchment. Six of the largest ungauged tributaries were identified and then ranked according to the catchment size.
- Lack of rainfall gauging at several existing streamflow gauging sites.
- Significant gaps in the rainfall gauging network particularly in upstream catchment areas and on catchment boundary ridgelines. It was noted that the average density of rainfall gauges in the Mid Goulburn catchment was approximately one gauge per 400 km^2 compared to a recommended density hydrological modelling of one rainfall gauge per 25 km^2.

13.4 Benefits of hydrometric network upgrades

The hydrometric network upgrades installed as part of the Victorian CMP provided the following benefits:

- Addressed deficiencies in the Mid Goulburn streamflow and rainfall gauges network through the installation of new gauges at key locations.
- A new streamflow gauge at Molesworth addressed a major gap in the mainstem of the Goulburn River between Eildon and Trawool.
- A new streamflow gauge on the Yea River at Yea township near the confluence with the Goulburn River addressed a gap in the gauging network.
- New rainfall gauges in the upper catchment of the Yea River and in the King Parrot and Yea River inter-catchment ridgeline has demonstrated that the project is addressing stakeholder concerns around the ability to forecast stream flows in the Yea River.

- A new rainfall gauge is proposed to be installed in the upper Murrindindi catchment. This new site has been included in response to stakeholder feedback about being able to better attribute rainfall between the Acheron and Murrindindi catchments, as the other new gauges are being installed near the ridgeline.
- The existing streamflow gauge on the Murrindindi River is proposed to be upgraded to have telemetry installed. This upgrade work is in response to stakeholder feedback and will allow real-time data to be available for flows in the Murrindindi catchment.
- The new gauging will be available to support future river operations models.

"It would be good to get the extra rainfall and streamflow stations to help in operating the river. Having access to the technology can help mitigate the risk."

13.5 Streamflow and rainfall gauges

The final list of streamflow and rainfall gauges to be installed as part of the Victorian CMP is summarised in Table 70 and shown in Figure 97.

Table 70 – Summary of final Streamflow and rainfall sites

No	Site	Type	Latitude	Longitude
1	Goulburn River at Molesworth	Streamflow & Rainfall Gauge	-37.1651	145.5438
2	Yea River confluence with Goulburn River	Streamflow & Rainfall Gauge	-37.2101	145.4130
3	King Parrot Creek confluence with the Goulburn River	Streamflow & Rainfall Gauge	-37.1731	145.2523
4	Major Creek upper catchment	Rainfall Gauge	-36.9708	144.7946
5	Dabyminga Creek & King Parrot Creek - Upper Catchment	Rainfall Gauge	-37.2694	145.2108
6	Acheron River & Murrindindi Rivers – Upper Catchment	Rainfall Gauge	-37.3766	145.6213
7	Rubicon River upper catchment	Rainfall Gauge	-37.3739	145.8653
8	Rubicon River lower catchment	Rainfall Gauge[1]	-37.2906	145.8275
9	Spring Creek upper catchment	Rainfall Gauge	-37.0777	145.7181
10	Murrindindi upper catchment	Rainfall Gauge	-37.4722	145.5661
11	Murrindindi River at Murrindindi	Telemetry Only[2]	-37.397	145.564

[1] Co-located near the existing streamflow gauge
[2] An existing streamflow gauge on the Murrindindi River upstream of the Yea confluence to be upgraded with telemetry only

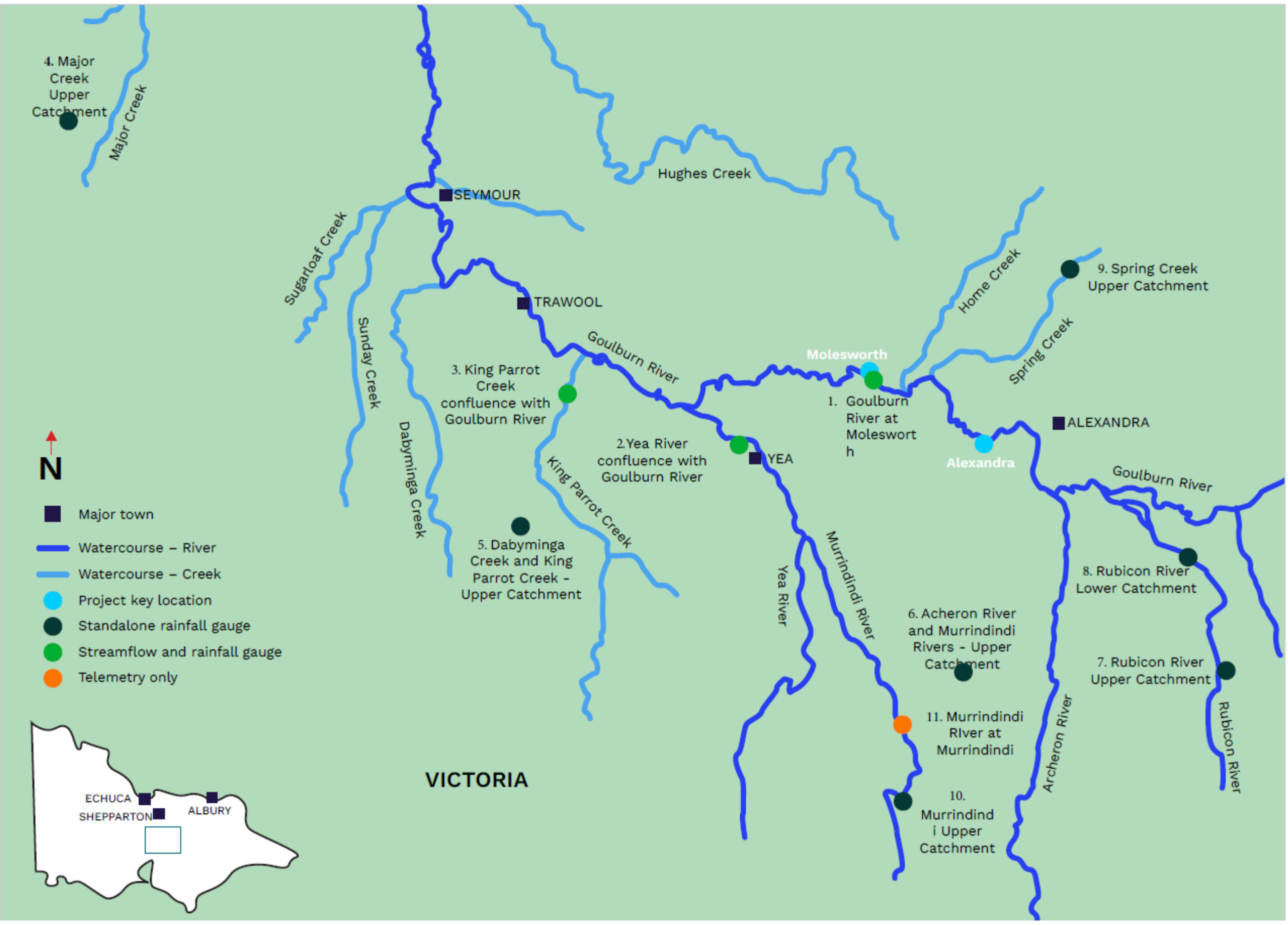

Figure 97 – Map of final streamflow and rainfall gauge sites

13.6 Approvals

A secondary factor considered during site identification, assessment, and selection, was the approval requirements for the hydrometric network installation. Sites were selected to minimise the likely regulatory approvals. For example, all sites are on cleared land which has been previously disturbed and no tree clearing will be required.

A Regulatory Approvals Strategy was developed for these works to identify the requisite statutory approvals to allow the works to be undertaken.

Generally, as most of the sites are located on public land, the sites are subject to:

- Agreement from Taungurung Land and Waters Council (TLaWC) under the Land Use Advisory Activity (LUAA) process
- Land Manager (DEECA) consent for works
- Secondary approvals such as Planning Permits, Works on Waterways Permits, and Works Within Road Reserve Permits.

The approvals required at each specific site varied, with details of site requirements included in Appendix F. The approvals required for the hydrometric upgrades are briefly described below.

- Taungurung Land Use Activity Agreement (LUAA) (8 sites): Taungurung Land and Waters Council is a Registerd Aboriginal Party (RAP) with several sites located within their RAP area. The Land Use Activity Agreement is part of a broader settlement package called the Recognition and Settlement Agreement (RSA). The RSA is made up of a set of agreements that are legally binding on the State of Victoria, including all government agencies, and on the Taungurung Land and Waters Council (TLaWC) as the representative body of the Taungurung people. These agreements, including the LUAA, recognise and protect the Traditional Owner rights of the Taungurung people. In return, the Taungurung people agreed not to pursue the legal recognition of native title rights that they may hold. These agreements are complementary with cultural heritage protection.

- DEECA land manager consent (7 sites): Some sites are located on public land managed by DEECA. This requires DEECA consent to undertake works on public land. A requirement of this application is consent provided by Taungurung Land and Waters Council as both via the LUAA and as Native Title holders. As the landholder, DEECA are defined as the decision maker for the project with respect to the LUAA and as such, engagement with TLaWC was via DEECA processes.
- Private landowner agreement (2 sites): landholder agreement was sought for sites located on private property. This was in the form of private access agreement signed between the contractor (Sequana), the Regional Water Monitoring Partnerships (DEECA), and the title holder.
- Council planning approval (10 sites): are required to undertake works in some circumstances determined by relevant Council planning scheme(s). The concept design and location of sites were submitted to the Council to confirm permit requirements. Planning permits are not required as Council have determined that the works are classified as minor utility works which are exempt from planning permit requirements under the planning scheme.
- Cultural Heritage assessment: a heritage advisor was engaged to assess CHMP requirements for all sites. The Cultural Heritage Due Diligence Assessment determined that the works are minor utility installations and are exempt from CHMP requirements under Regulation 46 of the Aboriginal Heritage Regulations on the basis that:
  a. the works are a linear project that is the construction of an overhead power line with a length exceeding one kilometre or for which more than 10 power poles are erected
  b. the works are a linear project that is the construction of a pipeline with a length exceeding 500 metres
  c. the works are a linear project with a length exceeding 100 metres (other than the construction of an overhead power line or a pipeline with a pipe diameter not exceeding 150 millimetres)
  d. the works affect an area exceeding 25 square metres.
- Works on waterways permit (4 sites): A review of project designs and construction footprints by GBCMA identified that Works on waterway permits would be required for the three Streamflow Gauge Sites.
- Works within road reserves permit (3 sites): is required to enable part of a council owned road reserve to be occupied and impacted for the purpose of access to sites for installation. These permits ensure that the works will minimise any effects on road users, minimise impacts to the road surface and other assets in the road reserve and ensure disturbed areas are rehabilitated to the satisfaction of Council.

13.7 Installation

Installation of the hydrometric network upgrades commenced in December 2022. The sites were being installed in accordance with the hydrometric report included in Appendix F. Figure 98 shows the Upper Murrindindi rainfall gauge installed in December 2022 as part of the Victorian CMP.

Figure 98 – Upper Murrindindi Rainfall gauge installed as part of the Victorian CMP, Ventia, December 2022

13.8 Commissioning and handover

Commissioning of the completed hydrometric network upgrades was completed in accordance with the requirements set out in the hydrometric report included in Appendix F.

13.9 Operation and maintenance

All stakeholders GBCMA, GMW, BoM and DEECA emphasised the importance of identifying responsibilities for operation and maintenance costs associated with the proposed rainfall and streamflow gauging installations installed by the project. The strong consensus from the agencies that is that arrangements for O&M costs need to be determined before the final decision is made on installation of the sites.

The final sites and design were confirmed in order to provide the likely operation and maintenance costs of the sites for consideration by stakeholders. The benefits of the hydrometric upgrades, largely in the improved rainfall run-off and river operation forecasting, justifies the need for investment in these sites, including commitment to operation and maintenance costs.

A briefing paper on the need for these new sites and consideration of the potential sources for O&M funding within government was circulated within DEECA. As these new gauges will primarily be used for planning and managing environmental flows in the Goulburn River (under current and potential future relaxed constraints scenarios), it has been agreed that ongoing costs will be funded by the DEECA Environmental Water team through existing funding arrangements with the GBCMA.

The commitment to cover the ongoing costs of the new and upgraded hydrometric sites was approved in May 2022.

14. Hydrologic assessment

14.1 Key outcomes

Key outcomes:

- The feasibility study has been supported by improved hydrology models that now use a daily time step. The models are ‘fit for purpose’.
- Relaxing constraints in the Goulburn and Murray Rivers increases the use of already available environmental water specifically for the benefit of Victorian environmental assets
- Modelling shows that relaxing constraints would enable more environmental water to be released from storages than under current operating rules. This would increase dam airspace enabling the dams to store more flood inflows and reduce the size of moderate floods. Releasing environmental water throughout the year can provide flood mitigation as a secondary benefit, depending on how the entitlement holders chose to use their water.
- Constraint relaxation will assist as an environmental climate adaptation strategy under most of the modelled climate change scenarios
- It is noted that operation rules and business decision processes are more likely to be adaptive to emerging drier climatic conditions in the future
- The reliability of allocations is not expected to be impacted by relaxing constraints
- The Mid Goulburn constraint at Molesworth is a limiting factor for the flows that can be achieved in the lower-Goulburn
- Under the highest modelled Goulburn constraint scenarios, flows will only approach the lower-Goulburn constraint if water released from Lake Eildon to the Mid Goulburn coincides with unregulated tributary inflows between Eildon and Shepparton
- Further work is required on the Goulburn model to improve the consideration of real-time management decisions that will influence how the model simulates environmental water orders and river operation
- This was the first time that the impact of constraint relaxation in the Goulburn and Murray systems were modelled in a connected way using Source models. Now we have established these models and their interaction, we can build on this in any future stages of the Victorian CMP.
- Timing of environmental demands and releases are equally important as the amount of environmental water used in determining the achievability of high in-channel and low overbank flows facilitated by constraints relaxation.
- Modelling suggests that flows of 40,000 ML/d may be achieved an additional 1 in 10 years at Doctor’s point under the highest modelled scenario. However, achieving targeted flows at the modelled constraint at Yarrawonga is less frequent and depends on ‘piggy backing’ on unregulated tributary inflows. Flow targets in the lower reach cannot be achieved by dam releases alone.
- Modelling suggests relaxing constraints would result in no change in the frequency of environmentally desirable higher flow rates in the Murray River at the South Australian border under all relaxed constraints scenarios tested in this stage of the Victorian CMP. Further work is required through the EEWD project to develop the tools and processes to further forecast and coordinate flows across all tributaries.

14.2 Overview

Hydrological modelling simulates how water will flow through a river system under different climate sequences and operating conditions. The modelling generally considers a range of factors such as inflow seasonality and patterns (rainfall-runoff), river operating rules (such as how dams are managed to supply water and mitigate flood impacts) and water demands (such as irrigation, environmental and trade volumes). This modelling can test how flow behaviour is expected to change based on adjustments to these factors.

A key objective for the Victorian CMP is to understand how relaxing constraints may change the flow behaviour in the subject reaches under various climate conditions and operating protocols.

Relaxation of constraints may produce some or all of the following outcomes:

- Increase the ability of environmental water managers to provide higher priority flow components, such as winter/spring fresh flows, which produce more significant environmental benefits than lower priority flow components
- Reduce shortfalls in meeting environmental water demands when environmental water allocations cannot be fully utilised because of constraints
- Reduce the duration, volume and peak flow in flood events associated with spills, particularly from Lake Eildon.

The outputs from the hydrological modelling, in combination with the inundation extents predicted by hydraulic models, were used to assess the expected environmental, cultural, social and economic outcomes of constraint relaxation. These outcomes have been compared with current conditions so that stakeholders can appreciate the scale of the potential changes and provide informed input as to the feasibility of this project.

Hydrological models of the Goulburn and Murray systems were used to run 100+ year simulations of hydrological conditions, assuming current demands, infrastructure and operational rules, to quantify the extent to which the above three outcomes would be influenced by constraint relaxation.

Modelling was undertaken for this feasibility study by University of Melbourne, DEECA and MDBA.

The three models used for this stage of the Victorian CMP were:

1. The University of Melbourne's Stochastic Goulburn Environmental Flow Model (SGEFM), which was used for a high-level analysis of the hydrological and ecological outcomes of relaxed constraints on the Mid Goulburn and Lower Goulburn[114]
2. DEECA's GBCCL Source model was used to analyse the hydrological outcomes of relaxed constraints on the Mid Goulburn and Lower Goulburn
3. MDBA's Source Murray Model (SMM) was used to analyse the hydrological outcomes for the Murray River if constraints are relaxed at Doctors Point, Yarrawonga Weir and in the Mid Goulburn and Lower Goulburn.

The hydrological modelling approach and outcomes are further described in Appendix A and the associated attachments.

14.3 Comparison with previous modelling approaches

14.3.1 Goulburn River hydrologic modelling improvements

The hydrology modelling component of this stage of the Victorian CMP is a step-change compared with the hydrology analysis[115] available for the 2016 and 2017 business cases for constraint relaxation along the Goulburn River. The previous hydrology analyses used historical streamflow data to assess whether environmental water releases from Lake Eildon could be added to tributary inflows to create events with peaks in the range of 25,000 ML/d to 40,000 ML/d at Shepparton. This assessment provided helpful information, however, much of the analysis assumed unlimited water availability and perfect knowledge of future rainfall and streamflow.

In contrast, the daily timestep hydrology modelling method used for this stage uses water resource models that simulate the sharing of the water available between consumptive users and environmental water holders and how the behaviour of these water users will combine with climate conditions and system operations to produce time-series of streamflow under different relaxed constraint scenarios. This means that a more robust assessment of the likely change in the frequency, timing and duration of flows at key hydraulic and environmental thresholds if operational constraints are relaxed was able to be undertaken.

[114] John A, Horne A, Fowler K, Nathan R, Stewardson M. 2021a. Constraints management scenarios and climate stress test for the Goulburn River (presentation slides)
[115] Jacobs. 2016. Goulburn Constraints Business Case Hydrology Analysis

14.3.2 Murray River hydrologic modelling improvements

This study is the first time in the modelling history of the Murray-Darling Basin that constraints modelling has been undertaken using the DEECA GBCCL Source model as inputs to the MDBA SMM to understand flow dynamics and environmental outcomes in the Lower Goulburn and Murray with different levels of constraint relaxation. This means that the outputs from the daily time-step DEECA Goulburn model can directly be used as inputs in the Murray River, modelling relaxed constraints along the length of the Goulburn River, with and without the Murray orders.

The previous hydrologic modelling of the relaxation of operational constraints in the southern connected Murray-Darling Basin is described in an October 2012 report by the MDBA[116]. A detailed comparison between the modelling completed in 2012 and what was undertaken for this stage of the Victorian CMP is beyond the scope of this report, but two differences can be highlighted here:

- In 2012, environmental water demands were modelled as a time series of demands constructed independently of the model. In contrast, in the SMM, environmental water demands are represented in the model – using the Source environmental flow-node – and the supply of water to these demands is subject to the same water availability and operational constraints that apply to consumptive water users.
- In 2012, the Murray River modelling was based on relaxing the operational constraint in the Goulburn River at McCoys Bridge to 40,000 ML/d. In this assessment, the inflows from the Goulburn River to the Murray River, as represented in the SMM, reflect the considered option(s) for constraint relaxation along the Goulburn River as informed by the Consultative Committee.

The Murray system dynamics upstream of Torrumbarry change with tributary inflows, especially from the Ovens and the Goulburn systems. The magnitude of regulated releases from Hume dam depends on these inflows. While unregulated flows from the Kiewa and Ovens catchments provide piggybacking opportunities to improve environmental outcomes, coordination of regulated flows from the Goulburn system is challenging to manage floodplain outcomes without unintentionally increasing risks of the existing current river operations.

The MDBA and DEECA continue to hold conversations to improve how to incorporate this connected nature of the southern system using different models and how to coordinate environmental water delivery from multiple sources. Once outcomes from these programs or other improved approaches become available, the current MDBA modelling approach should be reviewed and revised.

14.4 Goulburn River hydrologic outcomes

14.4.1 Constraint scenario range finding

In line with the Victorian Government's position that the Goulburn reach is only to consider 'in channel' flows, a range of baseline flow rates for modelling were presented to the Committee that satisfied the 'boundary parameters' of the feasibility study in that no modelling scenarios would include consideration of out of channel flows. The Committee response to the proposed Goulburn flows for modelling was divided, with some members raising concerns that the proposed flow ranges for the Goulburn River were not high enough to provide environmental benefits. These members expressed a desire to explore higher flows.

Concerns were raised that if flows from Eildon were not maintained at the current 9,500 ML/d, there could be negative impacts on properties and businesses thought to be impacted at 9,500 ML/d – 10,000 ML/d around the Molesworth area. GMW River Operators confirmed that releases from Lake Eildon were currently managed to target below 10,000 ML/d at Molesworth to address this concern.

Although there were dissenting views, the Committee discussed that a robust feasibility study should investigate the benefits and impacts of the larger flows (up to minor flood levels, including a risk buffer) along the length of the Goulburn River. This would then provide the Committee with information to understand what may happen within the range of flows.

Goulburn constraint options are assessed at the Mid Goulburn at Molesworth, downstream of the significant Goulburn tributaries of the Acheron and Rubicon rivers, and the Lower Goulburn at Shepparton, downstream of the confluence of the Goulburn and Broken rivers. The baseline (or existing constraints) scenario is modelled with constraints in the Mid Goulburn of 10,000 ML/d and the Lower Goulburn of 9,500 ML/d.

116 MDBA, 2012. Hydrologic modelling of the relaxation of operational constraints in the southern connected system: Method and results

Providing environmental water to the lower reaches of the Goulburn River can be achieved in two ways: through regulated releases at Lake Eildon, which are passed down to the Lower Goulburn, and through ceasing the diversion of tributary inflows into Goulburn Weir (directed to Waranga Basin). Given this, there are potential interactions between constraints in the Mid Goulburn and Lower Goulburn reaches. For example, although relaxing Lower Goulburn constraints is critical to providing high-flow recommendations in this reach, relaxing Mid Goulburn constraints can also help by supplementing tributary inflows from Lake Eildon.

The result is that different relaxation targets in the mid and Lower Goulburn must be tested in combination, and there is potentially an extensive range of options.

The University of Melbourne's SGEFM water resource model was used to narrow the range of potential constraint relaxation options in the mid (assessed at Molesworth) and lower (assessed at Shepparton) Goulburn River. The SGEFM was selected for this approach due to its flexibility and ability to evaluate multiple constraint scenarios rapidly. This was undertaken following a series of updates to the SGEFM to provide more fit-for-purpose outputs for the investigation of constraint relaxation. Further information on the SGEFM and the results can be found in Appendix A.

The range-finding exercise aimed to narrow potential constraint options in the mid and Lower Goulburn River to specific flow scenarios demonstrating potential ecological and hydrological benefits. This was undertaken for the Consultative Committee to consider the specific scenarios for the subsequent benefit and risk assessment.

The range-finding exercise also considers constraint relaxation options generally up to the minor flood level along the river (Table 71) in line with the government's position that flows are to be within minor flood levels where possible.

Table 71 – Minor flood level at selected gauging sites along the Goulburn River

Gauge number	Gauge location	Minor flood level stage (m)	Minor flood level flow rate (ML/d)*
405203	Eildon	3	13,700
405201	Trawool	4	21,800
405202	Seymour	3.8	22,600
405200	Murchison	9	29,900
405204	Shepparton	9.5	30,800

*at the time of analysis in 2022

The Lower Goulburn constraint is assessed at Shepparton; thus, up to 30,800 ML/d limits are considered. The Mid Goulburn constraint is assessed at Molesworth, which does not currently have a minor flood level. As such, the range-finding exercise considers up to the minor flood level at Trawool (21,800 ML/d). The model does not allow releases at Lake Eildon to exceed the Eildon minor flood level of 13,700 ML/d. For example, a scenario that considers up to 14,000 ML/d in the Mid Goulburn would not allow the combined controlled Eildon release and tributary inflow upstream of Molesworth to exceed 14,000 ML/d, nor would it allow the controlled Eildon release alone to exceed 13,700 ML/d. Note that the model has additional restrictions that do not allow the minor flood to be exceeded at Trawool and Seymour, regardless of the Mid Goulburn constraint. Still, these restrictions are unlikely to be triggered as they would require very large inflows in the reaches between Molesworth and Seymour combined with very low inflows in the larger Acheron and Rubicon tributaries.

The range-finding modelling output shown in Figure 99 summarises the range of outcomes expected for key hydrological indicators in the Goulburn River system under current climate conditions if constraints are relaxed in the Mid Goulburn and/or Lower Goulburn. These modelled outcomes are for the scenario where all environmental water holdings in the Goulburn system are used to meet environmental water demands in the Lower Goulburn as per the environmental flow recommendations[117]. The variation in the mean annual environmental water shortfall is shown in the left panels and the volume of constrained environmental water delivery is shown in the right panels.

[117] University of Melbourne (2020) Kaiela (Lower Goulburn River) Environmental Flows Study (Refer to Appendix A)

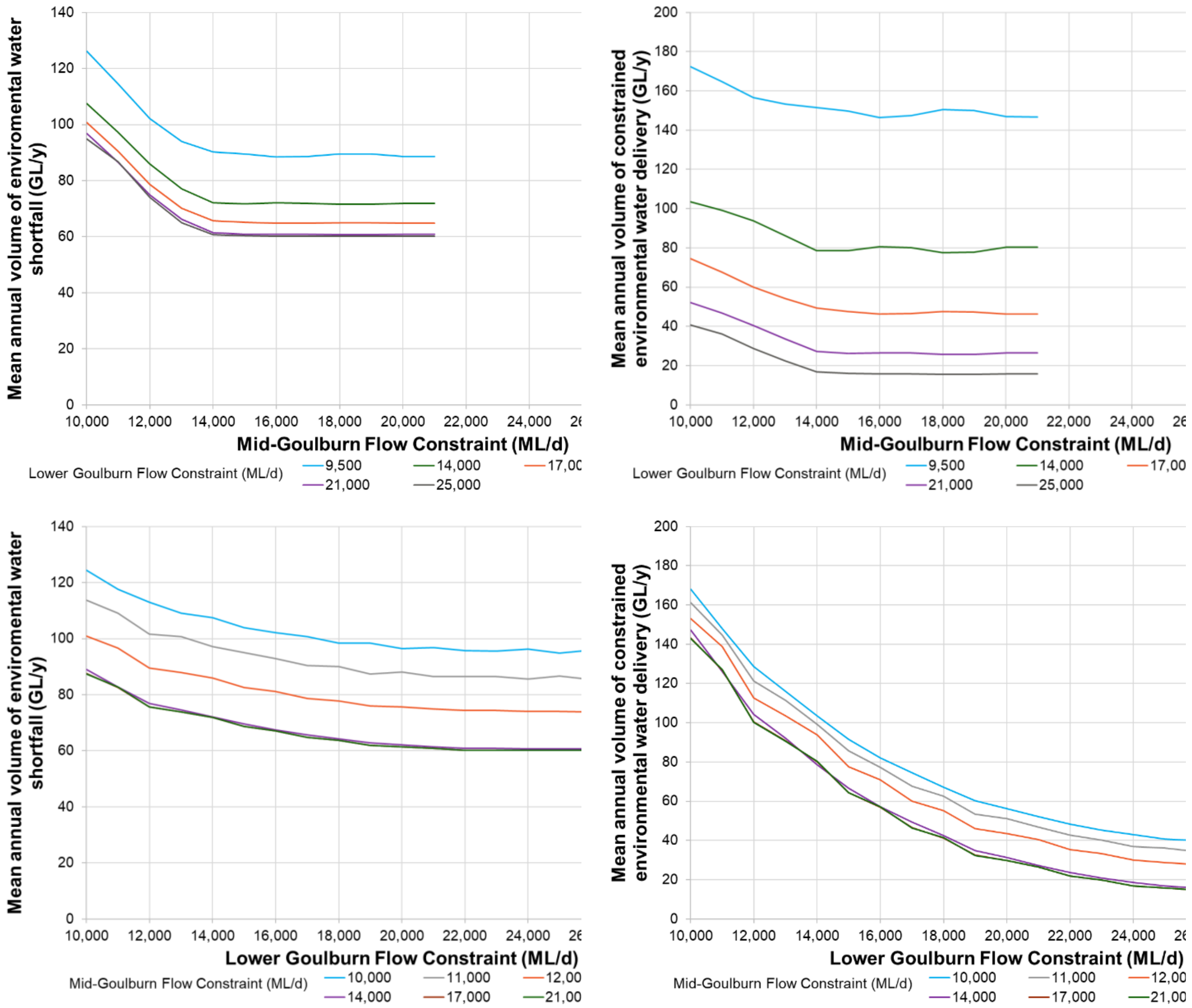

Figure 99 – Range finding modelling output (UoM, 2022)

The range finding modelling in shows that:

- The reliability of allocations to water shareholders is expected to be virtually unchanged by constraint relaxation.
- Shortfalls in meeting environmental water demands would decline as the Mid Goulburn constraint is relaxed from 10,000 to 14,000 ML/d and the Lower Goulburn constraint is relaxed from 9,500 ML/d to about 21,000 ML/d. However, environmental water shortfall reductions would plateau for constraint relaxation beyond about 14,000 ML/d in the Mid Goulburn and 21,000 ML/d in the Lower Goulburn.
- The degree to which the use of environmental water holdings is constrained reduces as constraints are relaxed in a similar manner observed for environmental water shortfalls. That is, the degree to which environmental water deliveries are constrained reduces as the Mid Goulburn constraint is relaxed from 10,000 ML/d to 14,000 ML/d and the Lower Goulburn constraint is relaxed from 9,500 ML/d to about 25,000 ML/d. The rate of reduction plateaus for constraint relaxation beyond 14,000 ML/d in the Mid Goulburn and about 25,000 ML/d in the Lower Goulburn.

These patterns suggest that if regulated releases from Lake Eildon are capped below minor flood level (13,700 ML/d at the time of writing), the change in environmental water shortfalls and delivery constraints will be minimal if Mid Goulburn constraints are relaxed beyond 14,000 ML/d. The results also suggest that if the Mid Goulburn constraint is 14,000 ML/d, the patterns of tributary inflows under current climate conditions are such that the change in environmental water shortfalls and delivery constraints will be minimal if Lower Goulburn constraints are relaxed beyond 21,000 – 25,000 ML/d.

John et al. (2022) found that these patterns were very similar regardless of whether all environmental water holdings in the Goulburn system were used to meet Lower Goulburn environmental water demands or a combination of environmental water demands in the Lower Goulburn and Murray River.

This “range-finding” exercise highlighted initial constraint relaxation options that were considered by the Consultative Committee (Table 72 below). These options were selected based on their modelled benefits in key hydrologic metrics: allocation reliability, environmental water shortfalls, and the volume of allocated environmental water shortfalls that cannot be delivered due to constraints (constrained delivery). These scenarios also covered a range of in-channel and out-of-channel flows per the Committee’s request.

Table 72 – Initial Goulburn flow scenarios for consideration

Constraint location	Current constraint	Range-finding scenario A	Range-finding scenario B	Range-finding scenario C
Eildon release	9,500 ML/d	9,500 ML/d	12,000 ML/d	13,700 ML/d (i.e., up to minor flood level)
Molesworth (Mid Goulburn)	10,000 ML/d	10,000 ML/d	12,000 ML/d	14,000 ML/d
Murchison/ Shepparton (Lower Goulburn)	9,500 ML/d	17,000 ML/d	21,000 ML/d	25,000 ML/d

The Committee discussed the range of proposed modelling flow scenarios following the range-finding modelling. An additional scenario of 10,000 ML/d in the Mid Goulburn (at Molesworth) and 21,000 ML/day at in the Lower Goulburn (at Shepparton) was also proposed by a Committee member to be further explored in the modelling. This was to explore the benefits that may be achieved in watering the predominantly public land in the Lower Goulburn while considering the concerns raised regarding potential negative impacts on properties and businesses in the Molesworth area that are thought to be impacted at 9,500 ML/d – 10,000 ML/d. The resulting Goulburn scenarios modelled further are shown in Table 73.

Table 73 – Goulburn flow modelling scenarios as considered by the Committee

Constraint location	Current constraint (M10/L9.5)	Relaxed constraint scenario 1 (M10/L17)	Relaxed constraint scenario 2 (M10/L21)	Relaxed constraint scenario 3 (M12/L21)	Relaxed constraint scenario 4 (M14/L25)
Eildon release	9,500 ML/d	9,500 ML/d	9,500 ML/d	12,000 ML/d	13,700 ML/d (i.e., up to minor flood level)
Molesworth (Mid Goulburn)	10,000 ML/d	10,000 ML/d	10,000 ML/d	12,000 ML/d	14,000 ML/d
Murchison/ Shepparton (Lower Goulburn)	9,500 ML/d	17,000 ML/d	21,000 ML/d	21,000 ML/d	25,000 ML/d

An additional scenario using the SGEFM assessed an alternate Murry River demand to test whether the outcomes from the range-finding exercise are robust when considering possible changes to the management of the Commonwealth Environmental Water Office’s entitlement.

In general, there were minimal differences between outcomes. The Murray scenario has slightly higher benefits in reducing constrained delivery volumes, noting that the Murray scenario has a higher baseline environmental water shortfall due to higher environmental flow demands. The Murray scenario also has slightly higher (~1%) baseline-constrained delivery volumes.

As such, the outcomes do not change the original recommendations from the range-finding exercise. These Goulburn flow scenarios (Table 73) were considered by the Committee and used in all subsequent hydrological, hydraulic and environmental modelling.

