New Goulburn Constraints Measure

Business Case

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Cover photos: Lower Goulburn aerial photo and in channel (Goulburn Broken CMA)

Glossary of terms

Anabranch

A stream that leaves a river and re-enters it further along its course.

Base flows (or low, in-channel flows)

Continual flows in parts of the channel that maintain aquatic habitat for fish, plants and invertebrates. Base flows comprise long-term seasonal flows and are usually delivered throughout the year as low volume (<1,000 ML/day at Shepparton) surface flows.

Basin Plan

The Basin Plan, MDBA, 2012 sets limits on the amount of water that can be taken for use from the Basin, known as Sustainable Diversion Limits (SDLs), which come into effect in 2019. Basin-wide, the sustainable diversion limits are set to recover 2,750 GL of water for the environment.

Bank-full flows

Larger flow events (up to 14,000 ML/day at Goulburn Weir) that fill the river channel and may inundate flood-runners in low-lying areas of the floodplain. These flows are important for maintaining bed diversity, native fish recruitment and colonisation, regeneration of native riparian species and to retain natural seasonality for macroinvertebrate life stages.

Flood runner

A small anabranch which flows only during periods of high flow in the stream it branches from
High flows

Generally connect most in-channel habitats and are less than bank-full and may include flow in minor floodplain channels. These flows inundate instream habitats, maintain channel connectivity and allows fish migration, inundation of organic matter and sediment movement.

In-channel fresh events

Small-to-medium flow events (up to 8,500 ML/day at Shepparton) which inundate benches within the river channel, replenish soil water for riparian vegetation, provide cues for fish spawning and access to a diversity of habitat for aquatic biota. They are relatively short in duration (up to 14 days) and occur in most years and possibly multiple times within a year.

Offsets

The Basin Plan adjustment mechanism allows for up to 650 GL of the Basin Plan's water recovery target to be achieved through "offsets" from projects that deliver equivalent environmental outcomes without the need for more water. Projects may include environmental works and measures, or operational rule changes.

Overbank flows

Larger flow events that fill the river channel and low parts of the floodplain. They are important for a range of floodplain processes to occur e.g. healthy wetland systems that support fish and waterbird breeding, as well as the transfer of food and organic material that support productive instream foodwebs (MDBA, 2014; GBCMA, 2015).

Executive summary

Victoria recognises that addressing flow constraints for environmental outcomes is an important part of the Basin Plan. Addressing constraints will allow for higher flows to achieve environmental benefits to the entire River Murray system.

In doing so, the Victorian Government recognises that any relaxation of constraints will pose third party related risks which can impact public and private land, infrastructure, stock and people. Victoria's policy remains that it will not intentionally flood people's land without prior agreement, nor will we compulsorily acquire land or easements.

On 16 June 2017 at the Murray-Darling Basin Ministerial Council meeting Ministers endorsed the final package of environmental works and measures to be included in the Sustainable Diversion Limit Mechanism. Basin Governments agreed to notify five constraints projects as supply measures, including Hume to Yarrawonga, which is a joint proposal between Victoria and NSW. The original Goulburn River constraints project (April 2016) was withdrawn as a supply measure in June 2017.

Victoria is committed to developing a new Goulburn project in a staged and bottom-up way to build confidence of landholders and the community that environmental water can be delivered more efficiently.

The project will initially investigate opportunities to address in-channel constraints only. Allowing the delivery of flows approaching the top of the bank, will improve river health outcomes including for birds, native fish, frogs, macroinvertebrates, vegetation and water quality

The current operational water delivery limit at Shepparton is 8,500 ML/day. The project aims to enable the delivery of higher in-channel flows of up to 20,000 ML/day (17,000 ML/day target with a 3,000 ML/day unregulated flow risk management buffer). The project will work with communities to understand the risks, impacts and costs, and develop feasible, practical and acceptable solutions to mitigate third party impacts. Victoria proposes to:

a) Undertake extensive community engagement and one on one landholder consultation;

b) Expand the capacity to monitor rainfall and streamflow;

c) Develop new tools that support improved water delivery operations and management;

d) Undertake technical investigations to build better understanding of risks and uncertainties;

e) Develop more informed assessment of potential impacts and mitigation costs;

f) Trial and monitor higher in-channel flow rates in an incremental way once mitigation measures are in place; and

g) Plan for investigations and implementation over a longer time-frame.

Building on this work, in close consultation with affected landholders and communities, further improvements to environmental water delivery will also be investigated. Landholder acceptance of potential mitigation activities will be critical.

At the March 2016 meeting of the MDB Ministerial Council, Ministers emphasised the importance of Basin states working together to integrate their proposals for measures to ease river flow constraints, and ensure that community consultation is effective in identifying and

developing options that mitigate any third party impacts. This Business Case is consistent with this Ministerial position.

This business case draws on the outcomes of the earlier Goulburn Constraints Measure feasibility investigations. It assesses the potential impacts to private and public land and assets arising from the proposed increased in-channel flows and examines possible mitigation options and costs.

Site description and values

The Goulburn River is 570 km long, flowing from the Great Dividing Range upstream of Woods Point to the River Murray east of Echuca. The river and its associated floodplain and wetlands support a variety of native vegetation communities and provides important habitat for fauna including water birds and native fish. Due to its significant environmental values, it has been identified as a high priority waterway in the Goulburn Broken Waterway Strategy 2014 – 2022, is listed on the Directory of Important Wetlands in Australia and stretches of adjacent land have been reserved as National and Regional Park (GBCMA 2015). Water resource development in the Goulburn catchment underpins the region's economy and is vital for sustaining the region's urban centres. The river and its floodplain also support a variety of recreational activities such as camping, fishing and boating.

Changes to hydrology

Flow along the Goulburn River has been highly modified by two major features; Lake Eildon and Goulburn Weir. Lake Eildon has a large storage capacity of 3,334 GL. Water released from Lake Eildon is diverted for irrigation purposes and used to provide managed environmental flows. The lake supplies a significant proportion of the water used in the Goulburn Murray Irrigation District.

With such a large storage capacity, operation of Lake Eildon fully regulates downstream flows in all but wet years. For example, under current conditions, flow events at McCoy Bridge of 15,000 ML/d:

- are nearly 50% less frequent compared to unregulated conditions;
- are 65% shorter duration compared to unregulated conditions; and
- have a maximum period between events that is 2.5 times longer compared to unregulated conditions

The volume, frequency and duration of in-channel flows are now less than what is needed to maintain the health of the lower Goulburn River.

Current condition

The Goulburn River and its floodplain are water dependent ecosystems that depend on flow variability and flooding to sustain its values. Regulation of the river has changed the seasonal flow pattern disrupting the natural cycles of feeding, growing and breeding for many plants and animals. Because of this, many native species associated with the Goulburn River have significantly declined.

The wider Goulburn River catchment now supports reduced diversity, abundance and range of native fish species. Similarly, the floodplain now supports a less diverse plant structure, limiting shelter for a range of species such as breeding zones for frogs and yabbies and nesting platforms for waterbirds. Loss of water habitat reduces the opportunity for water bird breeding, and feeding areas for diving species such as cormorants.

Proposed changes

Environmental water deliveries are currently constrained to 8,500 ML/day at Shepparton. The new Goulburn Constraints Measure will build on and enhance the environmental benefits achieved within current operating constraints by aiming to restore the volume, frequency and duration of in-channel flows (freshes, high flows and bank-full flows) of up to 17,000 ML/day (with a 3,000 ML/day unregulated flow risk management buffer).

Operating strategy

The Goulburn River is fed by many unregulated tributaries (e.g. Yea River, Acheron River, Seven Creeks, Broken River). The steep topography of the Dividing Range means that runoff into the tributaries and water levels in the Goulburn River can rise quickly.

Water operations and control of these high unregulated flows is difficult because of the limited water management infrastructure operated in the Goulburn River. Management options comprise controlling releases from Eildon Dam, capture and release of water at Goulburn Weir [1](25,000 ML storage) and diversions to Waranga Basin (432,000 ML storage) via channels with a maximum capacity of 7,200 ML/day. These storages are primarily managed for storage and delivery of consumptive and environmental water. Goulburn weir also has significant recreational values e.g. rowing courses, which are considered when undertaking water supply operations.

Goulburn-Murray Water (GMW) is delegated to manage the resources, storages and distribution systems of the Goulburn regulated water system, including the Goulburn River. GMW has strong regard for laws and property rights in its system planning and delivery services. The operation of the Goulburn River downstream of Lake Eildon is an example of the approach taken by GMW. To minimise the risk of third party impacts arising from tributary flows, GMW preferentially reduces Lake Eildon releases at earliest opportunity to ensure the Goulburn River flow remains in-channel. This approach helps GMW to limit the risk of legal action arising from accidental inundation of private land and/or infrastructure. All Victorian water corporations adopt similar practice for similar reasons.

To meet the 17,000 ML/day flow target, the project has investigated reducing water harvesting at Goulburn Weir (to Waranga Basin) and releasing from Lake Eildon (if necessary) to top up unregulated flows in the Goulburn River (from tributary streams). The current release rate of 9,500 ML/day from Lake Eildon will remain unchanged but releases could be made more frequently in the winter / spring months if unregulated flow risks are able to managed as a result of implementing an improved flow forecasting services and an enhanced streamflow monitoring system.

Together, these two mechanisms could be used to increase the volume, frequency and duration of in-channel flows in the lower Goulburn. Important elements of this business case to achieving the desired flow rates include:

- *Building increased flow management knowledge*: through the development of the necessary tools, operating procedures and organisational capacity needed to support the proposed operating strategy. This includes conducting simulated scenario testing against natural flow events in the period leading up to planned operation.
- *Phased implementation of the operating strategy*: the actual release of water is planned to start in late 2024 (after agreed mitigation measures are implemented). It will be necessary

[1] The ability to release water from Goulburn weir is constrained by the need to maintain water levels for significant social values e.g. rowing courses

to conduct trials of increased environmental water deliveries above the current operational limits incrementally and over several years. This will provide valuable experience by testing and monitoring changes in flow volumes, river heights and inundation extents with agencies and community to gain confidence that risks of third party impacts are effectively mitigated and ecological outcomes are achieved.

Ecological benefits and outcomes

More frequent watering will result in a healthier and more productive ecosystem both within the Goulburn River and its surrounding wetland and vegetation communities. This will contribute to more abundant and diverse native flora and fauna species including native fish, bird, reptiles and mammals.

The project will also contribute to improved ecological outcomes in the River Murray, notably recruitment of golden perch and dispersal of native aquatic plant seeds and propagules.

Social and recreational benefits are expected to accrue from the project, including improvement to nature based tourism opportunities which provides a source of revenue for the region. Other potential benefits may include more efficient water delivery during drier periods, which will benefit all entitlement holders.

Third party impacts and mitigation activities

To implement a target flow of 17,000 ML/day at Shepparton, potential private and public third party impacts (up to bank-full 20,000 ML/day) need to be fully investigated, understood and mitigated in agreement with affected parties.

Discussions will focus on the opportunities and barriers to easing in-channel constraints (i.e. primarily domestic and stock, and irrigation pumps currently situated within the bed and banks of the river) and identifying what can be done to mitigate the impacts of delivering higher in-channel flows.

It is estimated that up to 240 landholders with water supply infrastructure, and few public agency land and assets, may be affected by the project. All directly affected landholders and affected third parties e.g. public land managers and councils, will need to be actively engaged in the assessment of impacts and the subsequent development and implementation of any mitigation measures and be fully supportive should the project proceed.

A limited number of tourism facilities and recreational areas may be affected which, if left unmitigated, may result in a loss of revenue, as well as restricted access. Most public infrastructure has been designed to avoid or withstand higher flows than those targeted by the project. However, some dirt tracks and bike paths are impacted in the lower Goulburn. No urban centres are directly affected by these flows.

Flow management involving unregulated tributary streamflow involves uncertainty in predicting and managing flows. A risk management buffer of 3,000 ML/day above the target flows is proposed to reduce the impacts of uncertainty. While the operating strategy will always be designed to contain flow within a peak of 17,000 ML/day at Shepparton, the risk management buffer ensures that any project impacts to third parties are adequately compensated or mitigated in the event that an unforeseen event arises.

The business case outlines a suite of activities to mitigate the potential impacts of relaxing in-channel constraints and to ensure that communities are supportive of the proposal, including:

- remediation to private water supply infrastructure to maintain existing levels of service e.g. relocation of domestic and stock and irrigation water supply pumping equipment;

- agreements with public and private land owners/managers to enable higher in-channel flows;
- upgrades or remediation to public infrastructure, such as stormwater drainage outlets; and
- upgrade and refurbishment of the existing Hancocks regulator, located on a flood runner in the lower Goulburn.

Supporting activities have been identified to reduce uncertainty in predicting tributary inflows and to offset impacts to other users:

- expand the rainfall monitoring and stream gauging network in the mid-Goulburn; and
- developing operational river models including rainfall-runoff models for the Goulburn River and its tributaries.

Project risks

Potential adverse environmental impacts and risks to project delivery have previously been evaluated using the AS/NZS ISO 31000:2009 framework. The potential risks and mitigation activities were re-evaluated by a panel consisting of Goulburn Broken CMA, GMW and DELWP staff taking into account the in-channel objective. Should the project proceed beyond the feasibility stage, the project must be appropriately resourced from a project management and engagement perspective to manage potential risks.

Critically, the success of this project relies on a communications and engagement program that understands and appropriately deals with the issues of each of the stakeholders directly affected by the proposed delivery of higher in-channel flows in the Goulburn River, as well as full funding from the Commonwealth government.

Community acceptance is a key risk that will be closely monitored by a Project Control Board established to oversee the delivery of the project.

Eligibility and funding source

The Goulburn Constraints Measure Project is consistent with the Constraints Management Strategy (MDBA, 2013a) in that it relaxes a constraint on the capacity to deliver environmental water in one of the key focus areas of the strategy. As such it is anticipated that this project will be eligible for funding from the Water for the Environment Special Account.

This project is not part of a 'pre-existing' Commonwealth funded project, and it has not already been approved for funding by another organisation, either in full or in part. Victoria is seeking 100 per cent of project funding from the Commonwealth.

Ongoing investigations

The investigations to date have defined the scope of the overall project. However, further work in close consultation with directly affected landholders and key agencies is required to develop the detail of the project. A range of further investigations are required to refine the ecological flow requirements for in-channel outcomes, the inundation footprint, identify and confirm third party impacts and refine and define the proposed works package and reduce uncertainties in cost.

Additional work is also required to inform the operating strategy, including decision making and streamflow forecasting tools, to ensure the achievement of the target flows and the management of third party impacts within agreed parameters.

Costs and timelines

Project costs have been escalated using the Commonwealth method for cost escalation. The total estimated capital cost of this project is $71.19 million. Community consultation, investigations (technical and the on-ground assessment of third party risks and mitigating activities), and upgrading of the water monitoring networks and water system operating tools will be undertaken over a four year period up to 2021/22. Subject to funding and community agreement of the project, this will be followed by the on the ground implementation of agreed mitigation actions over a two year period. A phased implementation of the operating strategy and increased in-channel flows will occur following successful implementation.

Table of contents

Table index

Figure index

Appendices

1. Introduction

1.1. Purpose

The business case defines the proposal for relieving constraints on the Goulburn River, one that aims to maximise the achievement of environmental outcomes while minimising the overall cost associated with higher in-channel flows.

It draws on the outcomes of the earlier Goulburn Constraints Measure feasibility investigations and assesses the potential impacts to private and public land and assets arising from higher in-channel river flows and examines possible mitigation options and costs.

The business case applies to the 440-kilometre section of Goulburn River extending from Lake Eildon at the upstream end, to its connection with the River Murray near Echuca.

1.2. Context

The Constraints Management Strategy (MDBA, 2013a) identified seven priority areas (key focus areas) for addressing physical constraints in the Murray Darling Basin. The Goulburn River was identified as one of these focus areas where relaxing constraints is important for achieving both Basin-scale and local outcomes.

Victoria recognises that addressing flow constraints for environmental outcomes is an important part of the Basin Plan. In doing so, the Victorian Government recognises that any relaxation of constraints will pose third party related risks which can impact public and private land, infrastructure, stock and people. Victoria's policy remains that it will not intentionally flood people's land without prior agreement, nor will it compulsorily acquire land or easements.

During 2015/16 Victoria developed the original Goulburn Constraints Measure Business Case – Phase 2 Investigations and which was submitted for evaluation in April 2016. On 16 June 2017 at the Murray-Darling Basin Ministerial Council meeting Ministers endorsed the final package of environmental works and measures to be included in the Sustainable Diversion Limit Adjustment Mechanism. Basin Governments agreed to notify five constraints projects as supply measures, including Hume to Yarrawonga, which is a joint proposal between Victoria and NSW. The original Goulburn Constraints Measure Business Case (April 2016) was withdrawn as a supply measure at this meeting.

Victoria is committed to developing a new Goulburn constraints measure project in a staged and bottom-up way to build confidence of landholders and the community that environmental water can be delivered more efficiently. The project must be accepted by the community, be feasible and based on improved data and on ground knowledge.

The technical and cost information that underpins this business case has primarily been sourced from previous studies and investigations. This information was adapted and adjusted accordingly to reflect the revised in-channel objectives.

This business case is written in accordance with the Phase 2 Assessment Guidelines for Supply and Constraint Measure Business Cases (MDBA, 2014c) which sets out what is expected of proponent jurisdictions in developing business cases (including standards, information requirements and minimum specifications). The alignment between this business case and the Phase 2 Guidelines is in Section 15.

1.3. Brief history of the development of this Business Case

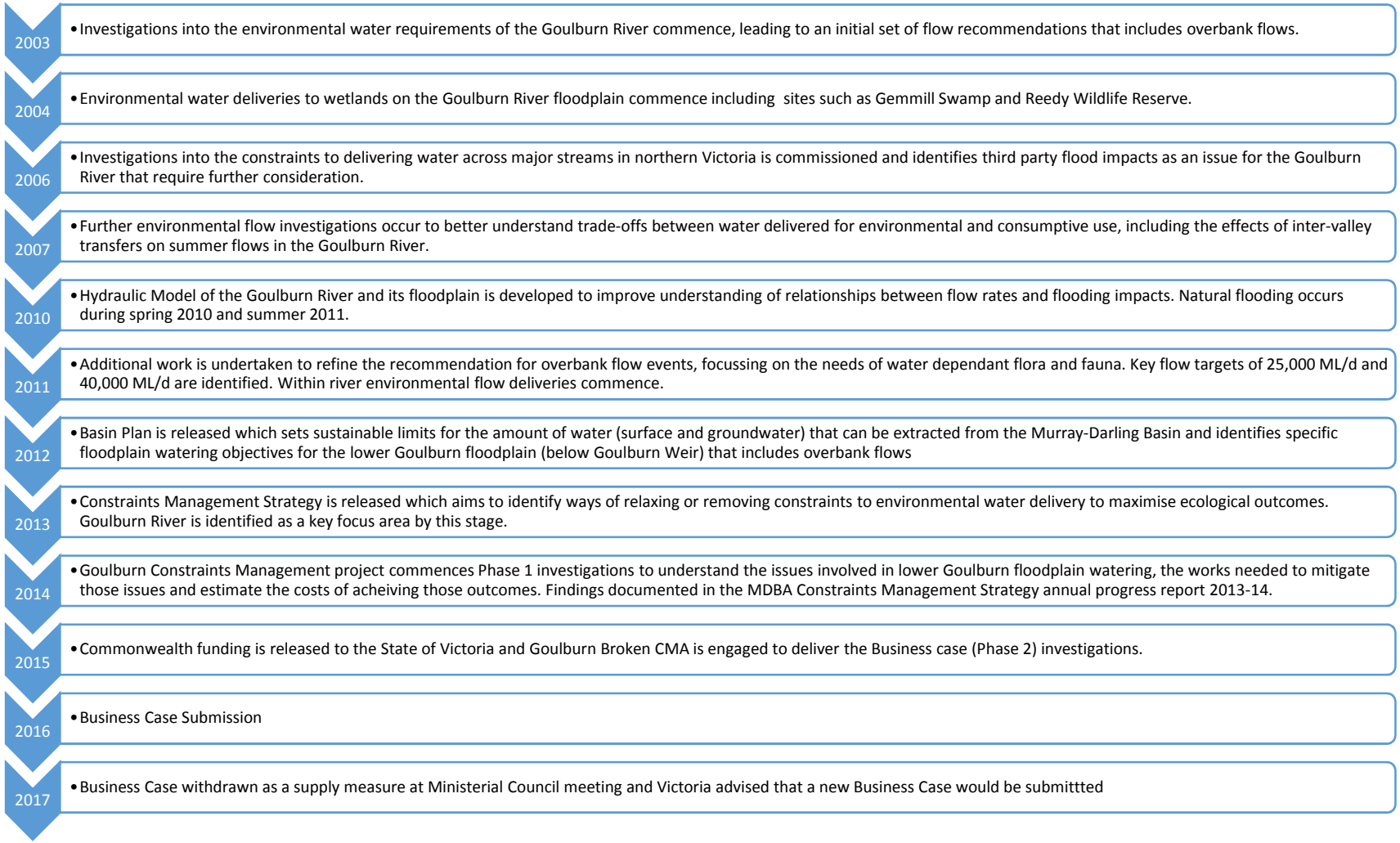

Figure 1 Key activities and investigations prior to the development of this business case

1.4. Project area

The Goulburn River key focus area encompasses the mid and lower sections of the Goulburn River. The mid Goulburn section extends from Lake Eildon to Goulburn Weir, and the lower Goulburn section extends from Goulburn Weir to the River Murray near Echuca (Figure 2). The upper Goulburn (above Lake Eildon) is unregulated and is not managed for environmental flows and therefore falls outside the focus area.

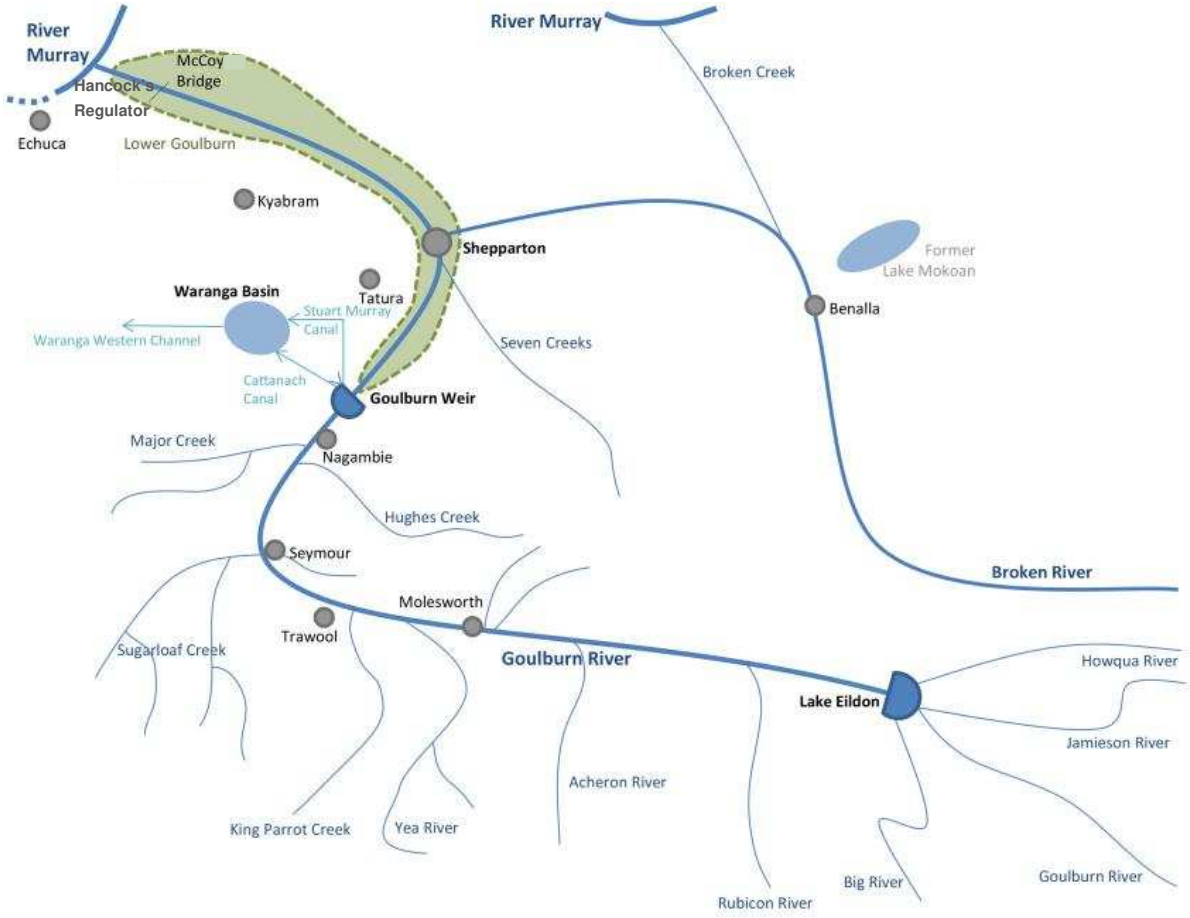

Figure 2 The Goulburn River key focus area, showing key tributaries and features (Source: MDBA, 2015)

1.5. Catchment overview

The Goulburn River basin is Victoria's largest covering 1.6 million hectares or 7.1 per cent of Victoria (GBCMA, 2014). It has a mean annual discharge of approximately 3,040 GL representing 13.7 per cent of the total state discharge (GBCMA, 2015b) and 11% of the total annual flows to the Murray-Darling Basin (MDBA, 2014b).

The Goulburn River is 570 km long and runs in a northeasterly direction, flowing from the Great Dividing Range upstream of Woods Point to the River Murray east of Echuca. The river flows through major towns such as Seymour, Nagambie and Shepparton (Figure 3).

Figure 3 Overview of the Goulburn Broken catchment

Between Eildon and Seymour the river flows through narrow floodplains, surrounded by hills (Figure 4). The river has a limited capacity in the Molesworth region, providing a natural restriction to higher managed flows through this section. Due to the steepness of the surrounding topography, rainfall can cause rapid flow increases in tributary streams, resulting in flashy flows that can affect riverbank farmers and communities, including the township of Seymour.

Figure 4 Goulburn River downstream of Lake Eildon, near Thornton (Credit Richard Hamilton)

Below Seymour the catchment flattens out and the river is joined by the large tributaries of Seven Creeks and the Broken River near Shepparton, which drain 25% of the total Goulburn Broken catchment area. Downstream of Shepparton, the river naturally breaks out and floods wide areas, particularly to the north of the river towards Deep Creek. Levee systems now exist along much of this length of the river to limit the extent of inundation in low to moderate floods.

The Goulburn River has been developed to capture water for consumptive use, particularly irrigation on the plains of northern Victoria. The Lake Eildon storage in the headwaters and Goulburn Weir (which supplies the Waranga Basin) in the middle of the catchment harvest flows in the river, capturing minor and moderate floods and disconnecting the river from its floodplain.

Figure 5 Goulburn Weir (GMW)

The current regulated operation of the Goulburn River system provides flows within a range that is largely governed by irrigation requirements, minimum flow provisions and operational constraints. Releases from storages that result in overbank flows are a consequence of managing storages when they are close to full or spilling, rather than deliberate actions to meet environmental objectives. As a result, the flows in the lower Goulburn have significantly changed from natural flow conditions.

Water resource development in the Goulburn River catchment underpins the region's economy and is vital for sustaining the region's urban centres. The Shepparton Irrigation Region alone creates agricultural products worth an estimated $1.38 billion per annum and supports an estimated 30% of jobs in the catchment's economy (Monticello, 2012).

Primary industries dispersed across the Goulburn River floodplain include dairy, horticulture, viticulture, livestock production (beef, sheep, goats, pigs and poultry), cropping, timber production and aquaculture. Smaller enterprises include horse breeding, nurseries, mushrooms, turf and cut flower production. Land use increasingly supports lifestyle living, particularly towards the south of the catchment closer to Melbourne.

The river is also valued by the broader community for its high recreational and aesthetic values, such as camping, fishing, bushwalking, kayaking and birdwatching, as well as a source of firewood for heating homes. A well-patronised and high quality recreational trout fishery exists between Lake Eildon and Yea, and contributes to approximately 25% of anglers catch (Cottingham et. al., 2014b). Nature based tourism is cited as the most common reason for visiting the Goulburn River valley (Ruzzene, 2014) and, combined with cultural heritage tourism, are also important employers (Montecillo 2012) particularly for bush-based tourism opportunities below Goulburn Weir.

The Traditional Owners of the Goulburn Catchment have an intrinsic connection to the land and water resources within the landscape. The Traditional Owners in the north of the catchment are the Yorta Yorta Nation, whose traditional lands include the northern plains of the Goulburn and Murray rivers. The south of the catchment forms part of the traditional lands of Taungurung Clans, which includes the mountains and rivers to the Great Divide.

Proposed changes to the management of the region's water resources through the Goulburn Constraints Measure are therefore of interest and concern to a broad range of stakeholders.

1.6. Rationale for the project

The Goulburn River and its associated minor channels and wetland habitats support reasonable quality river red gum forest, numerous threatened fish, mammal, and bird species. The lower Goulburn contains the Lower Goulburn National Park as well as many important cultural heritage sites.

The river underpins the region's economy, being a major source of water for irrigated food production. The associated water harvesting from the river has substantially altered the river's flow regime in the lower Goulburn, particularly reducing the frequency and duration of higher in-channel flows in the lower Goulburn. In addition, economic development over many years has resulted in significant economic and social use of the floodplain.

As discussed in the overview, the Goulburn River is now highly regulated and consequently, water supply operations and development of the floodplain constrains the occurrence of higher in channel flows that sustain the health of the river system. Changes to the seasonal flow pattern has disrupted the natural cycles of feeding, growing and breeding for many plants and animals. Because of this, many native species associated with the Goulburn River have significantly declined.

In summary, key changes in ecological condition include:

- reduced native fish diversity and abundance;
- reduced extent and quality of riparian zone due to land clearing and encroachment by agriculture;
- reduced overbank flows changing the nature of carbon inputs that support river and wetland food webs;
- loss of fish habitat and reduced bed diversity resulting from previous de-snagging activities and the removal of source material from the riparian zone;
- high incidence of exotic plant species in the riparian and wetland areas; and
- reduced opportunity for widespread waterbird breeding events.

The new Goulburn Constraints Measure project aims to contribute to the environmental objectives of the Basin Plan, being:

1. To protect and restore water-dependent ecosystems that support migratory birds listed under international agreements
2. To protect and restore water-dependent ecosystems that provide vital habitat
3. To protect and restore water-dependent ecosystems that support Commonwealth or state listed threatened species and/or ecological communities.

Higher in-channel flows are necessary to contribute towards achievement of these objectives. In the Goulburn River, this will require addressing physical constraints to the delivery of higher in-channel flows (Section 7).

2. Project Details

2.1. Description of the measure

The New Goulburn Constraints Measure ('the project') is aiming to provide increased flows within the river channel, and to water some wetlands and minor channels.

The objectives of the project are to:

1. Increase the size, frequency and duration of lower Goulburn River freshes, high and bank-full flows during the year to improve the health and condition of ecological values, and
2. In conjunction with the other constraint projects within the basin, improve river flows and floodplain inundation along the length of the Murray to the Coorong.

2.1.1. Flow rates

The project has defined a maximum target flow rate at Shepparton to achieve the project's intended environmental benefits (Table 1).

The proposed target flow rate is up to 17,000 ML/day (Section 6.3). In most event years, multiple flow peaks, potentially of different magnitudes, may be delivered to achieve different ecological outcomes. The target flow is less than the estimated bank-full flow of 20,000 ML/day to allow for an unregulated flow risk management buffer. The target flow considers both ecological objectives and potential third party impacts (Section 8).

Table 1 Summary of proposed flow rates at Shepparton

Current or Proposed flow	Flow rate at Shepparton
Current	8,500 ML/day
Target flow	Up to 17,000 ML/day
Risk management buffer	Up to 20,000 ML/day

Due to uncertainty in predicting unregulated tributary inflows, a risk management buffer of 3,000 ML/day is proposed to ensure the project has planned and accounted for potential third party risks if higher than anticipated flows occur.

For the purposes of this business case, the target flow of up to 17,000 ML/day is used to describe the potential ecological outcomes of the project and the risk management buffer (up to 20,000 ML/day) is used to assess the project's potential impacts and mitigation options.

A summary of the key terms used to describe the operating strategy and project impacts is provided in Figure 6 below.

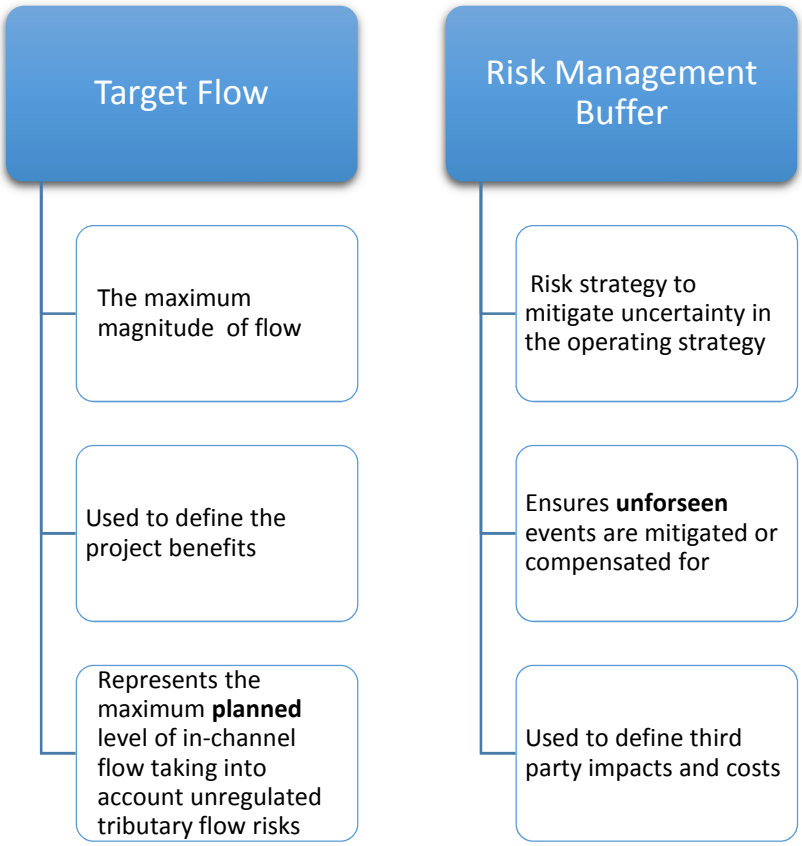

Figure 6 Summary of key terms used to describe the project benefits and impacts

2.1.2. Delivery method

To meet the flow target, the project has investigated temporarily reducing water harvesting to Waranga Basin from Goulburn Weir and releasing from Lake Eildon (if necessary) to top up unregulated flows in the Goulburn River (from tributary streams). The current release rate of 9,500 ML/day from Lake Eildon will remain unchanged but releases could be made more frequently in the winter / spring months if unregulated flow risks are able to managed as a result of implementing an improved flow forecasting services coupled with an expanded flow monitoring network.

The storage operator, Goulburn-Murray Water, normally harvests up to 7,200 ML/day from unregulated flow events at Goulburn Weir over the winter/spring months to fill Waranga Basin. When Waranga Basin is full, harvesting ceases. Reducing or ceasing diversions during targeted events could allow unregulated flows to pass downstream, increasing the flow peak passing through the lower Goulburn River. Any shortfall in harvesting to Waranga Basin that arises because of environmental watering will be debited from environmental water accounts to ensure no loss of resource to all entitlement holders. Accounting rules will be developed in consultation with environmental water holders.

Releases from Lake Eildon are currently restricted to a maximum of 9,500 ML/day (measured at Alexandra[2]) to avoid creating localised flooding downstream at Molesworth. Releases are reduced when there are significant flows in downstream tributaries, particularly the Acheron or Rubicon Rivers. In this proposal, releases from Lake Eildon will be made within the existing release limits.

[2] The Alexandra streamflow gauging station is important as it measures contributions from two significant unregulated tributaries, the Acheron and Rubicon Rivers.

These two mechanisms can be used to increase the volume, frequency and duration of up to bank-full flow events in the lower Goulburn. Decisions to cease harvesting to Waranga Basin will occur based on observed rainfall, measured flows at upstream gauging sites and modelled streamflow. Decisions to release from Lake Eildon will be made based on forecast rainfall and streamflow. As rainfall and streamflow occur, releases from Lake Eildon and diversions to Waranga Basin will be adjusted to provide the required flows and limit the risk of higher flows to within the risk management buffer.

A more detailed description of the delivery method is provided in Section 7.

2.2. Impacts and mitigation activities

Hydraulic modelling undertaken as part of the 2016 business case development, along with local knowledge, has been used to judge the risk to private and public land and assets posed by bank-full flows (Section 8.3). This is supplemented with information obtained from prior feasibility technical investigations on the potential impacts on public infrastructure, and private agricultural and specialist businesses (Appendix A).

With proposed flows contained primarily within the river bank,[3] potential impacts are limited to activities and assets along and within the river bank and potentially along low-lying flood runners and wetlands. The most significant impacts are likely to be on private assets such as irrigation and domestic and stock pumps located in the river channel. In addition, minor 'edge-effect' issues may affect public assets and private businesses along the river's edge or across anabranches and flood runners. One significant creek system in the lower Goulburn carries significant flow at less than bank-full flows, with potential impacts along the creek system. Most specialist businesses e.g. caravan parks, are unlikely to be affected, and the estimated small impacts are included in the 'private land mitigation costs.'

The proposed mitigating activities include:

- remediation to private water supply infrastructure to maintain the existing level of service e.g. relocation of domestic and stock and irrigation pumping equipment;
- refurbishing Hancocks regulator to ensure it prevents flooding along Hancocks and Wakiti Creek;
- possible upgrades to public infrastructure e.g. stormwater outlets;
- establishing agreements with public land or asset managers to offset increased maintenance costs due to of more frequent higher flows;
- establishing agreements with operators of affected businesses to mitigate impacts of higher in-channel flows;
- enhancing the existing streamflow and rainfall measurement network to manage the risk that flows may be higher than intended;
- developing effective decision support tools that assist with the prediction of tributary inflows and inform operations;
- providing adequate buffers to ensure that impacts do not occur outside planned areas if tributary inflows are greater than predicted; and

[3] The primary mitigating activities identified in the original Goulburn constraints business case e.g. easements and upgrading of the lower Goulburn levee system, are no longer required as floodplain watering is no longer proposed.

- undertaking a phased introduction of flow releases to test and develop operating practices and to allow ground-truthing of expected watering extent.

Further details on the mitigation options for managing third party risks are presented in Section 9.3. As the project is at the feasibility stage, further work to confirm third party impacts and refine the mitigation activities will be required if the project proceeds.

A high-level risk assessment has been completed and has found that most third party impacts could be managed within acceptable levels with appropriate mitigation actions in place (Section 8).

2.3. Costs and proposed schedule

The total estimated capital cost of this project is $71.19 million. All capital costs to implement the proposal have been scheduled across the six year implementation period. Indexation has been applied to these costs, which are shown in nominal dollars.

The ongoing annual operation and maintenance costs in each of the first three years of implementation are estimated at $1.07 million in present value dollars, with $0.36 million ongoing after that.

The proposed project schedule is presented in Section 14.3 and shows that the works are expected to be fully operational by June 2024, satisfying the requirements of clause 7.12(4)(d) of the Basin Plan and Table 1 of the IGA Protocol (MDBA, 2014c).

However there is a significant risk that reaching agreement on appropriate mitigation may take longer than the three years allowed, as discussed in Section 14.2.

A detailed breakdown of the proposed schedule is provided in Section 14.3

Table 2 Proposed Schedule

	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	Ongoing
Phase 1	Investigation and detailed design									
Phase 2	Data collection & consultation				Implementation of mitigation measures					
Phase 3							Commissioning & phased implementation of the operation strategy			⟷

2.4. Name of the proponent and proposed implementing entity

As the project owner, the Department of Environment, Land, Water and Planning (DELWP) will have oversight responsibility for project implementation, pending confirmation of funding. Further information regarding the proposed governance and project management arrangements is provided in Section 13.

2.5. Sustainable Diversion Limits resource unites affected

The project results in activity within the Goulburn Sustainable Diversion Limit resource unit (SS6).

The project also results in benefits in the Victorian Murray (SS2) and New South Wales Murray (SS14). However these are not considered in detail by this business case.

2.6. Eligibility for Commonwealth funding

As noted in the introductory section, any decision to proceed with this proposal will be done in consultation with affected communities.

Victoria confirms this is a new project, additional to those already included in the benchmark assumptions under the Basin Plan. Pending a final decision to proceed with this project, its operation is expected to:

- remove or ease a physical or other constraint on the capacity to deliver environmental water to the environmental assets of the Murray-Darling Basin;
- allow environmental water to be used to a greater effect (if incorporated into the final adjustment package); and
- be designed, implemented and operational within agreed timeframes.

It is anticipated that this project is eligible for funding from the Water for the Environment Special Account.

This project is not part of a 'pre-existing' Commonwealth funded project, and it has not already been approved for funding by another organisation, either in full or in part. If this project proceeds, Victoria will be seeking 100 per cent of project funding from the Commonwealth.

2.7. Confirmation that the measure is consistent with the CMS

The Goulburn Constraints Measure is consistent with the Constraints Management Strategy (MDBA, 2013a) in that it relaxes a constraint on the capacity to deliver environmental water in one of the key focus areas of the strategy.

The measure is consistent with the key principles of the strategy in that it:

- aims to maximise environmental outcomes that can be obtained from managing environmental water (and managing water for other purposes on route);
- considers and mitigates the impact on affected parties e.g. land holders, water entitlement holders, Traditional Owners, management agencies and local government;
- identifies solutions that use the approach outlined by the strategy and fall within the boundaries defined by the Commonwealth Water Act (2007), the Basin Plan and relevant state water access and planning schemes;
- allows all water holders to use their water efficiently to meet the needs of that use, while not adversely affecting other entitlements;
- confirms the proposed measure with relevant Basin governments and relevant stakeholders to resolve issues before changes to on-ground arrangements are made; and

- informs the decision making of government and recommends investment that is:
  - prioritised on optimising Basin-wide environmental outcomes, taking into account economic and social considerations
  - focussed on solutions that provide long term certainty and protection to stakeholders
  - focussed on avoiding and addressing any impacts to third parties.

2.8. Summary of options considered

During the development of the original Goulburn constraints business case (DELWP 2016), four different options were considered to water the lower Goulburn River floodplain. The proposed option, with a target flow of 25,000 ML/day at Shepparton and an Eildon release limit of 10,000 ML/day, was the lowest level watering option of the four considered.

The proposal presented here is a 5th option, based on maximising in-channel watering outcomes. It achieves a lower environmental outcome, but with substantially reduced impacts on third parties. The cost of this proposal therefore reduces from $140.12 million proposed in the 2016 business case to $71.19 million, with the reduction largely coming from lower risk mitigation requirements.

3. Environmental values

3.1. Instream values

The main channel of the Goulburn River provides a variety of native vegetation, physical and hydraulic habitats. The habitat in the mid Goulburn River is characterised by gravel beds, shallow fast flowing riffles, long slow flowing pools and beds of submerged and emergent aquatic vegetation. The habitat in the lower Goulburn River is characterised by sandy beds, benches, point bars, large deep pools, slack water and aquatic and amphibious vegetation along the lower banks.

Figure 7 Lower Goulburn River at Toolamba (Mark Turner GBCMA)

These habitats support invertebrates, amphibians, mammals, birds and a diverse and abundant native fish community. Murray cod, trout cod and Macquarie perch are of national conservation significance. The conservation significance of species supported by the Goulburn River are listed in Table 3.

Table 3 Conservation significance of species fish and invertebrate species supported by the Goulburn River system.

Common name	Scientific names	EPBC	FFG	DELWP Advisory List
Murray cod	*Maccullochella peelii*	VU	L	V
Trout cod	*Maccullochella macquariensis*	EN	L	CR
Silver perch	*Bidyanus bidyanus*	NL	L	V

Common name	Scientific names	EPBC	FFG	DELWP Advisory List
Golden perch	Macquaria ambigua	NL	I	NT
Macquarie perch	*Macquaria australasica*	EN	L	EN
Freshwater catfish	*Tandanus tandanus*	NL	L	EN
Flat-headed galaxias	*Galaxias rostratus*	NL	I	V

Legend
EPBC Act status: EXtinct, CRitically endangered, ENdangered, VUlnerable, Conservation Dependent, Not Listed
FFG Act status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing

DELWP Advisory status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known, Not Listed

Recent fish surveys have only detected small numbers of Macquarie perch in the mid Goulburn River. However, a number of mid Goulburn river tributaries have small self-sustaining Macquarie perch populations.

The lower Goulburn River is one of the only Victorian tributaries of the River Murray that supports golden perch spawning and acts as an important corridor for the movement of native fish linking geographically distinct populations across river networks (e.g. between the Goulburn River and its tributaries and the Goulburn River and the River Murray). The lower Goulburn River also provides important refuge habitat for fish seeking to avoid unfavourable conditions in other waterways.

3.2. Wetlands and minor channels

The riparian zone of the Goulburn River contains numerous wetlands and minor channels hydrologically connected to the river at a range of in-channel flows, including at current operational flows levels. These low-lying habitats support a diverse range of water dependent vegetation communities of state conservation significance (see Appendix B). The vegetation communities fringing the river and minor channels are dominated by river red gum woodlands, forests and swamps. The wetland vegetation communities are characterised by a dynamic variety of annual and perennial grasses, herbs, sedges and rushes. These vegetation communities support 12 known flora species of state conservation significance. Of these, river swamp wallaby-grass (*Amphibromus fluitans*) and small scurf pea (*Cullen parvum*) are of national conservation significance.

These vegetation communities provide food, drought refuge and critical habitat for terrestrial and water dependent fauna including invertebrates, amphibians, reptiles, mammals, fish and birds. Many species are of state and national conservation significance including those listed in Table 4.

The vegetation communities described above also play a vital role in the in-channel health of the Goulburn River by:

- providing organic matter, a major food source for instream plants and animals;
- providing essential instream habitat for many fish and invertebrates in the form of woody debris and roots;
- providing stability to banks, minimising erosion;

- providing shade, which protects instream flora and fauna from temperature extremes and can inhibit the growth of nuisance aquatic plants including algae; and
- trapping and filtering sediments and nutrients from runoff, protecting and improving water quality.

The numerous wetlands connected to the Goulburn River are of particular importance to waterbirds. When inundated, these highly productive habitats can support thousands of waterbirds and provide critical breeding areas for colonial nesting species including the DELWP advisory listed royal spoonbill (*Platalea regia*).

To date 69 waterbird species have been recorded at these wetland habitats. Of these, 24 are of conservation significance and include seven species listed under international agreements such as the Latham's snipe (*Gallinago hardwickii*) and the sharp-tailed sandpiper (*Calidris acuminate*).

Flora and fauna species of conservation significance recorded within the Goulburn River riparian zone and associated wetlands and connected channels are listed in Appendix C.

Table 4 Conservation significance of species supported by the Goulburn River wetlands and minor channels

Common name	Scientific name	EPBC	FFG	DELWP Advisory List
Ancient greenling damselfly	*Hemiphlebia mirabilis*	NL	L	EN
Squirrel glider	*Petaurus norfolcensis*	NL	L	EN
Lace monitor	*Varanus varius*	NL	NL	EN
Swift parrot	*Lathamus discolor*	EN	L	EN
Brown toadlet	*Pseudophryne bibronii*	NL	L	EN
Murray-Darling rainbowfish	*Melanotaenia fluviatilis*	NL	L	V
Broad-shelled turtle	*Macrochelodina expansa*	NL	L	EN
White-bellied sea eagle	Haliaeetus leucogaster	NL	L	V
Royal spoonbill	*Platalea regia*	NL	NL	NT

Legend
EPBC Act status: EXtinct, CRitically endangered, ENdangered, VUlnerable, Conservation Dependent, Not Listed
FFG Act status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing

DELWP Advisory status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known, Not Listed

3.3. Current condition

Changes in catchment land use since European settlement, combined with the construction and operation of Lake Eildon and other irrigation infrastructure, have impacted on the quality of the physical habitat and the ecological health of the river system. The Sustainable Rivers Audit (SRA) was conducted in 2004-2007 and repeated in 2008- 2010. Both audits assessed the

overall ecosystem health for the Goulburn River as very poor, driven by changed hydrology and low abundances of native fish populations.

The riparian zone in the mid Goulburn varies considerably in quality and extent (width), and generally exists as a narrow strip, sometimes as little as 1-2 trees wide with degraded understorey lacking a shrub layer and often dominated by pasture grasses. In many areas, the riparian zone is exposed to stock, as fencing is not continuous. Conversely, in the lower Goulburn, the riparian zone is generally wider and much more extensive, as well as being in better condition (floristically) and more structurally complex with shrub layers. The relatively high incidence of non-native plant species in the Goulburn is consistent with current understanding of the effects of seasonally-modified flows (Cottingham et al., 2014b). Wetlands on the floodplain now flood much less frequently and disadvantage native plant life-cycles (Cottingham et al., 2014b). Species lists for the riparian zone record blackberry (*Rubus anglocandicans)*, an array of willows (*Salix* spp.) and exotic grass species (Australian Ecosystems 2012). Long periods without being connected also has implications for the wetland seed bank and a return to inundated or partially inundated conditions is needed to ensure the native character of these system is retained.

The population structure of native fish species in the lower Goulburn system (below Goulburn Weir) is in reasonable condition, with self-sustaining populations of many species, including Murray cod and trout cod (Koster et al. 2012). In contrast, the population structure of these species between Lake Eildon and Goulburn Weir is considered to be in poor condition and are affected by cold water releases from Lake Eildon and high summer flows.

The wider Goulburn River catchment supports reduced diversity, abundance and range of many native fish species, with introduced species now dominating in many areas (Lieschke et al. 2014). A range of introduced fish species including: redfin perch (*Perca fluviatilis*), carp (*Cyprinus carpio*), oriental weatherloach (*Misgurnus anguillicaudatus*) and eastern gambusia (*Gambusia holbrooki*) have abundant, self-sustaining populations in the lower Goulburn River (Koster, 2012).

Supporting golden perch populations is a key driver for environmental flow delivery in the lower Goulburn River as flow variations are required to cue spawning. However, there appears to be limited recruitment of juveniles, which warrants further investigation. Murray cod and a number of other native fish species are thought to breed annually in the lower Goulburn regardless of flow levels (Koster et al, 2012).

The natural processes of erosion, avulsion and sedimentation are part of a rivers life and these processes can be impacted by modification of the river and broader catchment activities. The impact of environmental flows, positive or negative, on these processes is currently being assessed as part of a five year monitoring program in the lower Goulburn (Webb et al 2014).

The water quality in the Goulburn River is deemed generally good, with the main issue being cold water temperatures from Lake Eildon releases (Cottingham at al 2014b). Cold-water pollution primarily affects the mid-Goulburn section of river during the warmer months and is not an issue for the majority of the planned timing of releases considered by this business case. The release of cold water over a long period of time has created ideal conditions for the establishment of a highly valued trout fishery with significant recreational, social and economic value.

4. Anticipated environmental benefits of higher in-channel flows

4.1. In-channel benefits

Higher flows that connect the river to wetlands, minor channels (including anabranches) and benches will deliver organic material to the in-channel environment, supporting complex food webs that increase the number and diversity of organisms (from invertebrates such as insects to the higher order animals that feed on them such as fish and platypus).

Water velocities increase with higher flows. This promotes in-channel physical habitat diversity by overturning substrates and maintaining riffle, bench and pool habitats used by native fish and macroinvertebrates by transporting and depositing sediment.

Higher flows are expected to increase the extent, diversity and condition of bank and fringing riparian vegetation by providing more regular watering. Increased bank and riparian vegetation reduces bank erosion and can play an important role in the life cycles of small bodied native fish such as the threatened Murray-Darling rainbowfish (*Melanotaenia fluviatilis*), which rely on instream vegetation for spawning, and possibly egg and juvenile survival (Koster, 2012). More regular watering of banks and benches will also inhibit the establishment of undesirable terrestrial vegetation.

If undertaken, the project is expected to lead to an increase in the abundance and spatial distribution of large-bodied native fish such as Murray cod and trout cod in the lower Goulburn River. Higher flows increase habitat and food sources, which improves juvenile survival and provides greater opportunity for migrating fish to move and establish new home ranges. Higher flows are also expected to benefit silver perch and golden perch, which depend on flow for spawning and migration. Although evidence suggests the species spawn and migrate under a range of flow conditions, greater responses have been observed during higher flows (Koster, 2012).

4.2. Wetland and minor channel benefits

If in-channel constraints are relaxed, initial analysis shows some additional low lying riparian areas, wetlands and minor channels could be connected to the river more often, particularly in the lower reaches (Veitz and Russell, 2017). This will:

- Increase the extent, diversity and condition of their water dependent vegetation communities;
- Increase the extent and abundance of threatened water dependent flora species such as river swamp wallaby-grass;
- Provide food and habitat for a range of terrestrial fauna including insects, seeds, fruit and nectar for woodland birds and squirrel gliders, and foraging resources for herbivores such as kangaroos and wallabies;
- Increase frog and native fish access to wetland habitats needed to complete their life cycles including small bodied fish such as Australian smelt (*Retropinna semoni*) and large bodied native fish such as golden perch; and
- Increase feeding, roosting and breeding habitat for waterbirds including colonial nesting species if larger and deeper wetlands are connected.

4.3. River Murray benefits

Delivering higher in-channel flows down the Goulburn River will provide hydrological and ecological benefits to the River Murray.

As a major tributary of the River Murray system (second only to the Murrumbidgee in terms of surface water availability) (MDBA, 2013), the Goulburn River makes a significant contribution to stream flow in the mid-Murray. Delivery of higher in-channel flows down the Goulburn River could therefore help meet environmental water flow targets set for the mid-Murray system and further downstream as far as the Lower Lakes and Murray mouth.

Higher in-channel flows down the Goulburn River will carry organic material including plant propagules that will increase the instream productivity of the River Murray system and help establish flood-dependent vegetation. The capacity to deliver higher in-channel flows down the Goulburn River may provide more opportunities to mitigate water quality issues in the River Murray.

The delivery of higher in-channel flows down the lower Goulburn River are expected to increase the abundance and distribution of large bodied native fish such as Murray cod, trout cod, silver perch and golden perch (Section 4.1). The migration of these species into the mid-Murray to establish now home ranges will contribute to the resilience and recovery of local populations. The lower Goulburn River is also one of the only Victorian tributaries of the River Murray that supports golden perch spawning. Golden perch lay buoyant eggs that drift downstream in river currents and are suspected to enter the River Murray providing an important mechanism for the recovery of the species in the River Murray system.

4.4. Ecological objectives and targets

The benefits of the project described in the sections above contribute to the delivery of ecological goals, objectives and targets set out in the Goulburn Broken Waterway Strategy (GBCMA, 2015a) and the Basin Plan (2012). Their alignment and how this project contributes to their delivery is outlined below.

The long-term management goal for the Goulburn River has been informed by technical studies, the Goulburn Broken Waterway Strategy, advice from scientific experts and the environmental values it supports (GBCMA, 2015a). The long-term management goal is:

> To protect and improve the Goulburn River's important aquatic flora and fauna, instream habitats, connected floodplains and ecological processes

The Goulburn River Environmental Water Management Plan describes the desired ecological outcomes to be achieved through flow management over the next ten years (GBCMA, 2015a). These overarching objectives encompass the more detailed ecological objectives established for the site by various flow studies and technical reports (as presented in Appendix D), and include:

1. Increase the abundance, spatial distribution and size class diversity of key native fish species.
2. Increase the abundance and richness of aquatic and flood dependent native vegetation species.
3. Increase macroinvertebrate biomass and diversity.
4. Protect and promote natural channel form and dynamics (e.g. sediment diversity, rates of sediment transport and bank erosion rates).
5. Increase instream physical habitat diversity (e.g. shallow and deep water habitats).