14.4.2 Hydrological outcomes

Based on the flow scenarios considered by the Consultative Committee (Table 73), the GBCCL Source model was run for all scenarios by DEECA. The DEECA GBCCL Source model and outcomes is further explained in Appendix A.

Environmental water deliveries

A key requirement from the Consultative Committee is that the use of already available environmental water is maximised. As such, the DEECA GBCCL Source model was used to track the modelled delivery of the environmental water portfolio in the Goulburn system.

> *"We want to see the Victorian benefit with the water that has already been recovered as well as preserving cultural benefits."*

Figure 100 shows that relaxation of constraints allows much greater delivery of environmental water compared with current conditions. It also shows the difference in environmental delivery with and without environmental orders from the Murray. As Lower Goulburn constraints are relaxed, more of the Goulburn environmental portfolio is able to be delivered to meet environmental requirements in the Goulburn, and Murray orders decrease (i.e., the difference between the dotted line and solid line decreases).

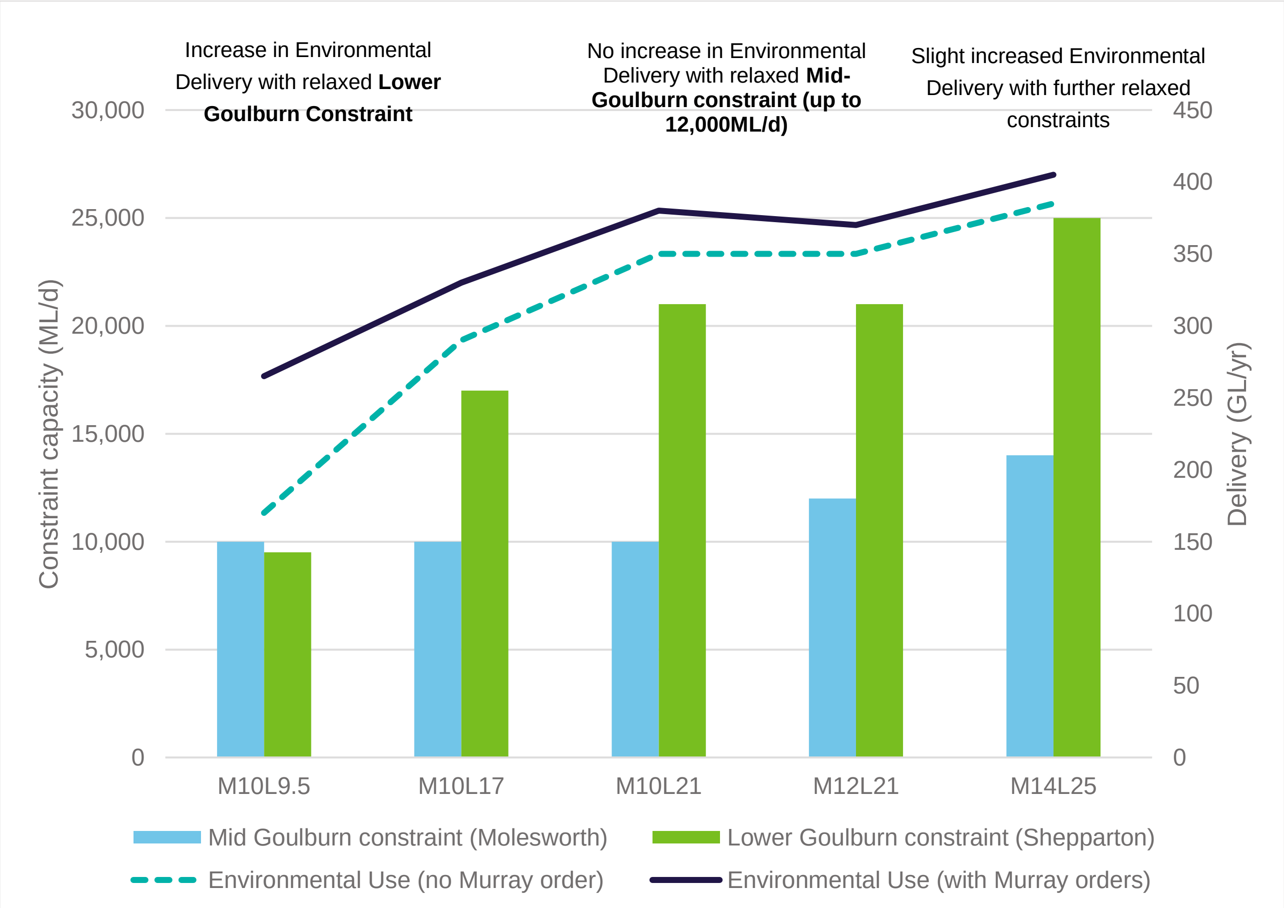

Figure 100 – Delivery of Goulburn environmental water portfolio under current and relaxed constraint scenarios

Although modelled delivery is used to make comparisons between scenarios, actual delivery figures will vary year to year based on climate and water availability, environmental demand assumptions and real-world flexibility (rather than fixed model rules). The sensitivity of this variable to climate can be seen by comparing utilisation over the long-term historic period (1895-2020) with the drier period experienced over the last 20 years (2000-2020). Under current constraints and the modelled environmental demand, utilisation is 58% over the long-term period, compared to 78% over the drier period.

Under current constraints and the long-term historical climate sequence, environmental utilisation is limited by channel constraints, timing of water availability and how the environmental demand is ordered. As constraints are relaxed, a higher proportion of the environmental water is able to be used to directly target the environmental demands. Further refinements to the model (e.g. debiting of losses) may also increase the environmental water utilisation.

Flow timing

A critical impact on landowners relates to the flow frequency, duration, and timing, particularly on land management. Depending on the timing and duration of higher flows, impacts to productive land may be costly. As such, this is a vital aspect that will need to be clearly communicated to affected landowners in any potential future stages.

In line with the environmental flow recommendations, the DEECA GBCCL Source model suggests that by relaxing constraints, higher flows can be targeted in the Goulburn for the winter/early spring fresh in July to October, resulting in a significant increase in utilisation of the environmental water portfolio (Figure 101 below).

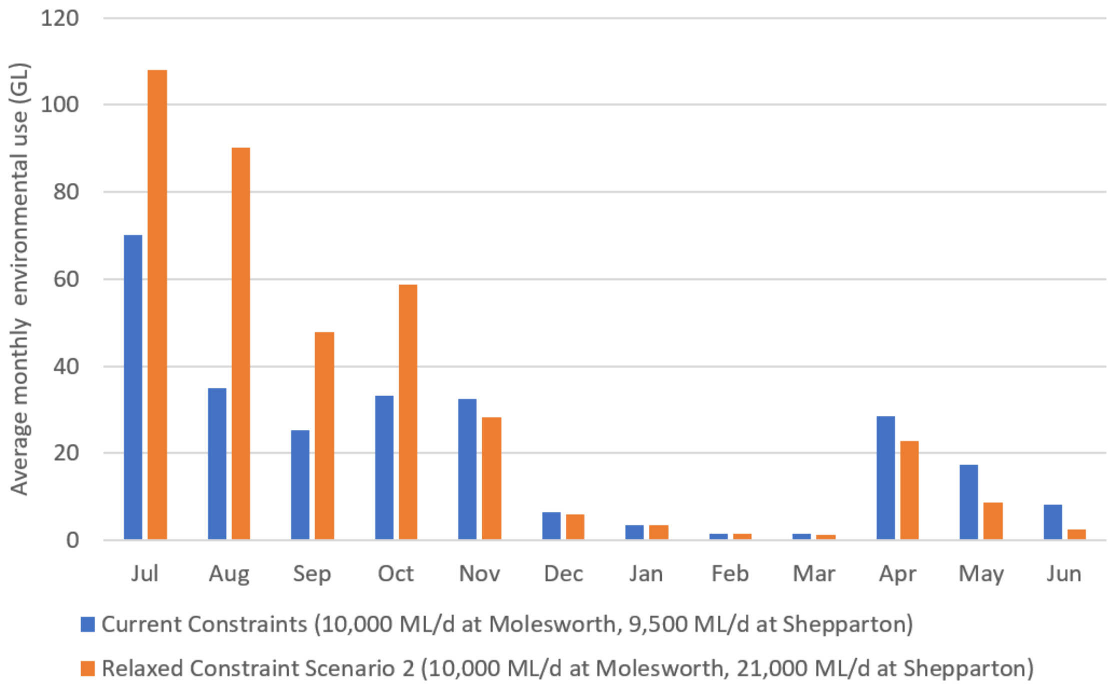

Figure 101 – Monthly distribution of within year use of environmental water for the current constraint (M10L9,5) and M10L21 (DEECA 2023- refer to Appendix A)

Further relaxing the constraint to compare the impact of relaxing the Molesworth constraint from the current 10,000ML/d to 12,000ML/d while holding the constraint at Shepparton to 21,000 ML/d, shows the change in the monthly pattern of use between the two scenarios (Figure 102 below). This is important to identify the impact the Mid Goulburn constraint has on the achievement of the desired environmental flows in the Lower Goulburn. Although average annual use is similar for both scenarios, the water used in Scenario 3 is meeting winter flow targets (July-October) more frequently with less failed attempts. Under Scenario 3, more water is used in July, with the relaxed Mid Goulburn constraint allowing a successful winter fresh to be delivered earlier in the season. This reduces the number of years when a fresh delivery is attempted in August and September, and hence reduces average use in those months. In dry years, when there is insufficient unregulated flow to trigger an event, the model will try to force a delivery at the end of October. More water can be delivered as part of these forced events when the constraint at Molesworth is lifted to 12,000ML/d, increasing average use in October.

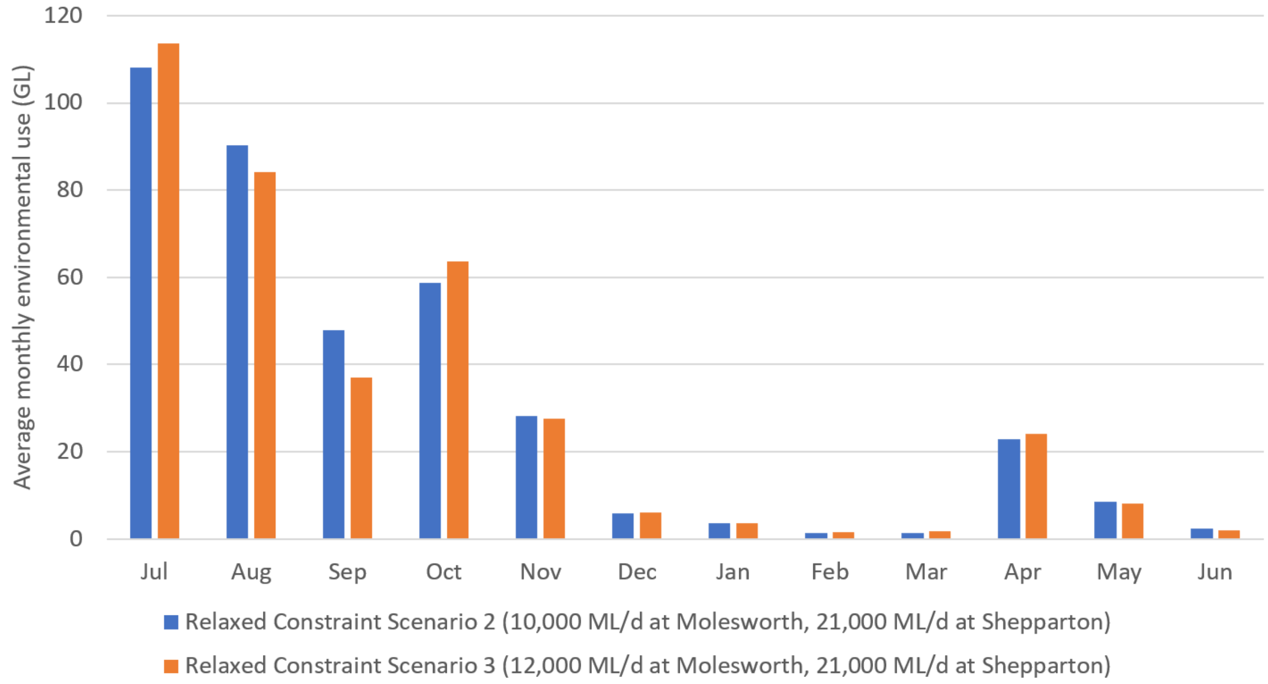

Figure 102 – Monthly distribution of within year use of environmental water for M10L21 and M12L21 (DEECA 2023- refer to Appendix A)

Table 74 below shows the winter fresh targets for relaxed constraint scenarios M10L21 and M12L21, and how often these are met successfully under each scenario as demonstrated in Figure 101 and Figure 102. Note that "success" in this context is as evaluated by the DEECA Source model and does not include unregulated events that meet the fresh targets outside of the periods expected by the model. This parameter is useful for illustrating the differences between scenarios, however for other purposes a more detailed assessment of success frequency may be required.

The ability to release up to 2,000 ML/d of additional flow from Eildon under M12L21 means that winter fresh targets are achieved more frequently under a range of water availability scenarios.

Table 74 – Winter fresh success rates for relaxed scenarios

	Scenario M10/L21			Scenario M12/L21		
Winter fresh target	**Years targeted**	**Years successful**	**% successful**	**Years targeted**	**Years successful**	**% successful**
15,000 ML/d for 5 days[1]	17	11	65%	9	14	74%
20,000 ML/d for 5 days[2]	27	11	41%	19	9	47%
21,000 ML/d for 5 days[3]	81	48	59%	87	57	66%
All targets	125	70	56%	125	80	64%

[1] *Winter fresh target under Dry and Drought water availability scenarios*

[2] *Winter fresh target under Below Average water availability scenarios*

[3] *Winter fresh target under Average and Wet water availability scenarios is 30,000 ML/d, but target is limited to Lower Goulburn constraint of 21,000 ML/d for Scenarios 2 and 3*

Flow frequency

A range of outputs from the DEECA GBCCL Source model have been prepared and presented at a range of locations along the Goulburn in Appendix A3.

The time series of the maximum flow within each month at Molesworth and Shepparton for relaxed constraints of 14,000 ML/d in the Mid Goulburn and 25,000 ML/d at Shepparton for the period post 1990 is shown in Figure 103 below. The orange shows the modelled flows under relaxed constraints compared to the current river operation in blue. Where the orange is higher than the blue, it means that flows are likely to be at higher levels than under current operations. Figure 103 also demonstrates periods where the orange is less than the blue, suggesting that at these times the flows will be less than observed under current operations.

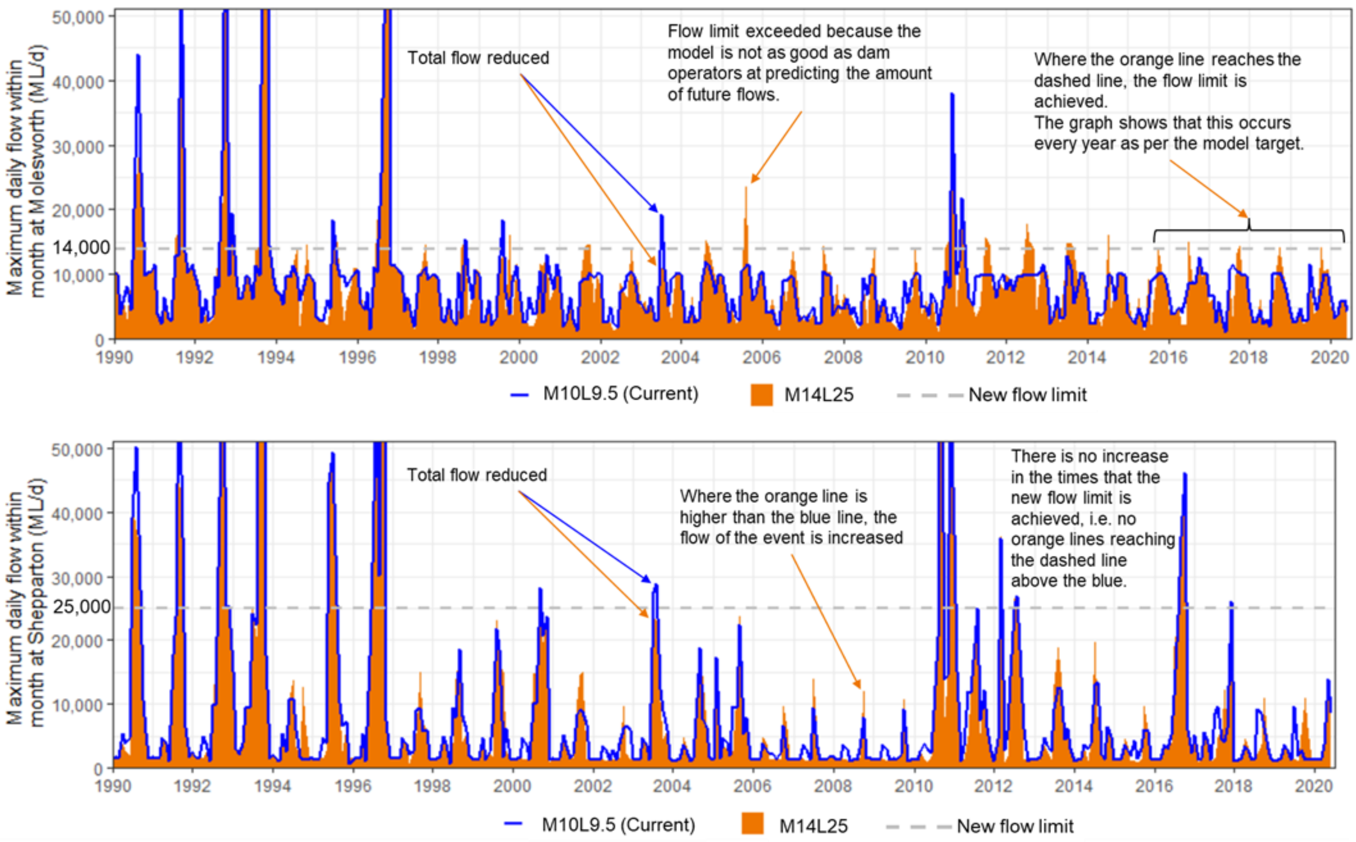

Figure 103 – Max. modelled daily flow at Molesworth (top) and Shepparton (bottom) within each month from 1990 to 2020 under current constraints and with constraints relaxed to M12L25

The top graph in Figure 103shows what the hydrology modelling predicts will happen to the peak flows at Molesworth. According to the model, in most years, the flow is expected to reach the relaxed mid-Goulburn constraint because we can control how much water is released from Eildon to achieve and stay within this limit. At Shepparton (the lower graph), the model suggests that there will be no additional times over the last modelled 30 years that achieve 25,000ML/d, although there will be a greater number of flows that achieve between 15,000ML/d and 20,000ML/d compared to current conditions. This suggests the mid-Goulburn constraint will be a limiting factor on the flow peaks that can be regularly achieved in the lower-Goulburn.

The DEECA modelling outputs in Figure 103 above and Figure 104 below suggests that the peak flow at Molesworth is expected to reach the Mid Goulburn constraint in most years due to the ability to control releases within the constraint at Eildon.

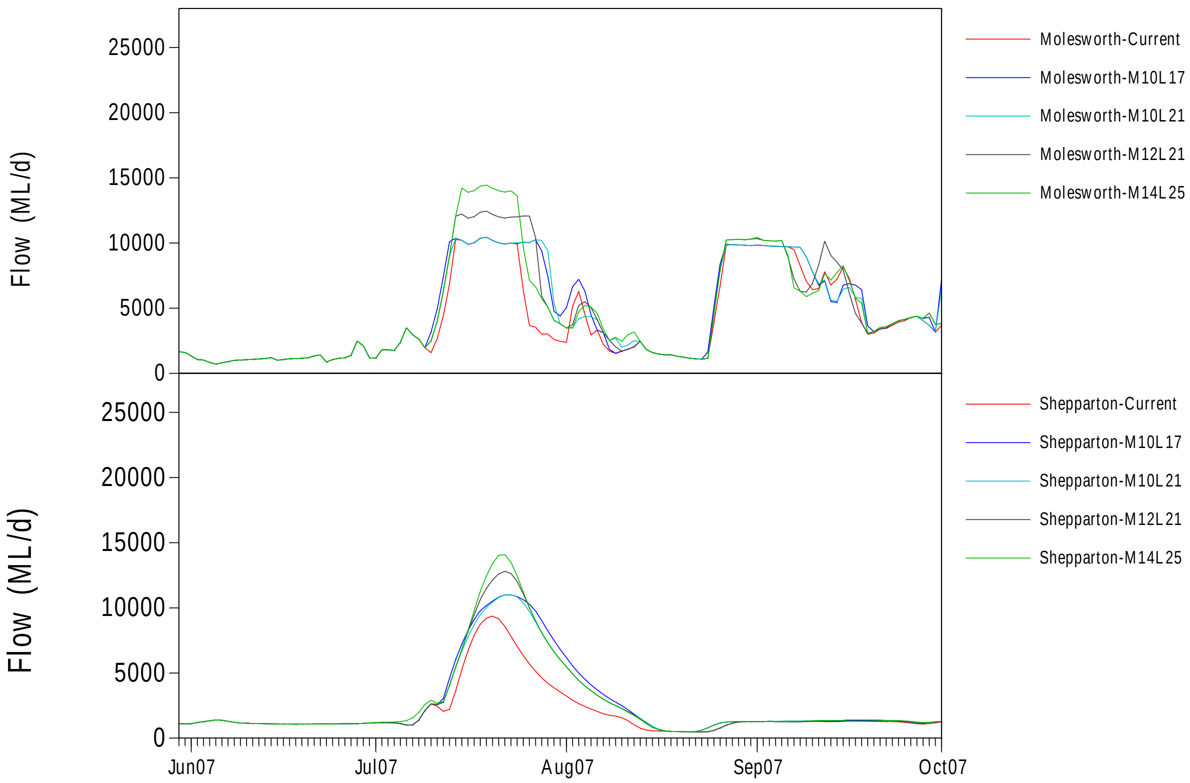

Figure 104 – Example outputs from the DEECA GBCCL Source model showing daily flow modelled for Molesworth (top) and Shepparton (bottom) under current constraints and four relaxed constraint scenarios

The current GBCCL Source model is limited in how it triggers environmental water releases from Eildon in that it does not consider forecasted rainfall and therefore what is flowing from unregulated tributaries. As such, the existing GBCCL Source model assumes a particular flow is required before environmental water releases are made, and that tributary inflows will be 90% of the previous day's inflow. This approach is therefore underestimating the ability of storage managers to adjust releases in response to weather forecasts and is not replicating what is seen in real-life operation. As such the model currently suggests periods where the modelled constraint limit at Molesworth is exceeded due to the assumed release from Eildon followed by tributary inflows (Figure 103).

The Committee discussed that multiple factors come into play when operating the rivers, and any releases from Eildon are made with consideration of what is also entering the Goulburn through the tributaries and what other consumptive demands are in place at the time.

It is acknowledged that this is a limitation of the model foresight not fully simulating releases in line with the approaches undertaken by river operators who currently successfully operate the river in line with the established Molesworth constraint.

The corresponding DEECA modelled hydrograph at Shepparton for relaxed constraints of 14,000 ML/d in the Mid Goulburn and 25,000 ML/d at Shepparton shown in Figure 103, suggests that for conditions of the last 30 years the peak flow at Shepparton will approach the Lower Goulburn constraint if water released from Lake Eildon to the Mid Goulburn coincides with unregulated tributary inflows between Eildon and Shepparton. Flows modelled by DEECA during this time period do not reach the constraint of 25,000 ML/d without having unregulated flows as the predominant basis.

This is also demonstrated using a spell plot that demonstrates on a monthly basis for the modelled record when flows exceeded a certain level. In both Figure 105 and Figure 106 below, the red shows the times of year and duration for when the river is at or above the given flow rate under the current constraints. The green represents the times of year and duration the flow is at or greater than the flow level of interest under the relaxed constraint scenario.

Figure 105 demonstrates that under the greatest constraint relaxation scenario that a larger number of higher flow events than under the current constraint will be experienced at Molesworth. This aligns with the information presented in Figure 103 that shows the flows reaching or exceeding the Molesworth constraint each year.

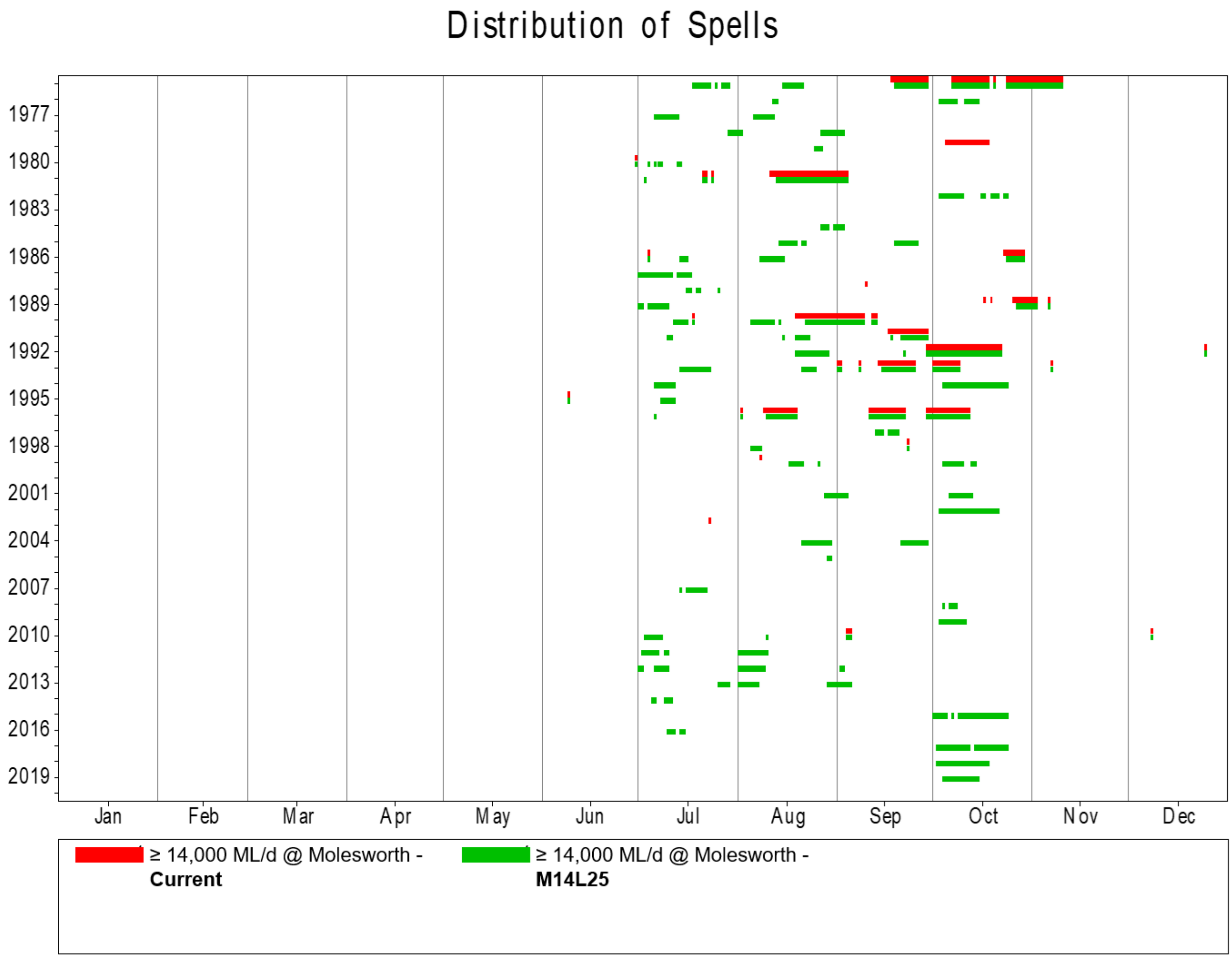

Figure 105 – 1975 – 2020 spells of flow at or above 14,000 ML/d at Molesworth under current constraints and with constraints relaxed to M14L25

Figure 106 shows that although there is greater use of environmental water under the highest relaxed constraint scenario of, the red and green representations show there is minimal difference for the number of and extent of periods that flows are at or greater than 25,000 ML/d at Shepparton.

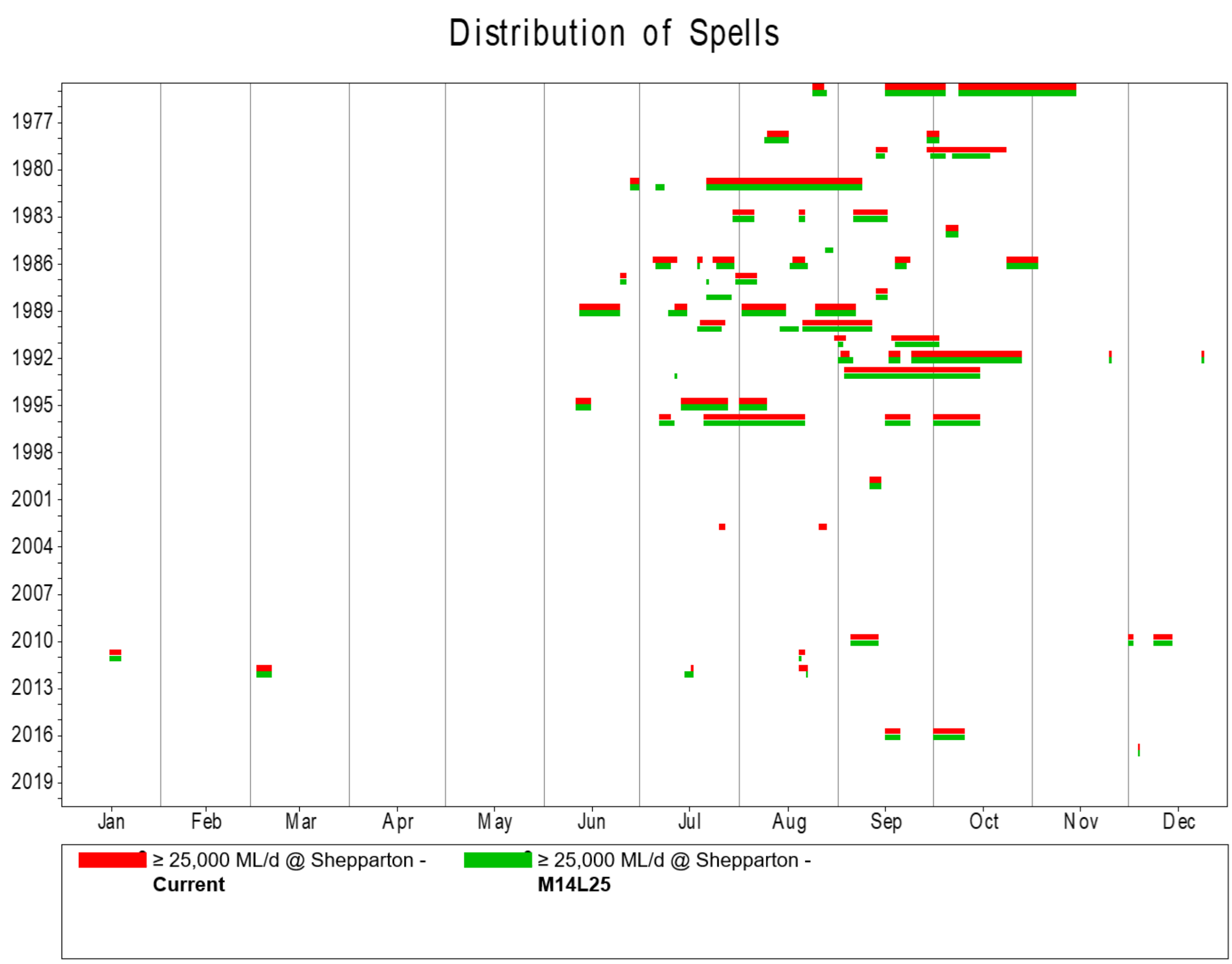

Figure 106 – 1975 – 2020 spells of flow at or above 25,000 ML/d at Shepparton under current constraints and with constraints relaxed to M14L25

Flow duration

Some Committee members note that inundation of anything more than a week will cause significant damage and death to productive pastures resulting in high re-establishment costs. A Committee member noted that they would rather have one more significant inundation event than multiple more smaller events, as multiple events would more significantly impact the business. It is vital that in any future communications with potentially affected landowners, there is clear information available regarding not only the inundation extents but also the timing, duration and frequency proposed under relaxed constraints so that landowners can assess the impact on their operations.

> *"Under environmental flows of 7-21 days, all our flooded productive pasture will be dead when the water goes down and it would take 18 months to come back to full production."*

In Figure 107, the proportion of years with at least 5 days of winter/spring flow above a range of thresholds at Molesworth is shown for the current constraint level and the four constraint relaxation scenarios simulated in the DEECA GBCCL Source model. This demonstrates that relaxing constraints increases the proportion of years with 5+ days of winter/spring flow at Molesworth for thresholds below or at the relaxed constraint. The frequency of flows at thresholds above the relaxed constraint reduces slightly.