6. Provide sufficient rates of in-stream primary production and respiration to support native fish and macroinvertebrate communities.

These align with the overall ecological objectives sought by section 8.04 of the Basin Plan (Table 5) and the anticipated ecological outcomes of the project.

Table 5 Links between the ecological objectives for the Goulburn River and the Basin Plan

Ecological Value	Overarching objective – Goulburn	Corresponding objective(s) - Basin Plan
Native Fish	Increase the abundance, spatial distribution and size class diversity of key native fish species.	Protect and restore water-dependent ecosystems (e.g. rivers, wetlands and floodplains; and their plants and animals) Ensure that water-dependent ecosystems are resilient to climate change and other risks and threats
Native Vegetation	Increase the abundance and richness of aquatic and water dependent native vegetation species.	
Macroinvertebrates	Increase macroinvertebrate biomass and diversity.	
Geomorphology	Protect and promote natural channel form and dynamics (e.g. sediment diversity, rates of sediment transport and bank erosion rates) Increase instream physical habitat diversity (e.g. shallow and deep-water habitats).	Protect and restore the ecosystem functions of water-dependent ecosystems (e.g. salt export, connectivity, carbon entrainment)
Stream Metabolism	Provide sufficient rates of in-stream primary production and respiration to support native fish and macroinvertebrate communities.	

Additional objectives and targets are set out in the Basin-wide Environmental Watering Strategy (BEWS) (MDBA, 2014). The expected contribution of increased in-channel flows to these targets is presented in Table 6. Environmental flow recommendations have been developed to achieve these objectives, as described in Section 6.3.

Table 6 Contribution of the Goulburn Constraints Measure to the Basin-wide Environmental Watering Strategy objectives and targets

Theme	BEWS Objective	Targets	Contribution of Goulburn Constraints Measure
River flows and connectivity	Improved connections along rivers and between rivers and their floodplains	Maintained base flows: at least 60% of their natural levels	Base flows can be delivered without the project in place (subject to water availability).
		Improved overall flow: 30% more into the River Murray	Will significantly contribute to the target. The estimated increase in discharge will be determined through further modelling.
		Improved connectivity with bank-full and/or low floodplain flows: by 10-20% in remaining catchments	Will contribute to the target. The estimated increase in connectivity will be determined through further modelling.
Vegetation	Maintain the extent and improve the condition	Maintenance of the current extent of: About 360,000 ha of river red gum, 409,000 ha of black box, 310,000 ha of coolibah forest and woodlands; and existing large communities of lignum Non-woody communities near or in wetlands, streams and on low lying floodplains	Will contribute to the target. The project is expected to better meet the watering requirements of these vegetation communities. The area that will benefit from this project will be determined through further modelling.
		Maintain the current condition of lowland floodplain forests and woodlands of: river red gum and black box	As above.
		Improved condition of: southern river red gum	As above.
Waterbirds	Maintain current species diversity, improve breeding success and numbers	Maintained current species diversity of: all current Basin waterbirds	Will contribute to the target. The project is expected to increase waterbird breeding habitat and opportunities. The increase in waterbird breeding habitat and opportunities will be determined through further modelling.

Theme	BEWS Objective	Targets	Contribution of Goulburn Constraints Measure
		Increased abundance: 20-25% increase in waterbirds by 2024	As above.
		Improved breeding: Up to 50% more breeding events for colonial nesting waterbird species A 30-40% increase in nests and broods for other waterbirds	As above.
Fish	Maintain current species diversity, extend distributions, improve breeding success and numbers	Improved distribution: of key short and long-lived fish species across the Basin	Will contribute to the target. The project can provide cues for fish movement as well as dispersing larvae into the River Murray system. The extent of benefit is influenced by flow management in the River Murray.
		Improved breeding success for: Short-lived species (every 1- 2 years) Long-lived species in at least 8/out of 10 years at 80% of key sites	Contributes to target. The project can facilitate an increase in breeding opportunities such as cues to trigger spawning in flow dependent species such as perch. The project can allow small-bodied native fish increased access to wetland habitat (for off-channel specialists) and the reestablishment of instream vegetation for shelter and spawning.
		Improved populations of: Short-lived species (numbers at pre-2007 levels) Long-lived species (with a spread of age classes represented)	Contributes to target. As above, enhanced breeding and access to habitat can lead to improved population structure. Increased in-stream carbon will improve the productivity of the system, providing an increased food supply for fish.

Theme	BEWS Objective	Targets	Contribution of Goulburn Constraints Measure
		Murray cod and golden perch (10-15% more mature fish at key sites)	
		Improved movement: more native fish using fish passage	As above.

4.5. Anticipated ecological benefits: River Murray

Delivering flow peaks in the Goulburn will also provide benefits to the River Murray, both from an ecological and hydrological perspective. Higher flows carry organic material that contribute to the productivity of the River Murray system and facilitates the dispersal of seeds and vegetative material for the re-colonisation of plants at downstream sites.

Monitoring has recorded golden perch spawning in response to freshes delivered to the Goulburn system (Koster, 2012). Additional research in the River Murray near the Barmah-Millewa Forest has shown that spawning events can occur in response to flow peaks of quite short duration (Raymond, 2013). The project therefore has the potential to make a significant contribution to the resilience of golden perch populations in the broader River Murray system, as well as potentially provide source populations for the recovery of endangered fish species like trout cod and Macquarie perch.

The connectivity between populations of adult golden perch in the Goulburn River and the mid-Murray channel is considered to be important for the conservation of the species (Koster, 2012). Long term studies (Koster, 2012) indicate that golden perch can move into the River Murray to spawn when conditions are suitable, returning to the Goulburn River afterwards.

Similarly, extensive spawning has occurred in the Goulburn River following overbank flow events, such as those observed in 2010-11. Golden perch lay buoyant eggs that drift downstream in river currents and are suspected to enter the River Murray, providing another mechanism for the recovery of the species in the main channel. Monitoring of fish movement has also shown that one quarter of the tagged fish moved from the River Murray into the lower Goulburn, with seven (9% of total tagged fish) appearing to remain permanently (Koster, 2012). These results suggest that population connectivity may be important for the exchange of genetic material among populations.

The results also suggest that higher winter spring flows are important for improving the condition of fish in the pre-spawning period, leading to higher spawning responses later in the season (Koster, 2012). This theory is supported by the 2010-11 event where golden perch moved onto the floodplain accessing a ready supply of food that subsequently lead to a high magnitude spawning event (Koster, 2012). The provision of bank-full and overbank flows through this project are therefore expected to lead to greater breeding responses within golden perch and assist the recovery of the species with the mid-Murray system.

4.6. Monitoring and evaluation plan

The effectiveness of environmental water use in the Goulburn River is monitored and evaluated as part of the Commonwealth Environmental Water Office's Long Term Intervention Monitoring Plan 2014/15-2018/19, which is partnered with other monitoring programs (Victorian Environmental Water Holder and the Victorian Environmental Flows Monitoring and Assessment Program).

The Lower Goulburn River Long-Term Intervention Monitoring (LTIM) Project is a joint venture between the University of Melbourne, Jacobs, Arthur Rylah Institute for Environmental Research, Monash University, Streamology, Goulburn Valley Water, and the Goulburn-Broken Catchment Management Authority. It is funded by the Commonwealth Environmental Water Office, with additional contributions from the Victorian Environmental Water Holder and the Victorian Department of Environment Land Water and Planning,. It takes a science-practice partnership approach, where a highly effective and collaborative relationship has been established between government agencies, local water managers, and the scientific community.

It is expected that in the future, and subject to the project being funded and implemented, that the above monitoring and evaluation programs will be extended and revised to reflect any future improvements to the delivery of environmental water.

5. Potential adverse environmental impacts

5.1. Overview

Although environmental watering actions are designed to achieve improved ecological outcomes, they also need to take into account the potential environmental risks and how they can be managed. Potential environmental risks include things like the spread of pest plants and animals and must be considered for all environmental watering.

Risk management is part of existing environmental water planning processes including the:

- *Commonwealth Environmental Water Holder's Framework for Determining Commonwealth Environmental Water Use* - that requires environmental watering actions to consider potential environmental risks, including downstream environmental risks, and measure that may be taken to minimise those risks (Commomwealth Environmental Water Office, 2013).
- *Victorian Environmental Water Holder's (VEWH) Seasonal Watering Planning process* - which has established an over-arching risk management framework that requires all parties to identify and control foreseeable adverse outcomes
- *Goulburn River Environmental Water Management Plan* (GBCMA, 2015a) – that sets out the long term strategy for the management of environmental water and guides the seasonal water planning process. Refining and adapting this plan is a key mechanism for mitigating potential adverse environmental outcomes.

A high-level assessment of the potential adverse environmental outcomes was completed in line with the requirements of AS/NZS ISO 31000:2009 and the GBCMA Risk Assessment Framework (DELWP 2017). The assessment considered the potential environmental risks in the Goulburn River below Lake Eildon, as well as the receiving River Murray (DELWP 2017).

5.2. Summary of significant environmental risks identified

Information on the full suite of risks considered by the assessment process is documented in the *Goulburn Constraints Management Project: Risk Management Strategy* (DELWP 2017). The scope of the assessment is limited to those risks associated with the project. The cumulative risks associated with the implementation of other constraints or SDL measures was not considered as part of the assessment.

Risks rated significant or higher prior to the management controls are summarised in Section 8.

Generally, the risks seem well within the scope of risks that can be managed by normal or current controls, as discussed below.

5.2.1. Residual risks

Following the implementation of management controls, the only remaining significant residual environmental risk is increased populations of exotic fish species e.g. carp, as there are currently no effective control actions for managing this issue on a Goulburn River reach scale. This is an issue common to all flow events (natural or managed) where flow in a river, its anabranches or connected wetlands may create low flow habitat or favourable breeding conditions for exotic fish. Research into control methods is ongoing.

Although the risk has potential within reach and downstream impacts, the residual risk is deemed to be acceptable given the scale of the potential ecological benefits to be generated by the project and the already ubiquitous presence of these pest fish in the region. Changes in

carp populations can be detected though fish sampling programs; however, effective management responses are limited.

5.2.2. Salinity risks

The Shepparton Irrigation Region has a long history of land and water management, and much is known about local salinity and groundwater issues. The risk assessment panel included members with specific regional expertise and considered potential salinity groundwater issues for the river and its floodplain (under both private and public ownership) as well as possible downstream impacts.

Salinity risks associated with a single environmental watering on the floodplain as proposed by the previous business case (DELWP 2016) were determined to be low (Jacobs, 2015). As this proposal now focuses on in-channel flows the salinity risk is further reduced. The main reasons for this are:

- the lower Goulburn floodplain contains relatively fresh groundwater;
- watertable levels are relatively deep, generally below the threshold for significant evaporation;
- there is only moderate potential for infiltration as a result of a short duration flow event; and
- the potential for lateral movement of groundwater after a watering event is low to moderate.

The implications in the context of Victoria's obligations under the MDBA Basin Salinity Strategy 2030, are that the salinity effect at Morgan is likely to be negligible and therefore not reportable under Schedule B to the MDB Agreement and the Basin Plan (Jacobs, 2015).

Additional work recommended to monitor and confirm salinity risks arising from this project if implemented includes:

- an upgrade of the water table monitoring network to detect any potential changes in groundwater levels or salinity risks;
- a preliminary salinity impact assessment against the benchmark model run; and
- time series sampling of the salinity of return flows to the River at the end of the environmental watering event.

The nature of any downstream salinity and/or water quality impacts arising from this project, and any potential cumulative impacts with other measures under consideration through the sustainable diversion limit adjustment mechanism process cannot be formally ascertained at this time. This is because such impacts will be influenced by other measures that may be operating upstream of this site, and the associated total volume of water that is recovered for the environment.

It is expected that likely or potential downstream/cumulative impacts will become better understood as the full package of adjustment and constraints measures is modelled by the MDBA, and a final package is agreed by Basin governments.

5.3. Further work

The outcomes of the risk assessment provides a preliminary basis for prioritising mitigation strategies and measures based on currently available information. A more detailed risk assessment will be carried out should the Basin Ministers decide to proceed further with the project.

6. Hydrology of the system and environmental water requirements

6.1. Current hydrology

As the largest Victorian tributary of the River Murray, the Goulburn River plays an important role in meeting the water need of communities in a large section of northern Victoria.

Flow along the Goulburn River has been highly modified by two major features: Lake Eildon and Goulburn Weir (Figure 9). Current regulated operation of the river system is largely based on irrigation requirements and minimum flow provisions (Section 6.2). Irrigation requirements generally follow crop demand patterns and do not vary significantly during the summer irrigation season. Generally, regulated flows do not exceed irrigation demands, although limited provision for additional releases exist in the Goulburn Bulk Entitlements [4](which may be granted to a water corporation, VEWH and other specified bodies). Outside of flood operating conditions, GMW does not release water from Lake Eildon or Goulburn Weir to supply orders if there is a risk of flooding.

A comparison of the natural and current flow regime at McCoy Bridge (downstream of Shepparton and the official junction with the Murray River) is shown in Table 7. Flows in the range targeted by this project now occur significantly less often, for shorter durations, with significantly greater periods between events.

Table 7 Summary of natural and current flow regime at McCoy Bridge

Flow (ML/d)	Flow frequency (number per year)		Mean duration in spring (days)		Maximum period between events (years)	
	Natural	Current	Natural	Current	Natural	Current
15,000	3.7	2.0	40	14	2.2	5.5

Flow frequency: average number of flood events per year

Duration: mean duration of high spells during September to November

Maximum period between events: based on modelled daily flow at McCoy Bridge from July 1896 – to June 2016

Source: Jacobs (2017)

Likewise, Cottingham (2003) found that under current conditions, flow events at Murchison (downstream of Goulburn Weir, but upstream of the confluences with Seven Creeks and the Broken River) across the range of 5,000 to 20,000 ML/day occur much less often compared to unregulated conditions. Figure 8 shows the flows at Murchison Bridge of 9,000 ML/day.

[4] **Bulk entitlements** and environment **entitlements** are legal rights to water granted by the Minister for Water under the Water Act 1989. They provide the right to take or store a volume of water subject to a range of conditions.

Figure 8 Murchsion Bridge flows at 9,000 ML/day, 30 June 2017 (credit Daniel Lovell, GBCMA)

Figure 9 Schematic of the Goulburn River water supply system

Lake Eildon is located in the river's upper catchment and has a capacity of 3,334 GL, which is approximately twice the average annual inflow in the Goulburn River (GBCMA, 2015a). Water

released from Lake Eildon is diverted for irrigation, urban and environmental use, supplying about 60% of water used in the Goulburn Murray Irrigation District (GMW website). With such a large storage capacity, the operation of the lake fully regulates downstream flows in all but wet years (GBCMA, 2015a).

Goulburn Weir is approximately 235 km downstream of Lake Eildon (Figure 9). It holds 25 GL and is held close to full capacity to facilitate water diversion into irrigation channels and extensive recreational use. Water is diverted to the Waranga Basin, which has a storage capacity of 432 GL (GBCMA, 2015a), and is used to capture winter and spring flows from tributaries downstream of Lake Eildon. Goulburn Weir and its operation (along with Lake Eildon) have reduced the average annual downstream flow to 1,340 GL, less than half the estimated pre-regulated flow (GBCMA 2015).

The harvesting to storages has resulted in a significant reduction of flow within the Goulburn River (CSIRO, 2008), as shown in Figure 10. In the 2013-14 winter/spring, water harvesting dramatically reduced the natural river flow in winter and spring, from flows up to and exceeding bank-full for extended periods to a peak flow of less than 10,000 ML/day; i.e. only half-filling the river channel at Shepparton.

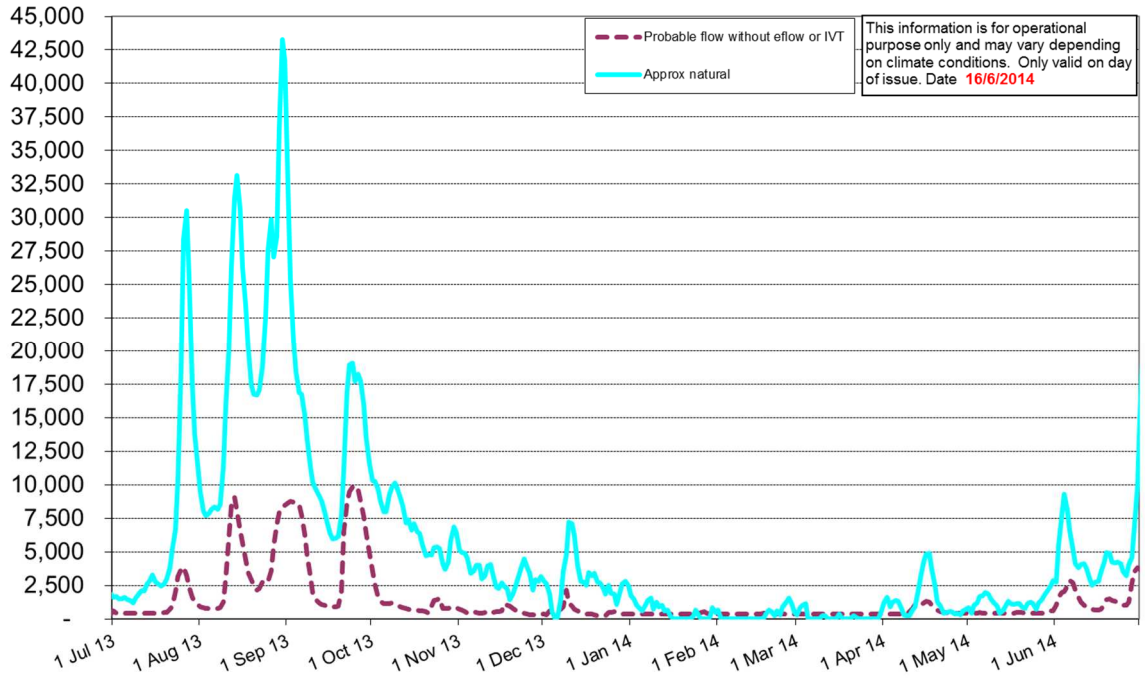

Figure 10: Probable versus approximate natural flows in the Goulburn River at McCoy Bridge during 2013-14

The Goulburn River is actively managed by GMW who manages the storage and regulated release of water for downstream use in northern Victorian catchments (GBCMA, 2015a). GMW has a wide range of customers that require different amounts of water at different times, which has resulted in a changed seasonality of flow within the river.

Lake Eildon and its operation have altered the river flow regime immediately downstream of the storage such that low flows now occur in winter and spring due to water storage, and higher flows now occur in summer and autumn due to releases to meet irrigation and other consumptive demands. However, Goulburn River flows below Lake Eildon progressively increase downstream due to tributary inflows, particularly in winter and spring (GBCMA, 2015a).

Downstream of Goulburn Weir the river retains some natural seasonal flow pattern due to the influence of tributaries such as the Broken River and Seven Creeks, and the diversion of

irrigation water at the Goulburn Weir during summer and autumn. Significant flows may be released in summer and early autumn from Goulburn Weir to the River Murray as Inter-Valley Transfers (IVT) to supply water allocations and entitlements traded from the Goulburn River to the River Murray system (GBCMA, 2015a).

Water starts inundating the Goulburn River floodplain at different flows along the river. As an indication, Bureau of Meteorology (BoM) minor flood levels (indicating low-lying areas next to water courses are inundated) along the Goulburn River are as follows:

- 3 metres (14,500 ML/d) at Eildon
- 4 metres (21,700 ML/d) at Trawool
- 4 metres (24,800 ML/d) at Seymour
- 9 metres (33,100 ML/d) at Murchison
- 9.5 metres (26,100 ML/d) at Shepparton
- 9 metres (28,300 ML/d) at McCoys Bridge.

Note that the stage heights refer to a local datum at each gauging site.

However, flows commence going out of the river at lower flows than these, as distributary channels start to become engaged. River channel capacity immediately downstream of Lake Eildon is between 9,000 and 10,000 ML/day, and at Shepparton bank-full flow is estimated to be approximately 18,000 to 20,000 ML/day.

6.2. Current infrastructure operations

Development of water management infrastructure to harness the waters of the Goulburn system commenced shortly after European settlement of the area, in order to meet the water needs to establish farms and towns in the region.

Key milestones in the development of water related infrastructure in the Goulburn system are:

- 1891 – Completion of Goulburn Weir, which was the first major diversion weir for irrigation in Australia.
- 1908 – Waranga Basin (first stage) completed, creating an off-stream storage.
- 1921 – Waranga basin embankment raising was completed to enlarge the storage to its current capacity
- 1929 – Sugarloaf Reservoir (377 GL) was completed, just upstream of the location of the current Lake Eildon embankment.
- 1955 – Construction of Lake Eildon was completed and filling of the storage commenced.

The current operating arrangements for the Goulburn River system have evolved over the period since the construction of these assets. These operating arrangements were developed and documented incrementally, with the arrangements distributed across various procedures, guidelines and manuals for the operation of assets and the water harvesting practices.

In 1992, the Victorian government commenced the development of the first Bulk Entitlement Order in Victoria, to codify the rights to water in the Goulburn River system. This culminated in the issuing of the Bulk Entitlement (Eildon – Goulburn Weir) Conversion Order 1995.

This bulk entitlement order established:

- the entitlements to water from the Goulburn system
- the cap on the volumes of water that could be extracted from the system to supply these entitlements

- the capacity of the harvesting assets that could be used to harvest, store and divert water from the system
- key operating practices and constraints (e.g. flood mitigation pre-releases, minimum passing flows.). The computer modelling that supported the Bulk Entitlement Order also documented the water allocation and management rules and practices that applied.

The key phases of current system operations are the harvesting phase and the water delivery phase. The sections below describe the operations during these phases for Lake Eildon and Waranga Basin (i.e. Goulburn Weir).

6.2.1. Harvesting phase

Water harvesting occurs throughout the year but peaks during the winter/spring period, when inflows to the river system are at their highest levels. Inflows above Lake Eildon (which average approximately 1500 GL per annum) are harvested and stored in Lake Eildon. During the winter/spring period, if there is no irrigation demand, releases from Lake Eildon are only the minimum passing flows, which are 120 ML/day or 250 ML/day depending on seasonal conditions.

Lake Eildon is filled in a controlled manner over the water harvesting period (i.e. from May onwards), so that there is a 95% probability that the storage will be full by 1 October under average conditions. Under wet conditions, the target filling date is delayed until 1 November. The storage operator, GMW, is authorised to make managed releases if the storage level rises above the filling targets established to meet these objectives. The overall purpose of these additional releases is to retain some air-space in the reservoir during the winter/spring to provide a measure of flood mitigation benefit to downstream communities, while not creating significant risks to overall water availability for entitlement holders.

Downstream of Lake Eildon, water harvesting activities focus on diverting a portion of inflows to the system below Lake Eildon out of the river at Goulburn Weir and storing them in Waranga Basin for use during the irrigation demand period. The mid Goulburn catchment between Lake Eildon and Goulburn Weir is highly productive, with average annual inflows only slightly lower than those received above Lake Eildon.

The ability to divert water to Waranga Basin in the harvesting period is constrained by the maximum capacity of the Stuart Murray and Cattanach Canals (Figure 9) which connect Goulburn Weir to Waranga Basin. The maximum combined capacity of these canals is approximately 7,200 ML/day. Any inflows to Goulburn Weir above this level will spill through the weir and continue down the Lower Goulburn. The filling of Waranga Basin is also managed in a controlled fashion with the aim of just filling the storage as irrigation demand develops (usually in late spring). This ensures that the storage is not held at full supply for extended periods, which can lead to wave damage on the embankment in high winds.

During the irrigation demand period, the level in Waranga Basin is progressively drawn down, with the aim of having the storage at its minimum operating level at the end of the irrigation season. The objective of this activity is to retain water in the uppermost storage (Lake Eildon) and maximise the potential for harvesting flows into Waranga Basin during the water harvesting phase.

Minimum passing flows at Goulburn Weir range between 250 ML/day and 400 ML/day, depending on the time of year.

6.2.2. Water delivery phase

Historically, the water delivery phase has been driven by meeting the needs of consumptive water users, which has been dominated by irrigated agriculture. Major irrigation sectors

supplied from the Goulburn system include dairying, horticulture and mixed cropping and grazing enterprises. As rainfall naturally reduces in the late spring/summer, irrigation demand increases to meet the water needs of these crops. The irrigation supply season within the irrigation areas nominally runs from mid-August to mid-May, however the major demand period generally occurs from November to April, depending on seasonal conditions.

In order to meet irrigation requirements, GMW estimates the likely demands based on an assessment of a range of data including water orders, historical demand patterns, weather forecasts and water availability. Demands at Goulburn Weir are met by using a combination of releases from Lake Eildon and harvested inflows from unregulated tributaries from the mid Goulburn reach. During the water delivery operations, releases from Lake Eildon are managed to avoid overbank flows and ensure no private land is subject to inundation.

Water is diverted at Goulburn Weir to meet irrigation demands within the Goulburn component of the Goulburn Murray Irrigation District. Maximum diversion rates can reach approximately 9,900 ML/day as water is diverted into the East Goulburn Main Channel to supply the Shepparton Irrigation Area and the Stuart Murray and Cattanach canals to meet the demands of the Central Goulburn Irrigation Area and releases from Waranga Basin. Water stored in Waranga Basin is also drawn on to meet peak demands that can exceed the capacity of direct diversions from Goulburn Weir.

Demands downstream of Goulburn Weir are met by unregulated inflows to the lower Goulburn reach, together with supplementary releases over Goulburn Weir. These demands include diversions from the lower Goulburn and transfers from the Goulburn to the Murray system (e.g. the Murray system operator can call for water from the Goulburn Inter-Valley Transfer (IVT) account to cover volumes of water traded from the Goulburn system to the Murray system).

GMW has adapted its operating practices in recent years to accommodate the deployment of environmental held water. The provision of environmental freshes and higher baseflows has occurred within the confines of the current operating range for the Goulburn River, with GMW focusing on operations to avoid affecting diversions at Goulburn Weir and private diverters in the lower Goulburn River. Several of the freshes have coincided with IVT account deliveries.

6.3. Reference to desired flows in environmental watering requirements

In Victoria the identification of the required water regime for a river occurs through scientific work to determine the water regime required to support environmental values identified for river systems using the FLOWS Method.

The environmental flow recommendations under the FLOWS Method (DEPI, 2013b) are expressed as flow components, which can be largely characterised for the Goulburn River as follows:

Base flows (or low, in-channel flows) are continual flows in parts of the channel that maintain aquatic habitat for fish, plants and invertebrates. Base flows comprise long-term seasonal flows and are usually delivered throughout the year as low volume (<1,000 ML/day at Shepparton) surface flows.

In-channel fresh events are small-to-medium flow events (up to 8,500 ML/day at Shepparton) (Figure 11) which inundate benches within the river channel, replenish soil water for riparian vegetation, and provide cues for fish spawning and access to a diversity of habitat for aquatic biota. They are relatively short in duration (up to 14 days) and occur in most years, or possibly multiple times within a year.

High flows generally connect most in-channel habitats and are less than bank-full and may include flow in minor floodplain channels. These flows inundate instream habitats, maintain

channel connectivity and allows fish migration, inundation of organic matter and sediment movement.

Bank-full flows are the larger flow events (up to 18,000 ML/day at Shepparton) that fill the river channel and may inundate flood-runners in low-lying areas of the floodplain. These flows are important for maintaining bed diversity, native fish recruitment and colonisation, regeneration of native riparian species and to retain natural seasonality for macroinvertebrate life stages.

Overbank flows are the larger flow events that fill the river channel and low parts of the floodplain. They are important for a range of floodplain processes to occur e.g. healthy wetland systems that support fish and waterbird breeding, as well as the transfer of food and organic material that support productive instream foodwebs (MDBA, 2014; GBCMA, 2015).

The Goulburn Constraints Measure aims to deliver increased freshes, high flows and bank-full flows, which have previously been constrained by agency concerns over potential liability associated with the risk of flooding private land.

An overview of the contribution of the different flow components in meeting the riverine and floodplain objectives are summarised in Appendix D.

A range of studies have been undertaken to determine the environmental flow requirements of the Goulburn River and its floodplain (Cottingham P S. M., 2003; Cottingham et al, 2007; Cottingham et al, 2011; Cottingham et al, 2014a; DSE, 2011). Collectively the assessments identified flow recommendations that achieve flow objectives for all environmental assets and aim to promote longitudinal and lateral connectivity.

Further detail on the full suite of environmental flow recommendations for the Goulburn River from these studies is presented in Appendix E

Figure 11 Shepparton Boat Ramp Flow 8000ML/day – 28 June 2017 (credit Daniel Lovell GBCMA)

6.4. Current environmental water management

Management of environmental water in Victoria is a state-wide partnership between the Victorian Environmental Water Holder VEWH, catchment management authorities including

Melbourne Water, DELWP, land managers including Parks Victoria and local councils, water corporations, Traditional Owner groups, and interstate agencies including the Commonwealth Environmental Water Office (CEWO) and the Murray-Darling Basin Authority (MDBA).

The Goulburn Broken Catchment Management Authority (GBCMA) is the designated waterway manager for the Goulburn River and has the responsibility to plan for and deliver environmental water with VEWH and other partners.

Water is also released along the Goulburn River specifically to improve environmental outcomes in the Goulburn River and downstream along the River Murray. Water entitlements for this purpose are held by the VEWH and by the CEWO. The GBCMA prepares an Annual Watering Plan to set environmental watering priorities for the Goulburn River. The VEWH and CEWO consider these priorities and allocate water for delivery. GBCMA places orders for release of water with GMW.

Environmental water is currently used to deliver increased baseflows and freshes up to 8,500 ML/day. GMW notifies Goulburn River customers up to six weeks in advance of a planned release to enable potentially affected parties to take any necessary action that may affect them e.g. irrigation deliveries around peaks, move stock or relocate temporary water supply equipment.

6.5. Proposed changes to flow regimes

This project aims to restore the volume, frequency and duration of freshes, high flows and bank-full events the lower Goulburn River.

These events will occur generally in winter and spring (July to November) when rain and higher unregulated tributary flows typically occur in the Goulburn River. Importantly, the project may provide a greater capacity to deliver flows during drier years when aquatic plants and animals need the water most.

Some flow events of less than 10,000 ML/day will also be delivered in summer and autumn, but only on the back of natural cues.

Importantly, the flows created over time will be of variable size and duration, i.e. not all flows will be at or near bank-full.

Environmental flow managers already target achieving three to four flow freshes per year, in autumn, winter and spring. High flows and bank-full events are not targeted with current constraints in the Goulburn River. Under this project, the magnitude and duration of these events will be increased as needed to provide high flows and bank-full.

The proposed flow regime considers both the third party impacts and previous environment flow recommendations.

The flow recommendations are described as target flows for the Shepparton flow gauge (station number 405204), which are known to achieve the desired rates of inundation downstream.

7. Proposed operating arrangements

7.1. Overview

The proposed operating regime has been designed to generate additional in-channel fresh, high and bank-full flows in the lower Goulburn reach during the year, to increase both the number of years with events and the number of events within a year. The targeted range for these events is 5,000 – 17,000 ML/day at Shepparton as measured at gauging station 405204. - Refer to Sections 6.3 and 6.5 for further details on the targeted frequency, magnitude and duration of events.

The fresh events will be generated by supplementing unregulated inflows from tributaries using two sources:

1. Additional releases from Lake Eildon. The rate of additional release will be managed so that the maximum flow immediately downstream of Lake Eildon (at Alexandra) doesn't exceed 9,500 ML/day. This helps ensure releases in the mid Goulburn reach are within existing operational flow magnitudes and any potential impacts to the change in timing of the events can be addressed through implementation of a package of feasible measures.
2. Additional releases to the lower Goulburn reach by ceasing diversions to Waranga Basin. The cessation of diversions will allow the flows to pass downstream over Goulburn Weir, together with any other mid Goulburn inflows and Lake Eildon releases.

7.2. Key features of the proposed operations

The key features of the proposed operational arrangements are summarised below.

a. At the beginning of each water year, the environmental water manager (GBCMA) will nominate the preferred requirements for in-channel freshes, high flows and bank-full flows in the lower Goulburn in accordance with the adopted environmental watering regime.

b. Watering proposals are prepared by the environmental water manager and submitted to the VEWH for consideration. If deemed a priority for that season, VEWH will allocate water from the environmental water account for use in the lower Goulburn.

c. In years when watering is desirable, the system manager (GMW), in consultation with the environmental water manager, will monitor the Bureau of Meteorology's seven and 30 day rainfall and streamflow forecasts to identify events that are likely to produce tributary inflows that are suitable for supplementation.

d. An assessment will be made of the capacity to supplement expected streamflows to determine if an event can proceed. The key considerations will include the current level of release from Lake Eildon and diversions to Waranga Basin. For example, if significant releases are already being made from Lake Eildon and no water is being diverted at Goulburn Weir for harvesting into Waranga Basin there is minimal capacity to supplement any additional inflows, so a managed release event will not proceed.

e. When suitable tributary flow conditions are forecast to occur, diversions to Waranga Basin will be ceased and additional flows directed downstream over Goulburn Weir. Event planning will determine the appropriate timing to coincide with the tributary flows. Given that Goulburn Weir is only 1.6 days river travel time from Shepparton, sufficient lead time is available for decisions on ceasing diversion to Waranga Basin to be based on actual streamflows observed in the mid Goulburn River and on tributary streams.

f. For events where a larger flow supplement is required to meet the environmental flow requirements, additional releases will be initiated from Lake Eildon, up to a maximum total flow of 9,500 ML/day downstream of the storage at Alexandra, taking into account flows from unregulated tributaries such as the Acheron and Rubicon Rivers. Due to the significant travel times from Lake Eildon to the lower Goulburn, many of these Lake Eildon release decisions will be based on streamflow and rainfall forecasts and modelling.

g. During a high in-channel environmental release, the system manager will notify potentially affected parties and closely monitor rainfall forecasts and data on rainfall and streamflow from catchment monitoring stations. This data will be used to run rainfall-runoff modelling tools to estimate streamflows that would be experienced during the event. Supplementary environmental releases will be adjusted as necessary, within the constraints established for environmental watering actions, to maximise the effectiveness of the event. Importantly, where forecast rainfall is expected to generate streamflows above the maximum targeted levels for supplemented flows, releases from Lake Eildon will be reduced or ceased and diversions to Waranga Basin at Goulburn Weir will recommence to avoid any impacts due to supplemented flows exceeding the capacity of the mitigation measures put in place as part of the project.

h. Depending on the environmental objectives for the year it is anticipated that these events could occur at any time of the year, but generally be in winter/spring.

GMW is generally supportive of the proposed changes at a conceptual level and will work closely with the proponent to refine the operational arrangements, should the project proceed.

7.3. Supporting investigations

Modelling has been undertaken to identify and test a range of operational approaches (Jacobs, 2015a). There are a number of challenges in supplementing tributary inflows that were considered in developing the proposed approach, including the physical travel time for the additional releases to reach the lower Goulburn, and development of processes to ensure that monitoring and forecasting lead times for tributary inflows can be aligned with the travel times for delivery of supplementary flows.

As shown in Figure 12, releases from Lake Eildon take approximately 2.4 days to reach Goulburn Weir, and a further 1.6 days for releases over Goulburn Weir to reach Shepparton, where they can supplement flows from the Broken River, which is one of the major lower Goulburn tributaries. In order to provide sufficient lead time to enable effective supplementation of natural flow events, approximately six days lead time is required to initiate Lake Eildon releases, increase them in a controlled manner to the desired peak rates, and for flows to travel down the Goulburn River to the lower Goulburn.

Jacobs (2015a) found that the flow travel time from Lake Eildon to Shepparton is longer than any other flow travel time in the Goulburn (excluding upstream of Eildon) and Broken valleys. Of particular note is that the flow characterisation review identified that of the flood events, a large proportion of the flow was contributed by the ungauged catchment area upstream of Trawool. This area is between zero and 1.5 days downstream of Lake Eildon.

The Broken River at Orrvale was also identified as an important contributor to a significant number of events. This is four days travel time downstream of Eildon. Therefore, if a release was initiated from Lake Eildon on the basis of waiting for a peak flow at Orrvale to occur, the increase in flow rate due to the release from Lake Eildon would not arrive at Shepparton until four days later.

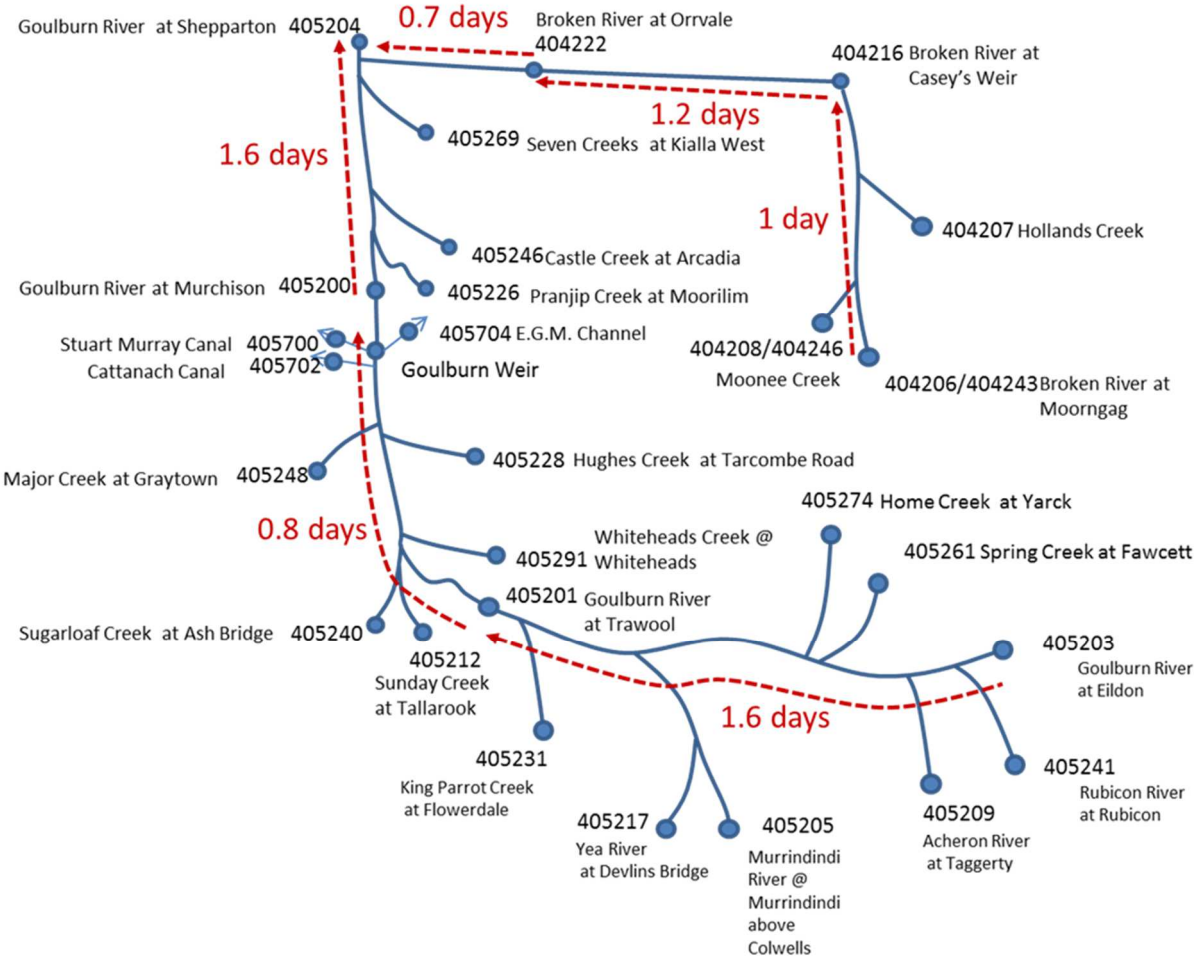

Figure 12: Transit times between Lake Eildon and Shepparton (Jacobs, 2015a)[5]

Hypothetical operations were modelled using just the option of ceasing Waranga Basin diversions for the 55 years from 1960 to 2014. The outputs show a significant increase in the number of events greater than 15,000 ML/day in the lower Goulburn reach compared to current operating conditions. Table 8 provides the results of this modelling.

Table 8: Estimated changes in the number and frequency of flows at Shepparton with proposed flow supplements

Peak Flow Threshold at Shepparton (ML/d)	Number of events over 55 years between 1960 and 2014	
	Current conditions	With ceasing Waranga Basin diversions
8,000-15,000	28	0
15,000-20,000	27	55
>20,000	85	85
Total	**132**	**132**

Table 8 shows that the proposed operating strategy is feasible.

[5] This schematic shows travel times based on calibrated values using daily timestep data. Events vary in travel time to some degree. Further work is proposed to be undertaken using data at a timestep less than a day such as hourly data to investigate variations in travel time.

There were 28 events within the target flow of 15,000 -20,000 ML/day (20% of total) between 1960 and 2014. This can be increased to 55 events (42% of total) by ceasing diversions to Waranga Basin.

Releasing from Lake Eildon in addition to ceasing diversions from Waranga Basin is likely to increase the potential to undertake environmental watering in the target range. There are an additional 269 events with flows of between 5,000ML/day and 8,000ML/day at McCoy Bridge that could be supplemented by Eildon releases to create the target flow of 17,000 ML/day at Shepparton. Providing increased frequency and duration of flows with lower peak flows is also a desired outcome of the proposal.

7.4. Proposed operating tools

The revised business case proposes increasing flows at Shepparton by adding environmental water to tributary flow events.

This action will require system operators to make decisions based on rainfall and streamflow forecasts to either release from Lake Eildon, Goulburn Weir or both to meet a desired environmental flow. Additionally, the operators will need to modify Lake Eildon and Goulburn Weir releases and diversions to Waranga Basin based on actual rainfall and flows.

A range of new operating tools and procedures is needed to provide the capabilities necessary to effectively manage environmental flow releases to supplement tributary inflows. These are described below and include:

- expanded rainfall and streamflow monitoring;
- development of river operation models and streamflow forecasting tools;
- data interfaces between Bureau of Meteorology (BoM) and GMW systems; and
- enhanced notification services.

7.4.1. Improved rainfall and streamflow monitoring

Enhancements to the existing rainfall and streamflow monitoring network in the Goulburn catchment include:

1. Installation of aditional streamflow and rainfall monitoring stations to monitor significant tributaries of the Goulburn River upstream of Trawool.
2. Installation of an additional streamflow gauging station on the Goulburn River between Eildon and Trawool.

7.4.2. River operation models and streamflow forecasting tools

GMW has an existing forecasting system which enables operators to forecast inflows into storages. This will be expanded to include the capability for them to manage the new operational flow requirements under this business case. River operation and rainfall-runoff models will be built to enable accurate prediction of future river flows in the Goulburn River and from its tributaries. This will enable GMW to run scenarios, predict future Goulburn river flows, and alter releases and infrastructure operation to meet the desired environmental flow requirements.

The new system will consist of three primary components. The first is a river operations model that will forecast Goulburn River flows considering tributary inflows and GMW operation decisions (e.g releases from storages). The second component will be hydrologic models including rainfall/runoff models to predict unregulated river conditions. Finally, GMW's forecasting system HyFM (based on the DELFT-FEWS platform) will be the interface that ties it

all together. This is an important action, as it will provide the capability to estimate tributary inflows during events and reduce supplementary environmental releases to avoid unacceptable impacts from higher than planned flow rates. This flow forecasting and management capability, in conjunction with the "buffer" allowance to provide additional freeboard above the targeted maximum environmental flows, provides a critical risk mitigation action (refer Section 8 for further details on risks).

The BoM provides a 7-day forecasting service for streamflow in key river catchments across Australia. Forecasts are currently provided for five sites in the Goulburn catchment; however, the BoM intends to extend this service. Subject to Commonwealth funding, the BoM intends to develop rainfall and streamflow forecasting for all gauging sites in the Goulburn (and Murray-Darling Basin). This will include forecasts up to 30 days (sub-daily up to a week, and aggregated days to 30 days).

It is possible that the BoM's enhanced forecasting services could be interfaced to GMW's systems as a future option for forecasting streamflow forecasts.

7.4.3. Data interfaces between BoM and GMW systems

Development of data interfaces between BoM and GMW systems that will allow timely access to high quality data is an essential input to the water management decision making and system modelling activities that will underpin supplementary environmental water release activities.

GMW already has extensive access to rainfall and river height data in the Goulburn River system. Additional automated interfaces will be developed to transfer BoM forecast data to GMW water management systems. As well as supporting water management activities in the lead up to and during events, this data will also be used as part of a structured adaptive management process to better understand river flow behaviour under a range of different conditions and to improve the predictive capabilities of the models.

7.4.4. Enhanced notification services

Releases supplementing tributary inflows to target higher in-channel environmental flows will not be covered by existing notification services from GMW relating to current environmental deliveries or by traditional flood warning services. Notification services will be developed to provide timely warnings to communities adjacent to the sections of the Goulburn River that may be affected by environmental releases. Effective notifications will allow landholders to move stock and assets (e.g. vehicles, temporary pumping equipment) out of the area to be inundated during an event. The proposed notification services will leverage off the work and learnings developed for delivering bushfire alerts.

7.5. Required changes to current operations

Changes to current operating procedures and accounting arrangements will also be needed if the project proceeds, as described below.

7.5.1. Water accounting

Development of appropriate water accounting protocols for the proposed operating arrangements is needed. Releases from Lake Eildon can be accounted for at the point of release; however, new accounting protocols are required to ensure that the water used to supplement tributary flow events is properly accounted for and that the reliability of water access entitlements is protected.

New protocols will also be needed to account for the additional releases over Goulburn Weir caused by ceasing diversions to Waranga Basin. Releases over Goulburn Weir can be measured, however releases will only affect entitlement holders if Waranga Basin fails to

`reach the same level that it would have if diversions had not ceased during an environmental watering event.

Any shortfall in harvesting to Waranga Basin that arises because of environmental watering will be debited from environmental water accounts to ensure no loss of resource to all entitlement holders. Accounting rules will be developed in consultation with environmental water holders.

Similarly, one of the proposed risk management strategies to manage third party impacts is to recommence harvesting into Waranga Basin if rainfall increases tributary flows above target levels. To the extent that this process results in the harvesting of environmental releases from Lake Eildon into Waranga Basin over and above that which would have been possible without a watering event, accounting processes will need be developed to ensure an appropriate credit is provided to environmental water accounts. This is most likely to occur in circumstances where increased tributary flows downstream of Goulburn Weir (which could not have been harvested) require the diversion of Lake Eildon releases into Waranga Basin.

7.5.2. Development of revised operating procedures

Current river operating procedures for the Goulburn system will need to be revised and updated to support management of environmental flow releases to supplement tributary inflows to target higher in-channel environmental watering events. This review will need to incorporate the risk management actions that have been identified to manage flows within the adopted target limits during supplemented flow events. GMW will lead the revision of the river operating procedures as delegated Goulburn Storage Manager and Resource Manager. Consultation with environmental water holders and the environmental water manager, as well as consumptive user representatives, will ensure the procedures address current and future operating regimes.

An important component of the revision may include adjusting the timing of filling targets for Waranga Basin, to ensure there is a small amount of airspace reserved during periods when release events are expected to occur. This will ensure that water released from Lake Eildon can be diverted to Waranga Basin if downstream tributary inflows increase unexpectedly during an event. If the reservation of airspace for this purpose ultimately results in a reduction in the resource harvested into Waranga Basin in the water year, the shortfall will need to be debited against environmental water accounts to ensure system reliability is maintained for all entitlement holders.

The updated system management procedures will document the notification, water ordering and consultation processes between the environmental water manager and the system operator that are required before, during and after an event. Similar consultation with the Murray system operator is needed to amend (if necessary) the use of Goulburn IVT account deliveries during the summer and autumn to help meet the revised environmental flow targets.

7.5.3. Review maximum rates of rise and fall for Lake Eildon releases

While analysis shows that the proposal for supplementing tributary inflows with releases from Lake Eildon is feasible under current Lake Eildon operating rules, the rate that flows can be increased (and decreased) to initiate flow events and in response to tributary flow fluctuations is limited by maximum rates of flow change rules.

The primary purpose of the rate of fall rules is to avoid damage to river banks through rapid changes in water level. If these rules can be relaxed, more rapid increases and decreases in flows downstream of Lake Eildon will be possible and the effectiveness of inflow supplementation actions will be improved. The current rules were established many years ago,

and are believed to be quite conservative. The MDBA has similar rules for rates of reduction in flows below Lake Hume, and has recently begun trials to relax these rules.

During the projects implementation phase, the current Lake Eildon rules will be reviewed and expert geomorphological advice sought on suitable rates of flow change. In addition, advice on environmental and public safety risks and management will be obtained

7.5.4. Review maximum rates of rise and fall for Goulburn Weir Canal Operations

Operating rules for the Stuart Murray and Cattanach canals require changes of flow to not exceed steps of 400 ML/day per four hours, with a limit of two changes per day under normal conditions and three per day when extreme flow conditions are being experienced.

These rules exist for the same purpose as those in place at Lake Eildon. Expert geomorphological and asset advice is needed to confirm how the rates on both canals could be modified to assist both environmental and consumptive demand deliveries.

7.6. Staff training

The project's proposed implementation phase includes the preparation and delivery of an extensive staff training program to build the necessary capability to apply the procedures and tools described above to deliver effective watering events.

Training will focus primarily on GMW river operations staff, but also include environmental water management staff from the GBCMA and the VEWH and CEWO as necessary to ensure a shared understanding of roles, responsibilities and communication and collaboration procedures required to deliver an event.

In additional to structured "classroom" learning, the training program will include a range of hands-on activities, particularly simulated events, including:

a. *Shadow operations in real time during natural events*. Staff would monitor the system and make the decisions that will be required to make supplementary releases for the environment. While releases will not be made, the proposed decisions will be tracked and simulated on modelling tools, and the flows that will have been generated in the lower Goulburn can be estimated and compared to the intended flow objectives for the shadow event.

b. *Simulated desktop operations*. Data from historic events that would have been suitable for supplementary environmental releases can be collected and fed to system operators to allow them to simulate the planning and decision making actions required in an event. The desk top simulation enables lengthy events to be replicated in a compressed timeframe (e.g. hourly rainfall data can be provided every 5 minutes and travel times for flows can be compressed).

7.7. Other required policy or operational changes

As noted above, a range of amendments would be required to river operating procedures and processes in the Goulburn River system.

No other amendments to state legislation or policy are anticipated. This includes no requirements for formal amendments to state water sharing frameworks, as the operating procedural changes proposed all fall within the provisions of current Bulk Entitlement orders. Implementation of the outcomes of the proposed review of the maximum rates of rise and fall for Lake Eildon releases will require Ministerial approval for any changes to this operating rule, but this does not require any amendment to the Bulk Entitlement Order.

It is not expected that the changes to operating arrangements in the Goulburn system will result in any requirement to amend the *Murray-Darling Basin Agreement 2008*, or operating rules that exist under this Agreement.

The process that will be required to settle agreements with affected landholders should this project proceed has been captured elsewhere in this business case (refer Section 9.3). This section deals with matters that are specifically relevant to state policy and legislation, and any associated inter-jurisdictional agreements.

The regulatory approval requirements to support project implementation are discussed elsewhere in this business case.

8. Third party impacts and mitigation measures

8.1. Refinement of risk assessment for third party impacts

A high-level risk assessment of potential third party impacts (DELWP 2017) has been undertaken using available information. The project is still at the feasibility stage therefore the risk assessment will be refined as the project is further developed.

This will require:

- re-evaluation of the project's risks as new information becomes available, particularly specific impacts to individual properties;
- continued refinement of the hydraulic model and topographical surveys to improve accuracy of watering footprints, particularly between Seymour and Goulburn Weir and around the junction with the River Murray ; and
- improved understanding of broader social and economic impacts through ongoing consultation and assessment with the community and other project stakeholders.

8.2. Overview

The harnessing of Goulburn River water resources and the subsequent operating rules have provided a secondary benefit of improved flood protection. This has allowed the development of the floodplain for farming, residential and other business purposes.

The focus of this assessment is on impacts in Victoria of increased Goulburn flows up to bank-full. Increased Goulburn flows in conjunction with high flows in the River Murray may increase the frequency of overbank flows in New South Wales (NSW), both north-east of the Goulburn-Murray confluence and further downstream, and in Victoria. This area is part of NSW's Yarrawonga to Wakool constraints key focus area and it is assumed that inundation in these areas is being considered in the development of the NSW-led business case.

This section focusses on third party (social and economic) impacts of which have been considered at two levels:

- **Identified impacts from planned flows**: the negative flow related impacts because of the project
- **Other potential impacts of the project**: adverse impacts during the project's construction or operational phase.

The assessment of third party impacts has been informed by a range of technical investigations and community consultation, as well as an AS/NZS ISO 31000:2009 compliant risk assessment process (Appendix F). Environmental and project delivery risks considered through this process are described in Sections 5.2 and 14.2 respectively.

Collectively, these assessments identified that the proposed mitigation measures will be effective in managing the identified and potential impacts of the project. While they may be effective, challenges are anticipated in achieving their implementation, posing a key risk to the project delivery (Section 14.2).

8.3. Overview of impacts from planned in-channel flows

8.3.1. Assessment of impacts

Potential impacts from the delivery of in-channel flows have been informed by several key studies including:

- asset mapping and 2-D hydraulic modelling of the river and its floodplain to improve understanding of what river flows inundate what assets (Water Technology 2015a);
- hydrologic analysis and modelling to understand the behaviour of tributaries in producing flows and scope the potential for using reduced diversion from Goulburn Weir and releases from Lake Eildon to top up these flows (Jacobs 2015a);
- a concept design of Hancocks regulator to understand the work required to upgrade (+GMR Engineering, 2015 & 2015a);
- assessment of the potential impacts on public infrastructure e.g. public roads, bridges and town drainage by consulting with local government (AECOM, 2015); and
- identification of the extent of specialist (higher value) businesses impacted using a representative sample of businesses (Jacobs, 2015b).

The community consultation undertaken during the development of the MDBA Constraints Management Strategy and the 2016 business case (see Section 12.3 for details) has informed the issues to be considered in the development of this in-channel proposal. This has contributed important local knowledge to the project, such as confirming hydraulic modelling outputs. Assessment of the specific impacts to more traditional farming businesses has not been undertaken due to time limitations but has been looked at in aggregate. Understanding of the potential impacts has been based on available hydraulic modelling. This has allowed costs to be estimated for in-channel mitigation measures. The estimates for mitigation measures will be refined and are an important element of the further investigations (Section 9.5) should the project proceed.

Third party impacts presented in this section are based on the **maximum identified impact** (i.e. maximum flows of 9,500 ML/day at Alexandra and the risk management buffer of 20,000 ML/d at Shepparton). High level public and private impacts are shown in Table 9 and Table 10 respectively. The tables present the direct project impacts and options to limit or offset the impacts on current economic and social use.

Table 9 High level third party public impacts and mitigation measures

Stakeholder	Description of potential impact	Mitigation Options
Land managers including traditional owners	Damage to tracks, crossings and other infrastructure Interruption to recreational and cultural floodplain activities Increased activity around notification of road closures and management of licence holders	Compensation for increased maintenance costs Notification of planned watering events and road closures
Local government	Damage to one or two roads Reduced performance of drainage infrastructure Increased activity around notification of road closures Inundation of public spaces and walking tracks	Notification of planned watering events and road closures Compensation for increased operational and maintenance costs
General community	Interruptions to access for recreational use Inconvenience and hazards due to road closures	Upgrade of roads Notification of planned watering events and road closures

Table 10 High level third party private impacts and mitigation measures

Stakeholder	Description of potential impact	Mitigation Options
Agricultural and specialist businesses	Impact on water supply works Minor impacts across minor river channels and wetlands	Upgrades to other farm infrastructure e.g. re-siting of pumps Provision for offsetting fencing impacts Improved flow warning notifications
Traditional Owners	Damage to cultural heritage sites	Construction controls to protect cultural heritage sites Compensation for increased maintenance costs
Commercial public land operators	Interruption to access required for day to day operations Potential loss of revenue	Notification of planned watering events

8.4. Residual risks

A range of mitigation measures have been developed to prevent unacceptable impacts on private and public assets. These measures include re-siting of pump infrastructure to be outside of the river channel (see Section 8.3 for details).