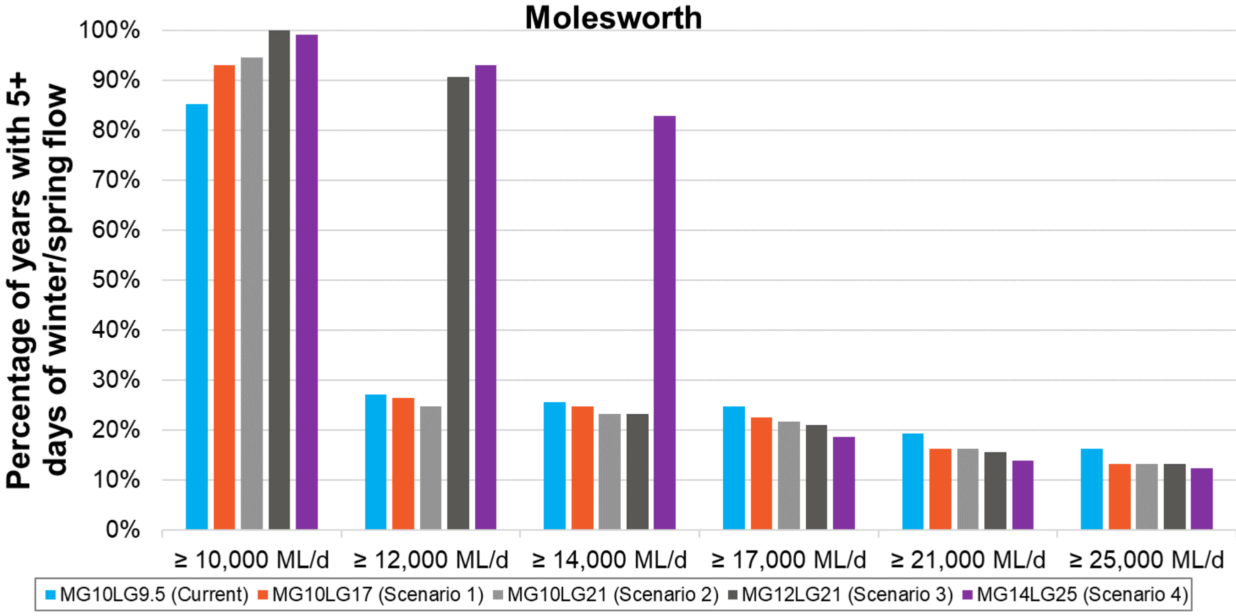

Figure 107 – Proportion of years (1891-2020), with 5+ days of winter/spring flow exceeding defined flow rates at Molesworth, for relaxed constraint scenarios

At Shepparton the consequence of relaxing constraints up to 14,000 ML/d in the Mid Goulburn is noticeable for flow thresholds up to 17,000 ML/d. The proportion of years with 5+ days of winter/spring flow at 21,000 ML/d is essentially unchanged and reduces slightly at 25,000 ML/d. This means that the GBCCL predicts that changes to the Lower Goulburn hydrology begin plateauing once the Lower Goulburn constraint is relaxed beyond ~17,000 ML/d, whereas the SGEFM predicted this plateauing to occur if the constraint is relaxed beyond ~21,000 ML/d.

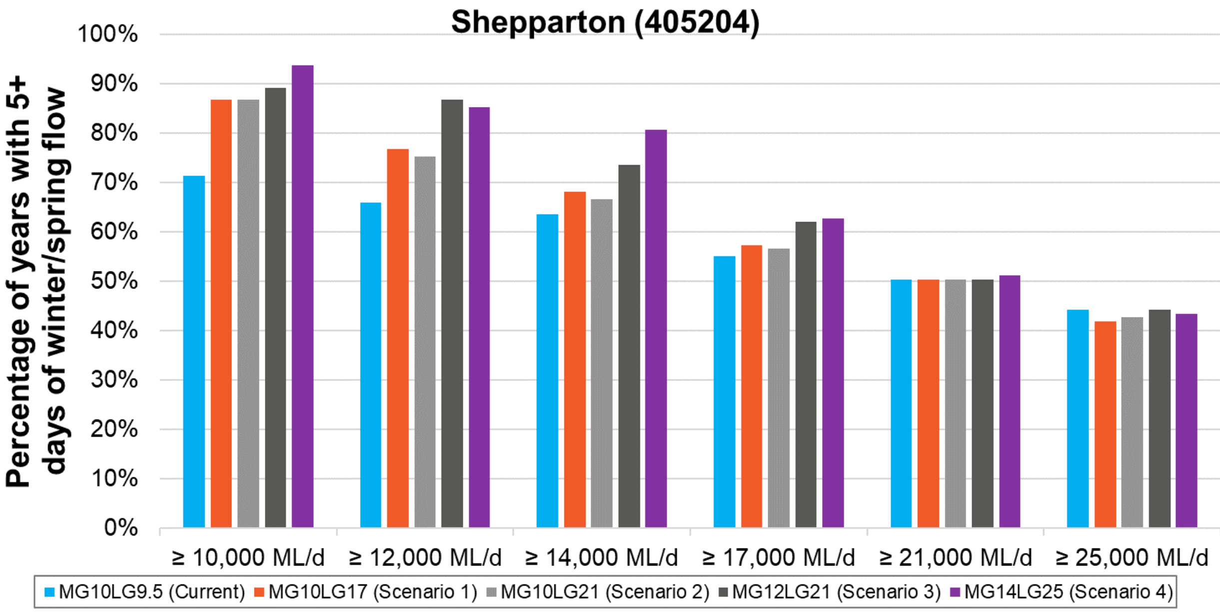

Figure 108 – Proportion of years (1891-2020), with 5+ days of winter/spring flow exceeding defined flow rates at Shepparton, for relaxed constraint scenarios

As with the Mid Goulburn constraint flows being exceeded in the DEECA modelling, the frequency with which winter/spring flows are expected to reach constraint thresholds in the Lower Goulburn is also influenced in part by how triggers for environmental water releases and inflow forecasts are represented in the GBCCL Source model. There is potential therefore that different hydrological outcomes in the Lower Goulburn could be simulated in the DEECA GBCCL Source model if a wider range of triggers for environmental water releases and a more realistic representation of inflow forecasts were modelled in future stages of the Victorian CMP. Improving the representation of inflow forecasts in the GBCCL Source model would also potentially reduce the frequency with which modelled peak flows exceed the simulated Mid Goulburn constraint (e.g., as shown in Figure 103). An investigation of the buffers required to avoid flows exceeding relaxed operational constraints is recommended for future stages of the Victorian CMP if it is to proceed.

14.5 Murray River hydrologic outcomes

Hydrological modelling was completed for the Murray River by MDBA using the MDBA's SMM. This was used to analyse the hydrological outcomes for the Murray River if constraints are relaxed at Doctors Point, Yarrawonga Weir and in the Mid Goulburn and Lower Goulburn.

Appendix A and the associated attachments provide more detailed information on the modelling approach and results. This work builds on the scenario modelling also completed for the NSW Reconnecting River Country Project using the SMM.

The SMM was run to test the outcomes for the ten scenarios in Table 75 below. The first scenario represents the current constraints.

The next five scenarios simulate the expected change in Murray River hydrology if constraints are relaxed at Doctors Point and/or downstream of Yarrawonga Weir, assuming the Mid Goulburn constraint is 10,000 ML/d and the Lower Goulburn constraint is 17,000 ML/d. The range of constraint relaxation tested was based on the hydrology modelling investigations first begun by the NSW Reconnecting River Country. Appendix A shows how the constraint relaxation thresholds relate to gauged water levels at Albury (near Doctors Point) and downstream of Yarrawonga Weir.

The last four scenarios simulate the expected change in Murray River hydrology if the Doctors Point and Yarrawonga Weir constraint is 40,000 ML/d, and the mid-and Lower Goulburn constraints vary as per the four relaxation scenarios listed in Table 75.

Table 75 – Murray flow modelling scenarios

Scenario Label	Scenario category	Flow constraint (ML/d) at location			
		Doctors Point	Yarrawonga Weir	Mid Goulburn	Lower-Goulburn
Y15D25	Current	15,000	25,000	10,000	9,500
Y25D25	G17 set (Goulburn inputs fixed at M10L17 with variable Murray)	25,000	25,000	10,000	17,000
Y30D30		30,000	30,000	10,000	17,000
Y35D35		35,000	35,000	10,000	17,000
Y40D40		40,000	40,000	10,000	17,000
Y45D40		40,000	45,000	10,000	17,000
M10L17 – Y40D40	Y40D40 set (Murray set at Y40D40 with variable Goulburn)	40,000	40,000	10,000	17,000
M10L21 – Y40D40		40,000	40,000	10,000	21,000
M12L21 – Y40D40		40,000	40,000	12,000	21,000
M14L25 – Y40D40		40,000	40,000	14,000	25,000

Environmental water use

As observed in the Goulburn system, the relaxation of constraints along the Murray results in increased use of the environmental water portfolio. This result is in line with the requirement from the Consultative Committee that the use of already available environmental water should be maximised.

The grey-shaded part of Figure 109 below demonstrates the average environmental water volume allocated over the year from the start of the year (SOY) to the end of the year (EOY). The bars compare the SOY account balance and annual use by the environment. With increasing constraints relaxation in the Murray, environmental water use increases as the environment gets more opportunities to target higher flow events. Consequently, the environmental water balance and allocation are reduced due to higher utilisation of the environmental portfolio.

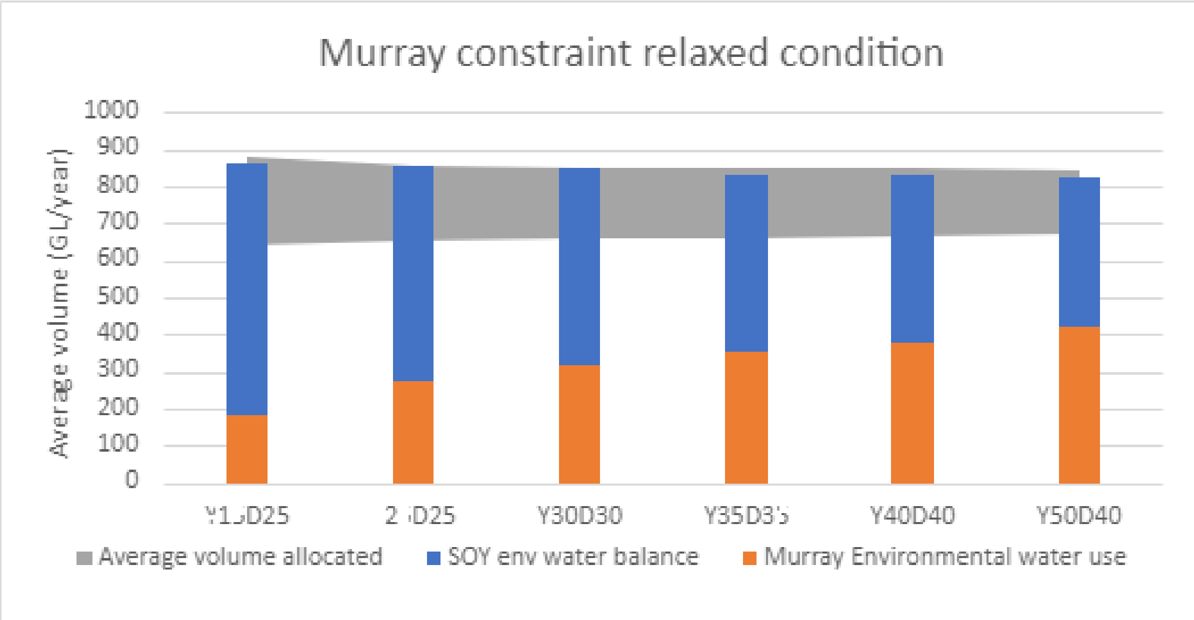

Figure 109 – Use of environmental water portfolio on the Murray under current and relaxed constraint scenarios (Goulburn constraint modelled at M10L17)

As the Goulburn inflows to the Murray will impact the use of environmental water, a scenario was run to determine the sensitivity of environmental water use to relaxing the constraints in the Goulburn. Figure 110 shows that relaxing the Lower Goulburn Constraint above current limits results in greater use of environmental water, however further utilisation is not observed as the Mid Goulburn constraint is further relaxed above 17,000 ML/d.

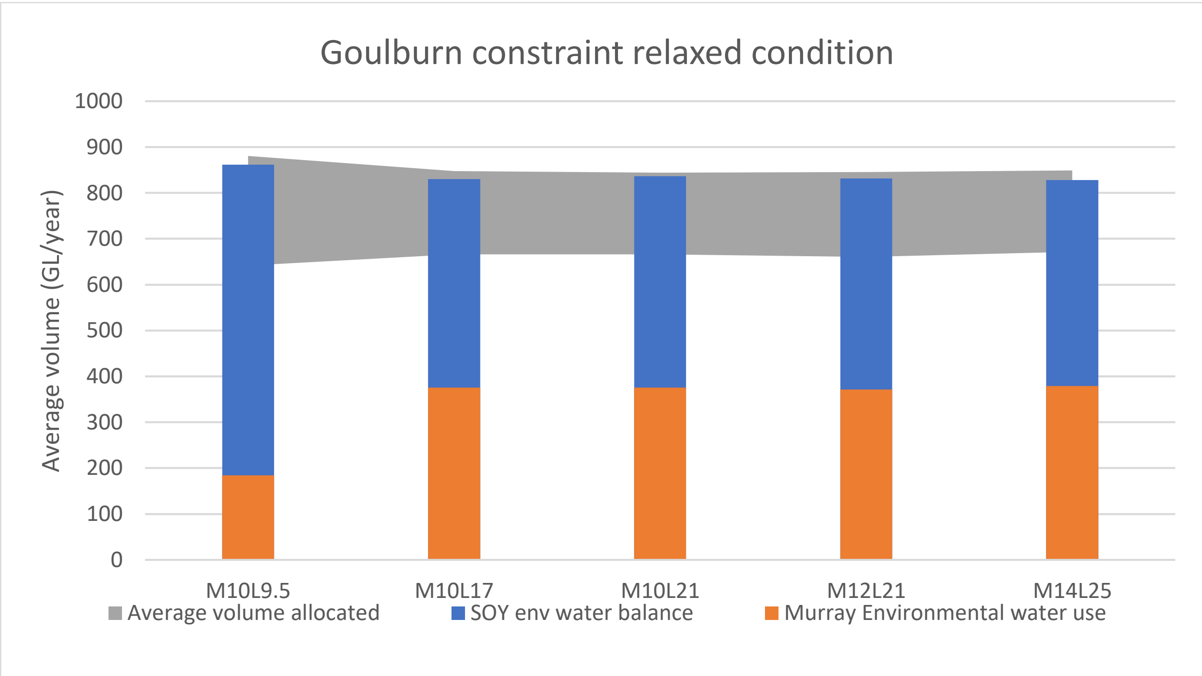

Figure 110 – Sensitivity of use of the environmental water portfolio on the Murray with changing Goulburn constraints scenarios (Murray constraint modelled at Y40D40)

Flow timing

As on the Goulburn, a critical impact on landowners on the Murray relates to the flow frequency, duration, and timing, of higher flows particularly on land management. Depending on the timing and duration of higher flows, impacts to productive land may be costly. As such, this is a vital aspect that will need to be understood and clearly communicated to affected landowners in any potential future stages.

The MDBA modelling suggests that in line with environmental flow recommendations, the relaxation of constraints enables higher flows to be targeted between April and November compared to the current constraints (Figure 111) which contributes to the increased utilisation of the environmental water portfolio as shown in Figure 109 above.

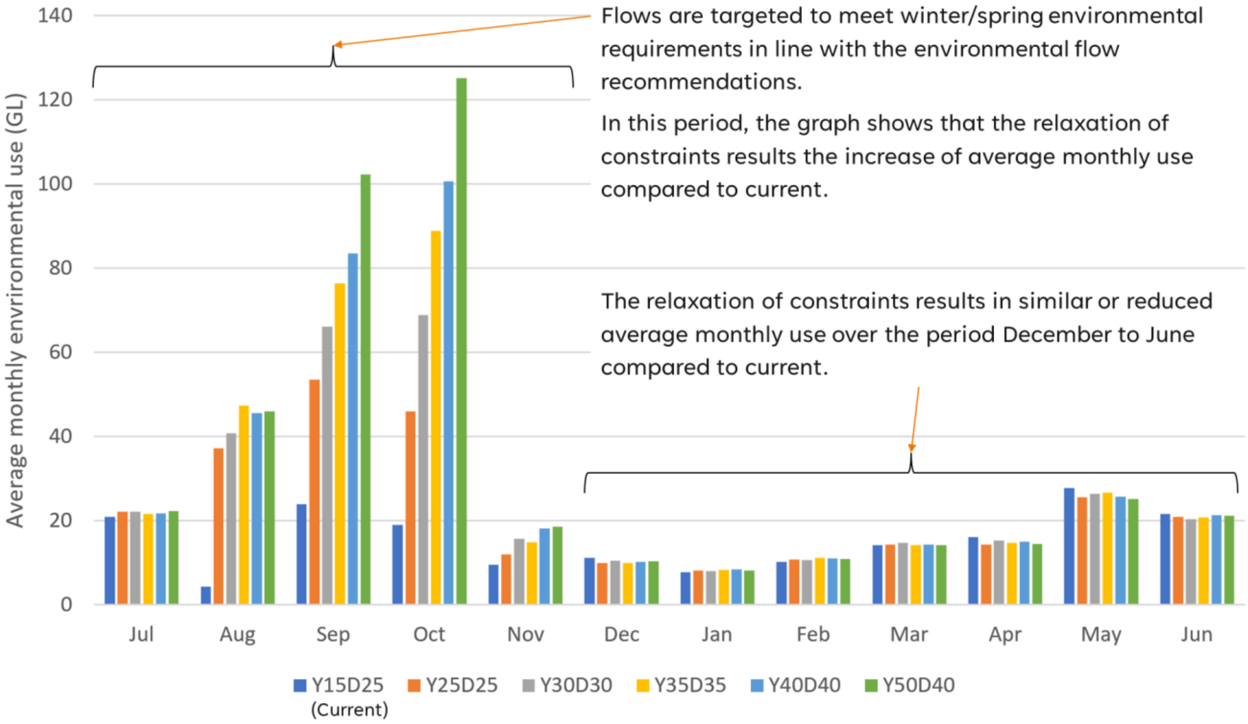

Figure 111 – Monthly average distribution of within year use of environmental water for the current constraint (blue) and modelled constraint scenarios on the Murray (Goulburn held at M10L17)

The relaxation of constraints results in similar or reduced average monthly use over the period December to June compared to the current constraint condition as flows are targeted to meet winter/spring environmental requirements in line with the environmental flow recommendations.

These targeted flow periods coincide with the months of peak productive pasture growth, meaning that extended periods of inundation during this time may have significant impacts on the enterprises of affected landowners.

Flow frequency

A range of outputs from the MDBA SSM model have been prepared and presented at a range of locations along the Murray River in Appendix A.

The time series of the maximum flow within each month at Doctors Point and downstream of Yarrawonga Weir for relaxed constraints of 40,000 ML/d for both locations for the period post 1990 is shown in Figure 112 below.

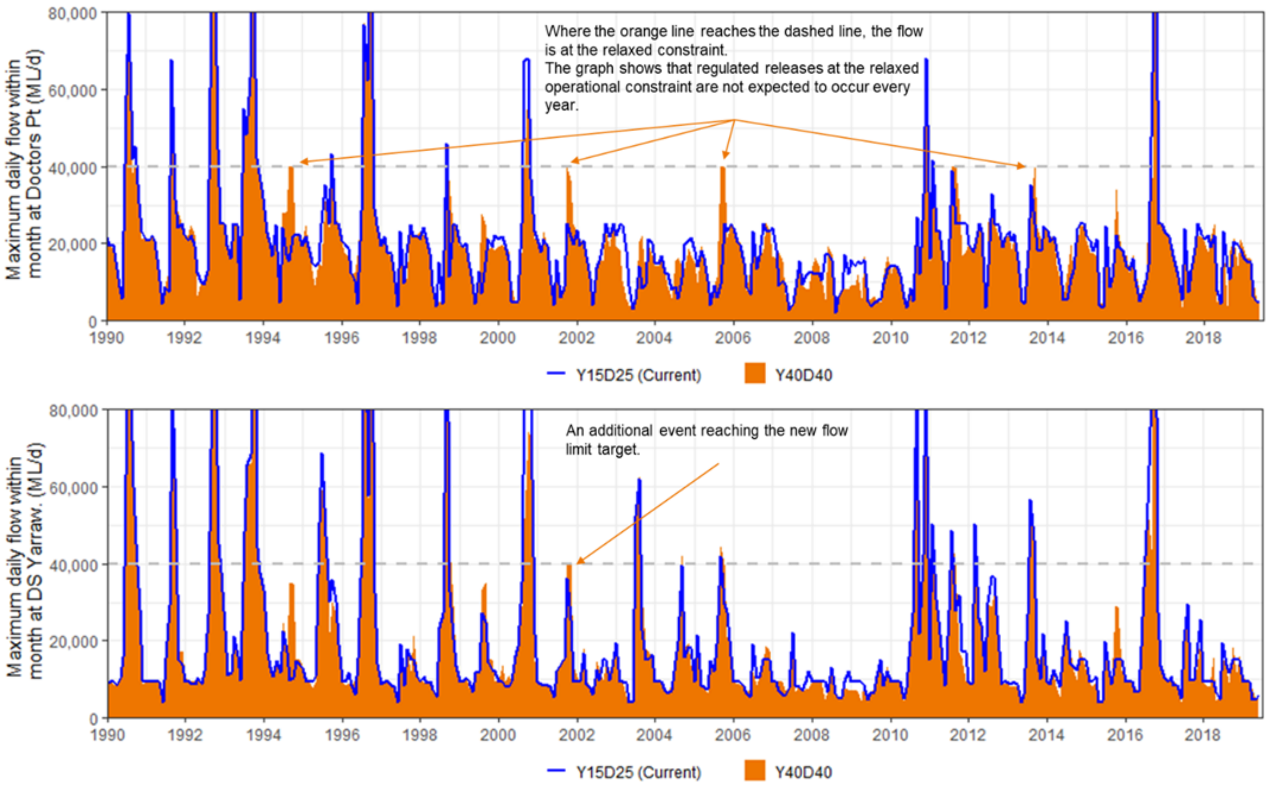

Figure 112 – Maximum modelled daily flow at Doctors Point (top) and downstream of Yarrawonga Weir (bottom) within each month from 1990 to 2019 under current constraints and with constraints relaxed to Y40D40

This shows that regulated releases at the relaxed operational constraint at Doctors Point or downstream of Yarrawonga Weir are not expected to occur yearly (Figure 112). Instead, they are more likely to occur in years that are not very dry or not very wet. Figure 112 suggests that under the Y40D40 scenario there will be an additional 4 instances over the past 30 years that would reach the 40,000ML/day flow limit at Doctor's Point, however as the peak of many unregulated or flood events are reduced under relaxed constraints (the orange is under the blue on the graph) the flows around 1999 are reduced below 40,000ML/d compared to under current conditions. This means that over the last 30 years there may have been an increase of 3 events reaching 40,000ML/d compared to under current constraints.

Figure 112 suggests that at Yarrawonga there would be only one additional event over the past 30 years (around 2002) where the orange exceeds the blue line to reach 40,000ML/day. Additional benefits are seen by increasing flows to 30,000ML/d to 35,000ML/d in another three events over the 30 years. As with other locations on the river the modelling suggests that relaxing constraints may assist to reduce the flood peak seen under current conditions (the orange is under the blue).

Comparison of modelled flow events against the current constraint at various points along the river are shown in subsequent figures demonstrating spells of flows. Figure 113 shows on a monthly basis for the modelled record when flows at Doctors Point reached or exceeded 35,000 ML/d. This shows that under relaxed constraints (green) there are more periods of flows greater than 35,000 ML/d compared to the current constraints (red). There are also instances where under the current constraint flows in excess of 35,000 ML/d are modelled, however there is no corresponding value in green, indicating that under relaxed constraints, the flows would be less than 35,000 ML/d during these times.

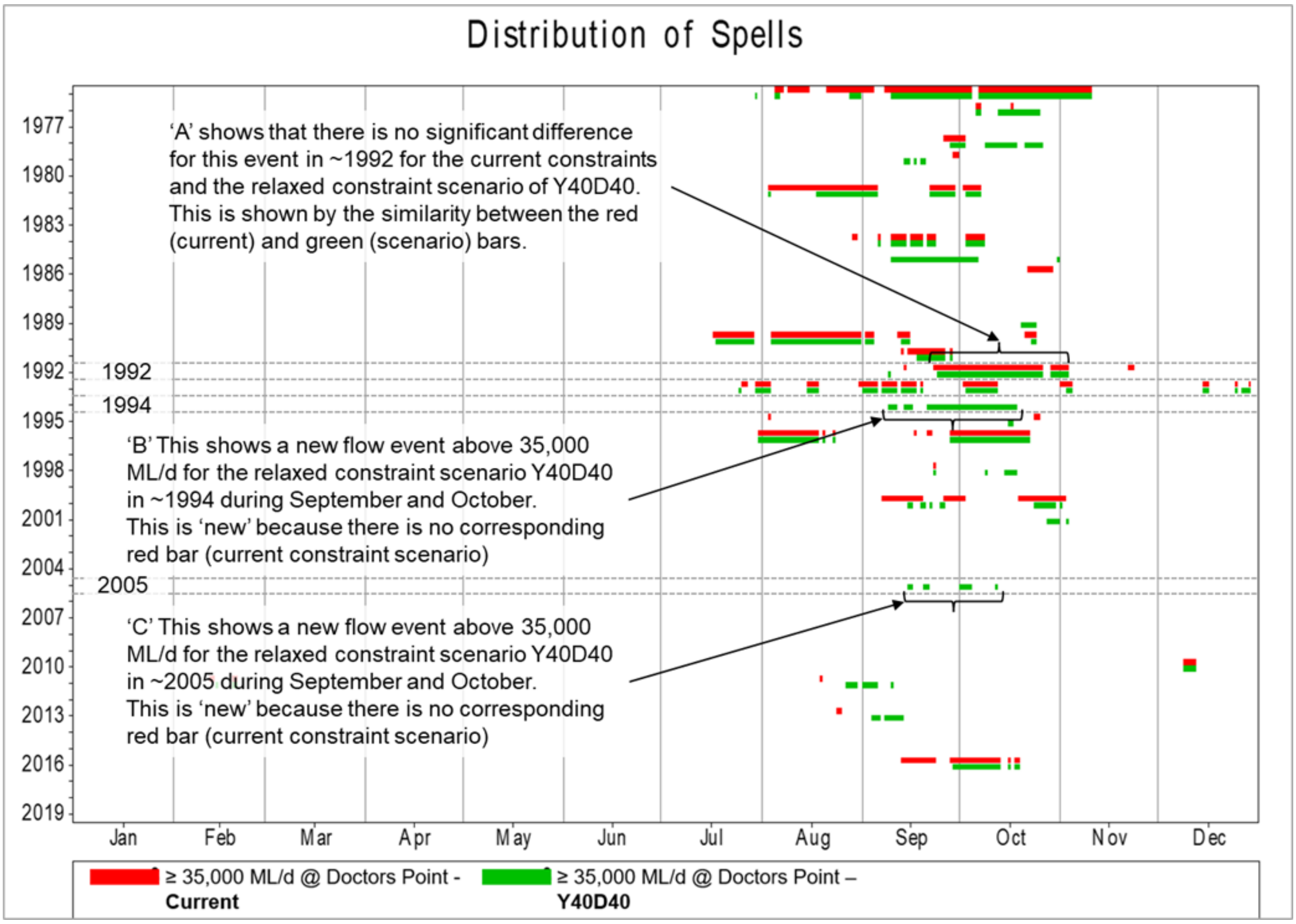

Figure 113 – 1975 – 2019 spells of flow at or above 35.000 ML/d at Doctors Point under current constraints (red) and with constraints relaxed to Y40D40 (green)

Although Figure 113 above shows that under relaxed constraints there will be additional time periods compared to current constraints where flows exceed 35,000 ML/d at Doctors Point, the length of time that flows exceed 35,000 ML/d downstream of Yarrawonga is generally extended as constraints is relaxed (Figure 114) with this increase in duration most likely to be observed in August, September and October. This is demonstrated by the green lines generally being wider than the red in the figure below.

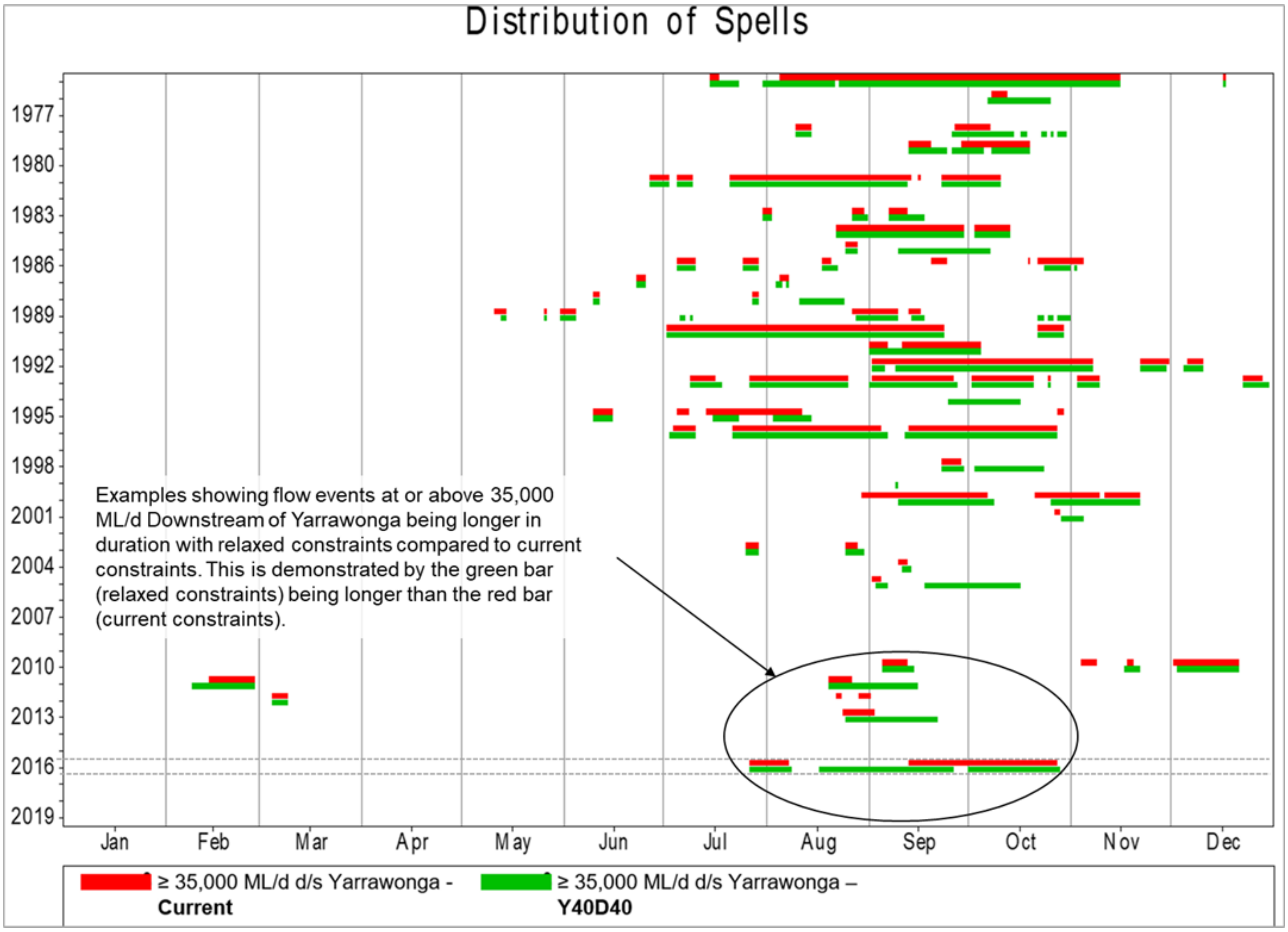

Figure 114 – 1975 – 2019 spells of flow at or above 35.000 ML/d at downstream of Yarrawonga under current constraints (red) and with constraints relaxed to Y40D40 (green)

The modelling shows that in parts of the upper Murray and Yarrawonga, there are significantly increased flows and environmental water use as constraints are relaxed to higher levels. However, downstream of Barmah Choke, the change in the number of days of winter/spring flow above 25,000 ML/d and 35,000 ML/d depends on the combination of location and constraint relaxation.

The MDBA modelling suggests that at the lower Murray section (i.e., Wakool Junction, Euston and Flow to South Australia), some increased low flow regimes are observed while medium flow durations are extended as channel capacities are relaxed to higher levels. These are represented in the MDBA Technical Report No 2022/15 Appendix A4.

As you move further down the Murray system. The modelling suggests that the relaxation of constraints will have minimal impact to the periods of high flow. Figure 115 shows the MDBA modelled impact of relaxing constraints on low flows (75% exceedance) at the South Australian border. Where the blue line (current constraint) is above the scenario coloured lines it indicates that the average monthly flows under the current constraint scenario will be greater than those with relaxed constraints. Conversely, if the blue line is below the coloured scenario lines, the MDBA modelling suggests that relaxing constraints will result in average monthly flows less than under the current constraint. This demonstrates that relaxing constraints will generally result in greater monthly average low flows at the South Australian border between August and December.