Any major project carries with it the possibility that unexpected or unplanned events may occur, with associated impacts to third parties during the project's construction and operational phases. These unplanned events are usually referred to as risks, and while they are unplanned, they are foreseeable.

A high-level risk assessment was undertaken for the project, in accordance with the provisions of AS/NZS ISO 31000:2009 (Appendix F). The outcomes of this assessment process are documented in the *Goulburn Constraints Management Project: Risk Management Strategy* (DELWP 2017) and takes into account the third party project risks associated with the project's construction and operational stages.

As discussed previously, the assessment provides a preliminary basis for prioritising mitigation strategies and measures based on currently available information. A more detailed risk assessment will be carried out should the Basin ministers decide to proceed further with the project.

The full suite of risks considered by the assessment process is documented in DELWP (2017) and a summary of pre-treatment risks with a rating of significant or higher is provided in Appendix G. There are a number of significant risks that need to be managed to avoid or minimise third party impacts, and Appendix G sets out the mitigation actions identified to address these risks. The majority of these risks can be effectively mitigated through identified measures.

Most of the risks identified can be managed through the implementation of control actions. There are two remaining priority risks that cannot be adequately managed with identified controls. These are discussed below and will need to be addressed in the subsequent stages of this project, should it proceed.

8.4.1. Inability to accurately predict tributary inflows:

A key risk for the project is supplementing tributary inflows to meet the planned flow targets at Shepparton. There are two aspects to this issue.

Supplementing tributary inflows with releases from Lake Eildon has been assessed as a **significant risk** for the project. If the expected inflows from tributaries cannot be predicted with sufficient accuracy, then there is potential for releases to result in flows higher or lower than the targeted rates, which may result in unintended flooding of private land with potentially large financial consequences, or failure to achieve the intended environmental outcomes. The second and closely related aspect of this risk is that once a release event has been initiated, if unexpected rainfall events occur, natural tributary inflows may increase, with potential for unplanned flooding to occur.

The risk mitigation strategy has five key elements:

a. Developing expanded data collection networks and improved tools to support accurate forecasting of tributary inflows and improved planning of river flow behaviour. This will improve understanding of the expected tributary inflows and how these flows and releases from Lake Eildon will travel through the system in time and space to contain flows within planned limits. These arrangements are described in more detail in Section 7, but will include:

- Expansion of the rainfall and streamflow monitoring network in the mid Goulburn catchment
- Further development of existing streamflow forecasting services by GMW
- Development of automated data interfaces between GMW and BoM system to effective share and manage forecast data which will drive modelling and decision support tools.
- Development of improved river management tools and procedures by the system operator, GMW

b. Provision of a 3,000 ML/day buffer allowance to provide additional freeboard above the targeted maximum environmental flows.

c. Reduction of Lake Eildon releases and diversion of Lake Eildon releases to Waranga Basin at Goulburn Weir if downstream tributary inflows increase unexpectedly during an event.

d. Development of revised operating procedures to formalise these mitigation actions together into clearly articulated processes for the operational management, monitoring and co-ordination of events.

e. Phased implementation of the watering program is proposed so that events are targeted at the lower end of the planned range initially to monitor system performance and to provide data for adaptive management of operational planning tools and procedures.

This mitigation strategy is ultimately expected to be effective in managing the likelihood of unplanned flood of private land. However, given that some of the streamflow forecasting and river operational management tools have not been fully scoped or designed, it is considered prudent to continue to rate this as a significant risk at this time.

8.4.2. Lack of community support:

Lack of support from potentially affected stakeholders and communities is also considered to be a key project risk. The primary control is an extensive and ongoing communications and engagement strategy that aims to fully inform stakeholders and appropriately address all issues that are identified. This communications and engagement strategy is detailed in Section 12, and is included in the costings for the project. Given the complex and potentially changing nature of community concerns, the engagement strategy will need to closely monitor these issues and be frequently revised and updated to ensure it is able to effectively engage with and address community concerns.

<u>Two other issues are worthy of noting.</u>

The assessment of risks and issues around physical performance of the river system and forecasting of inflows and likely flows that can be generated by supplementing inflows has been based on analysis of historic system performance over the last 55 years. This means that there is no explicit consideration of how climate change may change rainfall and river flows in future. It is likely that climate change may affect the frequency, magnitude and seasonality of future inflow events.

Climate change may affect the historical frequency, duration and timing of Goulburn River system flows. It is proposed that water system behaviour will be monitored and reviewed over time to understand if the nature and behaviour of high flow events is changing. The operating procedures for this scheme would be updated as necessary to respond to any changes identified.

9. Technical feasibility and fitness for purpose

A range of actions have been identified in this business case to enable the delivery of freshes, high flows and bank-full flows (up to 17,000 ML/day) in the lower Goulburn River downstream of Shepparton. These actions can be broadly categorised as those needed to deliver the increased flows and those required to mitigate unacceptable third party impacts associated with the delivery of these increased flows.

On the basis of the studies and assessments undertaken to date, these actions are considered technically feasible and are expected to effectively achieve the project's identified objectives. Should Basin ministers decide to proceed with the project, further investigations, analysis and development of engineering designs are proposed to confirm the final project for implementation. These activities are discussed in Section 9.5 (Further work required), Section 11 (Costs and funding arrangements) and Section 14.3 (Project plan for implementation).

9.1. Proposed actions to deliver increased flows

The key action required to deliver freshes, high flows and bank-full flows in the lower Goulburn is supplementing unregulated tributary inflows originating in the mid Goulburn and lower Goulburn reaches via ceasing diversions to Waranga Basin and passing these flows over Goulburn Weir, and additional releases from Lake Eildon (refer to Section 7 for further detail on proposed operations).

A hydrological analysis of historical daily flow data over the period 1960 – 2014 was undertaken using river flow routing techniques, to test the feasibility of these mechanisms to supplement tributary inflows and meet flow targets (Table 8). The analysis highlighted the need to use rainfall and streamflow forecasts to decide whether to release from Lake Eildon, rather than relying on observed streamflows to trigger releases. The analysis also confirmed that it will be possible to mitigate some higher than desirable flows once supplementary release had been initiated, by recommencing diversions to Waranga Basin and reducing Lake Eildon releases.

Overall, the analysis provides "proof of concept" that these mechanisms provide a feasible means to meet the flow target. Limitations and aspects for further development, particularly regarding improved forecasting ability, have also been identified. The key limitation is that the use of daily time step data does not allow detailed analysis of instantaneous flow peaks, which are greater than average daily flows.

Other actions that will be necessary to support the release of supplementary environmental flows include:

- additional rainfall and streamflow monitoring sites in the mid Goulburn; and
- expanded coverage of the streamflow forecasting services in the Goulburn catchment.

Development and implementation of eWater Source (or similar) modelling tools to support real time operational decision making on water systems management is also proposed. This is an important action, as it will provide the capability to estimate tributary inflows and to develop effective release plans to deliver the flows needed to meet the lower Goulburn target flow rates. This tool will also be used to estimate tributary inflows during events and reduce

supplementary environmental releases in order to avoid unacceptable impacts from higher than planned flow rates.

Streamflow forecasting for predicting catchment runoff will use existing techniques to develop models for subcatchments downstream of Lake Eildon. The accuracy of forecasts will need to be assessed further during implementation of this project. In the future, BoM forecasts could be used when a catchment wide service is available.

The eWater Source modelling tools have been developed through an extensive research and development program, and are being adopted as the standard national hydrologic modelling platform. Source has not been deployed in an operational mode in Victoria, and there will be a considerable amount of work required to implement and calibrate this tool to the level of accuracy required for this project. DELWP is currently implementing Source as their primary hydrologic simulation modelling tool. It is expected that this work will provide a strong base to develop the operational river management capabilities. The MDBA is also moving its simulation modelling to the Source platform and intends to implement the operational management capabilities, which will help build a wider community of practice to support development of these tools in both jurisdictions.

9.2. Principles and process for determining mitigation options

When determining the specific mitigation options to address each impact, the following principles were assumed to ensure that the measure effectively and appropriately mitigates the impact.

1. That the affected parties are not worse off.
2. That any safety considerations (such as critical public access routes) are not compromised.
3. That measures will help communities adapt to a changed flow regime.
4. Arrangements are enduring.
5. That the transaction costs to implement the mitigation actions are reasonable.
6. Other practical and policy considerations have been considered, particularly as they relate to working with stakeholders on just terms and avoid creating perverse incentives.

Recognising the above principles, in assessing the appropriate mitigation measures, it has generally been assumed that payments for future increased management and reinstatement costs will be the preferred mitigation option, and that infrastructure works (e.g. upgrades to infrastructure) will only be implemented where it is more cost effective to do so.

Note that in the context of this business case, mitigation options were considered at a regional rather than a property-by-property or individual asset scale. If this business case were to be implemented, further assessment will be undertaken at a property-by-property or individual asset level, in consultation with landholders and asset owners.

9.3. Actions required to mitigate third party impacts

Section 2.1 provides details of the extent of flow operations within the target flow range at Shepparton and the proposed mitigation actions to avoid potential impacts on public and private assets, to improve forecasting tools and real-time flow management, and protect cultural heritage sites. The proposed activities are listed in Table 11 and further detail is provided below.

Table 11 Summary of mitigation actions

Location of impact	Activities
Private land and assets	• Relocate / modify approximately 240 private irrigation and pumping infrastructure • Priority works to upgrade the Hancock Regulator on a lower Goulburn effluent system • Capital works as required.
Public land and assets	• Continuation of existing practices (and possible expansion) of notify adjacent landholders and owners of assets near the river in relation to significant planned changes in releases.
Across the project area	• Reinstatement/repair of public infrastructure subjected to more frequent inundation (e.g. roads, pathways and parklands).

9.3.1. Lower Goulburn Effluent Regulator

The environmental flows to be delivered under this business case are likely to flow though Hancocks Regulator into the Wakiti Creek system, located in the lower Goulburn. The regulator needs to be replaced and fitted with flow control mechanism to contain flows within the Goulburn River (Figure 13). Work in the first three years will confirm the need for flow control and the appropriate works.

Figure 13 Hancocks regulator outfall(left) and inlet (right) 4 July 2017. (Credit Daniel Lovell, GBCMA)

It should be noted that the works proposed to upgrade the Hancocks structure are widely applied, well understood, standard engineering works. There is a significant body of experience and expertise available to support their implementation.

9.3.2. Capital works to maintain water supply access for Goulburn River diverters

There are some 394 irrigation and some 630 domestic and stock pumps along the river. Modification or replacement of water supply infrastructure to maintain existing levels of service will enable higher flows to be delivered in-channel without interfering with landowner water supply infrastructure or its use.

GMW Diversion Inspectors were consulted and it is estimated that 240 irrigation and domestic and stock water supply water users have infrastructure located within the channel / or adjacent to the top of bank. Pumps located within the channel would be fully inundated by

the proposed bank-full flows. These need to be relocated from within the channel, or totally removed from the river bank to avoid any potential significant damage. Moving pumps involves significant management time, and requires adequate warning of impending higher flows to allow timely action. In addition, some pumps cannot be operated once moved/removed, hence stopping access to water for essential or productive use.

9.3.3. Activity to manage other Private Land Impacts

Other impacts on landowners are generally expected to be relatively minor. Loss of production and interrupted access is not expected to be significant issue with flows up to bank-full. Some rural fencing and one or two specialist businesses may be impacted. In the first three years, issues on each individual land holding will be assessed, and where appropriate, mitigation measures proposed. Project costs have been estimated for this activity.

9.3.4. Public infrastructure

A limited amount of public infrastructure and assets (e.g. pathways and parklands and possibly one road) may be subjected to more frequent inundation by this project. Reinstatement works on public infrastructure have been proposed in most cases rather than capital works as the latter will either be more expensive, and/or create undesirable third party impacts on the distribution of flood flows in larger natural events.

Upfront funding agreements will need to be negotiated with individual councils or asset owners, through which those councils or asset owners would agree to a specified flow regime being allowed to affect their assets in perpetuity. Similar to the proposed mitigation activities for private land and infrastructure, it will take some time and effort to set up and manage arrangements with affected asset owners, agree on the likely scope and nature of the impacts, the basis by which costs will be met, and to develop and implement legal and other administrative arrangements.

Table 12 Approach used for assessment of mitigation actions and implications for this business case.

Issue	Approach used for feasibility phase	Implications for this business case
Hydrology (what flows could be delivered, when, and how often)	Assumes more than 1 event every year, with damage related to using full buffer once per year.	Assumption is considered appropriate for purpose of defining an “upper bound” of potential additional environmental flows.
Private Water Supply Works (how many pumps are affected, their specifications, and what will need to be done to mitigate impacts and maintain existing levels of service)	Used GMW knowledge and data to assess pumps potentially impacted by more frequent bank-full flows.	Takes into account estimate of how many pumps could actually require capital works with rough associated unit costs for works. Note however that it was not possible to specifically identify individual pumps; this will require detailed property-by-property consultations and will be

Issue	Approach used for feasibility phase	Implications for this business case
		undertaken in the implementation phase.
Roads, paths, etc (which roads are affected, their specifications, and what will need to be done to mitigate impacts)	Uses modelling and local knowledge to roughly assess could be affected. It was also assumed that the majority of these assets will require increased reinstatement and management.	Recognises that it many cases stakeholders have indicated that rather than major capital works, inundation of roads will generally be better addressed through a mechanism to allow for reinstatement activities. Requires detailed modelling at bank-full flows to confirm potential impacts.
Outlet regulator structure	Concept design and cost report prepared by GMR Engineering Services. Included site inspection of existing structure and review of original design drawings to develop concept designs	Structural condition of existing asset established through visual inspection and costs for remedial works and addition of gates based on unit rates for similar recent works at Living Murray sites. Contingencies allow for uncertainty in current condition of structures etc. Accuracy of costing is considered suitable for feasibility level business case. Expert review confirms that the design is at a suitable level for a concept design.
Other impacts on landowners (e.g. fences, special businesses) and options for mitigating those impacts.	Assessed using available information.	Assessment of impacts, mitigation options and costs takes into account these impacts in a general sense. It was not possible to consider all impacts in detail, particularly at a micro (e.g. property) level. This will be undertaken in the implementation phase.
Implementation and approvals processes	Considered in detail, including through assessment of what processes will be required in different jurisdictions	Assessment takes into account these processes in sufficient detail for feasibility purposes.
Spatial uncertainties associated with implementation of	Considered through • Generally biasing to conservative	Assessment recognises that there are uncertainties and takes them into account

Issue	Approach used for feasibility phase	Implications for this business case
environmental flows, including: Potential for flows to be higher than anticipated, for example if water releases are combined with natural events, and there is more rain than expected Uncertainties in modelling and mapping Potential for channel cross sections to change over time	estimates of extent and impact • Contingency in cost estimates.	

9.4. Uncertainties

This is a feasibility level business case, and as such is based on available data combined with feasibility level investigations and analysis. This business case has used a subset of the investigations undertaken to inform the earlier Goulburn constraints business case. The limitations of these studies are acknowledged, and the business case has therefore included "buffers" and/or contingencies into the proposed mitigation options and costs, to take into account these inherent risks or uncertainties. Key uncertainties included:

- actual frequency, timing and duration of environmental flows;
- potential errors in river water level modelling and lack of modelling in some reaches at bank-full flows;
- economic assumptions; and
- costs of engineering works.

Key uncertainties, and how they were considered in the context of the proposed impacts and mitigation activities, are summarised in Table 13. The implications of this approach to uncertainties in relation to cost estimates are presented in Section 11. The costings for implementation of this proposal also include allowances for a range of further studies, data collection and other investigations to develop detailed designs and enable updating of the business case. These further investigations are designed to reduce the level of uncertainty associated with the project before moving into implementation of on-ground actions (refer Section 9.5 for further details).

Table 13 Mitigation measures assumed, and approach to taking into account uncertainties

Impact	Assumed mitigation activity	Key uncertainties	How uncertainties were considered
All impacts	All mitigation activities	Actual frequency, timing and duration of environmental flows	Assumed to reach buffer flow once per year
Inundation of agricultural and specialist business land	Minor mitigation allowed for Remediation of water supply infrastructure Minor fencing clean-up costs	Accuracy of modelled watering footprint. Conservative estimate of land and assets inundated Extent of water supply infrastructure changes required	Conservative estimate of land assumed to be inundated Conservative contingencies assumed.
Impacts on farm infrastructure			
Farm management issues			
Damage to public infrastructure	Reinstatement activities	Quantum of infrastructure affected (uncertainty in inundation modelling) Frequency on which such reinstatement activities will be required	Conservative estimate of key infrastructure affected

9.5. Recommended further work if this measure were to progress to implementation

If this project proceeds, it is recommended that further work be undertaken to develop a more refined assessment of third party impacts, mitigation options and costs. Key actions are summarised in Table 14. These matters are also discussed further as part of the implementation arrangements in Section 14.3.

Table 14 Recommended further work required as part of implementation phase

Issue	Further work that will be required
Supplementary releases of water to enhance flows at Shepparton	Further develop and refine hydrologic modelling to address limitations identified as part of feasibility level study. Includes testing use of actual forecast data to trigger simulated release for Lake Eildon, and extending modelling to sub-daily timestep. Installation of additional streamflow and rainfall monitoring sites in the mid Goulburn to provide data to improve understanding and forecasting of tributary flows and support development of operating arrangements and tools.

Issue	Further work that will be required
River water level for planned flows	Knowledge of the river water level will need to be further improved, particularly for bank-full flows. This will involve: Developing new, and/or and refining existing river flow-height models and improved mapping of assets On-ground assessment of actual flow events, involving local stakeholders (e.g. monitoring and measuring flows along the river) Assessment of Goulburn and Murray flow interaction impacts.
Water supply infrastructure	Collection of detailed information for each pump, and design and agree the required changes with landowners.
Other property issues	Property-by-property assessment required to identify specific issues that are affected, and specific mitigation measures required
Hancocks Regulator	Investigations to confirm need to stop flows through the regulator. Preparation of detailed designs and costings, including matters such as geotechnical investigations.
Public infrastructure (e.g. roads, crossings)	Need to negotiate agreements with asset managers (e.g. councils). This negotiation process will require further ground-truthing of impacts, mitigation measures and costs.
Regulatory approvals	Undertake relevant field assessments (cultural heritage, flora and fauna, heritage) to inform the regulatory approvals process on the uncertainty in the project construction footprint has been narrowed.

10. Complementary actions and dependencies

10.1. Interactions with other constraint measures

The delivery of bank-full flows in the lower Goulburn will not by itself produce land inundation in Victoria or NSW.

However, higher flows along the River Murray can inundate areas in Victoria and NSW near the confluence with the Goulburn River. Hence, higher flows along the River Murray at the same time as bank-full flows from the Goulburn River will cause inundation near the river junction not allowed for in this business case. There is therefore an ill-defined interaction between the Goulburn and River Murray constraints business cases.

It is also noted that the reduction of constraints to the delivery of environmental flows in the Goulburn system will support the creation of larger environmental flow regimes in the River Murray, which will facilitate the delivery of desired watering regimes to important downstream environmental assets, such as Gunbower Forest, through to the Coorong.

Any potential inter-dependencies for this project and its associated SDL resource unit (SS6 Goulburn), in terms of other measures, cannot be formally ascertained now. This is because such inter-dependencies will be influenced by other factors that may be operating in connection with this location, including other measures that form part of the final adjustment package, and the total volume of water that is recovered for the environment.

It is expected that all likely linkages and inter-dependencies for this project and its associated SDL resource unit, particularly with the six other key focus areas for physical constraints, will become better understood as the full adjustment package is modelled by the MDBA and a final package is agreed to by Basin governments.

Similarly, a fully comprehensive assessment of the likely risks for this project and its SDL resource unit cannot be completed until the full package of adjustment measures has been modelled by the MDBA, and a final package has been agreed between Basin governments.

10.2. Interactions with the pre-requisite policy measures

In order to maximise the environmental outcomes possible from the use of water recovered for the environment as part of the implementation of the Basin Plan, it was assumed that several important policy initiatives will be implemented. The measures are referred to as the unimplemented policy measures (refer Clause 7.15 (2) of the Basin Plan) or the pre-requisite policy measures.

These measures involve policies to:

1. Credit environmental return flows for downstream environmental use
2. Debit environmental accounts for water not harvested due to foregoing harvesting or retention of airspace.

The successful delivery of the planned flow regimes for this project will require the implementation of these policies.

In Victoria, the legislative arrangements to support implementation are already in place. These arrangements are described in Victoria's implementation plan for pre-requisite policy measures. The plan demonstrates that the arrangements to implement pre-requisite policy measures are secure, enduring, fully operable and transparent.

10.3. Interactions with other supply measures

This constraint measure affects the Goulburn (SS6) surface water SDL resource unit. No supply measures are proposed for this SDL resource unit, and so there will be no direct interactions with this constraints measure.

The removal of constraints to environmental water delivery on the Goulburn will facilitate the delivery of enhanced environmental flows to the River Murray system, even at rates lower than those envisaged by this business case. It is likely that there will be interactions between this project and supply measures on the Murray system downstream of its confluence with the Goulburn River.

As noted in Section 10.1, any potential inter-dependencies for this constraints measure and its associated SDL resource unit, in terms of other supply measures, cannot be formally ascertained at this time. This is because such inter-dependencies will be influenced by other factors that may be operating in connection with this location, including other supply/efficiency/constraints measures under the SDL adjustment mechanism, and the total volume of water that is recovered for the environment.

It is expected that MDBA modelling of the adjustment packages will enable the likely linkages and inter-dependencies between this constraints measure and other supply measures to become better understood.

10.4. Other complementary actions

In Victoria, integrated catchment management (ICM) underpins the sustainable management of land and water resources, and contributes to biodiversity management. Through this approach, the Victorian Government and its partners seek to achieve sustainability and ensure the long-term viability of natural resource systems, and human needs for both current and future generations.

Catchment management authorities are responsible for the integrated planning and coordination of land, water and biodiversity management in each catchment and land protection regions.

Regional catchment strategies are the primary integrated planning framework for the management of land, water and biodiversity resources. They seek to integrate community values and regional priorities with state and federal legislation and policies. CMAs also prepare supporting Waterway Strategies that identify key threats to community values and provides recommendations to influence the future management of waterways in the catchment.

As Caretaker of River Health for the Goulburn Broken Region, the Goulburn Broken CMA undertakes works with other government agencies and the community to maintain and improve river and wetland health and increase community flood resilience. State funding currently sits around $3.5 million annually to deliver these services across the Goulburn Broken Region. Key program areas are:

- Environmental Water Planning - delivery and monitoring is undertaken with the Department of Environment, Land, Water and Planning, the Victorian Environmental Water Holder and the Commonwealth Environmental Water Holder and the Murray Darling Basin Authority.

- Riparian and River Channel management (includes both wetlands and waterways) – protection and restoration activities are undertaken with land managers of riparian areas. This mostly occurs using a partnerships and incentives approach for activities such as weed control, controlled grazing, off stream watering and revegetation. River channel management activities include weed control, re-snagging, erosion control and improving fish passage.
- Floodplain management - managing legacy flood problems is largely done through flood warning and emergency management arrangements. This program also delivers the functions of the Waterways Protection By-law (2014) which enables the GB CMA to control works and activities on designated waterways.

11. Costs and funding arrangements

11.1. Cost estimates

A formal cost benefit analysis has not been completed for this project because it has not been possible to fully identify and properly quantify the complete range of impacts and benefits in the time that was made available to complete this business case. It is anticipated that further work will be needed to complete a thorough analysis, which ensures that the Basin Plan requirement to address third party impacts has been dealt with appropriately. Some consideration of the costs and benefits of this project has been undertaken in preparing this business case.

The managed release of bank-full flow events will inevitably create a range of third party impacts. These third party impacts have been assessed in aggregate and the cost estimates include allowances and appropriate contingencies for actions to mitigate these impacts. On the basis that the third party impacts have been identified and assessed, the project approach will be to effectively mitigate impacts or fully compensate affected individuals or organisations.

The costs to implement this project have been estimated from data and studies available at the time of preparation of this feasibility level business case. Details on the assumptions underpinning selection of project measures and the studies undertaken to inform this business case are provided in Section 9 (Technical feasibility and fitness for purpose) and Appendix A (Studies undertaken).

The costs presented in this document are the estimated costs to deliver the proposed target flow regime at Shepparton (refer to Table 1).

The expected upper bound costs for activities have generally been adopted, to ensure as far as possible that this business case provides an estimate of costs, which will be sufficient to deliver the proposed project outcomes. Further refinement of studies and preparation of detailed designs would further refine and improve the project cost estimates.

All costs quoted in this document are exclusive of GST, and are based on costs estimates developed in 2015 dollar terms. The identified implementation activities have been sequenced over the proposed six year implementation program starting in 2018/19, and costs have then been indexed using the recommended indexation factor of 2.68% per year to provide costs estimates in nominal dollars across the implementation program. This is consistent with the Commonwealth method for cost escalation.

11.1.1. Actions to enable delivery of increased flows

There are a range of actions required to be implemented to enable the release of flows to supplement unregulated tributary inflows originating in the mid Goulburn and lower Goulburn. These actions are identified in Table 15, together with their estimated costs.

Table 15 Estimated costs – Actions to enable delivery of increased in-channel flows

Actions	Issues taken into account in estimating costs (further details in Appendix A	Estimated cost ($m)
Development and enhancement of streamflow forecasting coverage in the Goulburn catchment	Preliminary costings, with contingencies included.	0.45
Expansion of rainfall monitoring and stream gauging network in the mid Goulburn	Estimated allowance for establishment of new rainfall and streamflow gauges Costs based on standard unit rates for these installations To be installed as soon as possible to provide data to improve understanding and forecasting of tributary flows and support development of operating arrangements.	0.59
Development and implementation of operational water modelling tools.	Operational decision making requirements. Calibration and testing requirements GMW holds licence rights to key software Some customisation and interfacing likely to be required.	0.94
Development of revised operational procedures and water accounting protocols, including staff training and capability building	Release planning actions to be documented. This will also include risk management actions to deal with higher/lower than planned flows. Water accounting to be automated via operational modelling tools wherever possible Includes training for GMW, GBCMA and VEWH/CEWO staff as appropriate. Capability development includes simulated exercises and shadow operations in real time.	1.66
Review of rates of rise and fall downstream of Lake Eildon and in Cattanach and Stuart Murray Canals	Geomorphic study and modelling, ecological and public safety assessment. Two year field trial to test any proposed changes, with detailed monitoring and assessment program	0.78
	Subtotal	**4.42**

11.1.2. Mitigation actions

As noted in Section 8, there are a range of expected impacts from providing overbank flows in the lower Goulburn, and mitigation actions have been identified to address the impacts on public and private assets. The mitigation actions and their estimated costs are set out in Table 16 below.

Table 16 Estimated costs – Mitigation actions

Mitigation actions	Issues taken into account in estimating costs (further details in Appendix 1)	Estimated cost ($m) (Flows up to 20,000 ML/day)
Private land mitigation: Landholders Private infrastructure works and agreement	Fencing clean up costs Pumps Cost-benefit analyses of infrastructure vs agreements (to determine where upgrades required) Costs of representative engineering works Allowance for negotiation and legal costs	47.93
Outlet structure	Current conditions and design of structure One structure to be upgraded Includes costs for remote operation to assist in operational management during events.	2.11
Public infrastructure mitigation: Operational response, reinstatement and capital works on public infrastructure	Asset Managers (Parks Victoria/Councils) incur additional resourcing costs associated with high in-channel flow preparations. Enacting flood mitigation controls (such as road management/closing and shutting off backflow prevention valves) was a common cost, not captured by asset costing. Rehabilitation of roads (potholes, pavements, regrading) Maintenance of tracks Replacement or reinstatement of culverts Grading and removal of debris in fords Impacts on landscaped areas	1.70
	Subtotal	**51.74**

In addition to these reach specific mitigation actions, there are some mitigations that will be relevant to all reaches of the mid and lower Goulburn. These actions are detailed in Table 17.