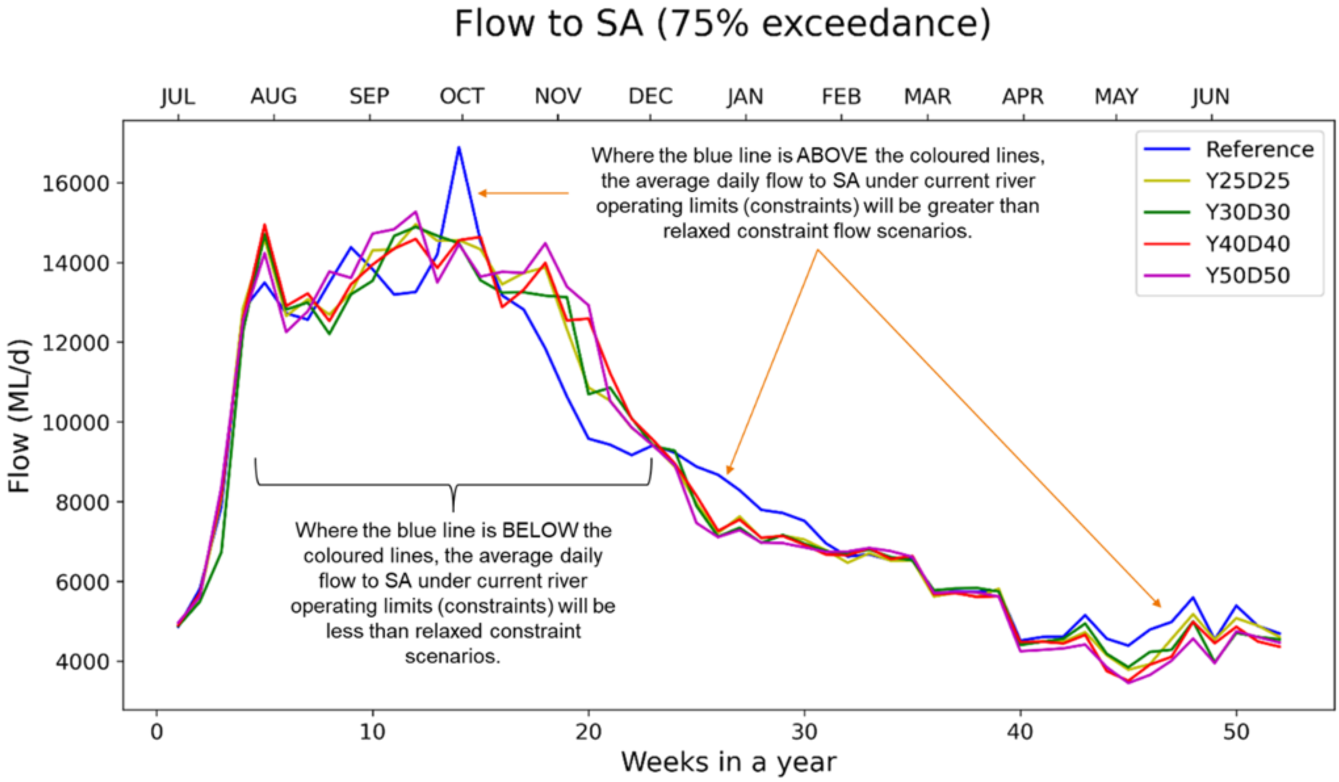

Figure 115 – 'Low flow' regime of flows at the South Australian Border at various constraints levels

The MDBA modelling suggests the impact of relaxing constraints at the South Australian border for the higher flow levels (greater than 60,000 ML/d) is minimal and may reduce peak flow events compared to current operations due to the higher use of the environmental water portfolio resulting in reduced spills. This is demonstrated in Figure 116 below.

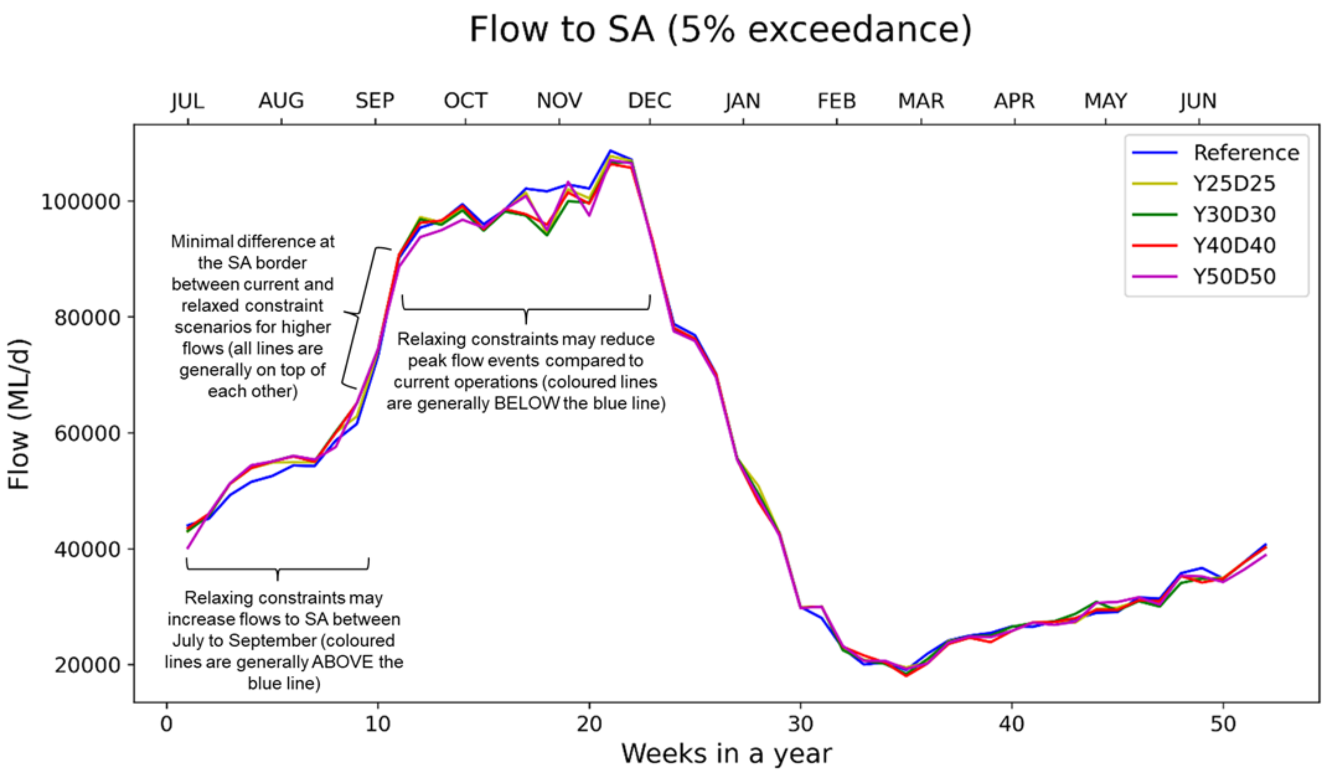

Figure 116 – 'High flow' regime of flows at the South Australian Border at various constraints levels

This reduction at the higher flow levels reflects the geographical nature of the mid-Murray section and the Edward-Wakool section where water needs to travel through the flat and wide landscapes once water goes beyond in-channel pathways. Therefore, the peak of events is largely attenuated by the time it reaches to Wakool Junction. It also shows difficulties to influence the peak of events just by releasing environmental water from upper storages.

Flow duration

Landowners along the Murray, particularly in the Hume to Yarrawonga reach have expressed concern about the duration of inundation, particularly on productive pasture. Landowners engaged through this stage of the Victorian CMP have expressed concerns that events greater than 5 days will cause significant impact. As such, the analysis has focused on the proportion of years modelled that demonstrated at least 5 consecutive days of inundation at various flow rates of interest.

For the Murray River upstream of Barmah Choke, the relaxation of constraints at Doctors Point and Yarrawonga increases the number of winter/spring days when flows are greater than the current constraints but less than or equal to the relaxed constraint threshold (Figure 117 to Figure 119 below). For example, the days per year of winter/spring flow greater than 25,000 ML/d or 35,000 ML/d increases at Doctors Point, Yarrawonga Weir and Tocumwal if constraints are relaxed to 35,000 ML/d or 40,000 ML/d at both locations.

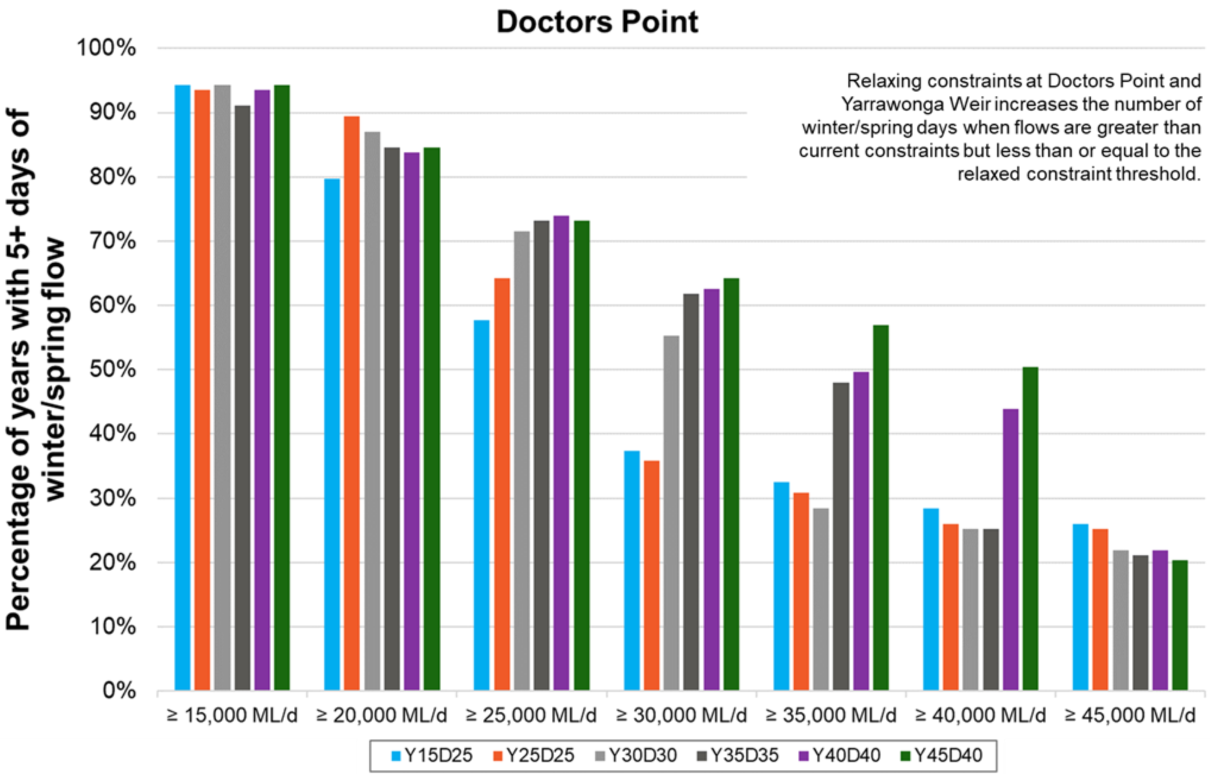

Figure 117 – Proportion of years (1895-2019), with 5+ days of winter/spring flow exceeding defined flow rates at Doctors Point for different Murray relaxed constraint scenarios

Community members have indicated that flows of 40,000ML/d for greater than 5 days in the Hume to Yarrawonga reach cause significant disruption to production. The modelling suggests that constraint relaxation to 35,000ML/d will reduce the occurrence of flows in excess of 40,000ML/d and duration compared to current conditions (Figure 118 below).

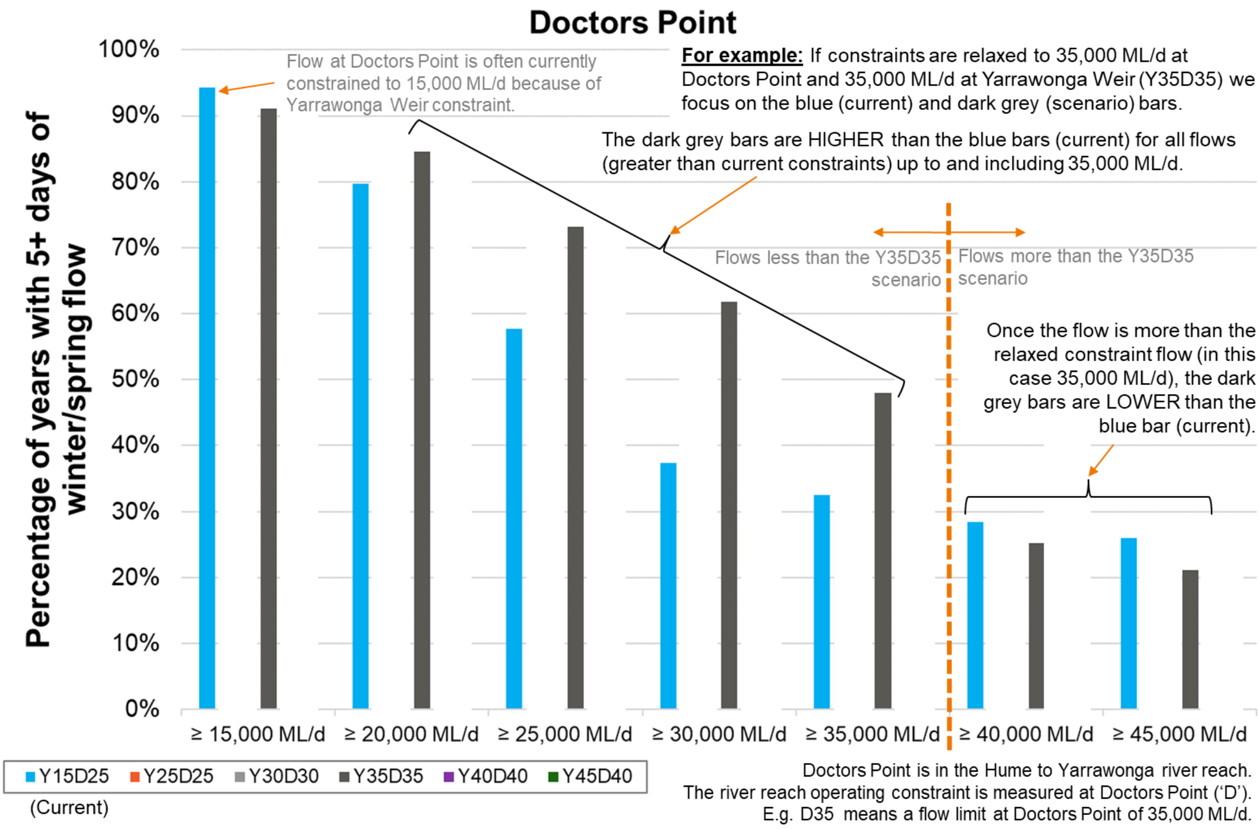

Figure 118 - Proportion of years (1895-2019), with 5+ days of winter/spring flow exceeding defined flow rates at Doctors Point for the current constraint and with constraints relaxed to Y23D35 (35,000ML/d at Doctors Point and 35,000ML/d at Yarrawonga)

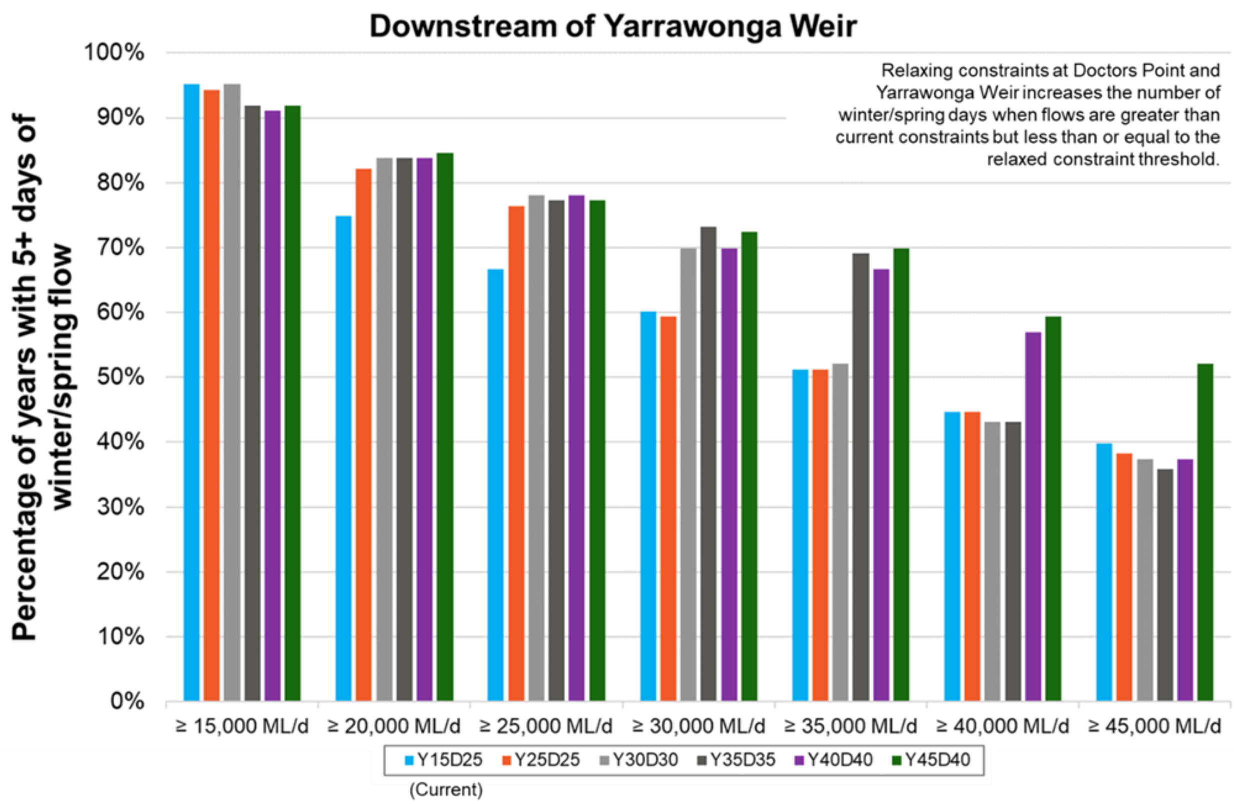

Figure 119 – Proportion of years (1895-2019), with 5+ days of winter/spring flow exceeding defined flow rates at downstream of Yarrawonga Weir for different Murray relaxed constraint scenarios

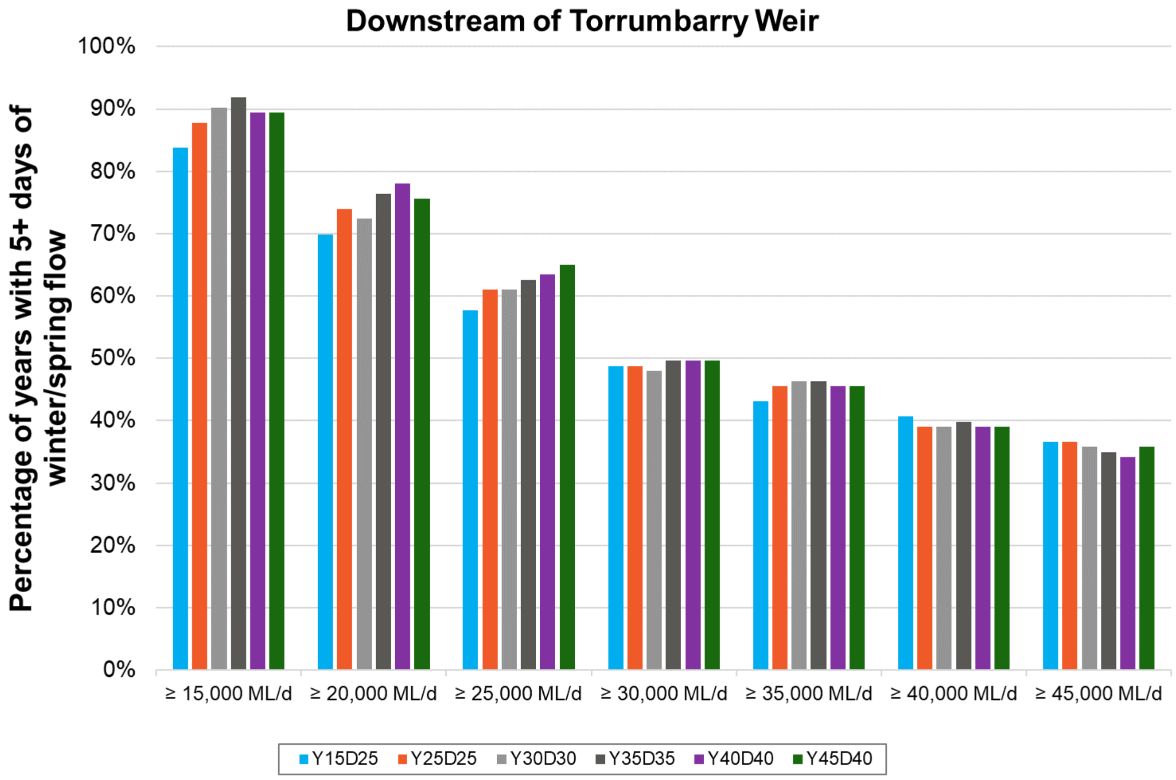

Figure 120 – Proportion of years (1895-2019), with 5+ days of winter/spring flow exceeding defined flow rates at downstream of Torrumbarry Weir for different Murray relaxed constraint scenarios

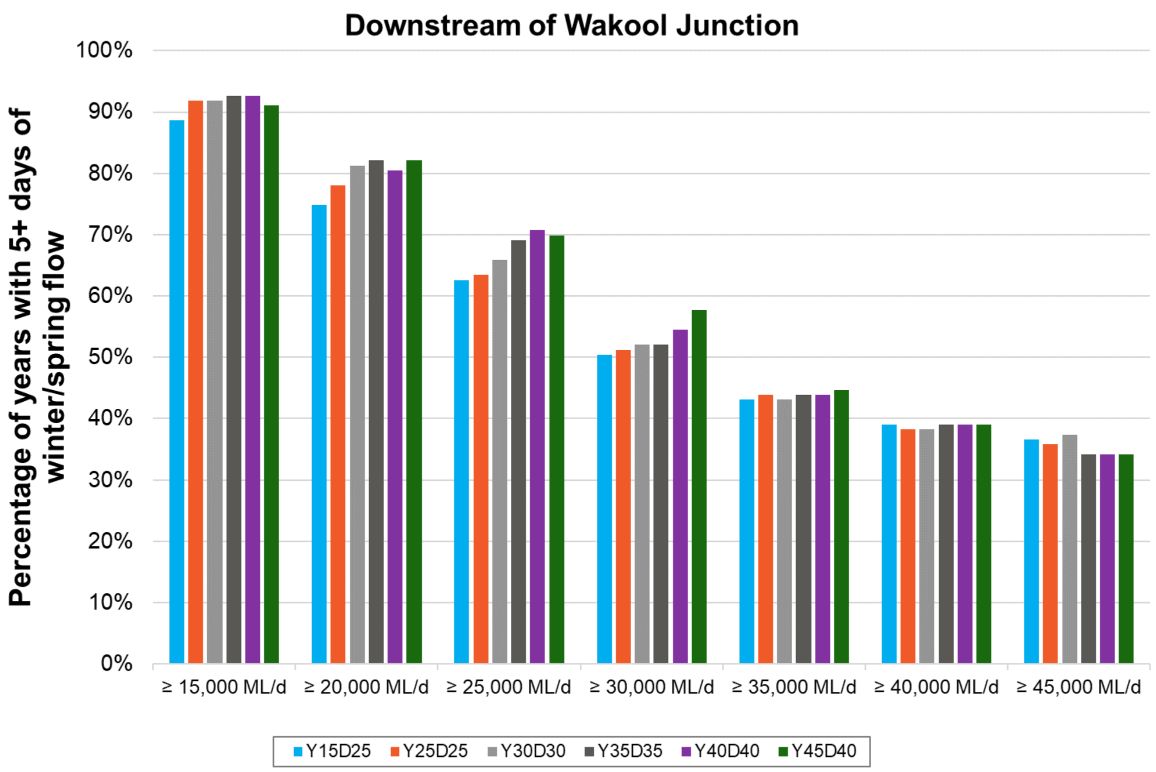

Figure 121 – Proportion of years (1895-2019), with 5+ days of winter/spring flow exceeding defined flow rates at Downstream of Wakool Junction for different Murray relaxed constraint scenarios

Once the flow of interest is above the relaxed constraint, the pattern changes. For example, downstream of Yarrawonga Weir, the number of days of winter/spring flow with a flow greater or equal to 45,000 ML/d reduces if the constraint is relaxed to 25,000 ML/d – 40,000 ML/d but increases if the constraint is relaxed to 45,000 ML/d. As the flow threshold of interest increases, the observed differences between current and relaxed constraint scenarios downstream of the Barmah Choke also decrease. The observed difference between the current and relaxed constraint scenarios decreases with distance downstream and is shown by the results above for locations downstream of Torrumbarry Weir and the Wakool Junction.

As constraints are relaxed further and environmental water use increases, it means that there is less chance of spills as more water is used from the dams. As a result, compared to the current constraint, there is a reduction in the high flow peaks associated with spill events.

To test how the potential variation in mid- and Lower Goulburn constraint thresholds is expected to influence the hydrology of the Murray River, the calculations used to create Figure 117 were repeated for the Y40D40 set of scenarios listed in Table 75, which varies the Goulburn constraint. The results are shown in Figure 122 to Figure 125 below. These figures suggest that based on the SMM methodology described by the MDBA (2022a), that as the degree of constraint relaxation on the Goulburn River is increased:

- Upstream of the Goulburn River confluence: The number of years with 5+ days of winter/spring flow greater than thresholds of 15,000 ML/d to 45,000 ML/d will generally be unchanged or slightly reduced
- Downstream of the Goulburn River confluence (to Wakool Junction): The number of years with 5+ days of winter/spring flow greater than thresholds of 15,000 ML/d to 45,000 ML/d will generally be unchanged or slightly increase.

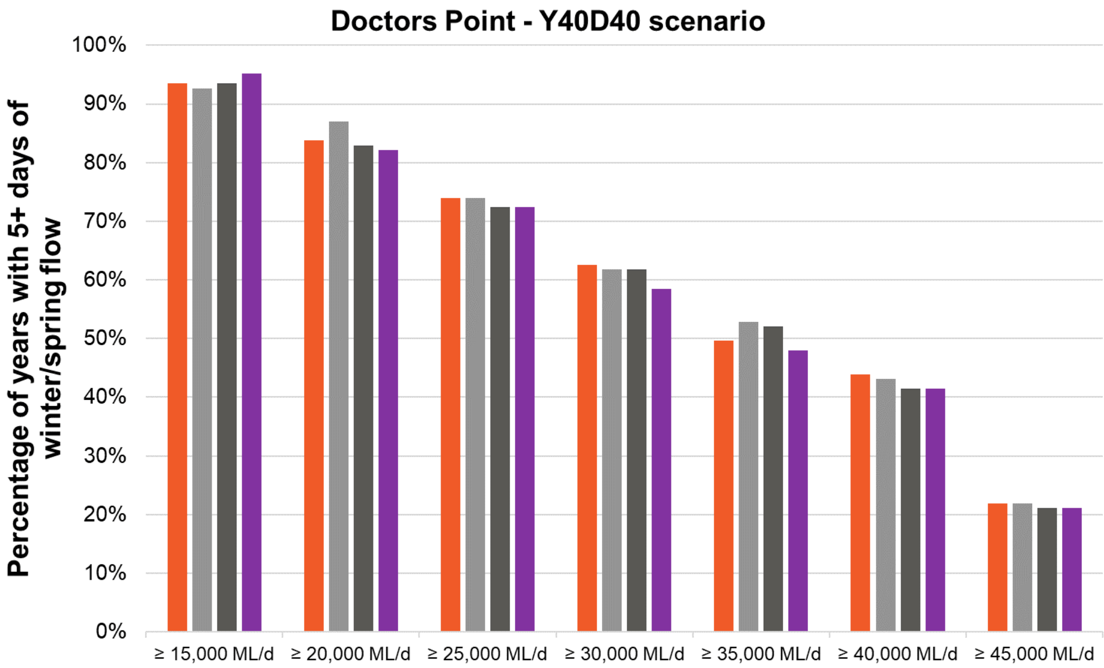

Figure 122 – Proportion of years (1895-2019), with 5+ days of winter/spring flow exceeding defined flow rates for the Y40D40 scenario and different Goulburn River constraints at Doctors Point

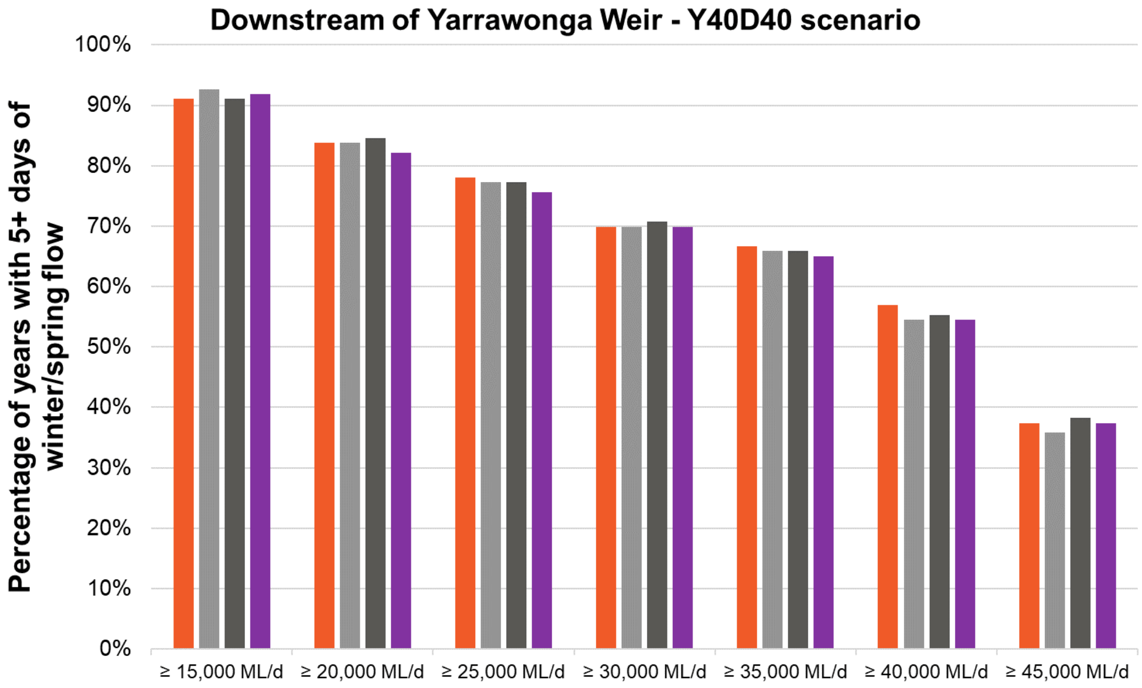

Figure 123 – Proportion of years (1895-2019), with 5+ days of winter/spring flow exceeding defined flow rates for the Y40D40 scenario and different Goulburn River constraints at downstream of Yarrawonga Weir

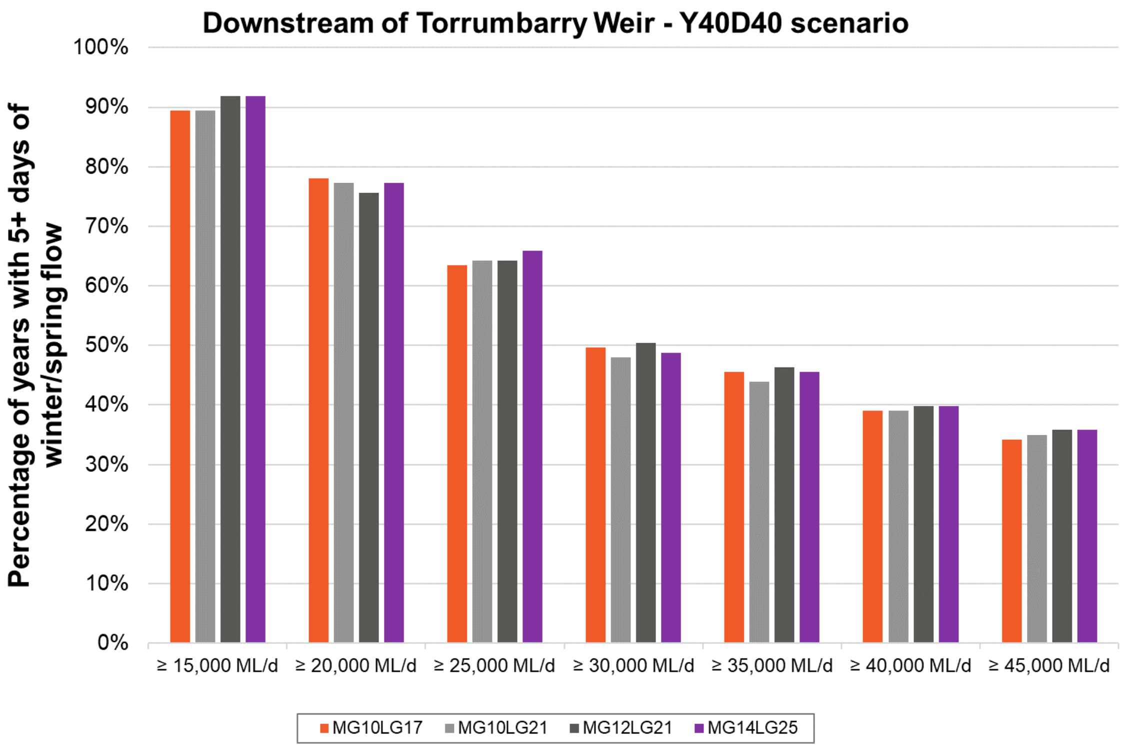

Figure 124 – Proportion of years (1895-2019), with 5+ days of winter/spring flow exceeding defined flow rates for the Y40D40 scenario and different Goulburn River constraints at downstream of Torrumbarry Weir

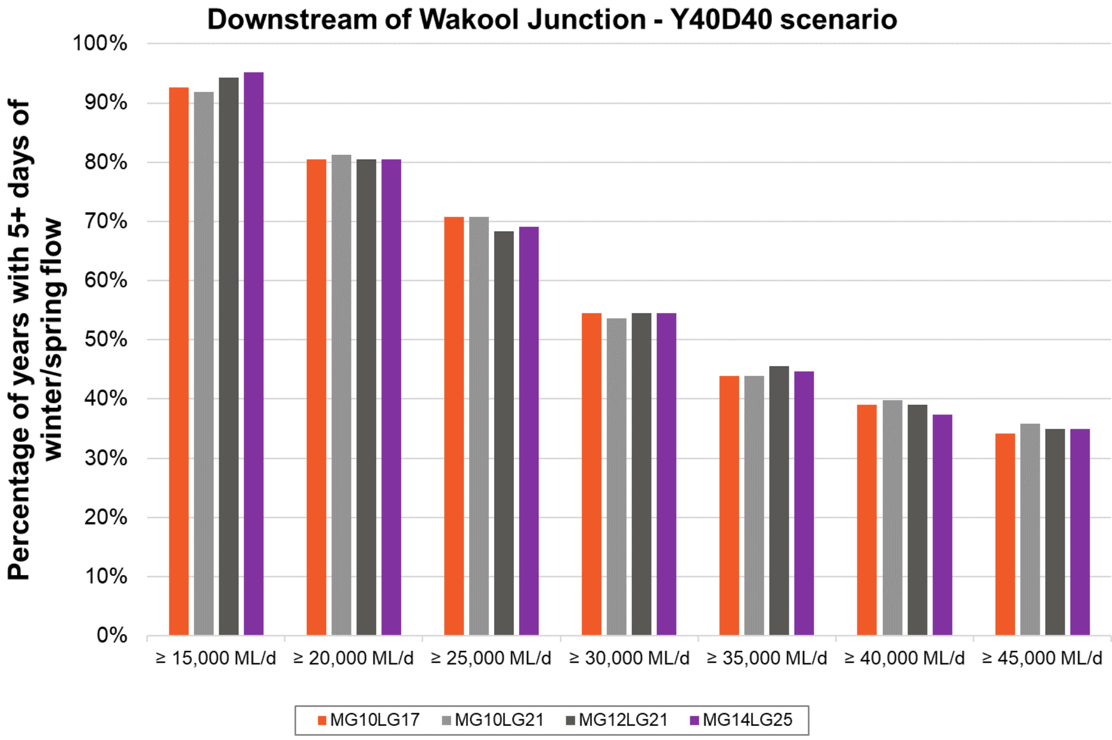

Figure 125 – Proportion of years (1895-2019), with 5+ days of winter/spring flow exceeding defined flow rates for the Y40D40 scenario and different Goulburn River constraints downstream of Wakool Junction

This indicates that hydrological outcomes for the Murray River are more sensitive to constraint relaxation options considered for Doctors Point and downstream of Yarrawonga Weir compared with constraint relaxation options considered for the Goulburn River. An example of this is provided below in Figure 126, which shows that in October 1994, the difference between the blue and green lines (M10L17 with Y40D40 versus M10L17 with Y25D25) is bigger than the difference between the green and black lines (M10L17 with Y40D40 versus M14L25 with Y40D40).

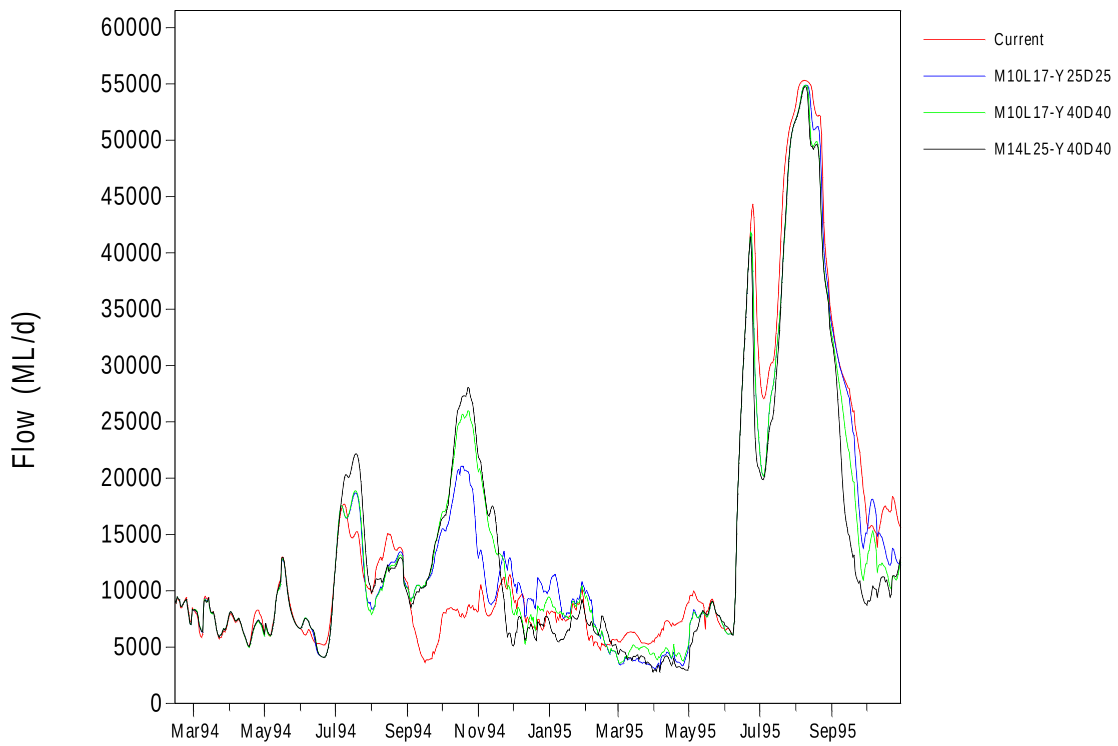

Figure 126 – Daily time-series of modelled flow downstream of Yarrawonga Weir for current constraints and three combinations of constraint relaxation at Doctors Point, Yarrawonga Weir, the mid- and Lower Goulburn

It is noted that the MDBA SMM simulations completed for this stage of the Victorian CMP do not attempt to coincide environmental water deliveries along the Murray River with environmental water deliveries from the Goulburn to the Murray. An example of the typical differences in the timing of environmental water deliveries from the Goulburn to the Murray River and from Hume Dam / Yarrawonga Weir to Torrumbarry Weir is shown in Figure 127, as reproduced from Section 8.1 of the MDBA (2022a) report. This example time series of daily flows simulated in the MDBA SMM shows the peak of Goulburn River flows to the Murray River for the Y25D25 scenario (dotted red line) arrives before the peak of Murray River flows downstream of Yarrawonga Weir (dotted green line). Modelled flows downstream of Torrumbarry (blue dotted line) peak shortly after the Goulburn River inflows peak but before the peak of the flow downstream of Yarrawonga Weir.

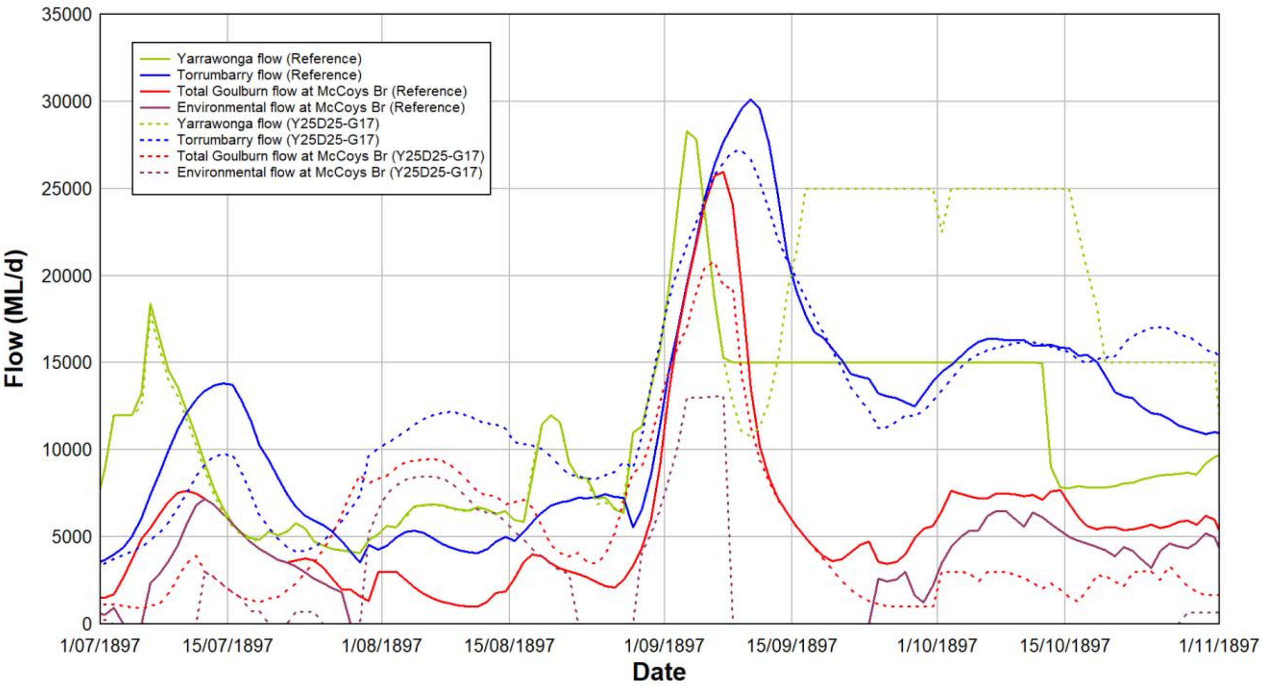

Figure 127 – Comparison of relaxed constraints flows against the current condition reference

The model suggests some positive changes in the lower Murray region by relaxing constraints in the Goulburn river. If environmental water managers and river operators work to better coordinate the environmental water flows between the Murray and Goulburn rivers, even more improvements can be expected. The potential benefits and impacts of more closely aligning the use of environmental water in the rivers that comprise the southern connected Murray-Darling Basin is being considered as part of the Enhanced Environmental Water Delivery (EEWD) project.

There are future opportunities to incorporate the outcomes of constraint relaxation through the other rivers in the other states as part of the Constraints Management Strategy. Such system-level modelling should be undertaken to provide a complete picture of what may be achievable. Further work may determine whether the notified flow rates can be achieved through the system or whether lower levels may be more appropriate.

14.6 Scenarios under climate change

Climate change can affect freshwater ecosystems in various ways, but one of the most significant impacts is on water availability. Higher temperatures can lead to drier soils, reducing runoff and increasing water losses through evaporation. Changes in precipitation patterns can also alter the timing of storage inflows and water allocations. This can make it harder to deliver environmental water when it's needed and put pressure on delivering irrigation water under constrained conditions. Additionally, increased unregulated floods can cause damage to riverbanks and drown out nesting habitats for platypus or turtles, affecting the way and time environmental water is used.

While projections from climate models provide a lot of information, there is still significant uncertainty about the magnitude of temperature increases and how precipitation patterns may change. Nonetheless, these projections suggest that the Goulburn and Murray basins will experience drying conditions (example as shown in Figure 128 below).

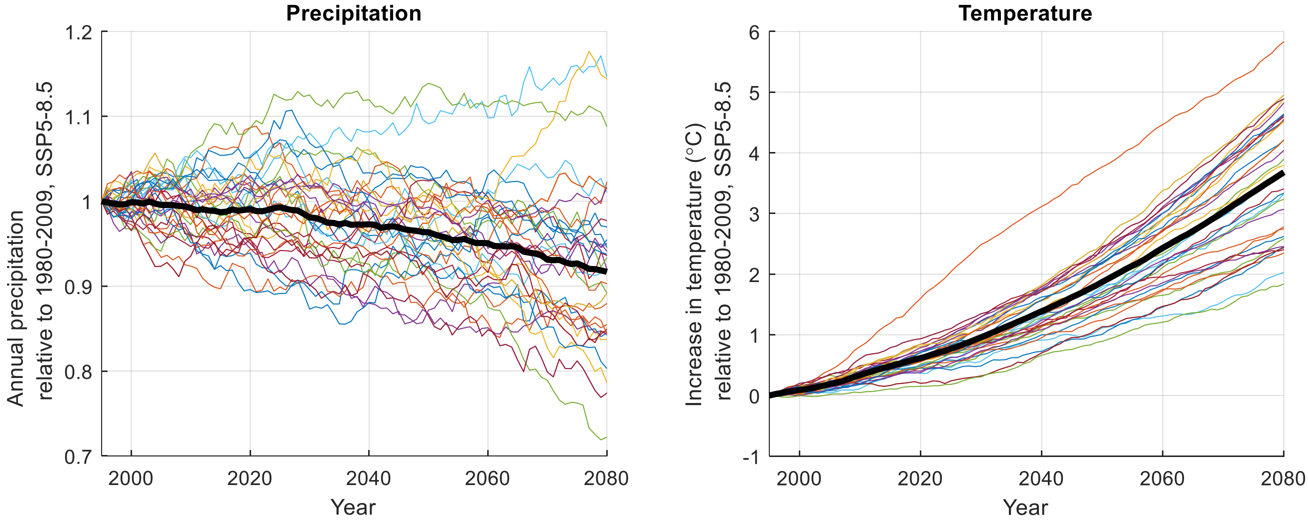

Figure 128 - Climate model projections for annual precipitation and temperature for the Goulburn River basin

Figure 128 shows the range of projections from 37 different climate models in the Intergovernmental Panel on Climate Change's most recent Coupled Model Intercomparison Project (CMIP6), and a high emissions scenario (SSP5-8.5). Each of the coloured lines represents a different climate model. The bold black line is the average of all models. Although there is high uncertainty, projections point to increasing temperatures and drying conditions over the Goulburn River basin. Similar conditions are expected for the Murray.

Modelling has been undertaken across the Goulburn and Murray Rivers to investigate how flows may be impacted by relaxing constraints under different climate change scenarios.

14.6.1 Goulburn River

The GBCCL Source model was used to simulate different scenarios for the Goulburn River system, including the current constraints scenario and the M10L17 constraint relaxation scenario (mid-Goulburn at 10,000ML/d and lower Goulburn relaxed to 17,000ML/d), under post-1975 conditions and projected conditions for the year 2070 with medium or high climate change. Further information about the climate change modelling and different constraints scenarios is presented in Appendix A3.

Figure 129 provides an example of how flows at Shepparton and Molesworth would be affected under current constraints at different climate conditions. The top chart shows how flows may change at Molesworth, while the bottom chart shows how flows change at Shepparton. This shows a significant reduction of flows at the highest climate change scenario (green line).

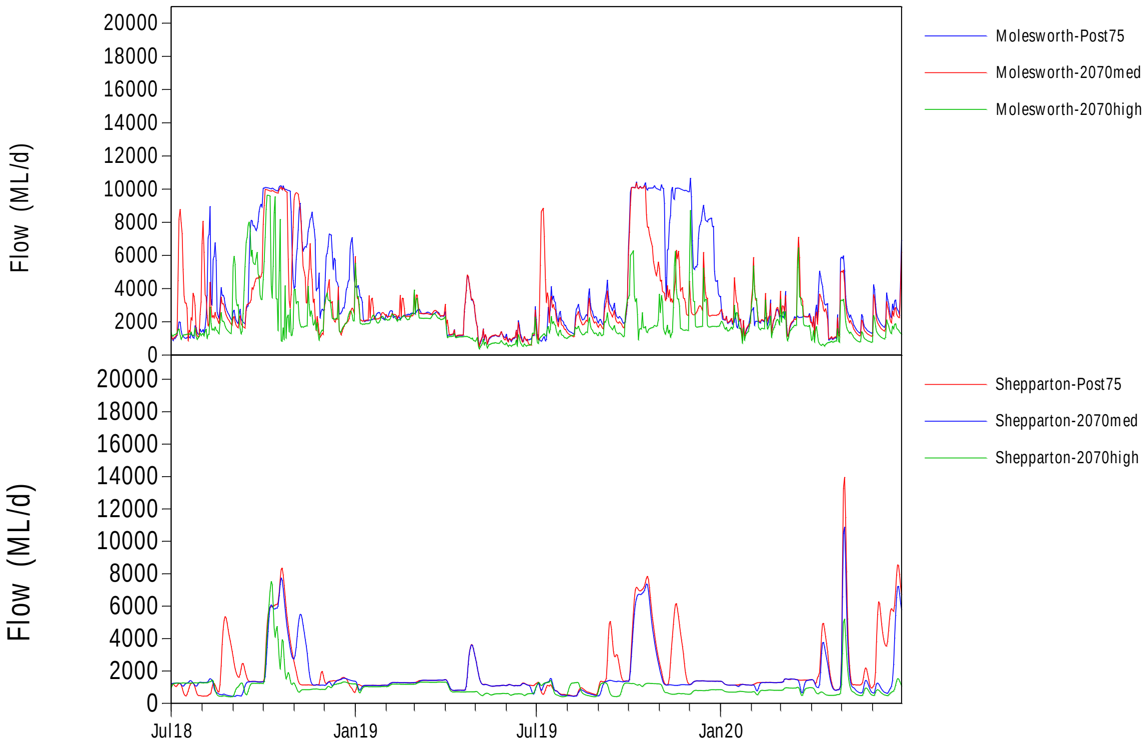

Figure 129 – Example time-series of daily flow modelled for Molesworth and Shepparton for current constraints (M10L9.5) from July 2018 to June 2020 for post-1975 conditions and year 2070 conditions under medium and high climate change. Historic conditions are the same as post-1975 conditions for these three years.

As seen in Figure 130 below, under the current constraint scenarios there is a significant reduction in environmental water availability as the climate dries (dashed line).

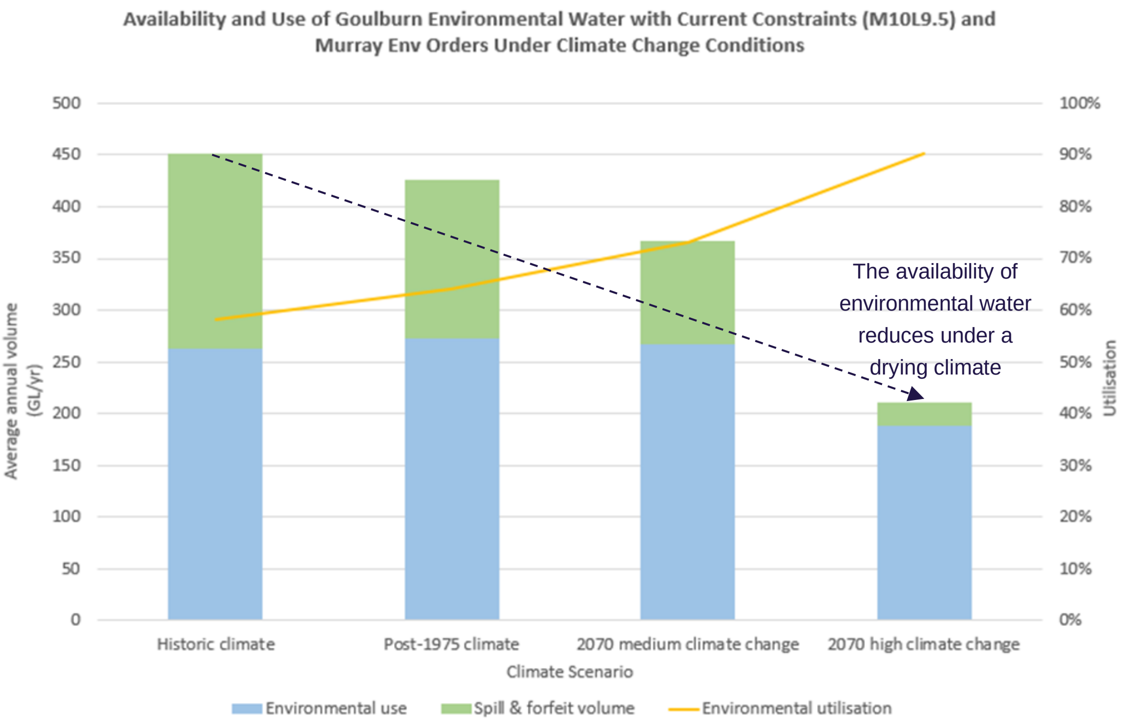

Figure 130 – Environmental water availability and use under current constraints (M10L9.5) and climate change conditions

All of the proposed constraint options offer benefits that are applicable to a broad range of climate models and scenarios. Therefore, relaxing constraints is expected to provide reliable benefits in terms of adapting to climate change (Table 76).

However, in extremely dry future climates where there are significant reductions in precipitation (20% or more), the benefits of relaxing constraints become less apparent. It is important to note that in such an environment, river management would be quite different from what we are accustomed to today.

Table 76 - Goulburn constraint scenarios under climate change

Constraint Scenario	Outcomes under climate scenarios compared to current
M10/L17 Molesworth 10,000 ML/d Shepparton 17,000 ML/d	Relaxing constraints to 17,000 ML/d in the lower Goulburn delivers consistent benefits across a range of future climates. Environmental water shortfall reductions are strongest under a moderately dry future climate. This suggests that this constraint option will deliver even greater benefits under a drier future climate. However, the total environmental water shortfall may still remain high.
M10/L21 Molesworth 10,000 ML/d Shepparton 21,000 ML/d	This delivers similar benefits to M10/L17 across the variable climate, with slightly better outcomes.
M12/L21 Molesworth 12,000 ML/d Shepparton 21,000 ML/d	This scenario delivers consistent benefits under a range of future climates. There is a notable stronger response in benefits compared to maintaining the 10,000ML/d constraint at Molesworth, especially for environmental water shortfall reductions.
M14/L25 Molesworth 14,000 ML/d Shepparton 25,000 ML/d	Shows the largest benefits across the range of climate scenarios.

The GBCCL Source model was also used to compare the difference in peak daily flows under current constraints and relaxing to Molesworth 10,000 ML/d and Shepparton 17,000 ML/d under different climate scenarios. Figure 131 and Figure 149 show this for Molesworth and Shepparton. This shows that under potential future climates, the difference in peak flows after constraint relaxation is similar to that of the current constraint scenario as the lines for the different scenarios are close together.

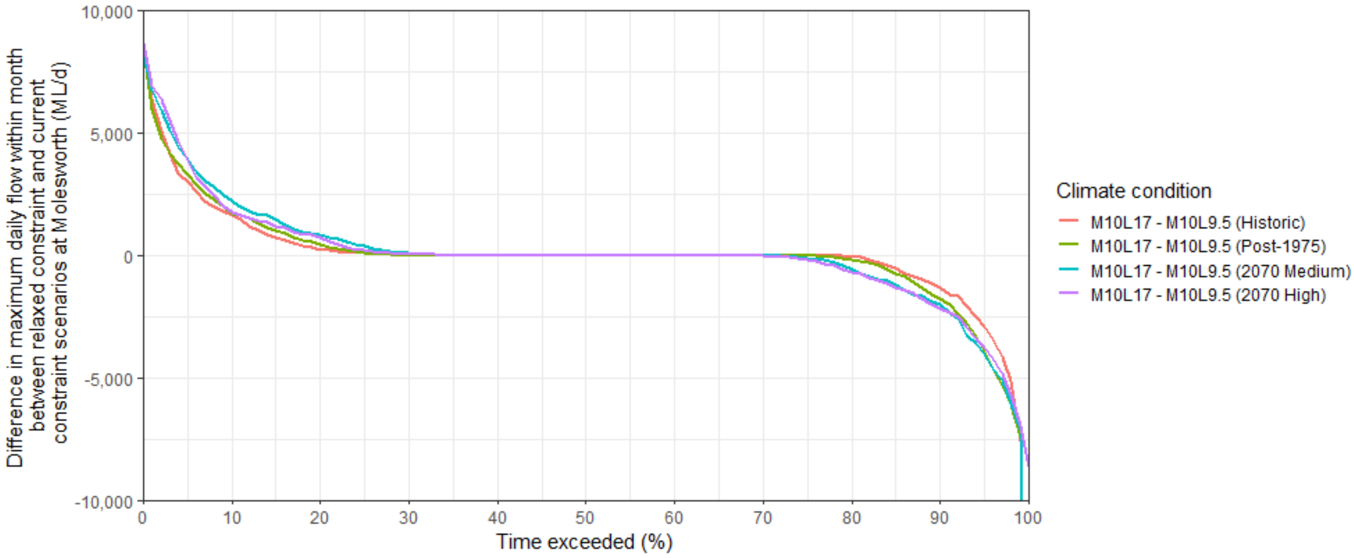

Figure 131 – Modelled difference in the peak daily flows at Molesworth when current constraints (M10L9.5) are relaxed to 17,000 ML/d in the Lower Goulburn (M10L17) under historic conditions and three representations of potential future climate conditions

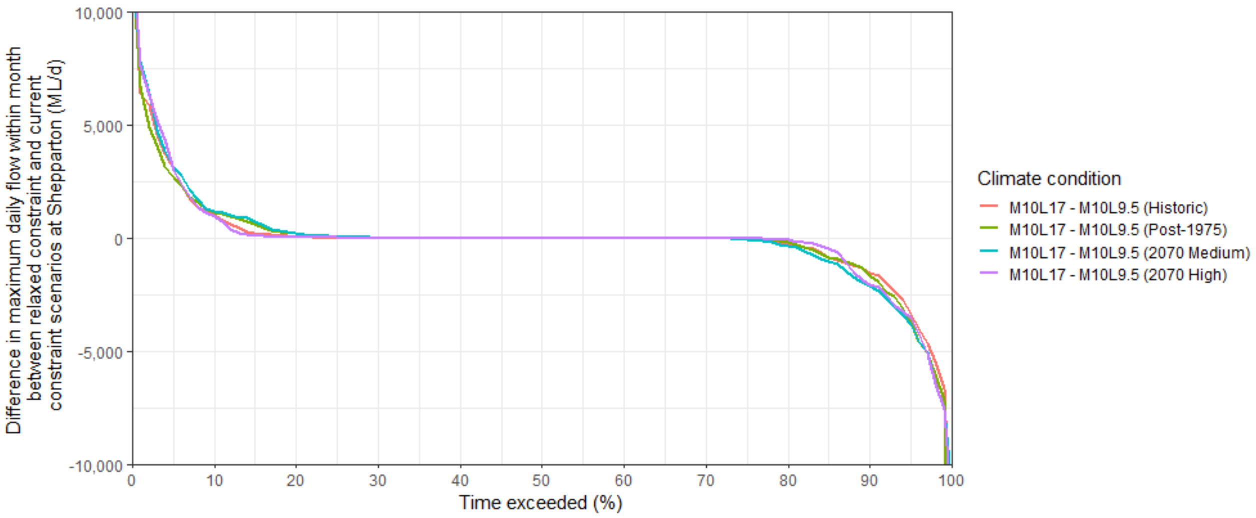

Figure 132 – Modelled difference in the peak daily flows at Shepparton when current constraints (M10L9.5) are relaxed to 17,000 ML/d in the Lower Goulburn (M10L17) under historic conditions and three representations of potential future climate conditions

Overall, the modelling results suggest that relaxing constraints will increase the efficiency of the use of environmental water holdings under post-1975 and 2070 medium climate change conditions, but may make less difference under severe 2070 high climate change conditions. This suggests that relaxing constraints may be a suitable tool for environmental water managers to adapt to a drying climate except under the severe climate scenario where water availability is the major limiting factor.

The following points summarise the key conclusions that can be made from the modelled climate change scenarios:

- Relaxing the Lower Goulburn constraint allows increased utilisation of the environmental water portfolio to meet Lower Goulburn environmental needs
- Relaxing the Mid Goulburn constraint increases the ability to meet large flow targets in the Lower Goulburn under climate change scenarios
- The duration of flows at or above the constraints reduces as the climate conditions become drier. The intervals between flows of these magnitudes also increases
- Under year 2070 with high climate change conditions, flows are rarely at or exceeding these constraints
- This suggests that there would be additional benefit from relaxing constraints beyond 10,000 ML/d in the Mid Goulburn and 17,000 ML/d in the Lower Goulburn under somewhat drier conditions (post-1975 and year 2070 with medium climate change) but not under much drier conditions (year 2070 with high climate change)
- In future stages of the Victorian CMP, this observation could be tested further by using the GBCCL Source model to simulate the other constraint relaxation scenarios (M10L21, M12L21 and M1425) under potential future climate conditions.

14.6.2 Murray River

The MDBA used the MDBA SMM model to simulate the effects of relaxed constraints on the Murray River system under different climate conditions. They looked at both the current constraint scenario and the scenario where constraints are relaxed to a Y40D40 level.

Figure 133 and Figure 134 show the modelled difference in peak flows at Doctor’s Point and Yarrawonga respectively between the current constraint and Y40D40 scenario. The figures compare these differences for historical, post-1975, and projected 2070 conditions with medium or high climate change. The figures show that, compared to the "do nothing" scenario, relaxing constraints leads to similar differences in peak flows across the different climate conditions. However, in the 2070 high climate change scenario, there is more departure from the other scenarios compared to what was observed for the Goulburn River (the gap between the purple line and the other lines in the figures below is greater than in the Goulburn Figure 131 and Figure 149)

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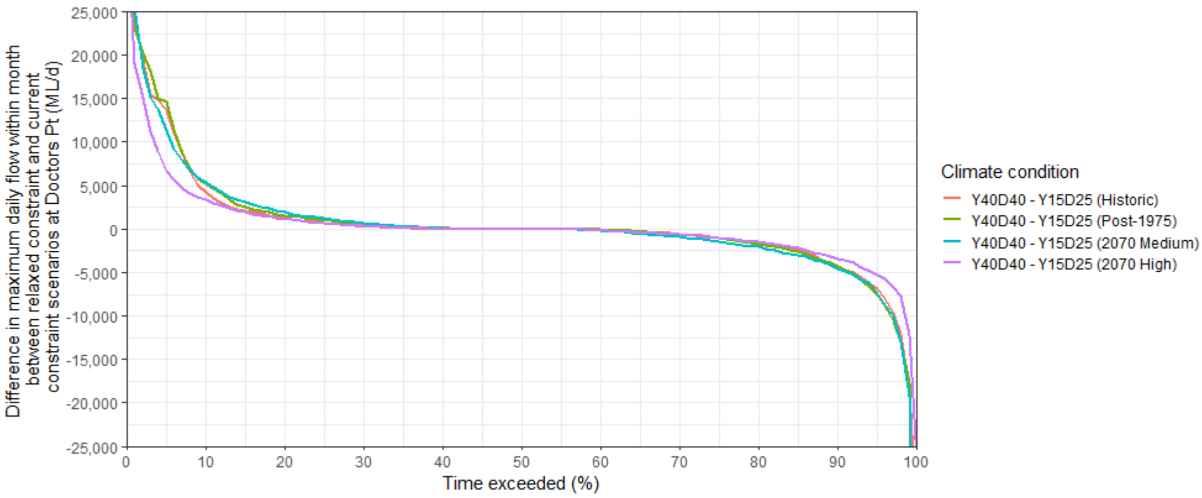


Figure 133 – Modelled difference in the peak daily flows at Doctors Point when current constraints (Y15D25) are relaxed to 40,000 ML/d at both Yarrawonga and Doctors Point (Y40D40) under historic conditions and three representations of potential future climate conditions

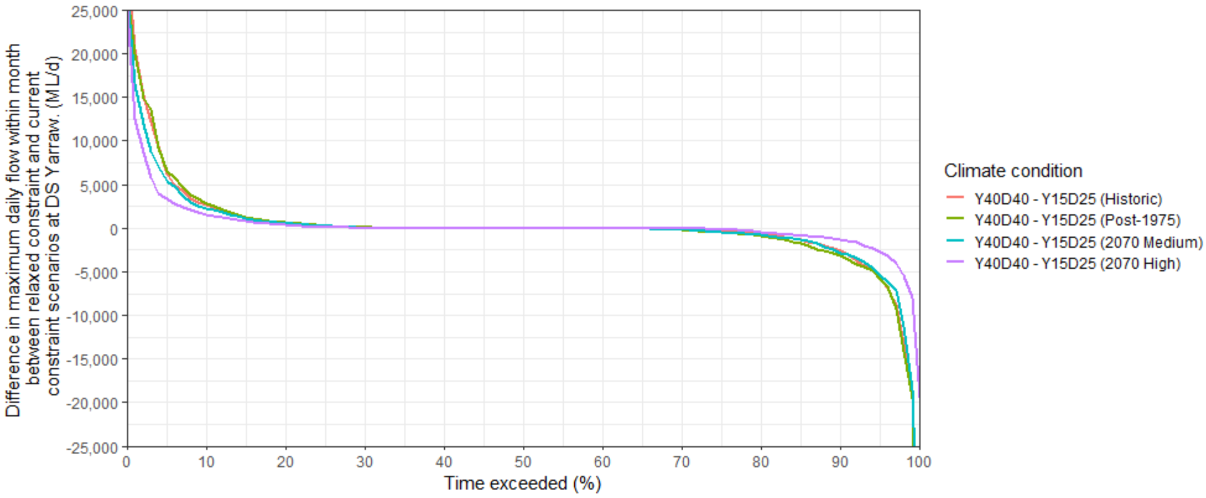


Figure 134 – Modelled difference in the peak daily flows Downstream of Yarrawonga when current constraints (Y15D25) are relaxed to 40,000 ML/d at both Yarrawonga and Doctors Point (Y40D40) under historic conditions and three representations of potential future climate conditions

The modelling suggests how environmental water use will be affected by relaxed constraints and changing climatic conditions in the Murray and Goulburn regions.