Table 17 Estimated costs - Other mitigation actions

Mitigation actions	Issues taken into account in estimating costs (further details in Appendix 1)	Estimated cost ($m)
Refine hydrologic modelling	Address limitation identified as part of feasibility level study. Includes testing use of actual forecast data to trigger simulated release for Lake Eildon, and extending modelling to sub-daily timestep	0.39
Groundwater monitoring	Install up to 6 shallow piezometers to monitor shallow water table response to overbank flows Review (and modify) preliminary assessment of salinity impacts of measure.	0.08
River level modelling	Developing new, and/or and refining existing hydraulic models of inundation, including survey and mapping On-ground assessment of actual flow events, involving local stakeholders (e.g. monitoring and measuring flows over specific properties)	1.14
Environmental objective review and development	Expert panel reviewing bank-full flow objectives and recommendations	0.11
	Subtotal	**1.72**

11.1.3. Annual operation and maintenance costs

Wherever possible, future annual costs have been assessed and their present value estimated to facilitate one-off upfront payments, especially to individuals or organisations that may have costs to address third party impacts. This approach is likely to significantly reduce future transaction costs that will otherwise be required to address the response. There will, be some annual costs for the operation and maintenance of key infrastructure. The estimated annual costs for these activities are in 2017 dollars Table 18.

Table 18 Estimated annual operation and maintenance costs

Mitigation actions	Issues taken into account in estimating costs (further details in Appendix 1)	Estimated O&M cost ($m/yr)
Outlet structure	Gate and communication tower maintenance Communication tower maintenance	0.02
Rainfall and stream gauging network	Only includes costs for additional sites to be added for project	0.05
BoM data provision services	Preliminary costings, with contingencies included. Final costs to be negotiated with BoM.	0.06

Mitigation actions	Issues taken into account in estimating costs (further details in Appendix 1)	Estimated O&M cost ($m/yr)
Operational flow model upgrades and recalibration	Routine updating of model and refining calibration to new data and learnings	0.05
Water level monitoring	Continuous water level monitoring to monitor results of increasing flows along the river.	0.03
Flow forecasting	Allowance for GMW resources to undertake task	0.15
Consultation	Continued consultation in first 3 years to monitor issues from increased flows	0.71
	Subtotal	**1.07**

11.1.4. Program management costs

It is not yet known what governance and implementation arrangements might apply, if this measure were to be implemented (refer also to Section 13 for implementation projects)

It is considered that the equivalent of one "program management group" will be required to implement this measure. It is assumed that a program management group will be resourced from scratch (i.e. existing resources cannot be mobilised). Program management costs are estimated as $0.78 million per annum, or $4.69 million over 2018/19 to 2023/24.

In addition to the direct program management costs, there will be a significant need for community and landholder engagement activities across the whole project implementation period. This will cover the necessary communications and engagement specialist resources needed to manage relationships with all key stakeholder groups throughout activities including negotiations for works and impact mitigation, and the conducting of trial releases to test and monitor the augmentation of tributary inflows. The estimated total cost for communications and engagement is $8.41 million over the six year implementation period.

11.1.5. Initial implementation costs

There is a range of further studies and investigations required to develop and test operating principles and to develop a more refined assessment of third party impacts, mitigation options and costs (refer Section 9.5). These activities are planned to occur over the first three to four years of the six year implementation period.

Costs for these activities are detailed in Table 19. It should be noted that these costs represent the first 4 years of the implementation program. These costs are all incorporated in the total costs for each of the project elements set out in the earlier parts of Section 11.

Table 19 Years 1-4 implementation activity costs

Activity	Issues taken into account in estimating costs (further details in Appendix G)	Estimated cost ($m)
Refine hydrologic modelling	Rework for bank-full flows.	0.39

Activity	Issues taken into account in estimating costs (further details in Appendix G)	Estimated cost ($m)
	Address limitations identified as part of feasibility level study. Includes testing use of actual forecast data to trigger simulated release for Lake Eildon, and extending modelling to sub-daily time-step.	
Expansion of rainfall monitoring and stream gauging network in the mid Goulburn	To be installed as soon as possible to provide data to improve understanding and forecasting of tributary flows and support development of operating arrangements.	0.48
Review of rates of rise and fall downstream of Lake Eildon, and in Cattanach and Stuart Murray channels	Geomorphic study and modelling Two year field trial to test any proposed changes, with detailed monitoring and assessment program	0.60
Groundwater monitoring	Install up to six shallow piezometers to monitor shallow water table response to overbank flows Review (and modify) preliminary assessment of salinity impacts of measure.	0.08
Environmental objective review and development	Expert panel reviewing bank-full flow objectives and flow recommendations.	0.11
Preliminary and detailed design of levee outlet structure including statutory approvals	Preparation of detailed designs and costings, including geotechnical investigations. Develop detailed submissions required to obtain necessary statutory approvals	0.36
River level modelling	Developing new, and/or and refining existing hydraulic models of inundation On-ground assessment of actual flow events, involving local stakeholders (e.g. monitoring and measuring flows over specific properties) Aerial photography of actual flow events	1.08
Development and enhancement of streamflow forecasting coverage in the Goulburn catchment	Preliminary costings, with contingencies included.	0.45
Development and implementation of e-	Operational decision making requirements.	0.88

Activity	Issues taken into account in estimating costs (further details in Appendix G)	Estimated cost ($m)
Water Source (or similar) modelling tools.	Calibration and testing requirements GMW holds licence rights to key software	
Development of revised operational procedures and water accounting protocols, including staff training and capability building	Release planning actions to be documented. Will also include risk management actions to deal with higher/lower than planned flows. Water accounting to be automated via operational modelling tools wherever possible Training programs to be developed and then delivered over a number of years (funded as a one-off upfront payment). Capability development includes simulated exercises and shadow operations in real time.	1.00
Private land mitigation	Ground-truthing of impacts, mitigation measures and agreement costs, at a property-by-property level Property-by-property assessment required to identify specific private works that are affected, and specific mitigation measures required	17.59
Public infrastructure mitigation	Ground-truthing of impacts, mitigation measures and costs.	0.17
Program management	Manage project activities including complex investigations and design works Includes cost to develop a revised and updated business case.	3.41
Community and landowner engagement	Engage with all key stakeholder groups throughout detailed investigation, design and impact assessments.	6.13
	Subtotal	**32.73**

11.1.6. Summary of estimated cost

The overall estimated costs to further develop and implement the project detailed in this business case are summarised in Table 20. The total upper bound cost, based on feasibility level assessments and costings is $71.19 million.

Table 20 Summary of estimated costs

Item	Estimated cost($m)
- Actions to enable delivery of increased flows (capex)	4.42
- Mitigation actions (capex)	51.74
- Other mitigation actions (capex)	1.72
Program management	4.90
Community and landholder engagement	8.41
Total estimated cost	**$71.19[6] m**

11.2. Assumptions and uncertainties

Table 21 summarises key assumptions and caveats associated with the key elements of the cost estimates, and the implications of those assumptions and caveats for the level of certainty associated with the estimates. Further details on the methods used, approach taken and data sources are provided in Appendix A.

Table 21 Assumptions and caveats associated with the cost estimates

Issue	Assumption/caveat	Implications for cost estimates
Hydrology	For costing purposes, it has been assumed that the mitigation costs relate to one event per year.	Affects non-capital works costs only (i.e. not pumps and regulators)
Water supply works	Possible unit costs and possible numbers of pumps estimated, with some uncertainty.	A contingency of 100% built into costs. Likely to be an upper estimate.
Other property issues	Little information available on extent of impacts at bank-full flows. A level of impact assumed. Unit costs based on GHD and Jacobs studies.	Expected to be minor cost, so should not have significant impact on overall project cost.
Pump and other agreements – administrative costs	A $9,000 “administration” cost has been assumed per property. These costs include negotiations with land owners and legal costs to prepare agreements.	Estimate may be too low if stakeholders reluctant to reach agreement.
Reinstatement works on public infrastructure	Identified through a desktop analysis. However, there were practical limitations to the level of detail to which the consultation	Reasonable overall allowance for possible overall impacts.

[6] All capital costs to implement the proposal have been scheduled across the 6 year implementation period. Indexation has been applied to these costs, which are shown in nominal dollars.

Issue	Assumption/caveat	Implications for cost estimates
	process could consider individual infrastructure items.	
Hancocks outlet regulator	Concept design prepared and unit rates for recent similar works used for costing	Contingencies of 40% included to cover uncertainty Estimates considered to be reasonable for feasibility level purposes and current scope.

11.3. Proposed funding arrangements

Should this project go ahead, Victoria will be seeking 100 per cent of project funding from the Commonwealth. The funding requested will be used to: finalise necessary stakeholder consultation to confirm the project is fully supported by affected communities; is construction ready; is built in accordance with all regulatory approval requirements and conditions; and is fully commissioned once construction is complete.

11.4. Proposed funding source

Victoria will be seeking 100% of project funding for this constraint measure proposal from the Commonwealth. The funding requested will ensure that the proposed constraint measure is construction ready, built in accordance with all regulatory approval requirements and conditions, and fully commissioned once construction is complete.

11.5. Ongoing ownership and maintenance

The delegation of asset ownership and operation in relation to this project, including any associated financial responsibility, cannot be confirmed at this time. Victoria currently has agreed arrangements in place through the Basin Senior Officials Group to resolve asset ownership arrangements for its nine works-based supply measures. This process is expected to inform any arrangements that are finalised for this project. A formal position on this matter will be clarified as part of the broader decision process as to whether or not this project will proceed.

As this project primarily focuses on mitigating potential impacts to existing private and public assets e.g. private water supply infrastructure or local government stormwater infrastructure, it is expected that responsibility for asset ownership and ongoing operation and maintenance costs would remain with the existing asset owner (assumes agreement by potentially affected parties to mitigating payments for any increased operation and maintenance costs).

It is envisaged that supporting legal agreements will be agreed and established prior to mitigating action being undertaken. The legal agreements will clearly address responsibilities for asset ownership, and operation and maintenance.

12. Consultation and engagement

The original 2016 business case proposed the targeting of small overbank flows and various communications and engagement activities were undertaken within the limited time available for the development of the business case. The activities and results are described summarily below and further detail can be found in Appendix H.

No further consultation has been undertaken in preparing this new business case. However, this project (which targets increased in-channel flows only) has drawn on the 2015/16 consultation program outcomes. As flows are significantly lower, a number of significant issues and concerns raised will not apply e.g. the purchase of easements to offset the impacts of inundating private land on floodplains. However, much of the material is still relevant.

12.1. Communications and engagement plan

A Communications and Engagement Plan (GBCMA, 2015) was developed to guide communications and engagement throughout the Phase 2 investigations (through to June 2016) for the original Goulburn Constraints Measure.

The plan was developed in line with the best practice standards set out by the International Association for Public Participation (IAP2 2006) to achieve one of the key principles underpinning the Constraints Management Strategy: *Affected communities, including landholders 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* (GBCMA, 2015).

Engagement activities were led by the MDBA and GBCMA and sought to:

- share the purpose of the Constraints Management Strategy and its associated implications;
- gain local knowledge and feedback on the movement of overland flows across the landscape;
- better understand the potential effects of such flows (positive and negative) at a regional level; and
- assist in the development of mitigation options that may address negative effects on stakeholders.

It is important to note, that the original Goulburn Constraints Measure project potentially affected an estimated 562 properties. [7]Opportunities for *individual* consultation with directly affected landholders were limited during the Phase 2 feasibility investigations due to time constraints (Section 12.3).

12.2. Key stakeholders

Stakeholders for the original Goulburn Constraints Measure project were categorised to ensure an appropriate level of consultation and engagement according to:

- direct decision making or approval role in the project (group 1)
- directly impacted (positively or negatively) by the changes (group 2)

[7] Note, this new business case focusses on the potential delivery of bank-full flows only and it is estimated that approximately 250 landholders with water supply equipment may be affected by the proposal.

- likely to be significantly interested in the project activities (group 3).

A summary of the key stakeholder groups is provided in Table 22. Further information on the specific stakeholders and their interest in the project can be found in the Communications and Engagement Plan (GBCMA, 2015)

Table 22 Stakeholders for the Goulburn Constraints Measure

Internal/ External	Category	Stakeholder Group
Internal	Group 1: Agency stakeholders	Goulburn-Murray Water Murray-Darling Basin Authority Goulburn Broken CMA DELWP Parks Victoria Victorian Environmental Water Holder, Commonwealth Environmental Water Office Department of Economic Development, Jobs, Transport and Resources Other statutory approval authorities e.g. local government, Registered Aboriginal Parties
External	Group 2: Potentially impacted stakeholders	Landholders, frontage licence holders and landholder representatives Water users along the river Specialist primary industries Leisure and tourism industry Local Government Traditional owners and other indigenous people Public land users (recreation and lifestyle) Water Authorities
	Group 3: Interested stakeholder	Environment groups Townships Emergency managers, warning and rescue services Melbourne/state residents State and Federal Members of Parliament Agricultural organisations e.g. Victorian Farmers Federation

12.3. Overview of the 2016 business case communications activities

The very short timelines for the development of the 2016 business case limited the amount of consultation possible. The three community advisory groups convened by MDBA in 2013 met several times during 2015 and 2016. Key agency stakeholders were directly involved via the project steering committee in project development. Other agencies were consulted as required.

Community consultation focused on directly affected landowners. Letters were sent to approximately 1,300 affected landowners on three occasions. The first two letters advised them of the project and invited them to attend one of eight open house meetings in August 2015 and nine in January 2016. The third letter in December 2015 advised landholders of the change in the project submission date. Approximately 200 people attended the August open house meetings and 246 attended the open house meetings in January. MDBA staff and contractors also visited individual properties to carry out assessments to inform the technical investigations underpinning the business case.

Knowledge was documented in two case studies, as well as the update of the MDBA's Goulburn River Reach Report (MDBA, 2015b). Four specialist businesses were inspected and a fifth contacted to understand issues associated with those businesses. Local government staff were consulted to understand the impact of flooding on local government assets, particularly roads, bridges and walking/bike paths.

Briefings were also provided to indigenous group representatives, most local government councils, and most local politicians.

12.4. Arrangements for ongoing consultation to support the new Goulburn project

The revised project will be undertaken over three phases, a development phase spanning three to four years, an implementation phase spanning two years, and a commissioning phase.

The development phase includes installation of the expanded streamflow gauging and weather monitoring network, development of flow forecasting tools, data gathering and detailed investigations to determine precisely what the project involves. It is vital that the community be heavily involved in this phase, to provide their local knowledge, particularly of potential impacts on their businesses and interests, to observe river behaviour, and to help shape the project. Involvement of owners in inundation measurement trials or natural events will be important in gaining confidence in the extent of inundation.

This revised project may involve some change for a significant number of water supply users and business owners and a number of local governments located over 440 km of the Goulburn River. As such, each owner may face significant uncertainty and adjustment which will need to be worked through over time. This includes understanding their particular issues and developing and negotiating appropriate mitigation options for each circumstance.

If governments decide to proceed with the project, the implementation phase will put the various mitigation measures in place, such as remediation activities for existing water supply infrastructure. This will require significant involvement from affected landowners, and maintaining communication with those not directly affected.

The commissioning phase involves the staged commencement of releasing higher in-channel flows. Local landowner observation of how river levels respond during these flow changes will be very important to gain confidence that inundation is as planned, and particularly ensuring that mitigation measures put in place are effective.

The different phases of the project will require different approaches to communication and engagement. Accordingly, a new communication and engagement strategy will be needed for

the implementation phase. In particular, the strategy will need to take into account the concerns raised by the community which have been identified as potential barriers to the successful implementation of the project (Section 14.2).

In summary, the project could impact up to 500 water users and other concerned parties, local businesses, traditional owners, six councils and a range of government agencies including GMW, Park Victoria. Consequently, the communications and engagement requirement for the project is substantial.

The strategy will need to provide a framework to inform, support and seek input from people throughout the project development, implementation and initial operation (or commissioning) phases of the project.

To ensure community input is front and centre in the further development of the project and any agreed implementation, a community reference group/s (CRG) consisting of directly affected landholders will be established. The CRG will be ongoing for the life of the project with direct and strong links to the Project Control Board. The broad role of the CRG will be to advise of the best approaches to communicating with people across all stages of the project, reviewing technical information, be a point of community contact, and assist with development of principles of fairness and equity to be applied to any mitigating activities.

The strategy also needs to address infrastructure on public land and would engage government agencies, local government and Parks Victoria, but will also involve providing information to the public interested in those assets.

13. Legislative and policy requirements

DELWP previously developed a Regulatory Approvals Strategy to support the original Goulburn Constraints Measure which mapped out a broad approvals pathway under State and Commonwealth legislation. Approvals refers to all environmental and planning consents, endorsements and agreements required from Government agencies by legislative or other statutory obligations to conduct works. The strategy identifies the relevant legislation governing the proposed actions, the type of approvals likely to be required and an indicative program for obtaining the necessary regulatory approvals (DELWP, 2015). This strategy is still relevant to guide the likely range of approvals for activities associated with this new project.

A summary of the potential approvals required for this project is presented in Table 23. In addition to applications, a range of supporting documentation will be required or are likely to be requested through referral decisions or planning permit conditions (DELWP, 2015). The costs of preparing these documents are included in the overall costings for this project (Section 11).

It is not possible to capture all permit requirements at this stage. The Regulatory Approvals Strategy therefore represents the approvals likely to be required at time of writing. The strategy will need to be reviewed once the project scope and associated works are confirmed, prior to commencing the approvals.

No amendments to state legislation or policy are anticipated. This includes no formal amendments to state water sharing frameworks.

Further to this, no changes to the Murray-Darling Basin Agreement 2008 are required to implement this measure, nor do any new agreements need to be created either with other jurisdictions or water holders in the Basin.

Table 23 Regulatory approvals anticipated for the new Goulburn Constraints Measure

Approvals required	Description
Commonwealth legislation	
Environmental Protection & Biodiversity Conservation Act 1999: Referral	The project may affect a number of potentially affected "matters of national environmental significance" (MNES): Ramsar sites (either directly affected, in the vicinity or downstream) Migratory waterbird species (JAMBA, CAMBA, ROKAMBA) Nationally threatened species and communities
Native Title Act 1993	Applicant to notify native title claimants of any future act that permits or requires the construction, operation, use, levee or other device for management of water flows.
Victorian legislation	
Environmental Effects Act 1978: Referral	This project is unlikely to meet one of the six referral criteria for individual or multiple potential effects. Once the extent and location of impacts are known an assessment against the criteria will be undertaken.
Planning and Environment Act 1987: Planning permit and Public Land Managers Consent	Applicant to request permission from public land manager to apply for a planning permit for works on public land. A planning permit application is then submitted with supporting documentation which is likely to include an Offset Strategy and a Threatened Species Management Plan. Local Council refers applications and plans to appropriate authorities for advice.
Aboriginal Heritage Act 2006: Cultural Heritage Management Plan	A CHMP is required when a listed high impact activity would cause significant ground disturbance and is in an area of cultural heritage sensitivity as defined by the Aboriginal Heritage Regulations 2007 (Part 2, Division 5). To be prepared by an approved Cultural Heritage Advisor.
Water Act 1989: Works on waterways permit	Application for a licence to construct and operate works on a waterway.
Traditional Owner Settlement Act 2010	Likely to require negotiation or consultation with the Yorta Yorta Joint Body regarding activities on Crown land subject to the Yorta Yorta Co-operative Management Agreement. The Victorian Government is currently negotiating a settlement agreement with the Taungurang Clans; negotiation or consultation with this group is also likely to be required.
National Parks Act 1975: Section 27 consent	Approval for a public authority to carry out its functions in a national park.

Flora and Fauna Guarantee Act 1988: Protected flora licence or permit	Application for approval to remove protected flora within public land for non-commercial purposes.

14. Project governance and management arrangements

14.1. Governance and project management arrangements

Appropriate governance and project management arrangements will be established to minimise risks to investors (the commonwealth Department of Environment) and other parties from the proposed constraint measure, as described below in Figure 14.

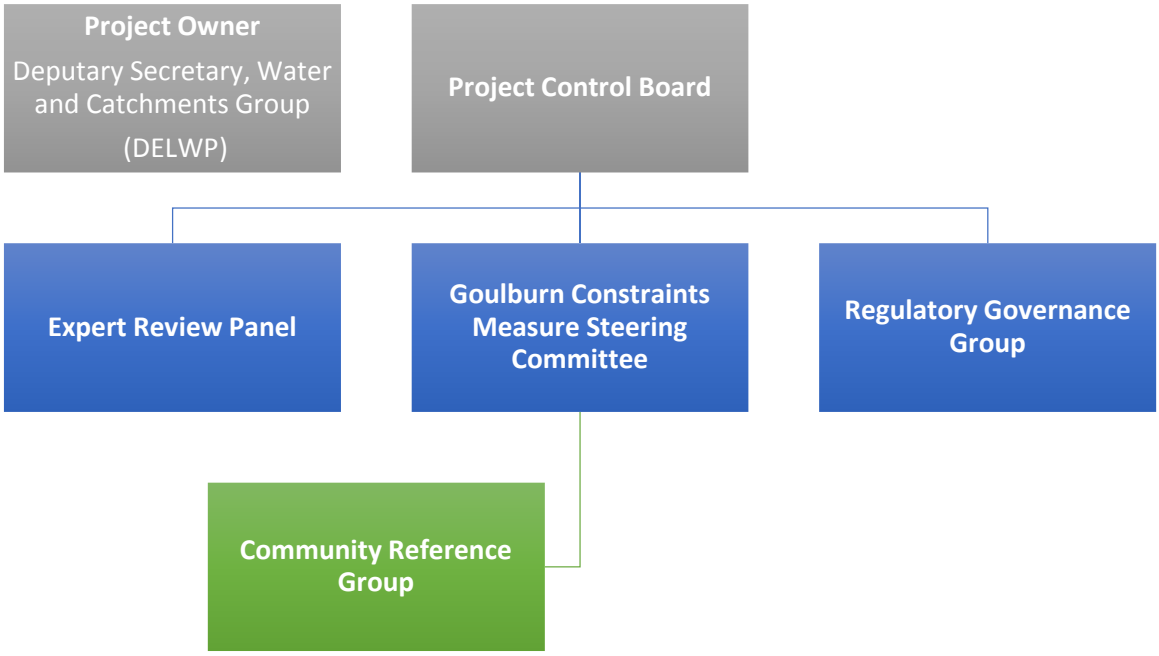

Figure 14: Proposed governance arrangements

Project Control Board

DELWP convenes a Project Control Board (PCB) to oversee the development and delivery of business cases for Victoria's supply and constraints measures. The PCB is comprised of senior executives from DELWP, Goulburn Broken CMA, GMW and Parks Victoria to ensure high level engagement of responsible agencies. The PCB's role has been to oversee the development and implementation of Victoria's business cases, and to identify and resolve program-level issues.

The PCB is supported by an Expert Review Panel, Regulatory Governance Group and relevant CMA Steering Committee's including the Goulburn Constraints Steering Committee.

Expert Review Panel

The Expert Review Panel ('the Panel') was originally established to support the development of supply measure business cases. The Panel's responsibility is to examine critical project elements at key stages to assess quality, credibility and fitness for purpose. The Panel is comprised of experts in engineering (including geotechnical, structural, hydraulic and water system operations) and hydrology. Its members include:

- Phillip Cummins (engineering)
- Shane McGrath (engineering)
- Dr Chris Gippel (hydrology).

Peer reviews were undertaken of the key technical investigations underpinning the original Goulburn Constraints business case. The reviews are still relevant to this new project and include:

- Engineering: Review of concept engineering designs to support water management structure design (SGM Consulting Pty Ptd, 2016), and
- Hydrology: Review of hydrodynamic and hydrological models, data, modelled scenarios and outputs (Fluvial Systems, 2016).

The individual reviewers have concluded the engineering and hydrology investigations as fit for purpose.

Regulatory Governance Group

The Regulatory Governance Group (RGG) was established to provide advice to the PCB regarding the regulatory approvals needed for Victorian supply and constraints measures. The RGG is comprised of relevant staff from Victorian approvals agencies, including DELWP, Parks Victoria and the Office of Aboriginal Affairs Victoria. The RGG has provided a mechanism for high-level engagement with responsible agencies at an early stage to identify the approvals likely to be required, opportunities for efficiencies and areas of potential risk.

Project Steering Committee

At a project level, the Goulburn Broken CMA has convened a Project Steering Committee that comprises representatives from GMW, GBCMA and DELWP.

The role of this committee has been to:

- provide technical advice on the development and proposed delivery of the project;
- ensure the project findings are technically rigorous and sound;
- monitor statutory and policy issues, including the identification of issues that may impede the success of the project;
- assist with the interpretation of policy and legislation relevant to their agency;
- advise on processes to resolve issues relative to their agency;
- identify issues associated with the proposed works that may impact upon project implementation, including any policy changes; and
- disseminate information within their respective agencies regarding project progress and issues.

14.2. Risk assessment for project development and delivery

The *Goulburn Constraints Management Project: Risk Management Strategy* (DELWP 2017) takes into account risks associated with the project development and delivery stages.

Previous sections of this business case focussed on the project's potential adverse impacts to the environment or third parties. The assessment of project development and delivery risks focuses on those risks that pose potential project delays and could result in cost increases, loss of goodwill, legal action or, in the worst case scenario, threaten project feasibility.

Risks identified through this process were evaluated using the approach outlined in Appendix F. The full suite of risks considered by the assessment process is documented in DELWP (2017) and a summary of pre-treatment risks with a rating of significant or higher is provided in Appendix G.

14.2.1. Residual risks

Understanding and controlling these risks is a routine part of project management therefore a standard set of controls exist that have been applied to this project. Most risks identified through the evaluation process can be managed by these current controls, as shown in Appendix G.

The remaining priority risks that need to be managed by the project are summarised in Table 24. These risks are a high priority for management in the ongoing stages of the project.

Table 24 Summary of priority project management and delivery risks once control activities are implemented

Risk	Control Activity	Justification
Lack of support – directly affected stakeholders	Communication plan to include landholder consultation and briefings to fully inform stakeholders, identify and address any issues. Establish Community Reference Group as part of the governance framework. Formalised agreements in place with affected parties.	This is considered a **significant risk** as it is likely to be difficult gaining unanimous support from directly affected landholders and there are limited controls in place. The key control is a communications and engagement strategy that aims to fully involve and inform stakeholders and appropriately address all issues. Due to the implications for project delivery, review of the effectiveness of this strategy will need to be monitored by the PCB through any ongoing stages of the project.
Lack of political support	Communication plan to include political consultation and briefings about the project and appropriately deal with stakeholder issues.	This is considered as a **significant risk**. Political support is needed at a number of levels within the project and is intrinsically linked to a lack of support by directly affected stakeholders. It is possible that, even with targeted activities to inform political representatives about the project and to appropriately deal with stakeholder issues, this risk may cause possible project delays. The project will need to allow project management resources to respond should these incidents occur.
Lack of certainty regarding liability	Clearly define the roles and responsibilities of all parties and formalise the roles before the project is implemented.	This is considered as a **significant risk.** Whilst this issue is a major concern for all agencies and stakeholders, it can be alleviated to some extent through agreements clearly assigning roles and responsibilities. It is recognised however, that these agreements cannot prevent litigation against any particular agency and, coupled with lack of certainty provided within legislation, the control activity does not reduce the residual risk. Due to the complexity of developing such agreements, it is possible that this will persist as an issue that has implications for the project's implementation. Sufficient time should be allowed to resolve any potential issues prior to the project's implementation phase.
Damage to cultural heritage sites	Undertake thorough cultural heritage survey and investigation. Construction to include compliance with conditions set out in all regulatory approvals (eg. CHMP). Ensure	This is considered as a **significant risk**. Construction activities may cause loss or damage of identified sites as well as unidentified sites (discovered

Risk	Control Activity	Justification
	adequate supervision and induction of contractors.	during construction) and may lead to delays, loss of goodwill and possible legal action/financial penalties.
Uncertainty in predicting and managing in-channel flows	A phased implementation of the environmental watering process will be taken to manage and reduce uncertainty. This will involve initial trials and the following steps. -collect data -develop forecasting and operational tools - monitor events including working with landowners and their observations - develop operational rules and procedures in consideration of freeboard or operational buffer requirements on river channel. - adapt flows and releases targeting smaller events and refining models and operational practices base on observations to gradually increase in-channel flows	This is considered as a **significant risk**. If tributary inflows are not able to be predicted with sufficient accuracy, actual e-flows achieved may be higher or lower than planned, resulting in unplanned river channel overtopping or failure to achieve intended environmental outcomes.
Lack of monitoring funding	GBCMA to seek adequate sources of funding (e.g. through CEWH, VEWH, DELWP and potential research partnerships with other organisations such as universities, ARI).	This is considered as a **significant risk**. Failure to adequately monitor the ecological outcomes of the project activities restricts the ability to demonstrate the full benefits of the works leading to perceived underperformance/failure of the project, loss of stakeholder support, failure to endorse watering plans and limited opportunities for adaptive management.