In Figure 135 below, the grey-shaded part demonstrates the average volume allocated over the year from the start of the year (SOY) to the end of the year (EOY). The bars show that as constraints are relaxed, environmental water use increases (the orange gets bigger) as the environment gets more opportunities to target higher flow events under climate scenarios. Scenarios are also shown where Goulburn constraints are relaxed and how environmental water use changes under climate change.

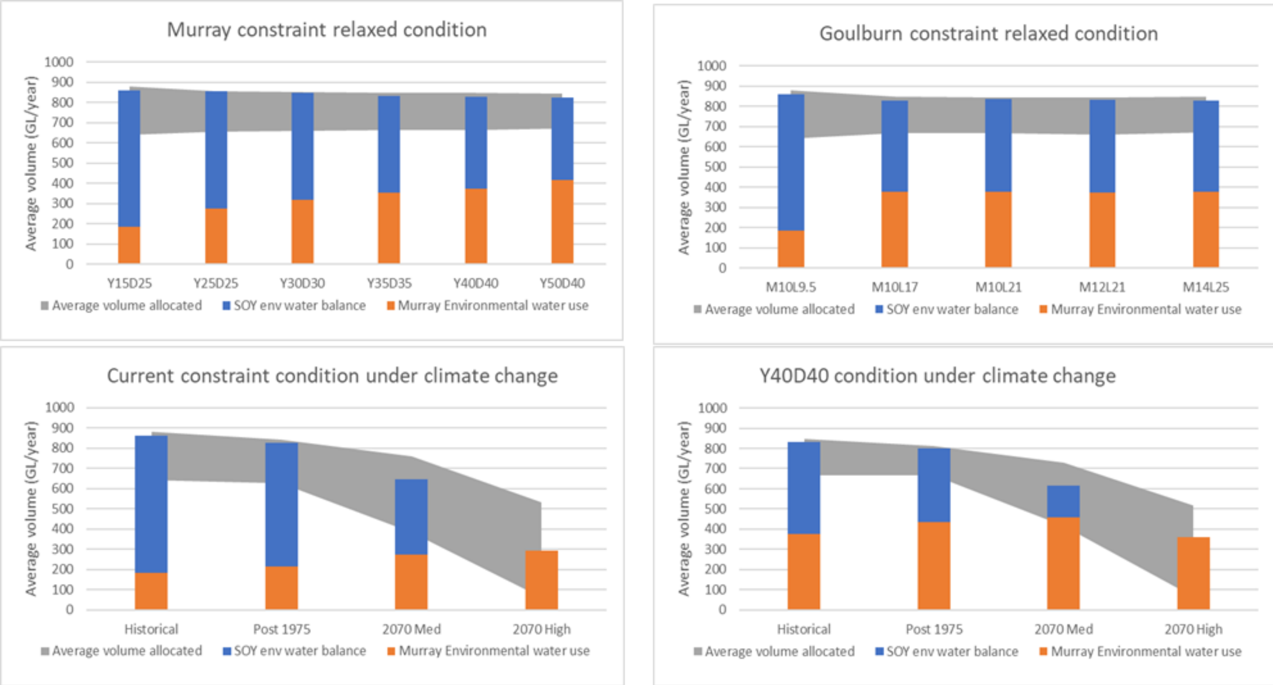


Figure 135 – Murray River environmental water use compared to environmental water balance and allocation

With increasing the relaxation of constraints in the Murray, environmental water use increases as the environment gets more opportunities to target higher flow events. Consequently, the environmental water balance and allocation get reduced due to higher utilisation of the environmental portfolio. The relaxing of Goulburn constraints shows more utilisation of environmental water as the Goulburn constraint is relaxed from the current condition to 17,000 ML/d. However, further relaxation in Goulburn has minimal impact on the Murray's environmental use.

In future climatic conditions, due to reduced water availability in the system, both the allocation and balance are reduced substantially under the current constraint and constraint relaxed (Y40D40) scenarios. In the 2070 medium climate, the account balance is utilised more to deliver the increased demand of the environment. Under the current constraint regime, the environmental portfolio has more unused account balances to be used than under the relaxed constraint scenario. As such the increased use in the 2070 medium climatic condition is more prominent under the current constraint. In the 2070 high climate scenario, the environmental water balance and allocation gets reduced significantly. The environmental water use eventually shows a very high utilisation of the available balance.

This indicates that environmental water holders can effectively use the relaxed constraints to sustain ecological outcomes under medium future climates. Still, their effectiveness is dramatically diminished under much drier future climate conditions. This is primarily because of much reduced piggybacking opportunities and limited water available due to reduced allocation to initiate environmental events from scratch without unregulated events to augment environmental demand.

The key outcomes from the MDBA SMM modelling for potential future climate conditions are similar to those observed using the DEECA Goulburn GBCCL Source model. That is:

- Significant reductions in flows for the entire flow regime as future climates become drier
- Flows during winter/spring seasons are more heavily affected, while flows during typical irrigation seasons are well maintained
- Utilisation of the available environmental water holdings increases if constraints are relaxed under post-1975 and year 2070 medium climate change conditions, but constraint relaxation makes little difference to the average annual volumes of modelled environmental water use under the year 2070 high climate change conditions
- The difference in peak flows after constraint relaxation is similar across the simulated climate conditions (Figure 133 and Figure 134), albeit that for the Murray River, the 2070 high climate change case departs more from the other instances compared with what was observed for the Goulburn River

- When the number of winter/spring days per year above various flow thresholds is considered, the difference between the current and relaxed constraint scenario is still apparent. What is particularly noticeable is how the total number of days above the flow thresholds reduces as the climate condition becomes drier
- As the climate condition becomes drier, the duration of flows at or near relaxed constraints is expected to reduce, and the intervals between flows of this magnitude will lengthen
- At mid- and lower Murray, there are improved flow regimes with the relaxed constraint scenarios, which are more evenly distributed across the different future climate scenarios. It indicates the potential benefits of relaxing constraints and the importance of coordinated water delivery under dry climatic conditions.

If future stages are to proceed of the Victorian CMP, these observations should be tested further by using the MDBA SMM to simulate other constraint relaxation scenarios (e.g., Y25D25, Y30D30, Y35D35) under potential future climate conditions. However, it is also noted that operation rules and business decision processes are more likely to be adaptive to emerging drier climatic conditions in the future.

15. Hydraulic assessment

15.1 Key outcomes

Key outcomes:

- The best available models and most up-do-date input data available has been used for this stage of the Victorian CMP. The modelling has delivered a step-change from previous modelling and addresses previous concerns raised by the Independent Expert Panel. The models are now considered fit for purpose to inform the feasibility of the Victorian CMP
- Mapping of the extent of inundation using hydraulic modelling has been completed for the full range of relaxed constraint scenarios across all reaches
- Hydraulic modelling was completed by the project team (**HARC)** for the Goulburn, **MHL** for the Murray River from Barmah to Torrumbarry (Zone 9) and **MDBA** for the remaining Murray River reaches
- Examples of model improvements include:
  - bathymetry datasets for the Mid Goulburn River (bed profile along 190 km and 30 cross-sections)
  - recalibration of the models to flow-level rating curves at 6 long-term streamflow gauges, and verification against aerial imagery of the September 2010 high flow event
  - higher definition water depth estimates in a 1-2 m grid size, compared to the 10m grid used to inform previous business cases
  - MDBA and MHL used 1D/2D and fully 2D models, with calibrations completed against recent flow data and aerial imagery
- Inundation mapping is critically important information for future community and stakeholder engagement. This can be further supplemented by aerial and satellite imagery taken when the rivers were at the modelled flow levels during 2022.
- Concerns remain from some Committee members regarding the impacts of relaxed constraints flow rates on floodplain landholdings in tributaries in times of higher flows within the main river stems, examples cited including the Yea, Ovens and Loddon Rivers
- Additionally, the hydraulic model for Zone 2 of the Murray River does not include the Little Murray River or the confluence of the Loddon River. A priority therefore in future work would be to include these areas in the Zone 2 hydraulic model.

15.2 Overview

Hydraulic modelling maps the expected depth and extent of inundation under different flow conditions. This is critically important information for engaging with the community and other stakeholders. When combined with the hydrological modelling, the hydraulic modelling results can quantify the expected environmental, cultural, social, and economic outcomes of relaxing operational constraints along the Goulburn River and Murray River.

A key finding from the Independent Expert Panel (IEP) Murray-Darling Basin constraints modelling review (2019) was that the previous hydraulic "modelling is not suitable for assessing and communicating the third-party risks. The modelling has been undertaken at an aggregate scale for planning purposes. The available modelling does not produce the information required to access and communicate risks to landholders, local governments, and infrastructure managers at that scale."

Therefore, the key objective of the hydraulic modelling completed under this stage of the Victorian CMP is to use the best available models and data to improve the scale and confidence in the information available for considering, assessing, and communicating the potential changes to inundation depths and extents under regulated flow conditions when operational constraints are relaxed.

Hydraulic modelling was undertaken by HARC for the Goulburn River, MHL for the Murray River Barmah to Torrumbarry, and MDBA for the remaining Murray River reaches.

The calibrated hydraulic models were used to simulate steady-state flows at regular intervals between the current operational constraint thresholds and the upper bounds of constraint relaxation considered during this stage of the Victorian Constraints Measures Program.

The hydraulic modelling approach and findings are detailed in Appendix A.

Information as to the impacts of the resulting modelled inundation ranges is discussed in Section 10 and the environmental benefits in Section 8.

15.3 Comparison with previous investigations

15.3.1 Goulburn River hydraulic modelling improvements

The hydraulic modelling of the Goulburn River for this stage of the Victorian CMP was completed using the most recent TUFLOW 2D model of the river and floodplain. This model was developed for the Goulburn and Broken Rivers flood study, which in turn was informed by the hydraulic modelling done by Water Technology (2016) for previous constraint relaxation business cases.

The hydraulic modelling:

- Incorporates additional bathymetry data sets (depth soundings and cross-section survey data) for the Mid Goulburn, which improves the representation of the river profile. The survey collected bed elevations over 190 kilometres along the Mid Goulburn using echo sounder technologies with 30 cross sections being surveyed using terrestrial survey techniques. This is particularly of note given that some of the flow ranges considered under relaxed constraints on the Goulburn are primarily within the bank
- Recalibration to flow-level rating curves at 6 long-term streamflow gauges, and verification against aerial imagery of the September 2010 high flow event for the flow range of interest (i.e., approximately 10,000 ML/d - 25,000 ML/d)
- Simulated steady-state flows for the Mid Goulburn (10,000 – 14,000 ML/d) and Lower Goulburn (10,000 – 25,000 ML/d) that were generally lower than the range of flows modelled by Water Technology (2016) for the previous constraint relaxation business cases
- Produced water depth estimates at 2 m grid cells, compared with the 10 m grid cell information available for the previous business cases. This means the information is more meaningful at the scales that property owners and public land managers are most interested in.

These improvements mean that the hydraulic modelling results used for this feasibility study are more robust and address the comments of Wilson et al., who found that potential inundation risks need to be modelled in more detail and presented at smaller scales to enable meaningful consultation with the community about constraint relaxation.

15.3.2 Murray River hydraulic modelling improvements

Compared with the hydraulic modelling that informed previous business cases for constraint relaxation along the Murray River, the information available from the hydraulic models developed by the MDBA and MHL for the nine zones between Hume Dam and the Wakool Junction is more robust.

This is because the 1D/2D and fully 2D hydraulic models developed by the MDBA and MHL simulate the movement of water through the river channels and floodplain. These models have been calibrated to flow data and aerial imagery available for recent flow events. In contrast, the previous estimates of inundation extents along the Murray River were based on The River Murray Floodplain Inundation Model (RiM-FIM) approach, which estimates a static water level for a given flow threshold by interpolating between historical inundation extents that have been linked to corresponding flows at discrete gauged locations. The estimates of inundation extents available from the MDBA and MHL hydraulic models are, therefore, more appropriate than those used in previous business cases for constraint relaxation along the Murray River, particularly for river reaches with few streamflow gauges.

15.4 Hydraulic outcomes along the Goulburn River and Murray River

Along both the Goulburn River and Murray River as constraints are relaxed and flows increase, the commencement of overbank flow sees the river's engagement with connected low-lying flood runners, billabongs and oxbows. The connection to these features will depend on the topography of the area and the height of the flows.

An example of how rising river levels will inundate the surrounding landscapes is shown for the Mid Goulburn at the Molesworth constraint in the following four figures. This is a key location along the Goulburn River which surrounding land commences inundation as the river rises above current operational limits. The darkness of the blue in the areas inundated indicates the modelled water depth, and the yellow labels show the modelled water level (in m AHD). As the flow levels increase to 10,000 ML/d, flood runners are engaged which results in lower lying areas of the floodplain being inundated. From Figure 136 and Figure 137 it is noted that the areas inundated at 10,000 ML/d are predominantly vegetated or identified water bodies (oxbows).

Figure 136 – Goulburn River at Molesworth - aerial imagery

Figure 137 – Goulburn River at Molesworth - Inundation extent at Mid Goulburn flows of 10,000 ML/d

As flows increase from to 12,000 ML/d and 14,000 ML/d the area under inundation increases as further parts of the landscape are engaged (Figure 138 and Figure 139).

Figure 138 – Goulburn River at Molesworth - Inundation extent at Mid Goulburn flows of 12,000 ML/d

Figure 139 – Goulburn River at Molesworth - Inundation extent at Mid Goulburn flows of 14,000 ML/d

Similarly, the areas along the Murray River also demonstrate increased engagement with the surrounding wetlands as flows increase. Figure 140 to Figure 143 show the hydraulic model inundation extents as flows in the Hume to Yarrawonga reach increase in 5,000 ML/d increments in the section upstream of Corowa.

Figure 140 – Murray River upstream of Corowa - base aerial imagery

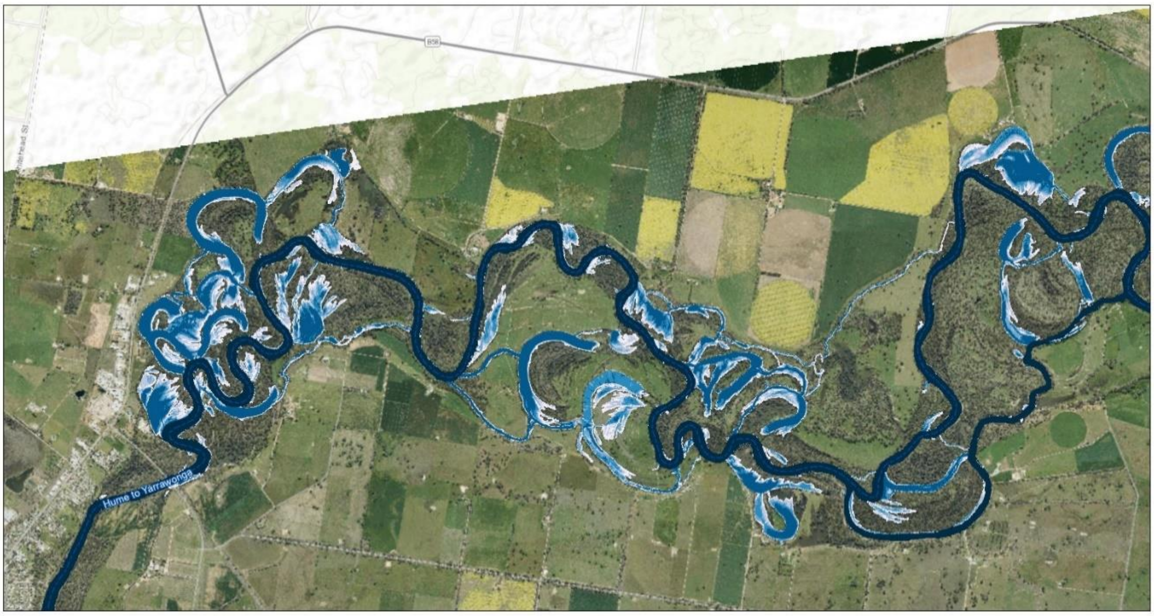


Figure 141 – Murray River upstream of Corowa - Inundation extent of Hume to Yarrawonga flows of 25,000 ML/d

Figure 142 – Murray River upstream of Corowa - Inundation extent of Hume to Yarrawonga flows of 30,000 ML/d

Figure 143 – Murray River upstream of Corowa - Inundation extent of Hume to Yarrawonga flows of 40,000 ML/d

The use of steady-state hydraulic model scenarios to develop maps such as those shown above means that the predicted water levels and depths are for total flows at that particular location. For example, the water levels and depths in Figure 142 are for a flow of 30,000 ML/d at Corowa, regardless of whether the 30,000 ML/d is comprised solely of releases from Hume Dam or is a combination of releases from Hume Dam and inflows from tributaries such as the Kiewa River.

Concerns remain from some Committee members regarding the impacts of tributaries in times of higher flows within the main river stems. Concerns were raised that flows in the Yea River were being held higher and could not drain as fast if there were higher flows in the Goulburn. This is thought by local landowners to cause ‘backing up’ of water, which causes localised flooding. Landowner perspectives were presented, demonstrating the ‘flashy’ nature of catchments within the Mid Goulburn that, in previous major flood events, have caused cattle to be stranded and people to get caught in flood waters that have risen very quickly.

“Flood water doesn’t get away easily when the Goulburn is high.”

These concerns were mirrored by Committee members on the Murray, particularly about flows from the Ovens and Loddon into the Murray, with examples detailed of previous major inundation events that had caused significant flooding, particularly up the Loddon.

The influence of Goulburn River and Murray River flows on tributary creeks and rivers was hydraulically modelled by simulating no or low tributary inflows and allowing the main river stem water levels to ‘back up’ the tributaries. This approach will have estimated the maximum distance over which the main stem flows will influence tributary water levels by magnifying the difference between the Goulburn River / Murray River flows and the tributary inflows. Further background information on the main stem and tributary interactions along the Goulburn River is provided in HARC, 2023 (Appendix A). It demonstrates that for the Yea River in particular, the Goulburn River water level changes associated with environmental water deliveries up to relaxed constraints of 10,000 ML/d – 14,000 ML/d (in the Mid Goulburn) are not going to influence Yea River water levels beyond distances stated by Water Technology (2016).

This was further explored by comparing modelled inundation extents along the Goulburn and the Acheron River with satellite imagery as water levels rose through the September and October 2022 flood event. Although this 2022 event was due to unregulated flows and did not involve environmental deliveries, it can provide information on how the system responds to higher flows, including significant tributary inflows. The comparison between modelled and observed inundation extents at the Acheron River confluence with the Goulburn River is shown in Figure 144 to Figure 146.

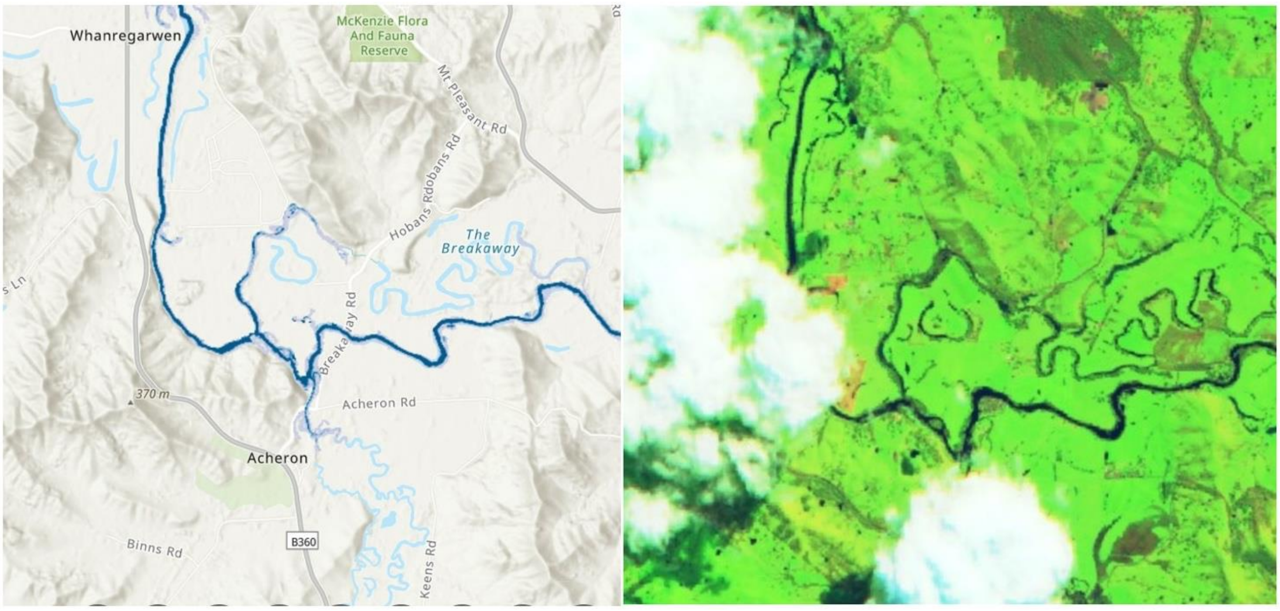


Figure 144 – Comparison of 10,000 ML/d modelled flows at the Goulburn and Acheron River confluence (left) and SentinelHub imagery for 9 October 2022 with an average indicative daily flow rate of 10,330 ML/d @ Taggerty & Eildon (combined) on the right (satellite imagery impacted by cloud cover) (WMIS)

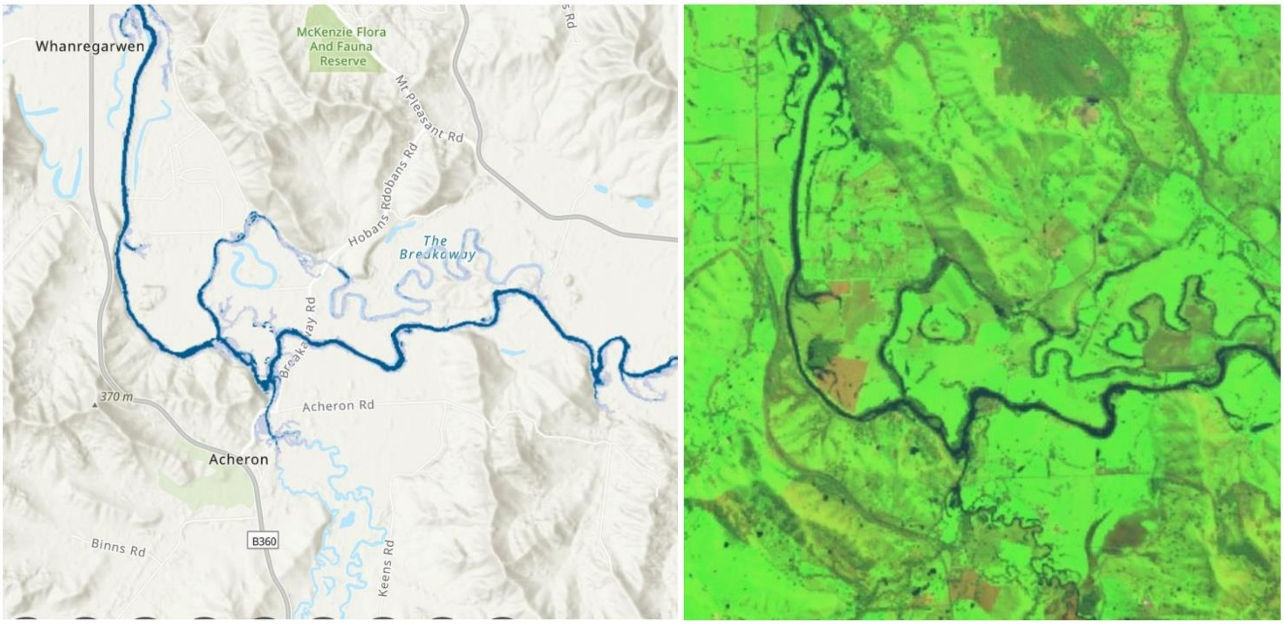


Figure 145 – Comparison of 10,000 ML/d modelled flows at the Goulburn and Acheron River confluence (left) and SentinelHub imagery for 5 October 2022 with an average indicative daily flow rate of 12,800 ML/d @ Taggerty & Eildon (combined) on the right (WMIS)

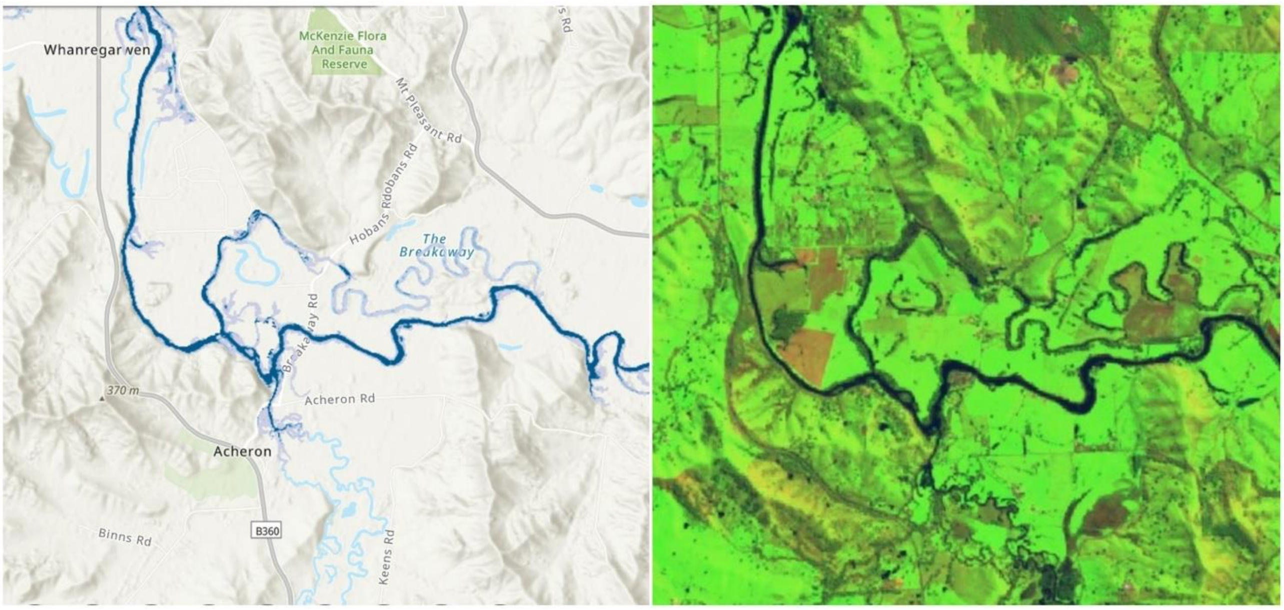


Figure 146 – Comparison of 14,000 ML/d modelled flows at the Goulburn and Acheron River confluence (left) and SentinelHub imagery for 22 September 2022 with an average indicative daily flow rate of 13,830 ML/d @ Taggerty & Eildon (combined) on the right (WMIS)

Although it is recognised that flows being considered under relaxed constraints are not comparable to the past significant major flood events, the Committee suggests future consideration of the modelling at the confluence with tributaries to help inform engagement and communication with affected landowners in potential future stages.

It is noted from the modelling that properties at the confluences of tributaries along the Goulburn River and Murray River are more likely to be impacted due to the contribution of inflows from the tributaries. However, the magnitude of the impact is related to the slope of the land. In the Mid Goulburn and upper Murray, the tributaries fall is steep compared to the mid-areas of the Murray, for example, at the confluence with the Goulburn and Loddon rivers. As such, a greater area of land is likely to be impacted up the tributaries along the Campaspe and the Loddon rivers than at tributaries along the Mid Goulburn.

Some Committee members have raised the requirement for ground-truthing inundation extents about concerns with previously modelled areas as part of the 2013-2016 investigations in the Goulburn and Murray. Although it is recognised that broader landowner engagement on model outcomes is not part of the scope of this stage of the Victorian CMP, sections of the Goulburn model outputs were tested with CMA and Traditional Owner representatives, a few Committee members and individual private landowners.

During the development of the feasibility study, Northern Victoria experienced significant flooding during September and October 2022. The project team leveraged this unregulated event to target the capture of aerial and satellite imagery as river levels rose to flow rates of interest as part of this investigation. This imagery and data will provide invaluable to inform discussions with landowners and stakeholders in any potential future stages. This imagery provides a ‘real-life’ example to understand what particular flow levels mean at a property level, rather than solely relying upon modelled data and will assist in discussing and assessing property-scale impacts. This imagery and data can also be used to refine the available models and improve future modelling outcomes. It will enable the development of a digitised extent of inundation at different flow rates based on the real-life event of 2022.

It is noted that observations were generally positive from the ground-truthing and the alignment with aerial and satellite imagery taken from the September – October 2022 event when observed flows were in the order of those being modelled. A series of examples of observed SentinelHub imagery at a range of flow rates and the modelled inundation extent are shown below. These show the strong correlation between the modelled and observed inundation extents. Other areas of the landscape not directly connected to the river may show water signals in the SentinelHub images due to rainfall in the catchment and other water bodies (e.g., Victoria Park Lake in Shepparton).

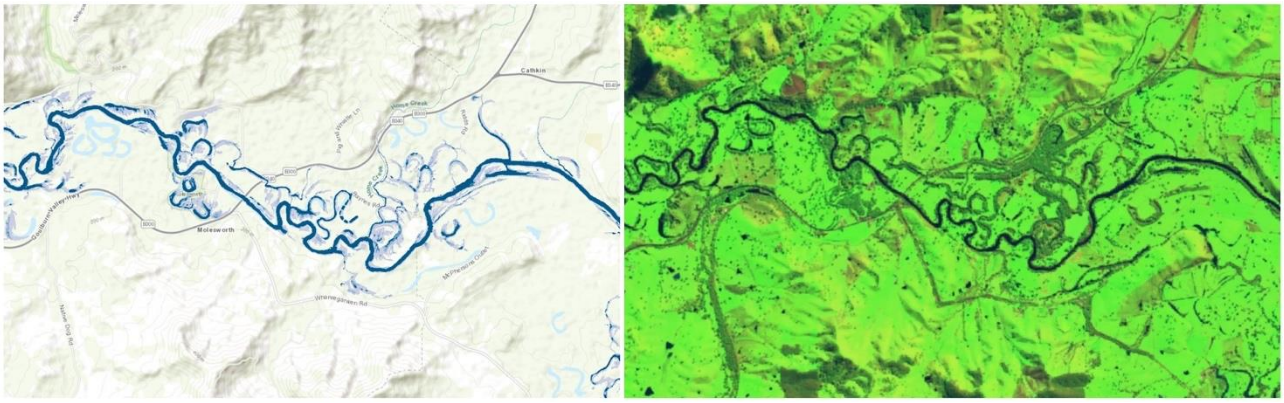


Figure 147 – Comparison of 14,000 ML/d modelled flows at Molesworth (Mid Goulburn) (left) and SentinelHub imagery for 28 August 2022 with an average daily flow rate of 13,800 ML/d @ Trawool on the right (WMIS)

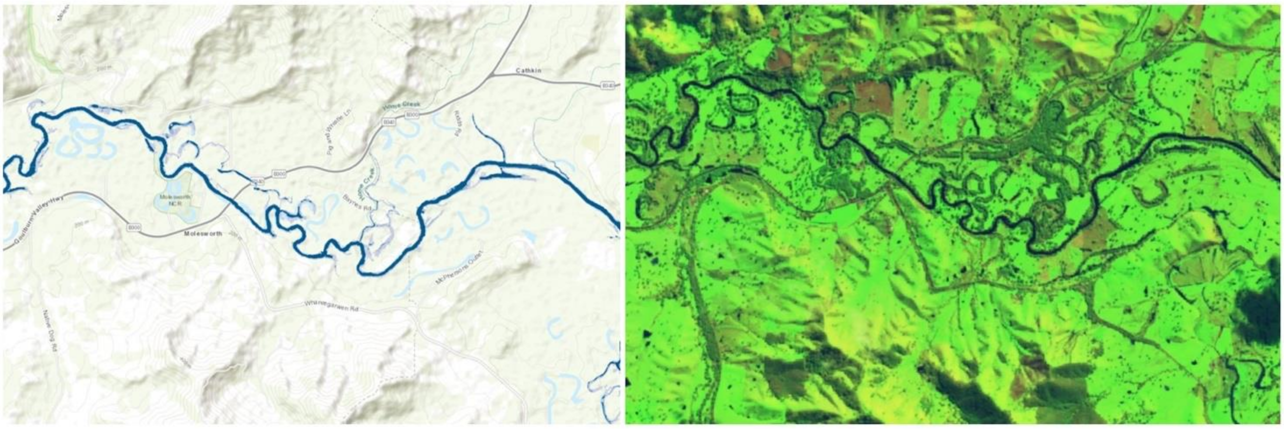


Figure 148 – Comparison of 10,000 ML/d modelled flows at Molesworth (Mid Goulburn) (left) and SentinelHub imagery for 28 August 2022 with an average daily flow rate of 9,750 ML/d @ Trawool on the right (WMIS)

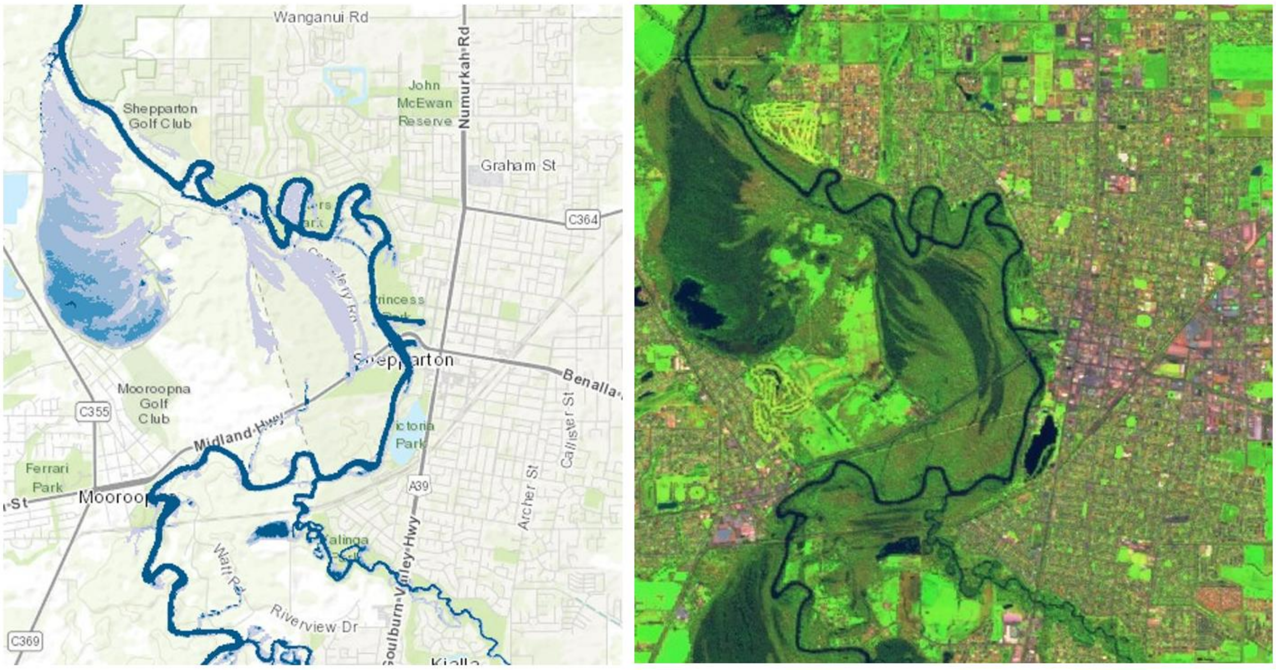


Figure 149 – Comparison of 21,000 ML/d modelled flows at Gemmill Swamp (Lower Goulburn) (left) and SentinelHub imagery for 27 September 2022 with an average daily flow rate of 21,450 ML/d @ Shepparton on the right (WMIS)

Figure 150 – Comparison of 25,000 ML/d modelled flows at Gemmill Swamp (Lower Goulburn) (left) and SentinelHub imagery for 13 October 2022 with an average daily flow rate of 26,000 ML/d @ Shepparton on the right (WMIS)

Figure 151 – Comparison of 17,000 ML/d modelled flows at Reedy Swamp (left) and SentinelHub imagery for 12 September 2022 with an average daily flow rate of 17,860 ML/d @ Shepparton on the right (WMIS)

It is noted that the main difference between the modelled inundation at Reedy Swamp and the satellite imagery is due to remnant water within Reedy Swamp prior to river levels increasing to be further fed by the Goulburn River.