14.3. Project plan for implementation

14.3.1. Project delivery arrangements

Once a decision has been made to proceed, arrangements will be put in place that ensure appropriate senior oversight of project governance and delivery. It is envisaged that these arrangements will be informed by those that were used to deliver the four *Living Murray Environmental Works and Measures Program* (EWMP) projects within Victoria, complemented with existing state government frameworks, which together will underpin a set of robust and thorough processes for procurement and project management.

A detailed scoping of the governance and project management arrangements will be carried out if it is agreed that this project is included in the final adjustment package.

14.3.2. Timelines

The project largely falls into 3 phases - investigation and detailed design, implementation, and commissioning.

The first phase will occur from 2018/19 to 2021/22. This involves further investigation of how and when to add releases to unregulated tributary flows, the inundation target and buffer flows, the detailed design of the lower Goulburn outlet upgrade, the detailed assessment of on-farm and specialist business mitigation, and the detailed assessment of public infrastructure needs. The building of flow management knowledge and development of water operational tools will occur in this period.

The second phase (implementation) will occur from 2022/23 to 2023/24. This will involve implementing the outlet upgrade, and implementing on-farm works and public infrastructure needs. There is a significant risk that reaching binding agreement could take longer than the time allowed. The development of flow management knowledge continues through this period.

The third phase (commissioning) will likely occur in two periods. Infrastructure could be tested using a natural flow event in 2022/23 to 2023/24 (but later if dry conditions occur). The commissioning of flow management (i.e. the actual release of water) is planned to start in 2024/25 (assuming all mitigation measures are in place) and commence at a lower flow levels, progressively targeting higher flows over a few years as experience in releasing and risk management is gained and continue over a three year period up to 2027. This will also involve “commissioning” associated public and private mitigations (involving monitoring).

The high level draft implementation plan is shown in Figure 15

	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	Ongoing
Project Management										
Business Case Preparation										
Communications & Engagement										
Stream/Rainfall Gauging	Install	Collect Data			Collect Data		Collect Data			
Eildon, Cattanagh, Stuart Murray Release Rise & Fall Study	Study	Trial								
Flow Analysis & Modelling										
Flow Forecasting		Develop Forecasting			Forecast Provision & Testing		Forecast Provision			
Operational Model Development										
Flow Event Planning							Actual Release Planning			
Survey Goulburn & Murray Bed Levels										
Water Level Monitoring	Install	Collect Data			Collect Data		Collect data			
River level measurement										
Building Survey										
River Level Modelling										
Salinity Impact Assessment										
Environmental objective review										
Levee Outlet	Detailed Design & Approvals				Construction		Commission	Operate & Maintain		
Private Infrastructure/Agreement	Data Collection, Design & Negotiation				Implement					
Public Infrastructure/Agreement	Data Collection, Design & Negotiation				Implement					

Figure 15 Proposed high level implementation plan for the Goulburn Constraints Measure

	thinking, studies / ongoing
	development
	commissioning
	building

15. Alignment between this business case and the Phase 2 Guidelines

The Key Evaluation Criteria specified in the Phase 2 Assessment Guidelines for Supply and Constraint Measure Business Cases (**the Guidelines**) have been addressed in this business case as referenced below by Table 25.

Table 25 key evaluation criteria addressed

Guidelines Section	Heading	Requirement	Business Case Section
4.1	Project details	Key project details and overview	Section 1, 2.1 to 2.8, Appendix A
4.2	Ecological values of the site	Description of the ecological values of the site	Section 3, Appendix B & Appendix C
4.3	Ecological objectives and targets	Confirm objectives and targets	Section 4.4, Appendix D
4.4.1	Anticipated ecological benefits	Proposed outcomes from the investment	Section 4.1 to 4.3
4.4.2	Potential adverse ecological impacts	Assessment of potential adverse impacts	Section 5, Appendix F & Appendix G
4.5.1	Current hydrology and proposed changes	Clear articulation of current and proposed hydrology	Section 6
4.5.2	Environmental water requirements	Water requirements of new inundated areas	Section 6.3 & Appendix E
4.6	Operating regime	Explanation of the role of each operating scenario	Section 7
4.7	Assessment of risks and impacts of the operation of the measure	Assessment of risks and mitigation options	Section 8, Appendix F & Appendix G
4.8	Technical feasibility and fitness for purpose	Evidence that the project infrastructure is technically feasible	Section 9
4.9	Complementary actions and interdependencies	Confirm interaction with other initiatives	Section 10
4.10	Costs, Benefits and Funding Arrangements	Detailed costing and listing of benefits	Section 11
4.11.1	Stakeholder management strategy	Confirm stakeholder list and stakeholder management strategy	Section 12

4.11.2	Legal and regulatory requirements	Legal and regulatory requirements	Section 13
4.11.3	Governance and project management	Governance and project management	14.1 & 14.3
4.11.4	Risk assessment of Project Development and Delivery	Risks from project development and delivery	14.2, Appendix F & Appendix G

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Appendices

Appendix A – Feasibility phase investigations and studies

A number of supporting investigations have been undertaken by consultants for GBCMA and the MDBA to inform the development of the original Goulburn business case. The investigations included assessments of river hydrology, floodplain inundation, inundation impacts to public and private land and assets, the identification of possible mitigation activities, costing of possible mitigation activities, regulatory approvals and program implementation and engineering.

This new project has used subsets of information from these investigations and studies that were relevant to an in-channel watering objective.

These projects are summarised in Table A-1.

Table A-1: Projects undertaken

Project	Consultant(s)	Tasks	Sub-tasks	Methods used
Hydrology(2)	Jacobs	Assess the ability to increase unregulated flow events at Shepparton	Collate unregulated flow event data and characterise these events	Collation of historic flow data and analysis
			Investigate potential triggers to commence flow releases	Daily timestep modelling
			Model possible Lake Eildon release scenarios	Daily timestep modelling
Mapping of assets on public and private land	ThinkSpatial	Generate accurate GIS layers locating key asset classes	Realign roads and bridges on existing GIS layer	Analysis of aerial photography and GIS adjustment
			Realign buildings on existing GIS layer and locate additional buildings	
			Map outline of specialist activities	
River bed level survey	Oxley	Survey the river bed level of the Acheron and Yea Rivers		Field survey of stream thalweg
Hydraulic Modelling(1)	Water Technology	Estimate the area of land along the Goulburn River that is inundated	Collate topographic data	Data collation and analysis
			Set up GPU 2-D hydraulic model and calibrate.	Hydraulic modelling

Project	Consultant(s)	Tasks	Sub-tasks	Methods used
		at different river flows	Model flows in river and map land inundated	Hydraulic modelling and GIS analysis
		Assess combined River Murray and Goulburn River flow impact on the area inundated	Model flows in river and map land inundated	Hydraulic modelling and GIS analysis
		Assess the interaction of impact of Goulburn River flows on inundation along the Acheron and Yea Rivers	Collate topographic data	Data collation and analysis
			Set up GPU 2-D hydraulic model.	Hydraulic modelling
			Model flows in river and map land inundated	Hydraulic modelling and GIS analysis
Lower Goulburn levees(1)	Water Technology	Undertake levee risk assessment and mitigation strategy	Undertake risk assessment of levee condition	Risk assessment and GIS analysis
			Prepare risk mitigation strategy and costs to mitigate	Expert analysis
Private agricultural land	GHD	Refine prefeasibility assessment of impacts on agriculture, and the costs of easements that may be required over the land in light of those impacts	Reassess key assumptions, e.g. land use, land value, impacts, and recalculate costs	Consultation with informed stakeholders (e.g. local agricultural experts)
			Reassess hydrological assumptions, i.e. frequency/timing/duration of flows, and recalculate costs	Use new simplified hydrological assumptions
		Identify and cost works on private infrastructure	Assess where private infrastructure works will be required to complement easements, and estimate costs of those works	Expert analysis

Project	Consultant(s)	Tasks	Sub-tasks	Methods used
Public infrastructure	AECOM	Refine assessment of public infrastructure (e.g. roads, crossings, bridges, stormwater), how it might be affected by changes in flows, and mitigation options and costs.	Reassess and refine existing GIS-based datasets	Expert analysis
			Consult with regional stakeholders to refine understanding of impacts on specific infrastructure items, and works required	Consult with regional stakeholders
			Estimate costs of infrastructure works and mitigation	Expert analysis
Implementation costs	Jacobs	Assess what processes will be required to implement mitigation measures, and estimate costs of those processes	Stocktake of approval and management requirements relevant to implementing mitigation measures	Expert analysis
			Estimate costs of processes	Expert analysis
Specialist activities	Jacobs	Consider specialist activities (e.g. caravan parks, golf courses, quarries and Murray Shacks), how they might be affected by changes in flows, and mitigation measures and costs	Identify specialist activities which will be affected, and develop methodology for identifying potential impacts and appropriate mitigation measures.	Expert analysis
			Engage with potentially affected businesses and develop story about how affected	Consult with regional stakeholders
			Develop indicative estimates of costs	Expert analysis
Risk Management Strategy	DELWP	Undertake high level project risk assessment and develop risk mitigation strategy	Develop risk register	Expert analysis
			Assess risks and develop mitigation strategies	Expert workshop
Regulatory approvals strategy	DELWP	Develop scope of regulatory approvals required		Expert analysis

(1) Peer review completed

Appendix B – Water Dependent EVCs

Data extracted from 'Wetlands – Freshwater – Native Vegetation (EVCBCS – 2005)' (DELWP 2017).

WETLAND EVCs				
168	Drainage Line Aggregate	Vulnerable	Endangered	NA
1022	Drainage Line Aggregate/ Riverine Swamp Forest Mosaic	Vulnerable	Endangered	NA
334	Billabong Wetland Aggregate	Depleted	Vulnerable	NA
172	Floodplain Wetland Aggregate	Depleted	Vulnerable	NA
804	Rushy Riverine Swamp	Depleted	Depleted	NA
1090	Tall Marsh/ Open Water Mosaic	Least Concern	Depleted	NA
1081	Spike-sedge Wetland/ Tall Marsh Mosaic	Vulnerable	Vulnerable	NA
810	Floodway Pond Herbland	Depleted	Vulnerable	NA
RIPARIAN & MINOR CHANNEL EVCs				
56	Floodplain Riparian Woodland	Depleted	Vulnerable	Endangered
1035	Floodplain Riparian Woodland/ Sedgy Riverine Forest Mosaic	Depleted	Vulnerable	NA
816	Sedgy Riverine Forest	Depleted	Vulnerable	NA
815	Riverine Swampy Woodland	Vulnerable	Vulnerable	NA
814	Riverine Swamp Forest	Depleted	Depleted	NA
1068	Riverine Swamp Forest/ Sedgy Riverine Forest Mosaic	Depleted	Vulnerable	NA
68	Creekline Grassy Woodland	Endangered	Endangered	NA
18	Riverine Forest	NA	NA	Vulnerable
256	Floodplain Riparian Woodland/Floodplain Wetland Mosaic	NA	Vulnerable	NA

Wetlands – Freshwater – Native Vegetation (EVCBCS – 2005). Department of Environment Land Water and Planning 2017.

Appendix C – Listed species recorded in the Goulburn River Riparian Zone and Wetlands

Data extracted from Assessment of environmental water requirements for the proposed '*Basin Plan: Lower Goulburn River Floodplain'* (MDBA, 2012); '*Lower Goulburn Wetlands Flora and Fauna Surveys'* (Cook, 2012a); *'Mid Goulburn Wetlands Flora and Fauna Surveys'* (Cook, 2012b); '*Status of fish populations in the lower Goulburn River'* (ARI, 2012); '*Assessing the current status of Macquarie perch (Macquaria australasica) in the mid-Goulburn River'* (ARI, 2014); *'Victorian Biodiversity Atlas flora records'* (DELWP 2017); *'Victorian Biodiversity Atlas fauna records'* (DELWP 2017).

Species	Recognised in international agreement(s)[1]	EPBC Act 1999 (Cwlth)	FFG ACT 1998 (VIC)	Advisory List of Threatened Species (VIC)
AMPHIBIANS AND REPTILES				
Lace goanna (*Varanus varius*)[4]			L	V
Brown toadlet (*Pseudophryne bibronii*)[4]			L	E
Broad-shelled turtle (*Macrochelodina expansa*)			L	E
Common Long-necked Turtle (*Chelodina longicollis*)				DD
Murray River Turtle (*Emydura macquarii*)				V
BIRDS				
Australasian bittern (*Botaurus poiciloptilus*)[2, 3]			L	E
Australasian shoveler (*Anas rhynchotis*)[4]			L	V
Australian Little Bittern (*Ixobrychus dubius*)			L	E
Azure Kingfisher (*Alcedo azurea*)				NT
Baillon's crake (*Porzana pusilla*)[2, 3]			L	V
Barking owl (*Ninox connivens*)[2, 3]			L	E
Blue-billed Duck (*Oxyura australis*)			L	E
Brown Quail (*Coturnix ypsilophora australis*)				NT
Bush stone-curlew (*Burhinus grallarius*)[2, 3]			L	E
Diamond firetail (*Stagonopleura guttata*)[4]			L	NT
Eastern great egret (*Ardea modesta*)[2, 3]	J, C		L	V
Freckled duck (*Stictonetta naevosa*)[4]			L	E
Glossy ibis (*Plegadis falcinellus*)	C			NT
Grey-crown babbler (*Pomatostomus temporalis)*			L	E
Ground cuckoo-shrike (*Coracina maxima*)[2, 3]			L	V
Hardhead (*Aythya australis*)[4]			L	V

Species	Recognised in international agreement(s)[1]	EPBC Act 1999 (Cwlth)	FFG ACT 1998 (VIC)	Advisory List of Threatened Species (VIC)
Intermediate egret (*Ardea intermedia*)[4]			L	CE
Latham's snipe (*Gallinago hardwickii*)[2, 3]	J,C,R		N	NT
Lewin's rail (*Lewinia pectoralis*)[2, 3]			L	V
Little bittern (*Ixobrychus dubius*)[2, 3]			L	E
Magpie goose (*Anseranas semipalmata*)[2, 3]			L	NT
Marsh sandpiper (*Tringa stagnatilis*)	J,C,R			V
Musk duck (*Biziura lobata*)[4]			L	V
Nankeen Night Heron (*Nycticorax caledonicus*)				NT
Painted honeyeater (*Grantiella picta*)[2, 3]			L	V
Pied Cormorant (*Phalacrocorax varius*)				NT
Rainbow bee-eater (*Merops ornatus*)	J			
Royal spoonbill (*Platalea regia*)[4]				NT
Sharp-tailed Sandpiper (*Calidris acuminata*)	J,C,R			
Superb parrot (*Polytelis swainsonii*)[2, 3]		V	L	E
Swift parrot (*Lathamus discolor*)[2, 3]		E	L	E
Turquoise parrot (*Neophema pulchella*)[2, 3]			L	NT
Whiskered Tern (*Childonias hybridus javanicus*)				NT
White-bellied sea eagle (*Haliaeetus leucogaster*)[2, 3]	C		L	V
Wood Sandpiper (*Tringa glareola*)	J,C,R			V
FISH				
Flat-headed galaxias (*Galaxias rostratus*)[4]			L	V
Freshwater catfish (*Tandanus tandanus*)[2, 3]			L	E
Macquarie perch (*Macquaria australasica*)[2, 3]		E	L	E
Murray cod (*Maccullochella peelii peelii*)[2, 3]		V	L	E
Murray–Darling rainbowfish (*Melanotaenia fluviatilis*)[2, 3]			L	DD
Golden perch (*Macquaria ambigua*)				NT
Silver perch (*Bidyanus bidyanus*)[2, 3]			L	CE
Trout cod (*Maccullochella macquariensis*)[2, 3]		E	L	CE
Unspecked hardyhead (*Craterocephalus*			L	DD
MAMMALS				
Squirrel glider (*Petaurus norfolcensis*)[2, 3]			L	E
Brush-tailed phascogale (*Phascogale tapoatafa*)[2, 3]			L	V

Species	Recognised in international agreement(s)[1]	EPBC Act 1999 (Cwlth)	FFG ACT 1998 (VIC)	Advisory List of Threatened Species (VIC)
FLORA				
River swamp wallaby-grass (*Amphibromus fluitans*)		V		
Small scurf pea (*Cullen parvum*)		E	L	E
Annual Bitter-cress (*Cardamine paucijuga* s.l)				V
Sand Rush (*Juncus psammophilus*)				R
Pale Knotweed (*Persicaria lanigera*)				K
Groundsel (*Senecio campylocarpus*)				R
Riverine Bitter-cress (*Cardamine moirensis*)				R
Dwarf Brooklime (*Gratiola pumelo*)				R
Native couch (*Cynodon dactylon* var. *pulchellus*)				K
Groundsel (*Senecio campylocarpus*)				R
Water Shield (*Brasenia schreberi*)			L	V
Hypsela (*Hypsela tridens*)				K
INVERTEBRATES				
Murray spiny crayfish (*Euastacus armatus)*			L	NT
Ancient greenling damselfly (*Hemiphlebia mirabilis*)			L	E

CE = critically endangered DD = data deficient E = endangered L = listed NT = near threatened V = vulnerable DD = data deficient

1. Japan–Australia Migratory Bird Agreement, China–Australia Migratory Bird Agreement, or Republic of Korea – Australia Migratory Bird Agreement
2. Victorian Department of Primary Industries (2010)
3. Department of the Environment, Water, Heritage and the Arts (2009)
4. Department of Sustainability and Environment (2009)

Koster, W., Crook, D., Dawson, D. and Moloney, P. (2012) Status of fish populations in the lower Goulburn River (2003-2012). Arthur Rylah Institute for Environmental Research Unpublished Client Report for Goulburn Broken Catchment Management Authority, Department of Sustainability and Environment, Heidelberg, Victoria

Kearns, J., O'Mahony, J., Raymond, S., Hackett, G., Tonkin, Z. and Lyon, J. (2014). Assessing the current status of Macquarie perch (*Macquaria australasica*) in the mid-Goulburn River. Confidential Client Summary Report prepared for the Goulburn Broken Catchment Authority. Department of Sustainability and Environment, Heidelberg, Victoria.

Victorian Biodiversity Atlas fauna records. Department of Environment Land Water and Planning 2017

Appendix D – Link between ecological values and objectives

ECOLOGICAL VALUE	OVERARCHING OBJECTIVES	ECOLOGICAL OBJECTIVES	NESTED ECOLOGICAL OBJECTIVES
BASEFLOW			
• **Macroinvertebrate** • **Native vegetation** • **Native fish**	• 1 • 2 • 3 • 6	• Wet and maintain riffles for macroinvertebrates and small bodied fish, maintain wetted perimeter and aquatic vegetation • Provide suitable in channel habitat for all life stages. • Provide habitat and food source for macroinvertebrates by submerging snag habitat within the euphotic zone	• Scour fine sediment from gravel bed and riffle substrate • Maintain existing beds of in-channel vegetation • Provide slow shallow habitat required for larvae/juvenile recruitment and adult habitat for small bodied fish • Provide deep water habitat for large bodied fish • Provide conditions suitable for aquatic vegetation, which provides habitat for macroinvertebrate • Provide slack water habitat favourable for planktonic production (food source) and habitat for macroinvertebrate • Entrain litter packs available as food/habitat source for macroinvertebrate • Maintain water quality suitable for macroinvertebrate
BASEFLOW/FRESH			
• **Geomorphology**	• 4 • 5	• Maintain pool depth	• Maintain natural rates of sediment deposition
FRESH			

ECOLOGICAL VALUE	OVERARCHING OBJECTIVES	ECOLOGICAL OBJECTIVES	NESTED ECOLOGICAL OBJECTIVES
• **Geomorphology** • **Macroinvertebrate** • **Native fish** • **Native vegetation**	All	• Scour fine sediments from riffle surfaces to maintain invertebrate habitat • Maintain habitat for macrophytes • Sloughing filamentous algae and refreshing biofilms • Maintain areas of riffle habitat • Provide flows to promote large bodied endangered species colonisation • Initiate spawning, pre-spawning migrations and recruitment of native fish (preferably late spring early summer for native fish) • Remove terrestrial vegetation and re-establish amphibious vegetation	• Macroinvertebrate provides food source for fish • Mobilise sediments • Increase flow variability to more closely mimic natural hydrological regime • Promote Macquarie perch spawning • Maintain aquatic macrophyte, macroinvertebrate and fish habitat by mobilising fine sediments, submerging snags and replenishing slackwater habitat
BANK-FULL			
• **Geomorphology** • **Native fish** • **Native vegetation** • **Macroinvertebrate**	• All	• Maintain channel form and key habitats (including in channel benches) • Maintain bed diversity • Provide flows to increase native fish recruitment and colonisation • Provide periodic opportunities for regeneration of riparian and floodplain species and improve in channel carbon availability • Retain natural seasonality to ensure synchronicity of life cycle of macroinvertebrates	• Overturn bed substrate • Maintain channel form and key habitats • Maintain riffle habitat for macroinvertebrates • Maintain or increase connection to warmer water • Maintain channel connectivity to tributaries • Scour sediments from base of pools to maintain quantity and quality of habitat • Maintain channel and inlet for connectivity to main channel with floodplain and wetlands • Promote colonisation by large bodied endangered species • Provision of lateral connectivity for habitat and production
OVERBANK			

ECOLOGICAL VALUE	OVERARCHING OBJECTIVES	ECOLOGICAL OBJECTIVES	NESTED ECOLOGICAL OBJECTIVES
• **Geomorphology** • **Native fish** • **Native vegetation** • **Macroinvertebrate**	• All	• Maintain channel form • Maintain connectivity to floodplain and wetlands • Provide floodplain connection for exchange of organic matter • Provide periodic regeneration opportunities for native floodplain wetland plants • Increase the extent and diversity of flood dependent vegetation communities, including higher floodplain areas	• Maintain diversity among low lying wetlands • Promote colonisation by large bodied endangered species • Overturn of bed material and maintain benches • Provide lateral connectivity as habitat and recruitment areas for native fish • Provide habitat for wetland specialist fish • Exchange of food and organic material between the floodplain and channel to improve in channel carbon availability • Increase breeding and feeding opportunities for native fish, waterbirds and amphibians
RATE OF RISE AND FALL			
• **Native fish** • **Macroinvertebrate** • **Geomorphology**	• 1 • 3 • 4 • 5	Manage rate of rise to reduce displacement of macroinvertebrates and small/juvenile fish	
		Manage rate of fall to reduce bank slumping/erosion and stranding of macroinvertebrates and small/juvenile fish	

Appendix E – Environmental flow recommendations for the Goulburn River

Reach	Flow Component	Flow (ML/DAY)	Duration	Season	Ecological Value	Overarching Ecological Objectives	Ecological Objectives	Report
4 - 5	Baseflow	320 - 540	All year	All	• Native fish	• 1	• Provide suitable in channel habitat for all life stages.	2007
4 – 5	Baseflow	830 - 940	All year	All	• Macroinvertebrate	• 3 • 6	• Provide habitat and food source for macroinvertebrates by submerging snag habitat within the euphotic zone • Entrain litter packs available as food/habitat source for macroinvertebrate • Maintain water quality suitable for macroinvertebrate	2007
4 – 5	Baseflow/fresh	Ranging from 856 – 6,060	< 90 days	Summer	• Geomorphology	• 4 • 5	• Maintain pool depth and natural rates of sediment deposition	2007
4 – 5	Fresh	5600	2-4 days 1-4 events a year	Spring Summer	• Native fish	• 1 • 2 • 3	• Initiate spawning of golden perch, migrations of Murray cod and silver perch and recruitment of other native fish (preferably late spring /early summer) • Maintain aquatic macrophyte, macroinvertebrate and fish habitat by mobilising fine sediments, submerging snags and replenishing slackwater habitat	2010

4 – 5	Fresh	5600	2-4 days 1-4 events a year	Summer Autumn	• Native vegetation	• 2 • 3	• Establish amphibious and lower bank vegetation • Maintain aquatic macrophyte, macroinvertebrate and fish habitat by mobilising fine sediments, submerging snags and replenishing slackwater habitat	2010
4 – 5	Fresh	5600	14 days 1-4 events a year	Winter Spring	• Native vegetation	• 2	• Remove terrestrial vegetation and re-establish amphibious and lower bank vegetation	2010
4	Overbank*	25 000	5+ days 2-3 events in a year 7-10 event years in 10	Winter Spring	• Native vegetation	• 2 • 6	• Increase the extent and diversity of flood dependent vegetation communities • Provide habitat for wetland specialist fish • Exchange of food and organic material between the floodplain and channel • Increase breeding and feeding opportunities for native fish, waterbirds and amphibians	2011
4	Overbank*	40 000	4+ day 1 – 2 events in a year 4 - 6 event years in 10	Winter Spring	• Native vegetation	• 2 • 6	• Increase the extent and diversity of flood dependent vegetation communities higher on the floodplain • Provide habitat for wetland specialist fish • Exchange of food and organic material between the floodplain and channel • Increase breeding and feeding opportunities for native fish, waterbirds and amphibians	2011
4	Rate of flow rise	Max rate of 0.38/0.38/1.20/0.80 metres river height in summer/autumn/ winter/spring		All year	• Native fish • Macroinvertebrate	• 1 • 3	• Reduce displacement of macroinvertebrates and small/juvenile fish	2007
4	Rate of flow fall	Max rate of 0.15/0.15/0.78/0.72 metres river height in summer/autumn/ winter/spring		All year	• Geomorphology • Native fish • Macroinvertebrate	• 1 • 3 • 4 • 5	• Reduce bank slumping/erosion and stranding of macroinvertebrates and small/juvenile fish	2007

Appendix F Risk Assessment Methodology

A high level assessment of the potential adverse environmental outcomes was completed in line with the requirements of AS/NZS ISO 31000:2009 (DELWP 2017). The assessment considered the potential environmental risks in the Goulburn River, as well as the receiving River Murray (DELWP 2017).

The risk assessment considered the likelihood of a negative environmental response occurring and the severity of the outcome if that event occurred. The assessment generated a risk matrix in line with the ISO standards and evaluated the availability and effectiveness of management options to diminish those risks (mitigation options).

Table A-: Risk assessment matrices

Risk Ranking		Consequence				
		1-Insignificant	**2-Minor**	**3-Moderate**	**4-Major**	**5-Extreme**
Likelihood	**1-Rare**	2-Low	3-Low	4-Low	5-Low	6-Moderate
	2-Unlikely	3-Low	4-Low	5-Low	6-Moderate	7-Significant
	3-Possible	4-Low	5-Low	6-Moderate	7-Significant	8-High
	4-Likely	5-Low	6-Moderate	7-Significant	8-High	9-High
	5-Almost certain	6-Moderate	7-Significant	8-High	9-High	10-Intolerable

The broad approach to completing the risk assessment involved the following steps:

1. Developing a risk register drawing on experience of delivering similar projects that considers potential environmental risks for the **investigation, project delivery** and **operational** phases of the project
2. Using the risk register to identify categories of threat, individual threats and a risk rating for each threat with a score against:

The likelihood of those events occurring

The consequence of the outcome if the event occurred

A (pre-treatment) risk rating based on the combination of likelihood and consequence

The available mitigation strategies and controls to offset these risks

The residual risk once those controls were imposed.