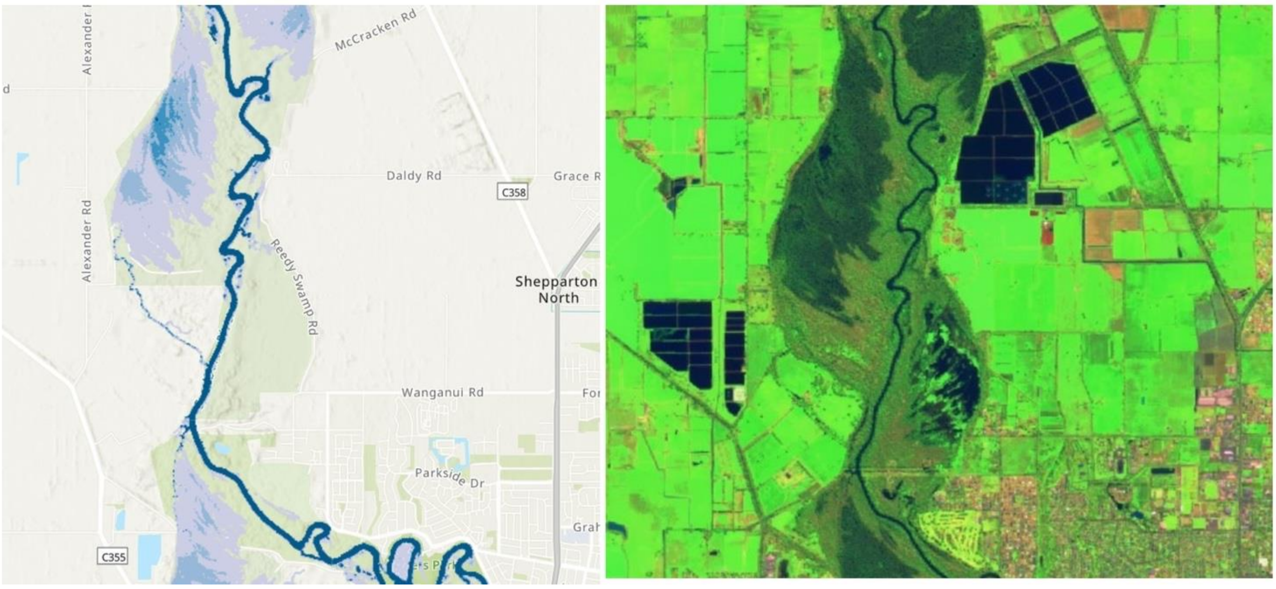


Figure 152 – Comparison of 21,000 ML/d modelled flows at Reedy Swamp (Lower Goulburn) (left) and SentinelHub imagery for 27 September 2022 with an average daily flow rate of 21,450 ML/d @ Shepparton on the right (WMIS)

Figure 153 – Comparison of 25,000 ML/d modelled flows at Reedy Swamp (Lower Goulburn) (left) and SentinelHub imagery for 13 October 2022 with an average daily flow rate of 26,000 ML/d @ Shepparton on the right (WMIS)

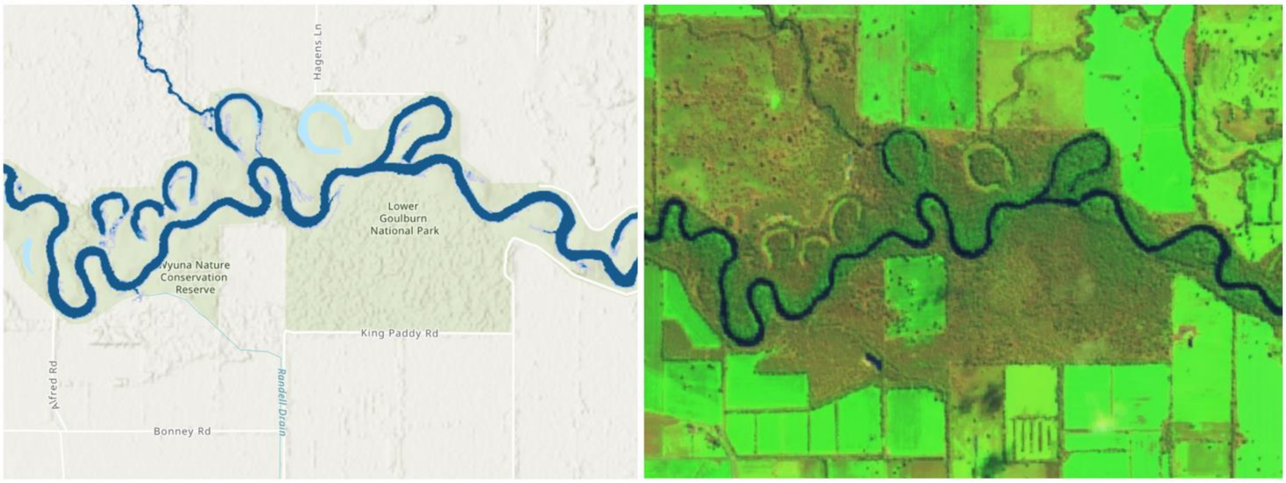


Figure 154 – Comparison of 17,000 ML/d modelled flows at Lower Goulburn National Park (left) and SentinelHub imagery for 22 September 2022 with an average daily flow rate of 17,657ML/d @ McCoys Bridge on the right (WMIS)

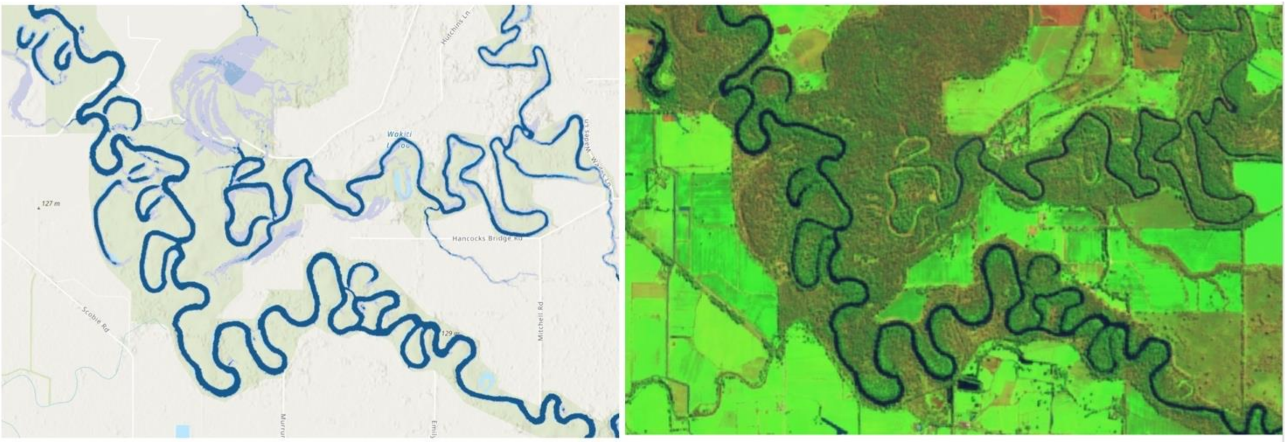


Figure 155 – Comparison of 17,000 ML/d modelled flows at Waitiki Creek (Lower Goulburn) (left) and SentinelHub imagery for 22 September 2022 with an average daily flow rate of 17,657 ML/d @ McCoys Bridge on the right (WMIS)

Figure 154 (Lower Goulburn National Park) and Figure 155 (Waitiki Creek) show greater inundation extents and depths in the modelled output compared to satellite imagery taken during the September event.

Figure 156 – Comparison of 40,000 ML/d modelled flows at Lower Ovens Wildlife Reserve (Murray Hume to Yarrawonga) (left) and SentinelHub imagery for 19 August 2022 with an average daily flow rate of 39,875ML/d @ Corowa on the right (MDBA)

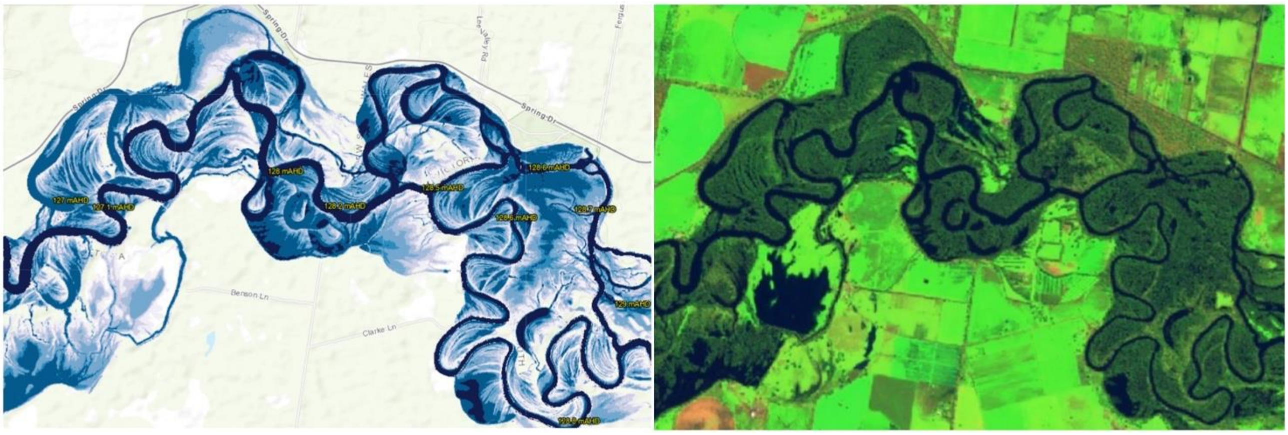


Figure 157 – Comparison of 45,000 ML/d modelled flows at Brimin (Murray Hume to Yarrawonga) (left) and SentinelHub imagery for 29 September 2022 with an average daily flow rate of 49,560 ML/d @ Doctors Point on the right (MDBA)

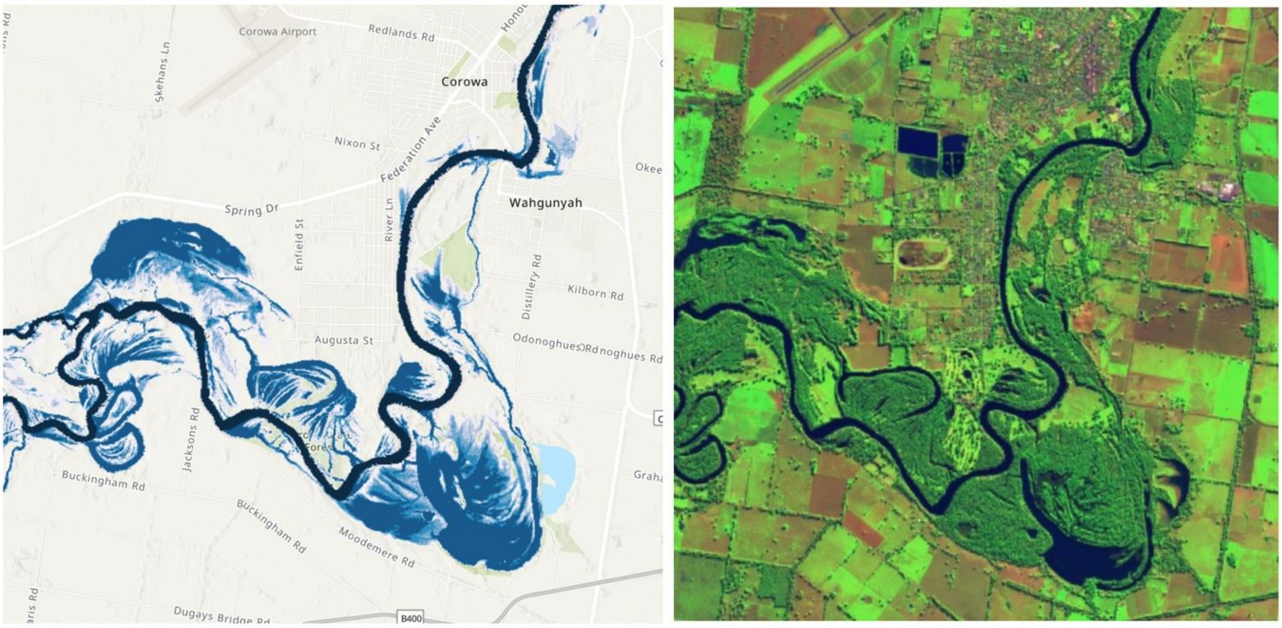


Figure 158 – Comparison of 40,000 ML/d modelled flows at Lake Moodemere (Murray Hume to Yarrawonga) (left) and SentinelHub imagery for 19 August 2022 with an average daily flow rate of 39,875ML/d @ Corowa on the right (MDBA)

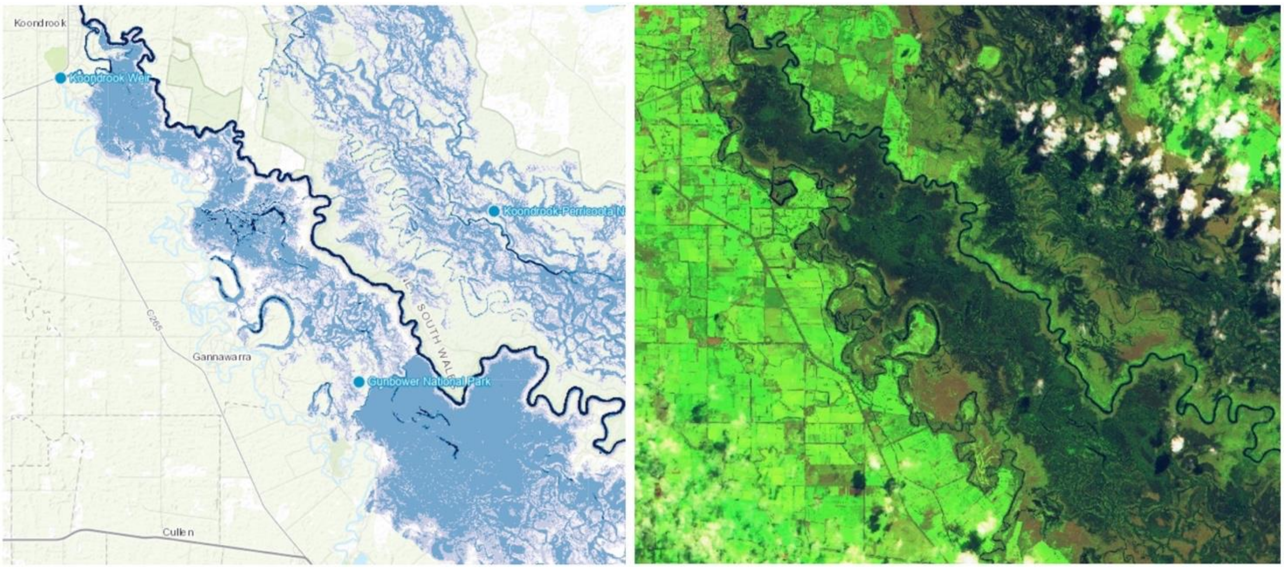


Figure 159 – Comparison of 40,000 ML/d modelled flows at Gunbower State Forest (Murray Yarrawonga to Wakool) (left) and SentinelHub imagery for 25 September 2022 with an average daily flow rate of 38,780 ML/d @ Torrumbarry on the right (MDBA)

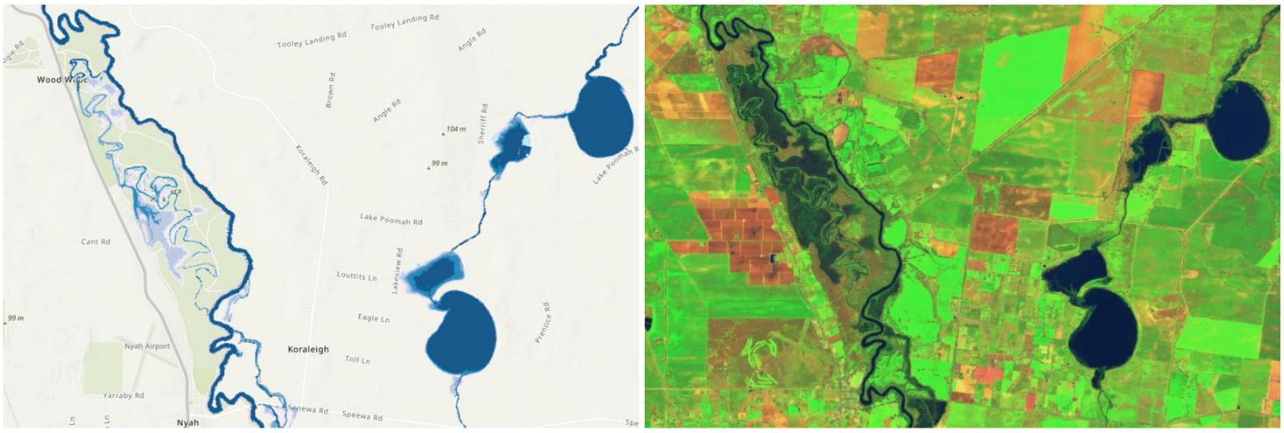


Figure 160 – Comparison of 25,000 ML/d modelled flows at Nyah-Vinifera National Park (Murray Yarrawonga to Wakool) (left) and SentinelHub imagery for 3 October 2022 with an average daily flow rate of 24,818ML/d @ Swan Hill on the right (MDBA)

During this stage of the Victorian CMP, review of the inundation mapping along both the Goulburn and Murray was targeted to a small number of landowners and stakeholders. Therefore, as part of further work for the Victorian CMP, there is an opportunity to obtain additional review of the modelled inundation extents by those who live along the Goulburn River and Murray River and those involved in managing the river systems. New South Wales DPE is developing a GIS-based method for systematically collating feedback from the community on modelled inundation extents. This approach could be replicated in Victoria if the CMP continues beyond this feasibility stage.

The Committee supports the further ground-truthing of the model outputs during one-on-one engagement with impacted landowners proposed for future stages of the program. This should be informed by the aerial and satellite imagery obtained during the higher flow event in September-October 2022 to present the 'real-life' observed inundation at the flow rates of interest.

"I think the issue of ground-truthing the model is very important"

15.5 Additional information opportunities

As well as broader consultation and ground-truthing modelled extents with landowners who live along the river, there are opportunities to further develop the hydraulic models along the Goulburn and Murray to leverage additional information.

Goulburn River

Aerial imagery of areas inundated during flows within the range of operational constraint relaxation being considered for the Mid Goulburn (10,000 ML/d – 14,000 ML/d) and Lower Goulburn (17,000 ML/d – 25,000 ML/d) was captured in late September and early October 2022. Therefore, if the Victorian CMP proceeds further, there will be an opportunity to further improve the Goulburn River hydraulic model by comparing predicted and recently observed inundation areas and refining the model calibration if needed. If model re calibration is warranted, LiDAR data captured by the GBCMA in 2021/22 and improvements made by Ventia in October 2022 to depth soundings captured from Eildon Dam to Goulburn Weir in June 2022 could also be incorporated into the model.

Murray River

The hydraulic model for Zone 2 of the Murray River does not include the Little Murray River or the confluence of the Loddon River. A priority therefore in future work would be to include these areas in the Zone 2 hydraulic model, and simulate the expected water level, inundation area and water depth during the scenarios considered in this stage of the Victorian CMP. This also aligns with the Consultative Committee's requirement for future focus on the tributaries and how they may be impacted under relaxed constraint scenarios.

16. Regulatory approvals

16.1 Key outcomes

Key outcomes:

- Delivery of the Victorian CMP is complex as it requires an understanding of hydrological, ecological and social systems over a large geographic scale within Victoria, New South Wales and South Australia
- The Program's regulatory environment is equally complex, because it covers multiple jurisdictional boundaries and requires involvement of regulatory authorities and approvals under both Commonwealth and State legislation
- The cross-border nature of the Murray River means that key approvals must be obtained under both Victorian and New South Wales legislation for the Murray River constraints measures to be delivered, whilst delivery of the Goulburn River constraint measures requires Victorian-based key approvals
- Both the Murray River and Goulburn River programs will require consideration under Commonwealth environmental legislation
- The current environmental approval process for a project of this scale, nature and cross-border interfaces is complex. As part of any future stage of the Victorian CMP, the New South Wales, Victorian and Commonwealth (as funder) Ministers must agree on the interjurisdictional approval framework across all states.
- A decision would be needed on the preferred regulatory approvals approach. Two feasible options have been identified:
  - **Pathway Option 1 - Program-wide strategic assessment:** the program would be assessed and approved with the Goulburn River and Murray River combined. The environmental assessment process would be addressed through a Strategic Assessment under Part 10 of the EPBC Act, which would rely upon agreements between the Commonwealth, New South Wales and Victorian Governments to establish an interjurisdictional process for assessing both Commonwealth and State environmental matters
  - **Pathway Option 2 – Separate assessment of Goulburn River and Murray River:** the program would be assessed and approved as two projects with the Goulburn River and Murray River considered separately. The separation could allow for separate proponents for each. A key difference to Option 1 is that a Strategic Assessment would not be prepared to assess Commonwealth environmental matters. Instead, each project would be assessed under state-based environmental assessment processes, such as an EES, with existing bilateral agreements used to accredit the State process to address Commonwealth environmental matters
- A decision is needed on who will be the proponent/s of the project/s. This will require a decision on governance arrangements for program delivery and consider the inter-jurisdictional nature of the project
- The regulatory approval pathways identified are expected to take in the order of 3 years to complete.

16.2 Overview

As part of this stage of the Victorian CMP, a preliminary Regulatory Approvals Strategy (Strategy) was developed to identify the key considerations and options for navigating key approvals for the program.

As explored throughout the feasibility study report, the program involves relaxing operational constraints at key locations across the Murray and Goulburn rivers to achieve inundation generally up to the minor flood level. This inundation aims to provide a range of local environmental, recreational, and cultural benefits within each river, as well as providing desired watering regimes to important downstream environmental assets. To manage the risk of impact from inundation to private and public land, and to identified assets, values and uses, inundation mitigation measures are proposed as physical works at certain locations across each river.

The Strategy is informed by a regulatory approvals perspective on the program's possible governance arrangements, proponent(s), and approach to program delivery (across scope, spatial and temporal contexts) and has considered the interdependencies of each aspect. Whilst the Strategy presents a regulatory approvals perspective on governance arrangements and potential proponent models, it is acknowledged that the program will need to consider many other factors that will contribute to the ultimate governance and proponent arrangements, which will likely require agreement between the Commonwealth, Victorian and New South Wales Governments.

The Strategy recommends two feasible pathways for navigating key approvals for the Program, either through a Program-wide Strategic Assessment or separate assessment of the Goulburn River and Murray River. The advantages and disadvantages of each option are outlined for consideration alongside other factors relevant to Program delivery outside of the Strategy.

The Strategy identifies the key considerations for navigating the key approvals for the program as:

- **Governance**: The Program should establish a system of governance that defines roles and responsibilities between the Program's complex set of stakeholders. The Program would benefit from formal arrangements between stakeholders including a Program Control Group, a key approvals working group, and the continuation of the community-centric co-design approach through subsequent stages
- **Proponent(s):** A proponent or proponents should be established early to ensure consistent decision-making across the planning, delivery, and operation of the Program. The proponent could be either the Commonwealth Government, the Victorian Government (for the Goulburn River only), or a combination of the Commonwealth, Victorian, and New South Wales Governments
- **Program delivery:** There are various options for scope, spatial, and temporal contexts to deliver the Program. The following approaches can be feasibly delivered:
  - The key approvals must consider changes to river operations together with the proposed inundation mitigation measures.
  - The Goulburn and Murray rivers can be considered separately or together.
  - The delivery of pilot inundation ahead of the main works would benefit the key approvals processes
- **Key approvals**: There are two feasible approvals pathways for the Program, as described above
- **Effects framework**: An effects framework has been drafted to provide an overarching framework for assessing the potential benefits and impacts of the Program, including cumulative effects.

The Strategy is included in Appendix G for further information.

16.3 Regulatory approvals context

Delivery of the Program is complex, as it requires an understanding of hydrological, ecological and social systems over a large geographic scale within Victoria, New South Wales and South Australia. The Program's regulatory environment is equally complex, as it, by nature of its geography, covers multiple jurisdictional boundaries and requires involvement of regulatory authorities and approvals under Commonwealth and State legislation.

The Goulburn River is located entirely within Victoria and its flows join the Murray River just upstream of Echuca and Moama. The Murray River largely defines the border between Victoria and New South Wales with its banks being within each state. The Murray River (including flows from the Goulburn River) flows downstream to reach South Australia at its borders with New South Wales and Victoria.

The approach to navigating regulatory approvals must consider how relaxing constraints on the Goulburn River would affect the Murray River, as well as how relaxing constraints on the Murray River could affect downstream reaches of the Murray, including within South Australia.

The cross-border nature of the Murray River means that key approvals must be obtained under both Victorian and New South Wales legislation for the Murray River constraints measures to be delivered, whilst delivery of the Goulburn River constraint measures requires Victorian-based key approvals. Both projects require consideration under Commonwealth environmental legislation.

The Victorian CMP must be considered in the context of the Basin Plan, and the other Basin Plan related projects that complement and support improved environmental outcomes.

As the Program scope is developed further, consideration should be given as to whether floodplain inundation will occur downstream of Wakool Junction and into South Australia. This area is currently not subject to assessment as part of this Strategy and associated feasibility study, however further system-level assessments should be undertaken to determine if inundation is likely to occur as a result of the program and if inundation mitigation measures would be required. Key approvals beyond what is outlined in the Strategy may be required if inundation mitigation measures are proposed downstream of Wakool Junction and into South Australia.

16.4 Program delivery options (regulatory approvals context)

From a regulatory approvals context, the options that were considered for the Strategy for program delivery include scope, spatial and temporal as described below. The advantages and disadvantages of each are explored in further detail within Appendix G.

- Scope: whether the components of river operations and inundation mitigation measures should be considered separately or combined.
- Spatial: whether the Program should be defined geographically as a single project encompassing both the Murray and Goulburn Rivers, or as multiple projects split across each river or river reach.
- Temporal: whether there are feasible and beneficial options to stage delivery of aspects of the program.

Following the preliminary assessment of the above, the feasible approaches to program delivery are summarised in Figure 161. These approaches will need to be considered in detail if the program should proceed to the next stage.

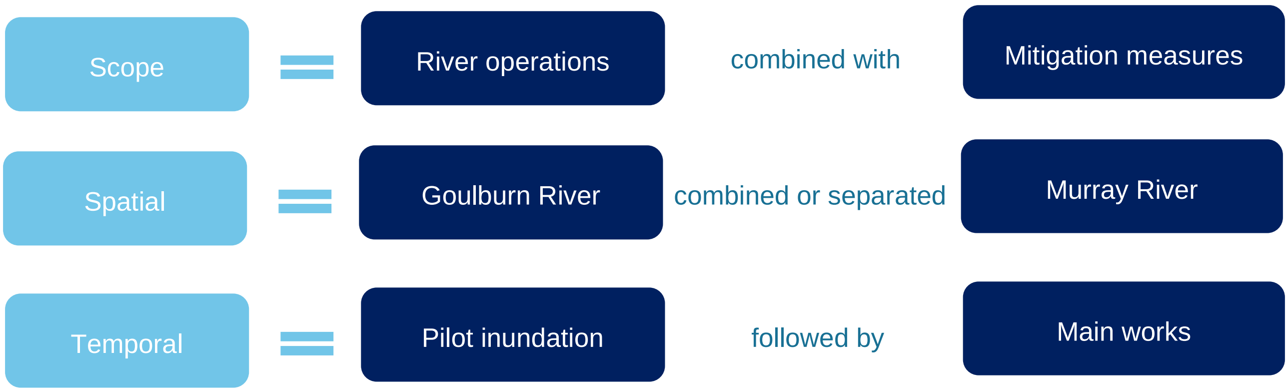


Figure 161 – Approach to program delivery

16.5 Proponent(s) for key approvals

A proponent or proponents should be established early to ensure consistent decision-making across the planning, delivery, and operation of the Program. From a statutory approvals perspective, the key considerations for determining the proponent(s) include:

- The proponent or proponents must be a legal entity that has been established under relevant legislation to allow for the appropriate level of accountability throughout the Program's lifecycle. This may either be an existing legal entity, or one established specifically to implement the Program
- The proponent or proponents must be able to deliver a project that is entirely within Victoria (the Goulburn project), as well as a project that spans both Victoria and New South Wales (the Murray projects)
- Given the scope of the Program is centred on changes to river operations, the proponent or proponents should include river operators responsible for the subject reaches
- The roles and responsibilities outlined in the Basin Plan for recovery of environmental water. Under the Basin Plan, the Commonwealth Government (including the MDBA) coordinates the management of water resources across the Basin, and the relevant State Governments (Basin States) are responsible for implementing the Basin Plan. Some responsibilities are shared between the Commonwealth Government and the Basin States.

The proponent(s) for the Program could either be the Commonwealth Government, Victorian and New South Wales Governments as standalone or combined, or the Commonwealth, Victorian and New South Wales Governments combined. The advantages and disadvantages for each of these options are detailed in Appendix G.

16.6 Key approvals

Key approvals for the program include:

- Commonwealth environmental approval under the EPBC Act (Cth)
- Victorian environmental assessment under the *Environment Effects Act 1978* (Vic)
- Victorian planning approval under the *Planning and Environment Act 1987* (Vic)
- Cultural Heritage Management Plan under the *Aboriginal Heritage Act 2006* (Vic).

Further background to the key approvals and secondary approvals relevant to the program are provided in Appendix G.

16.7 Pathway Option 1 – Program-wide strategic assessment

Under this pathway option, the program would be assessed and approved with the Goulburn River and Murray River combined to provide an integrated approach to assessing the Program’s direct, indirect and cumulative effects.

The environmental assessment process would be addressed through a Strategic Assessment under Part 10 the EPBC Act, which would rely upon agreements between the Commonwealth, New South Wales and Victorian Governments to establish a process that assesses both Commonwealth and State environmental matters.

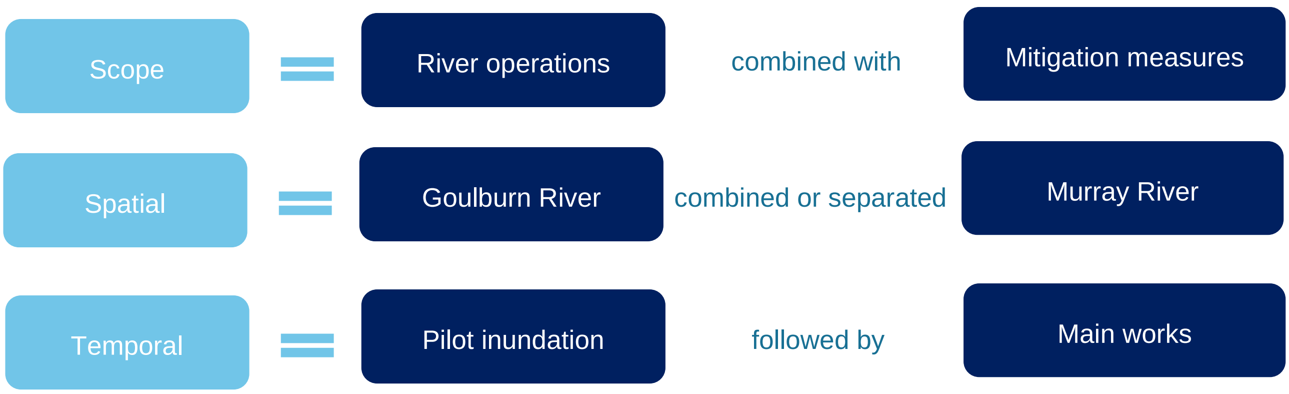
The Strategic Assessment process should be coordinated with other State-based key approvals, such as Planning Scheme Amendments and Cultural Heritage Management Plans to the extent possible.

This option could either be delivered by:

- a single Commonwealth Government led proponent
- a co-proponent model shared between the Commonwealth, Victoria and New South Wales Governments
- a co-proponent model shared between the Victorian and New South Wales Governments
- The co-proponent model could be facilitated by the establishment of a special purpose vehicle.

A pilot inundation program could be implemented to deliver a smaller increase in flow limits to provide a ‘proof-of-concept’ and inform community engagement on the basis of demonstrable benefits and managed impacts. A separate Pilot Inundation Approvals Strategy should be prepared to guide the scope and extent of any pilot inundation program.

Figure 162 provides a summary of the pathway option which is explored in more detail within Appendix G. The high-level indicative schedule for Option 1 indicates that the key approvals process could be completed within approximately 35 months, noting that the Murray River constraints measures is dependent on successful project and regulatory engagement between Commonwealth, New South Wales and Victorian Governments.



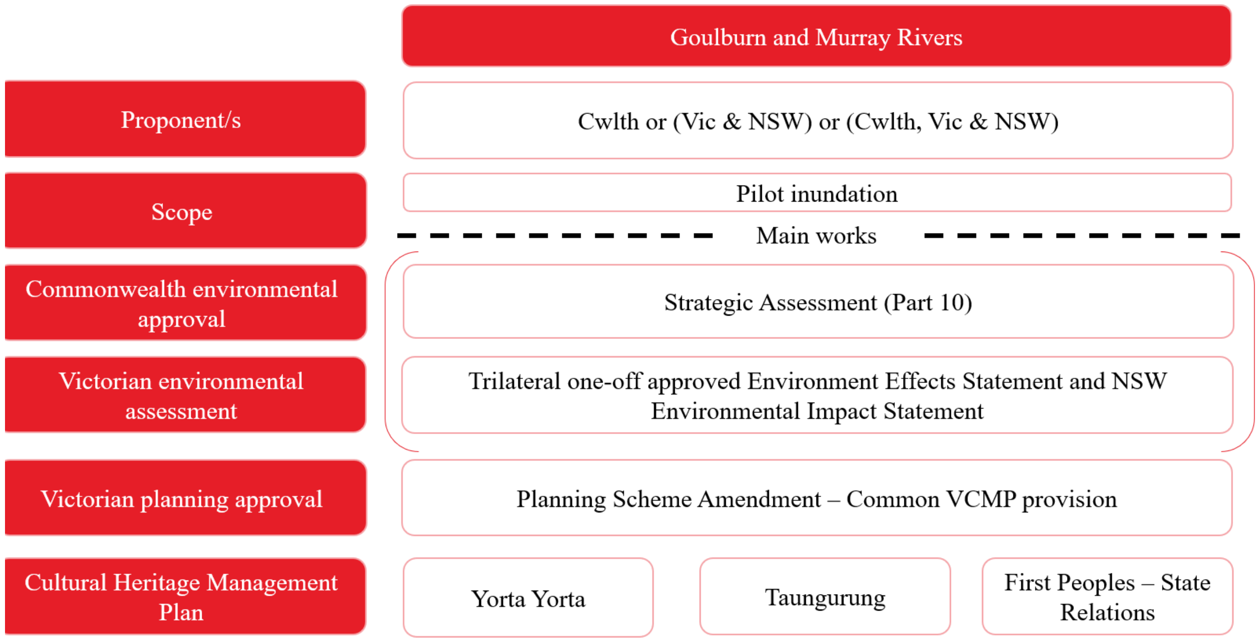


Figure 162 – Approvals approach Option 1 (From Arup 2022 – Appendix G)

16.8 Pathway Option 2 – Separate assessment of Goulburn River and Murray River

This pathway option is distinct to Option 1 as it assumes the Program would be assessed and approved as two projects with the Goulburn River and Murray River considered separately.

The separation of the Goulburn River and Murray River could potentially allow for separate proponents for each project. For example, the proponent for the Goulburn River could be either the Commonwealth and/or Victorian Governments, while the proponent for the Murray River could be either the Commonwealth or a co-proponent model similar to the Program-wide approach.

A key difference to Option 1 is that a Strategic Assessment would not be prepared to assess Commonwealth environmental matters. Instead, each project would be assessed under state-based environmental assessment processes, such as an EES, with existing bilateral agreements used to accredit the State process to address Commonwealth environmental matters.

As with Option 1, other State-based key approvals, such as Planning Scheme Amendments and Cultural Heritage Management Plans, should be progressed alongside, rather than following completion of, the Commonwealth environmental assessment process.

The potential to implement a pilot inundation program is common across both options and should be explored further to provide a proof-of-concept and inform community engagement on the basis of demonstratable benefits and managed impacts. A separate Pilot Inundation Approvals Strategy should be prepared to guide the scope and extent of any pilot inundation program.

Figure 163 provides a summary of the pathway option which is explored in more detail within Appendix G. The indicative schedule for Option 2 indicates that the key approvals process could be completed within approximately 31 months for the Goulburn River Project, and 36 months for the Murray River Project, noting that the Murray River constraints measures program would be require successful project and regulatory engagement between Commonwealth, New South Wales and Victorian Governments.

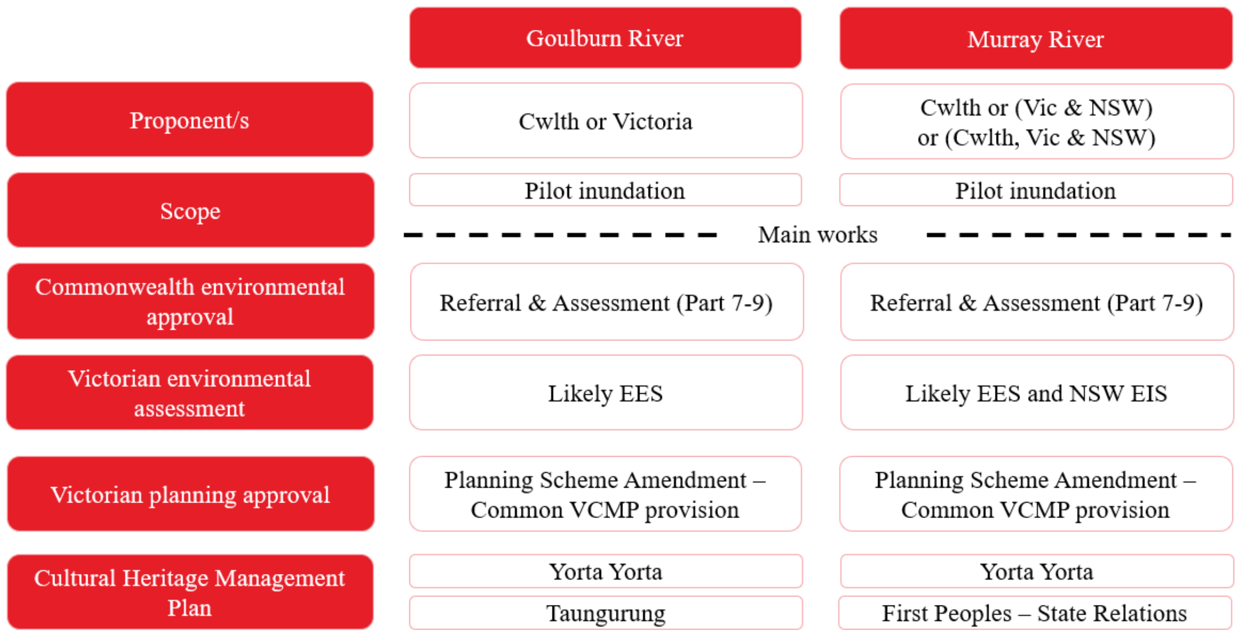


Figure 163 – Approvals approach Option 2 (From Arup 2022 – Appendix G)

16.9 Comparison of approvals approaches

From a statutory approvals perspective, both proposed pathway options are feasible options to navigate the key approvals for the Program.

The key advantages and disadvantages of each option are outlined in Table 77 and should be considered alongside other elements of program development in selecting a preferred approach.

Table 77 – Comparison of approvals options

Option	Advantages	Disadvantages
Option 1: Program-wide Strategic Assessment	• Provides for assessment, approval of the Program at an appropriate landscape scale • Avoids need for separate Commonwealth referrals to be prepared for each project • Potential to coordinate the State based environmental assessment processes with the EPBC Act Strategic Assessment	• Introduces risk that the overall schedule is reliant on the slowest component of the Program to obtain approval, therefore not allowing potential efficiencies with delivering less complex aspects of the Program separately • Significant time and cost to prepare Strategic Assessment covering both rivers • Significant community engagement exercise to seek the views of impacted parties across both rivers
Option 2: Separate assessment Goulburn River and Murray River	• Allows each individual project to be delivered without its progress being contingent on the delivery of the other project • State-based environmental assessment processes can be accredited to address EPBC Act matters in a combined manner.	• Requires coordination between separate projects and assessment processes to ensure cumulative effects are appropriately assessed

16.10 Effects framework

Regardless of the preferred approval pathway option, it is crucial that the approach to assessing the potential benefits and impacts of the program, including cumulative effects, is well established by the program and regulatory authorities.

An effects framework has been prepared to provide an overarching framing of the hydrological, ecological, cultural heritage and socio-economic (including any potential land use change) effects of the program.

The effects framework will establish how to assess and then monitor, evaluate and report on the effects through the program's lifecycle and in accordance with regulator guidelines.

Figure 164 provides a simplistic representation of the key aspects of the program that require consideration through the effects framework. It illustrates how each aspect relate on a geographic and temporal scale, including:

- Environmental water: Is the key operational input for the program, which is defined by the volume, frequency timing and duration of environmental water delivery in the context of the statutory Commonwealth and State environmental water frameworks
- Assets, values and uses: Existing high value aspects that will be identified to inform assessment of the Program's direct, indirect and cumulative effects
- Inundation area: Is the land which will be subject to inundation by the environmental water delivery. This land will be subject to a change in the frequency, timing and duration of inundation, relative to the existing regulated river. It will include inundation of public and private land
- Inundation mitigation measures: Are the physical works that will be implemented to manage risk of inundation to private and public land, and to identified assets, values and uses
- Cumulative effects: Will be identified and assessed on transverse and longitudinal scales within each river and downstream to the Murray River mouth.

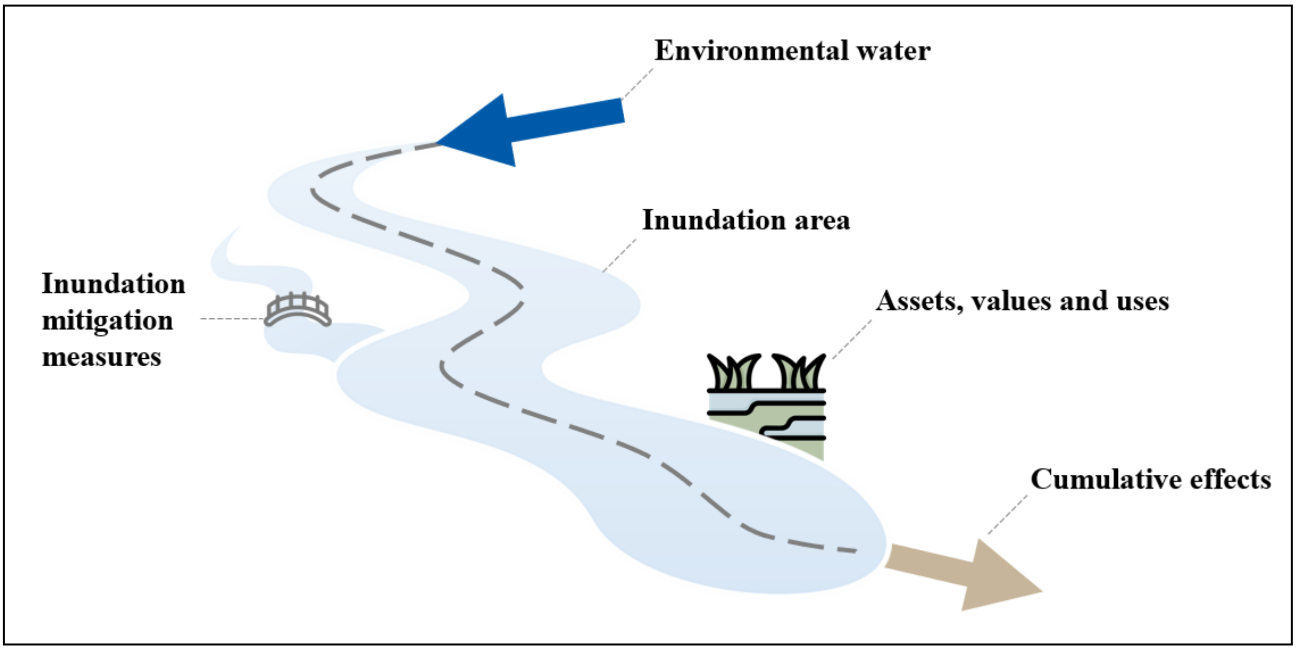


Figure 164 – Effects framework

Table 78 demonstrates how each aspect of the effects framework would be identified and assessed to ensure the approach provides a suitable geographic and temporal scale. The assessment approach outlined in Table 78 can be applied through the key approvals process regardless of whether pathway option 1 or pathway option 2 is progressed further.

Table 78 – Effects framework assessment approach

Aspect	Extent	Assessment approach	Examples
Environmental water	Within the study area and downstream to Murray Mouth	Environmental water delivery	Define the volume, timing, frequency and duration of environmental water delivery
Assets, values and uses	Within study area and downstream to Murray Mouth	Initial desktop screening assessment	Identify listed wetlands and National Parks
Inundation area	Up to approximately 60,000 ha[1]	Landscape scale assessment of effects	Cultural values assessment Socio-economic assessment
Inundation mitigation measures	Physical works to manage risk of inundation	Site specific assessment of impacts	Cultural Heritage Management Plan Planning permit assessment Habitat hectare assessment
Cumulative effects	Downstream to Murray Mouth	Landscape scale assessment of cumulative effects	Assessment of residual effects of the Program and related existing projects

[1] based on the highest degree of constraint relaxation (hydraulic inundation area) under investigation for each reach in this feasibility study stage.

16.11 Next steps

The current environmental approval process for a project of this scale, nature and cross-border interfaces is complex. As part of any future stage of the Victorian CMP, the New South Wales, Victorian and Commonwealth (as funder) Ministers must agree on the interjurisdictional approval framework across all states.

The Strategy identified key next steps for consideration to progress the key approvals for the program. Broadly these include the following activities:

- Continued early and ongoing engagement with regulatory authorities and key stakeholders, including the Commonwealth, New South Wales and South Australia.
- Further development of the approach to delivering the program, including governance models, operational scenarios and consideration of a pilot inundation program
- Early identification of the program's assets, values and uses that can be used to inform development of an effects framework to frame the program's benefits and adverse impacts
- Commencing referral self-assessments informed by assets, values and uses.
- Revalidation of the regulatory approvals strategy as the program scope develops, including with regard to the potential for floodplain inundation downstream of Wakool Junction.

It is anticipated that these considerations will form part of the Constraints Roadmap to be developed as part of the commitment under the *Water Amendment (Restoring Our Rivers) Act 2023*.

17. Risk management

Key Victorian CMP implementation risks have been identified through the Consultative Committee discussions, research, and prior experience before being supplemented with input from key stakeholders during a workshop. Subject-specific risks, particularly river operations, have also been identified as part of the relevant workstreams and are not captured within the key project risks.

The anticipated mitigation strategy for each key risk has been identified that needs to be considered if the Program is to proceed to the next stage.

The identified risks and mitigations are shown in Table 79.

Table 79 – Key program risks

Risk	Description	Mitigations
Inability to implement the program in line with the legislated Basin Plan deadline	The *Water Amendment (Restoring Our Rivers) Act 2023* was enacted at the end of the Committee's tenure which extended the completion date of the SDLAM projects to 31 December 2026. If the full implementation of the Victorian CMP cannot be achieved by this time, there is a risk that the Commonwealth Government will not accept this program, and funding will not be available over the time required for delivery. This may result in alternate mechanisms for Commonwealth Government water recovery for any SDLAM shortfall, including water buybacks. The Consultative Committee is resolute that further buybacks from the consumptive pool will negatively impact Northern Victorian communities and the broad majority believe that suitable solutions to manage the impacts of constraints relaxation can be achieved by embracing local knowledge through close community co-design and engagement.	Clear communication with Commonwealth and Basin states regarding the required implementation timeline in line with planning approval requirements and community expectations Staged approach to delivery with critical outcomes and decision points Development of the Constraints Road Map as part of the commitment under the *Water Amendment (Restoring Our Rivers) Act 2023* Community co-design through all delivery phases to ensure the program reflects and recognises community concerns and local knowledge
Inability to achieve 100% voluntary landowner acceptance	The current Victorian government position is that landowners will not be inundated without prior approval and that there will be no compulsory easements. The Consultative Committee has identified a risk that, given the number of landowners requiring consultation and agreement, not all landowners will voluntarily agree, resulting in the program being unable to be implemented. There will also be instances where there will be difficulties contacting landowners (e.g., absent landowners, deceased estates etc.), which will impact acceptance levels and program timing. River operators are also concerned about the liability implications if suitable easements were not in place for all land	Transparent, robust and equitable mitigation and compensation approach Governments (State and Commonwealth) should agree to reserve the right to use compulsory powers. This should only be where inundation of private land has been avoided as far as practical, and where transparent compensation approaches are in place, all voluntary options have been exhausted, and there are overwhelming environmental outcomes (greater public good). The use of a Consultative Committee, including landowner representatives, to assist in the development of detailed mitigation and compensation arrangements and associated communication materials

Risk	Description	Mitigations
	that might be affected by proposed environmental flows.	Engagement framework to deliver consistent and equitable consultation with all impacted parties Mitigation and compensation framework includes consideration of mediation avenues Landowner access to payments for legal and professional advice to provide a greater understanding of what the program will mean to the individual property Experienced engagement staff to undertake consultation activities, supported by transparent, consistent communication materials Policy considerations to be included as part of the Constraints Roadmap to be developed under the *Water Amendment (Restoring Our Rivers) Act 2023*
Articulating the benefits of the Victorian CMP	The Consultative Committee recognises the complexity of this program. There is a risk that the benefits are not clearly articulated which may result in community misunderstanding of the project and a lack of broader support.	Clear communication strategy that focuses on the benefits as well as the impacts and associated mitigation measures for affected landowners and interested parties Inclusion of landowner representatives on a Consultative Committee to provide inputs to the development of key future communication materials Further technical investigations to assess areas of particular concern to the Consultative Committee, such as erosion and carp populations and distribution.
Regulatory approvals	Due to the large geographical spread of the Victorian CMP, the ecologically, culturally, and socially rich areas which are within the project area, and the nature of the impacts and benefits, multiple and complex statutory approvals will be required, including the jurisdiction of several States and the Commonwealth Government. There is a risk to project cost and timelines if regulatory authorities require extensive investigations, documentation, and approvals. There is also the potential that the regulators may impose approval conditions that would lead to the project not being feasible for implementation.	Early engagement with regulatory authorities to build a joint understanding of the environmental benefits of the project, what impacts may be experienced, and identify the most efficient path for considering and managing those impacts Coordination of the project approval approach with New South Wales, South Australia and the Commonwealth Government. Regulatory approval considerations to be included as part of the Constraints Roadmap to be developed under the *Water Amendment (Restoring Our Rivers) Act 2023*
The large volume of landowner	The number of private properties inundated is a key indicator of the deliverability of the Victorian CMP as it	Realistic timelines to allow for genuine engagement and negotiation

Risk	Description	Mitigations
agreements to be negotiated	reflects how many agreements will need to be successfully negotiated with the landowners and agreed mitigations subsequently delivered. Due to the large number of impacted landowners suggested by the inundation modelling and the time required to engage, negotiate an agreement and complete mitigation works, there is a risk to implementation timelines.	Engagement and compensation framework to deliver consistent and equitable consultation with all impacted parties Appropriately resourced program Experienced engagement staff to undertake consultation activities, supported by transparent, consistent communication materials Development of pragmatic policies to identify modelled outcomes which are unlikely to result in inundation or impacts that are in the interest of landowners and government to seek to mitigate
Valuer general process and ability to resource valuation requirements	Under the *Victorian Government Land Transactions Policy (2022),* the determination of payments for independent landowner advice, option fees, easement consideration or land purchase must be made by the VGV. There is a risk that the landowner's expectations associated with compensation for losses and damage because of inundation are not met by the Valuer General process. There is also a risk of inconsistent loss valuation methodologies being used across landowners. There is also a risk of inadequate VGV resources to undertake the large number of valuations required, resulting in program delays and landowner frustration.	Early engagement with the Valuer General's office regarding the project and associated future resourcing requirements Development with the VGV of a consistent and transparent valuation framework to be utilised for all compensation calculations Involvement of the Consultative Committee in the development of the valuation framework to ensure that community concerns and knowledge are considered Clear communication of the valuation framework in all engagement material
Coordination across cross-jurisdictions	Relaxation of constraints along the Murray River will impact communities in Victoria, New South Wales and South Australia. There is a risk that project timing, engagement, compensation and management processes do not align across state jurisdictions resulting in landowner confusion and dissatisfaction with the programs.	Collaboration between the Victorian CMP and New South Wales Reconnecting River Country Project through regular project meetings and co-ordination of approaches where possible Consistency (where possible given differences in legislative frameworks) in approaches to compensation and mitigations for landowners to ensure equity across both sides of the river Considerations to be included as part of the Constraints Roadmap to be developed under the *Water Amendment (Restoring Our Rivers) Act 2023*
Impact of 2022 floods on community perception of the Victorian CMP	Although the flow scenarios being considered by the Constraints program are well below those experienced through Northern Victoria during the 2022 floods, there is a risk that the community may confuse the Victorian CMP with the effects experienced during the floods.	Clear communication strategy that focuses on the benefits as well as the impacts and associated mitigation measures for affected landowners and interested parties Communication materials will also explain the difference between Victorian

Risk	Description	Mitigations
	This may result in the community not accepting the program	CMP flows of interest and those experienced during the 2022 floods Inclusion of landowner representatives on a Consultative Committee to provide inputs to the development of key future communication materials Timing engagement so it is mindful and sensitive to the flood recovery efforts in affected communities Considerations to be included as part of the Constraints Roadmap to be developed under the *Water Amendment (Restoring Our Rivers) Act 2023*
Lack of agreed roles and responsibilities across landscape-scale environmental water planning and consultation process	There are many agencies and parties that would be involved in the planning, consultation, and delivery of environmental watering events across multiple catchments. Due to the multiple-agency approach, there is a risk that without clear roles and responsibilities for all aspects that there may be the inability to quickly plan complex events over one or more river systems and/or missed environmental watering opportunities. There is also the risk of inadequate communication with the wider community and impacted landowners if roles and responsibilities are unclear.	Consultation and coordination with agencies and organisations involved to clearly outline roles and responsibilities, including financial, communication and timing aspects Policy considerations to be included as part of the Constraints Roadmap to be developed under the *Water Amendment (Restoring Our Rivers) Act 2023*
River operator acceptance	Even with better tools and forecasting, future river flows will still have an element of uncertainty and will never be 100% precise. This may leave river operators legally and reputationally exposed through inadvertent inundation of property. There is also a risk that due to unclear cross-jurisdictional liability, river operators may be unable to deliver relaxed constraint flows.	Close coordination with river operators through the development of tools and controls Modelling of the sensitivity of flow buffers Appropriate buffers included in easements Legislation provisions to give clear power to be able to deliver overbank environmental flows Development of a clear decision framework that provides river operators with authority to work within the adopted risk tolerance Collaboration with the EEWD Project Adaptive approach to implementation

Appendix A Hydrology assessment

1. Stage 1A of the Victorian Constraints Measures Program, Hydrology Synthesis Report, HARC, September 2023
2. Stage 1A of the Victorian Constraints Measures Program, SGEFM updates, Goulburn range-finding exercise, and climate vulnerability analysis, The University of Melbourne, August 2022
3. GBBCL Source Model, Modelling for Constraints Measures Program, the Department of Environment, Land, Water and Planning, Surface Water Assessment and Modelling, Water Resource Strategy, October 2023.
4. Murray Constraints Modelling to inform Victorian Constraints Measures Program: Methodology, assumptions and key outcomes, Technical Report No. 2022/15, MDBA, December 2022

Appendix B Hydraulic assessment

1. Stage 1A of the Victorian Constraints Measures Program, Synthesis Report – Hydraulic Modelling, September 2023
    a. Appendix A: Goulburn River Hydraulic Modelling
    b. Appendix B: River Murray Hydraulic Modelling – Hume to Yarrawonga (Zone 7), MDBA
    c. Appendix C: River Murray Hydraulic Modelling – Yarrawonga to Tocumwal (Zone 8), MDBA
    d. Appendix D: River Murray Hydraulic Modelling – Barmah-Millewa (Zone 1), MDBA
    e. Appendix E: River Murray Hydraulic Modelling – Barmah to Torrumbarry (Zone 9), MHL
    f. Appendix F: River Murray Hydraulic Modelling – Koondrook-Perricoota (Zone 3), MDBA
    g. Appendix G: River Murray Hydraulic Modelling – Wakool River Reach (Zone 2), MDBA
    h. Appendix H: River Murray Hydraulic Modelling – Niemur-Murray-Boundary Bend, MDBA
    i. Appendix I: Main Stem and tributary interactions, HARC

Appendix C Environmental assessment

1. Environmental Benefits and Risks Report, Stage 1A of the Victorian Constraints Measures Program, Final Report, Alluvium, October 2023

Appendix D Cultural values engagement

1. Cultural Values Engagement Report, Stage 1A of the Victorian Constraints Measures Program, Final Report, Alluvium, October 2023

Appendix E River operations

1. River Operations Report, Stage 1A of the Victorian Constraints Measures Program, Final, Sequana Partners, December 2022

Appendix F Goulburn River hydrometric network upgrades

1. Goulburn Hydrometric Network Upgrades Report, Stage 1A of the Victorian Constraints Measures Program, Final, Sequana Partners, December 2022

Appendix G Regulatory approvals strategy

1. Victorian Constraints Measures Program, Regulatory Approvals Strategy – Stage 1A, ARUP, December 2022

Appendix H Alignment with Basin Plan principles

The MDBA Constraints Management Strategy[118] includes overarching principles that were central to its development and to guide its roll-out. The alignment of the Victorian CMP to these principles is shown in Table 80 below.

Table 80 – Alignment of the Victorian CMP with the MDBA Constraints Management Strategy Principles

MDBA Constraints Management Strategy Principle[119]	Victorian CMP alignment
The Strategy aims to maximise environmental outcomes that can be obtained from managing all water available for environmental use (and managing water for other purposes on route).	The hydrological modelling demonstrates that the Victorian CMP will enable greater use of the environmental water portfolio to address Goulburn and Murray environmental watering demands (refer to Section 14). The environmental modelling shows that relaxing constraints will provide the opportunity to achieve greater environmental benefits along the Goulburn and Victorian Murray (refer to Section 8)
Affected communities, including land holders and managers, water entitlement holders, Traditional Owners, management agencies and local government need to be involved from the beginning to identify potential impacts and solutions.	The Victorian CMP has been delivered with a community-centred approach that places the people impacted by change at the centre of providing advice to the Minister. To achieve the community-centred objectives of this stage of the Victorian CMP, a Consultative Committee was established to provide the Minister with advice on the benefits, risks and design of the Program. Refer to Section 4 for further information about the Committee and its considerations. The continuation of the Consultative Committee is a key aspect of governance for any future delivery.
In pursuing environmental outcomes through the relaxation or removal of constraints, solutions need to:	
recognise and respect the property rights of landholders and water entitlements holders	The Compensation and Mitigation framework has been developed specifically in recognition of landowner property rights (Section 9). The Victorian CMP modelling demonstrates that the reliability of allocations to water entitlement holders is expected to be virtually unchanged by constraint relaxation (refer to Section 14)
not create any new risks on the reliability of entitlements	The Victorian CMP modelling demonstrates that the reliability of allocations to water entitlement holders is expected to be virtually unchanged by constraint relaxation (refer to Section 14)
be identified in consultation with affected parties to determine if impacts can be appropriately addressed and mitigated to enable changes to proceed	The Compensation and Mitigation framework has been established with the Consultative Committee. A key principle of the framework is that affected parties will be best placed to identify measures that could most effectively mitigate their impacts (Section 9.4). The Consultative Committee recommends that in any future stage, all impacted landowners will require one-on-one

[118] MDBA (2013). Constraints Management Strategy 2013 to 2024 https://www.mdba.gov.au/sites/default/files/pubs/Constraints-Management-Strategy.pdf

[119] MDBA (2013). Constraints Management Strategy 2013 to 2024 https://www.mdba.gov.au/sites/default/files/pubs/Constraints-Management-Strategy.pdf

MDBA Constraints Management Strategy Principle[119]	Victorian CMP alignment
	consultation to assess the potential effects and mitigation options.
identify and aim to achieve net positive impacts for the community	The Compensation and Mitigation framework has been established in consultation with the Consultative Committee (Section 9), and considerations have been made about the socio-economic impact of the Victorian CMP (Section 7). The Consultative Committee recommends that in any future stage, all impacted landowners will require one-on-one consultation to inform a detailed cost-benefit assessment at a system-level scale.
be worked through in a fair and transparent/equitable way	A proposed Compensation and Mitigation Framework has been designed to be transparent in its approach to enable consistency in its application for all impacted landowners (Section 9). The Engagement Framework developed with the Consultative Committee to guide engagement during future stages is also explicit that engagement must be transparent and equitable in its approach (Section 5.2.2).
work within the boundaries defined by the Water Act, the Basin Plan and relevant state water access and planning systems.	The Victorian CMP has been developed in close collaboration with MDBA, GMW and DEECA to consider the requirements under the legislation, particularly regarding river operations and regulatory approvals. This is further discussed in Sections 12 and 16.
All water holders, whether existing consumptive users or environmental water holders, should be able to use their water efficiently to meet the needs of that use while not adversely affecting other entitlements.	The hydrological modelling demonstrates that the Victorian CMP will enable greater use of the environmental water portfolio to address Goulburn and Murray environmental watering demands (refer to Section 14). The Victorian CMP modelling demonstrates that the reliability of allocations to water entitlement holders is expected to be virtually unchanged by constraint relaxation (refer to Section 14)
Potential changes will be worked through with relevant Basin governments and relevant stakeholders to resolve issues before changes to river management practices or on-ground arrangements are made.	Significant consultation has been undertaken with MDBA, GMW and DEECA regarding river management risks and required considerations for river management practices (Section 12)
Decisions to proceed with removing constraints will be made by Basin governments with investment being decided by the Commonwealth on the collective advice of governments. Investment should:	
be prioritised on addressing the constraints that will provide the best Basin-wide environmental outcomes, taking into account economic and social considerations	The scope of the Victorian CMP is to identify Victorian environmental outcomes and associated risks and benefits to Victorian communities. While socio-economic considerations have been made (Section 7), future stages will undertake detailed assessments based on one-on-one landowner engagement to fully capture the required mitigation at an individual landholding level. The Consultative Committee requests that a system-wide assessment be

MDBA Constraints Management Strategy Principle[119]	Victorian CMP alignment
	considered to determine the socio-economic impacts of the broader MDB Constraints program.
focus on lasting solutions to provide certainty and protection to stakeholders over time.	A key principle of the Compensation and Mitigation framework developed with the Consultative Committee is that mitigations must be enduring to reflect the permanent change in river operation arrangements (Section 9.4). Key risks and associated mitigations have also been considered to provide greater certainty in river operations under relaxed constraints (Section 12).
be focussed on avoiding and addressing any impacts to third parties.	Impacts to third parties are considered within the proposed Compensation and Mitigation framework (Section 9). Details of potential third-party impacts would be determined in the next stage if the Victorian CMP progresses.