The risk register was developed at a workshop (20 June 2017) by stakeholders with knowledge of the relevant sites and experience of delivering similar projects. This risk register identified core values at the sites, categories of threat, individual threats and a risk rating for each threat. The assessment also identifies the potential mitigation strategies and the level of residual risk once these have been implemented.

The stakeholder agencies represented at the workshop included GBCMA, GMW, DELWP. This harnessing of local knowledge with broader stakeholder experience was effective in the

identification of relevant threats and the informed allocation of likelihood and consequence ratings for each threat.

The outcomes of the risk assessment provides a preliminary basis for prioritising mitigation strategies and measures based on currently available information. A more detailed risk assessment will be carried out should the Basin Ministers decide to proceed further with the project.

Appendix G – Significant pre-treatment risks identified through the assessment process

Threat	Description	Pre-treatment risk assessment			Mitigation options	Residual risk assessment (post-treatment)		
		Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
Investigation Phase								
ENVIRONMENTAL IMPACTS								
Spread of weeds and pathogens.	Vehicles moving between properties during consultation may carry and spread weeds or pathogens between properties. This can cause spread of noxious weeds, pathogens and loss of good will.	3	3	6	All vehicles cleaned prior to entering properties in accordance with the Environmental Management Plan.	2	2	4
Loss of native vegetation and fauna habitat	Gauging stations may require the removal of small areas of native vegetation. This could cause a loss of native vegetation and potentially fauna habitat.	3	2	5	Surveys conducted to allow siting of gauging stations to minimise/avoid vegetation impacts. Include vegetation management in the construction Environmental Management Plan and follow legislative requirements as appropriate (including consideration of offsets). Ensure adequate supervision during construction phase.	2	1	3
THIRD PARTY IMPACTS								
Damage to Cultural and European heritage impacts	Construction activities may cause loss or damage to identified sites as well as unidentified sites (discovered during construction) and may lead to delays, loss of goodwill and possible legal action/financial penalties.	3	3	6	Undertake thorough cultural heritage survey and investigation. Construction to include compliance with conditions set out in all regulatory approvals (eg. CHMP). Ensure adequate supervision and induction of contractors.	2	2	4
Vehicle accidents	Accidents involving construction vehicles as well as public vehicles leading to project delays, possible legal action/financial penalties and most importantly, loss of life or serious injury.	2	5	7	JSEA and pre-work assessments to include risk assessment and mitigation measures to avoid vehicle accidents (e.g. speed limits, restricted access during wet weather, dust suppression, road condition inspections and repairs, road barriers to construction sites).	1	5	6

Threat	Description	Pre-treatment risk assessment			Mitigation options	Residual risk assessment (post-treatment)		
		Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
PROJECT DELIVERY RISKS								
Lack of support - directly affected landholders and agencies.	**Landholders who are directly affected by the works may object leading to loss of goodwill, project delays, possible legal action and additional costs.**	**4**	**3**	**7**	**Communication plan to include landholder and agency consultation and briefings to fully inform, identify and address issues.** **Establish Community Reference Group as part of the governance framework.** **Formalised agreements in place with affected parties.**	**4**	**3**	**7**
Loss of support from funding agencies	Loss of support for the project from funding agencies could lead to possible cancellation of the project.	2	5	7	Funding agencies strongly involved in project implementation. Communication plan to include stakeholder consultation and briefings to identify and address any issues.	1	5	6
Lack of political support	**Lack of support at local, state and/or federal level could lead to project delays, negative publicity and potential stop work.**	**4**	**4**	**8**	**Communication plan to include political consultation and briefings to inform about the project and appropriately deal with stakeholder issues.**	**3**	**4**	**7**
Inaccurate cost estimate	Project not completed within the approved budget unless additional funding is provided or the scope of works reduced.	3	4	7	Undertake detailed investigations to minimise uncertainties. Include suitable contingency allowances in cost estimate. Obtain expert peer review of cost estimates.	2	2	4
Insufficient budget for implementation	Approved funding is less than the estimated project cost stopping the project from been completed unless additional funding is provided or the scope of works reduced.	3	4	7	Determine the impacts on project scope/outcomes of any shortfall in funding and communicate with funders to agree on a revised scope or additional funding.	2	2	5
Unsuitable contractor	Contractor does not have the necessary experience, plant, financial resources and management systems and skills (safety, work	3	4	7	Procurement strategy to include preparation of suitable tender documents and works schedules including contractor resources, experience and referees. Tender interviews undertaken by persons with experience in similar projects and contractor resources.	2	3	5

Threat	Description	Pre-treatment risk assessment			Mitigation options	Residual risk assessment (post-treatment)		
		Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
	scheduling etc.) to successfully complete the works resulting in delays, cost overruns and possible legal action.							
Uncertainty regarding future ownership	Disagreement between agencies and/or landholders regarding future responsibility for the operation and maintenance of the works.	2	3	5	Obtain legal agreements that clearly defines the roles and responsibilities of all parties before the project is approved. Operator input to design and construction process.	2	2	4
Natural disasters	Natural disasters (eg. bushfire and floods) impact on construction activity leading to possible damage to persons (including fatality) and property leading to, loss of goodwill, damage costs and project delays.	3	5	8	Implement relevant Safe Work Procedures.	3	2	5
Change in landholder or landholder capacity.	The landholder involved in original agreement is incapacitated or there is a change in land ownership resulting in project delivery delays.	4	4	8	Formalised agreements in place with affected parties.	4	2	6
Denial of access to land	Landholder refuses access to project staff causing delays.	3	3	6	Commence negotiations before the project is approved. Ongoing engagement dealing with issues raised by directly affected landholders.	2	3	5
Change of staff	Loss of continuity resulting in poor communication, time delays, cost increases and loss of trust and corporate knowledge.	4	3	7	Identify backup staff for key roles (e.g. project manager, superintendent, works supervisor), ensure depth of project team and alternative employment models/succession plan.	3	2	5
Inconsistent delivery of constraints	Lack of community trust and potential to impact landholder negotiations as a result of:	4	4	8	Develop agreed approach to costing methodology, mitigation principles and principles for landholder support with Constraints Measures Working Group.	3	3	6

Threat	Description	Pre-treatment risk assessment			Mitigation options	Residual risk assessment (post-treatment)		
		Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
projects across the basin.	• Different costing methodologies for mitigation activities • Different mitigation principles - e.g. mitigation activities to provide current level of service • Different provisions of landholder support e.g access to legal advice for landholders • Degree to which flows are agreed to be eased in Yarrawonga to Wakool reach of the Murray • Timeframes for implementation of any agreed activities				Monitor progression of constraints easing and implementation via CMWG and adjust programs if considered necessary			
IMPLEMENTATION PHASE								
ENVIRONMENTAL IMPACTS								
Loss of native vegetation and fauna habitat	Proposed construction activities may result in the loss of native vegetation and fauna habitat in the construction footprint.	4	2	6	Surveys conducted to allow detailed designs to minimise/avoid vegetation impacts. Include vegetation management in the construction Environmental Management Plan and follow legislative requirements as appropriate (including consideration of offsets). Ensure adequate supervision during construction phase.	3	2	5

Threat	Description	Pre-treatment risk assessment			Mitigation options	Residual risk assessment (post-treatment)		
		Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
Water quality impacts	Contamination of water through sediments fuel spills entering the waterway during construction.	4	3	7	Construction to be undertaken as per licence conditions and Environmental Management Plan	3	2	5
Fire caused by construction equipment	Construction machinery or equipment may start a fire, causing loss of biodiversity (and potentially human and property damage).	3	5	8	Fire management plan developed. Site Environment Management Plan. Site safety plans. Liaison with fire services.	1	4	5
THIRD PARTY IMPACTS								
Damage to cultural heritage sites	**Construction activities may cause loss or damage of identified sites as well as unidentified sites (discovered during construction) and may lead to delays, loss of goodwill and possible legal action/financial penalties.**	**5**	**4**	**9**	**Undertake thorough cultural heritage survey and investigation. Construction to include compliance with conditions set out in all regulatory approvals (eg. CHMP). Ensure adequate supervision and induction of contractors.**	**3**	**4**	**7**
Damage to European heritage sites	Construction activities may cause loss or damage of identified sites as well as unidentified sites (discovered during construction) and may lead to delays, loss of goodwill and possible legal action/financial penalties.	2	2	4	Undertake thorough heritage survey and investigation. Construction to include compliance with conditions set out in all regulatory approvals. Ensure adequate supervision and induction of contractors.	1	2	3

Threat	Description	Pre-treatment risk assessment			Mitigation options	Residual risk assessment (post-treatment)		
		Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
Vehicle accidents	Accidents involving construction vehicles as well as public vehicles leading to project delays, possible legal action/financial penalties and most importantly, loss of life or serious injury.	2	5	7	Traffic Management Plan to include risk assessment and mitigation measures to avoid vehicle accidents (e.g. speed limits, restricted access during wet weather, dust suppression, road condition inspections and repairs, road barriers to construction sites).	1	5	6
On-site injury to workers or community	Injuries to site workers during construction or members of the public at the work site including unauthorised visits leading to project delays, possible legal action/financial penalties and most importantly, loss of life or serious injury.	3	5	8	Site Safety Plan to include risk assessment and mitigation measures to identify and avoid site accidents (e.g. manual lifting, machinery operation, site safety briefings and barriers). Selection of contractors.	1	5	6
PROJECT DELIVERY RISKS								
Loss of support from funding agencies	Loss of support for the project from funding agencies could lead to possible cancellation of the project.	2	5	7	Funding agencies strongly involved in project implementation. Communication plan to include agency consultation and briefings to identify and address any issues. Establishment of legal agreements to funding and compliance with conditions.	1	5	6
Lack of support - directly affected landholders and agencies.	**Landholders who are directly affected by the works may object leading to loss of goodwill, project delays, possible legal action and additional costs.**	**4**	**3**	**7**	**Communication plan to include landholder and agency consultation and briefings to fully inform, identify and address issues.** **Formalised agreements in place with affected parties.**	**4**	**3**	**7**
Lack of political support	**Lack of support at local, state and/or federal level could lead to project delays, negative publicity and potential stop work.**	**4**	**4**	**8**	**Communication plan to include political consultation and briefings to inform about the project and appropriately deal with stakeholder issues.**	**3**	**4**	**7**

Threat	Description	Pre-treatment risk assessment			Mitigation options	Residual risk assessment (post-treatment)		
		Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
Inaccurate cost estimate	Project cannot be completed within the approved budget unless additional funding is provided or the scope of works reduced.	3	4	7	Undertake detailed investigations to minimise uncertainties. Include suitable contingency allowances in cost estimate. Obtain expert peer review of cost estimates.	2	2	4
Insufficient budget for implementation	Approved funding is less than the estimated project cost stopping the project from been completed unless additional funding is provided or the scope of works reduced.	3	4	7	Determine the impacts on project scope/outcomes of any shortfall in funding and communicate with funders to agree on a revised scope or additional funding.	2	2	4
Unsuitable contractor	Contractor does not have the necessary experience, plant, financial resources and management systems and skills (safety, work scheduling etc.) to successfully complete the works resulting in delays, cost overruns and possible legal action.	3	4	7	Procurement strategy to include preparation of suitable tender documents and works schedules including contractor resources, experience and referees. Tender interviews undertaken by persons with experience in similar projects and contractor resources.	2	3	5
Uncertainty regarding future ownership	Disagreement between agencies and/or landholders regarding future responsibility for the operation and maintenance of the works.	2	3	5	Attempt to obtain legal agreements that clearly define the roles and responsibilities of all parties before the project is approved. Operator input to design and construction process.	2	2	4
Natural disasters	Natural disasters (eg. Bushfire and floods) impact on construction activity leading to possible damage to persons (including fatality) and property leading to loss of goodwill, damage costs and project delays.	3	5	8	Implement relevant Safe Work Procedures..	3	2	5
Change in landholder or landholder capacity.	The landholder involved in original agreements is incapacitated or there is a change in land ownership resulting in project delivery delays.	4	4	8	Formalised agreements in place with affected parties.	4	2	6

Threat	Description	Pre-treatment risk assessment			Mitigation options	Residual risk assessment (post-treatment)		
		Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
Interruption to irrigation supply	Inconvenience and loss of production to landholders leading to loss of goodwill, additional costs, project delays and possible legal action.	4	3	7	Communication plan to include landholder consultation and briefings to identify and address any issues. Scheduling of works agreed with landholders prior to works.	1	1	2
Denial of access land	Landholder refuses access to contractors, causing delays.	3	3	6	Commence negotiations before the project is approved. Ongoing engagement dealing with issues raised by directly affected landholders.	2	3	5
Failure to get rights to inundate river channel, wetlands and anabranches on private land	Landholders refuses to provide legal access to inundate river channel, wetlands and anabranches on private land.	3	3	6	Commence negotiations before the project is approved. Land valuations conducted so that payment offered is considered fair. Ongoing engagement dealing with issues raised by directly affected landholders.	2	2	4
Change of staff	Loss of continuity resulting in poor communication, time delays, cost increases and loss of trust and corporate knowledge.	4	3	7	Identify backup staff for key roles (e.g. project manager, superintendent, works supervisor), ensure depth of project team and alternative employment models/succession plan.	3	2	5
OPERATIONAL PHASE								
ENVIRONMENTAL IMPACTS								

Threat	Description	Pre-treatment risk assessment			Mitigation options	Residual risk assessment (post-treatment)		
		Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
Flood duration too long or too short	Water regime does not support breeding and feeding requirements of fauna or vegetation establishment and growth	3	3	6	Determine water requirements to support potential breeding events Monitor flood duration to inform water delivery Monitor the ecological response of the waterway and ecology to flows. Adaptively manage water availability and priority ecological outcomes.	2	2	5
Limited water availability creates an inability to provide optimal water regime to the target area.	Failure to achieve hydrological and ecological objectives for the site	2	3	5	Monitor the ecological response of the River and wetlands to the water regime and add top-ups where appropriate or practical	2	3	5
Loss of structural diversity in wetlands	Changed flow patterns may create conditions suitable for mass river red gum recruitment and establishment in wetlands and flood-runners, or encroachment of emergent macrophyte stands e.g. cumbungi, resulting in loss of plant diversity and permanent changes to structural composition that negatively affect habitat for native fauna.	4	3	7	Update flow study. Update and implement the Environmental Water Management Plan taking (EWMP) into account the ecological objectives. Adaptively manage in response to monitoring and evaluation outcomes and update the EWMP as required. Implement river red gum thinning programs as required.	3	2	5

Threat	Description	Pre-treatment risk assessment			Mitigation options	Residual risk assessment (post-treatment)		
		Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
Increased rates of erosion and bank slumping	High river flows may result in erosion of river banks and/or slumping during periods of flow recession leading to a loss of streambank vegetation and habitat e.g. mature river red gum trees reducing the diversity and extent of native flora and fauna, as well as destabilising water extraction sites and possible loss of farmland.	4	3	7	Incorporate and refine allowable rates of rise and fall into the Operating Strategy. Obtain agreement with river operator G-MW.	3	2	5
Increased populations of exotic fish species	Inundation of flowing anabranches and wetlands may create favourable breeding conditions for exotic fish e.g. European carp leading to increased populations and dispersal during subsequent periods of connectivity impacting on aquatic vegetation and competition for resources with native fish populations.	3	3	6	Implement the Environmental Water Management Plan (EWMP) taking into account the ecological objectives. Adaptively manage in response to monitoring and evaluation outcomes and update the EWMP as required. Undertake event-based monitoring to better understand management options for minimising exotic fish species responses. Study life history of exotic fish species and develop management strategies. Where practical, manage the timing and duration of high flow events to minimise favourable breeding conditions for exotic fish.	3	3	6
Blackwater events	Inundation of flowing anabranches and wetlands may generate anoxic blackwater events, which may result in the death of native fish and other aquatic fauna and loss of community good-will.	3	3	6	Develop blackwater risk assessment and response plans. Adaptively manage in response to monitoring and evaluation outcomes and update the EWMP as required.	2	2	4
THIRD PARTY IMPACTS								

Threat	Description	Pre-treatment risk assessment			Mitigation options	Residual risk assessment (post-treatment)		
		Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
Changes to in-channel flow extent.	Uncertainties in modelled in-channel flow extents result in unexpected areas of inundation leading to compensation claims, legal action and loss of goodwill - finance and reputation - driven by potential spatial or financial inaccuracy.	3	4	7	Progressively increase in-channel flows as certainty of delivery and management of risks improves. Monitor ecological outcomes and impacts on third parties. Develop tools to support implementation and manage risks including river operational strategies, procedures and models.	2	4	6
Damage to infrastructure	Damage to public and private infrastructure could lead to increased vehicle accidents leading to compensation claims, legal action and loss of goodwill. Increased frequency of inundation (in the operational phase) may lead to increased maintenance costs for Parks Victoria or local government.	2	5	7	Ensure ongoing maintenance and repair funding and responsibilities have been agreed. The proposed package of works to include upgrade of roads and bridge structures to ensure that safety issues are considered. Install warning signs as/where appropriate. Communications during seasonal planning.	1	5	6
OPERATIONAL IMPACTS								
OH&S risks to operational staff	Operation of regulating structures poses a range of potential OH&S risks – stress on operational staff, driving to access sites, risk of injury when accessing and operating structures (incl. snakebite), working over water.	3	5	8	Mitigation options should follow the hierarchy of controls - design of works needs to focus on reducing risks through: - safe design, to reduce risk of injury -- incorporation of remote operational capabilities where warranted. - Support in place for staff with regards to stress and associated mental health issues. Safe working procedures and strong safety management would also mitigate risks.	1	5	6

Threat	Description	Pre-treatment risk assessment			Mitigation options	Residual risk assessment (post-treatment)		
		Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
Failure of flow control structures	Flow control structures may fail through a range of mechanisms including leakage around the structure, erosion downstream of the structure due to flow through the regulator or structural failure of the embankment or regulating doors.	3	4	7	Good practice design of structures and appropriate construction supervision as identified in construction phase risk mitigations. Effective asset management program to be established for O&M phase, with condition assessment and programmed maintenance as necessary.	1	4	5
Uncertainty in predicting and managing in-channel flows	**If tributary inflows are not able to be predicted with sufficient accuracy, actual e-flows achieved may be higher or lower than planned, resulting in unplanned river channel overtopping or failure to achieve intended environmental outcomes.**	**4**	**5**	**9**	**A phased implementation of the environmental watering process will be taken to manage and reduce uncertainty. This will involve initial trials and the following steps.** **-collect data** **-develop forecasting and operational tools** **- monitor events including working with landowners and their observations** **- develop operational rules and procedures in consideration of freeboard or operational buffer requirements on river channel.** **- adapt flows and releases targeting smaller events and refining models and operational practices base on observations to gradually increase in-channel flows**	**3**	**4**	**7**
Lack of funding for operation, maintenance and renewal costs	Ongoing operation and maintenance activities cannot be fully implemented leading to deterioration of the works and perceived underperformance of the project.	3	4	7	Obtain ongoing funding commitments to cover future O&M activities at project development.	2	2	4

Threat	Description	Pre-treatment risk assessment			Mitigation options	Residual risk assessment (post-treatment)		
		Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
Operational clashes with other downstream activities	Release of e-flows in the Goulburn River may reach the River Murray when high flows are occurring due to natural processes or e-flow releases, causing increased flooding and damage.	4	4	8	Integrated planning of basin wide e-water delivery actions, through SCBEWC and OAG processes. Co-ordination and liaison between GMW and MDBA RMO to ensure impacts of planned operations are assessed and managed.	1	2	3
Lack of monitoring funding	**Failure to adequately monitor the ecological outcomes of the project activities restricts the ability to demonstrate the full benefits of the works leading to perceived underperformance/failure of the project, loss of stakeholder support, failure to endorse watering plans and limited opportunities for adaptive management.**	**4**	**4**	**8**	**GBCMA to seek adequate sources of funding (e.g. through CEWH, VEWH, DELWP and potential research partnerships with other organisations such as universities, ARI, ECL).**	**3**	**4**	**7**
Lack of understanding regarding roles and responsibilities	Disagreement and confusion between agencies leading to a failure to fully implement monitoring, operation and maintenance activities and a consequent deterioration of the works.	3	4	7	Clearly define the roles and responsibilities of all parties and formalise the roles before the project is implemented.	2	2	4
Lack of certainty regarding liability	**Uncertainty amongst agencies regarding risk and indemnity issues, as well as different risk appetites, may lead to concerns over liability (financial) impacts and result in lack of endorsement for seasonal watering projects or planned water activities not being fully implemented.**	**4**	**4**	**8**	**Clearly define the roles and responsibilities of all parties and formalise the roles before the project is implemented.**	**3**	**4**	**7**

Threat	Description	Pre-treatment risk assessment			Mitigation options	Residual risk assessment (post-treatment)		
		Likelihood	Consequence	Rating		Likelihood	Consequence	Rating
Change to private land ownership	Change in responsibility for the satisfactory performance of the work leading to gradual deterioration of the works.	3	4	7	Obtain legal agreements that clearly define the roles and responsibilities of all parties before the project is approved. Agreements to be documented to ensure they are not affected by a change in land ownership. Agencies to include provisions to ensure any new pump station is constructed above the bank is a condition of licenses/permits.	2	2	4
Environmental water requirements underestimated	Works do not perform as expected (e.g. uncertainty regarding estimating losses) and the expected benefits are not achieved.	3	4	7	Sanity check and expert peer review of planned operating strategies. Phased implementation and ground-truthing of the operating plan. Reallocate additional water from environmental water holding.	2	2	4

Appendix H 2016 Communications and Engagement summary

Traditional Owner views

The Yorta Yorta Nation Aboriginal Corporation is generally supportive of any investment and activities which would aim to bring a more natural flow regime to the Goulburn River and floodplain on their country. They see such opportunities as supporting cultural values for traditional owners not only along the Goulburn River but along the River Murray downstream. Such measures would align with their Whole of Country Plan. If the business case were to be supported, Yorta Yorta would be interested in opportunities to increase their capacity around the management of river, floodplain and wetland systems and associated flows.

The Taungurung Clan Aboriginal Corporation see the increased frequency and extent of small overbank flows along the Goulburn River and floodplain as providing huge cultural benefits. They believe that there would be a strong overlap in environmental and cultural values of such an initiate and that it would align with the intent of their draft Country Plan. Taungurung see the additional rainfall and flow gauging proposed under the business case of value to them and necessary even if the project was not funded. Taungurung would also like to take any opportunities that would arise from the implementation of the business case that would enable further involvement of Taungurung people in river and floodplain management.

Community views

Landowners are worried about the proposal to deliver environmental flows at higher levels and the subsequent effects on them and their businesses. Key concerns include unpredictability of rainfall (imperfect forecasting), and the inadequacy of the existing river and rainfall gauging network. Some concerns were expressed about the accuracy of inundation mapping and the uncertain future of the lower Goulburn levee system. These concerns are recognised as project risks (section 8).

People were generally very unhappy that a decision regarding further implementation through the Basin Plan process will be made before property level assessments are carried out. People feel that everyone who could be directly affected should know this and be able to input before a decision is made. It is anticipated that a further decision point will be formally incorporated into Phase 3 following the completion of further investigations and consultation.

A flow of 20,000 ML/d between Eildon and Molesworth was confirmed as 'untenable' as a community view from those who attended mid Goulburn meetings during August 2015. A flow of 40,000 ML/d at Shepparton was also confirmed as being of significant concern in the lower Goulburn at this time, but more on the basis of risk rather than direct impact (i.e. if the target flow was 40,000 ML/day, actual flows could be higher for a range of reasons).

For a number of farmers between Eildon and Yea (>15 people), there is concern that farm viability is at stake as they currently rely on river flat productivity to support grazing on surrounding poorer quality hill country (or they may not have access to hill country to agist or move stock and totally rely on the river flats).

People that spoke up at the mid Goulburn sessions want Governments to know they do not want easements. Many want to keep farming their land as they currently do and view easements and the associated impact on property values as an erosion of their property rights. These views are recognised as project delivery risks.

For the lower Goulburn, work on delivery constraints raises the possibility of investment in the protective rural levee network downstream of Shepparton. This is appealing as many people rely on

the levees. However significant concern remains as capital investment doesn't address long-standing levee ownership and ongoing maintenance issues. This issue was captured though the risk assessment process (Appendix G).

Further, a key issue throughout the whole Goulburn River is flood risk. Not enough detail is currently available to answer questions regarding how environmental water could be used to top-up tributary flows and what the risk is of getting the event wrong (flows higher than anticipated or targeted) or making flooding during a follow-up event worse (i.e. need event case studies or proof of concept). The further investigations proposed through this business case seek to address this concern.

Key feedback gained through consultation with community advisory groups and landholder meetings that helped shape this business case included:

- *The timing of flows is important:* The impacts increase if flows occur during late spring, as it coincides with pasture growth periods and affects subsequent feed reserves (hay production) or capacity to re-sow pasture.
- *The duration of flows is important:* Loss of pasture would occur if inundation persists beyond the expected duration and can reduce feed reserves as stock cannot be returned to the floodplain until it dries out.
- *The magnitude of flows is important:* as discussed previously.
- *Notification of impending releases:* Early notification of managed releases is needed to assist with farm planning, as well as improved flood warning notification systems and rainfall measurements.

After the open house sessions in January 2016, the proposed target flows and risk management buffers, while still a significant concern to some sections of the community, particularly in Molesworth, were more widely accepted. This statement is supported by the results of the feedback sheets filled in by attendees.

The following outlines the key points raised at January open house sessions

Target flow rates

Although the community is relieved the 40,000 ML/day target flow rate in the lower Goulburn and the 20,000 ML/day flow target in the mid-Goulburn are no longer being considered in the business case, there was still significant concern about revised lower flow targets.

Molesworth landholders were concerned not only over the buffer level (and whether it is adequate), but also at the target flow rate of 10,000 ML/day at Alexandra. This is partially due to uncertainty as to what a 10,000 ML/day flow at Alexandra could turn into by the time it moves downstream to Molesworth, but also with concern regarding Alexandra.

The duration of flow events have not been defined tightly enough, especially as it is a major driver of the amount of damage that is done.

There was concern too that decision makers could increase target flow rates in the future and decrease the protection sought through the buffer levels.

Flow footprint mapping

The community is concerned the flow footprint mapping in the Molesworth and Alexandra regions is not accurate and therefore the number of properties and public land, and the size of area affected by the target flow rates and the buffer levels are considered underestimated.

Mitigation and offset costs

There is a lot of confusion about attempting to calculate an upfront cost large enough to pay for a recurrent flood event in perpetuity. Some landholders suggested an event based compensation process would be preferred.

The community questioned the costing assumptions used to determine land worth – both that an 'agricultural value' was being used, and the level of compensation, and that clean-up costs after a flow event were inaccurate or inappropriate.

There was considerable concern about compensation for the decreased production value of the land, pointing out it didn't take into account the potential decrease in market value for the whole property, nor the effect on other 'lifestyle' components of market value, i.e. aesthetic characteristics and access beyond agricultural purposes.

The community said there would need to be independent legal and farm advice provided for affected landholders, not just advice at a community reference group level as currently costed in the business case.

Is the future potential of the land taken into account, not just its current use?

How is the contribution of the affected land to the whole farm enterprise costed? The impacted land could be integral to the functioning and feasibility of a farm (primary source of water, stock feed, shelter).

That the following costs have not been detailed in the business case:

Impacts on Goulburn River landholders from flow interactions with the Murray River.

Impacts on tributary landholders (e.g. Broken River and Seven Creeks) from flow interactions with the Goulburn River (also see comment under "Other" heading below).

Councils who want some of their public infrastructure assets to be upgraded to maintain access rather than the current costing assumption of reinstatement.

If property values decrease it could decrease the rate income to councils.

Flow on effects to the economy and community (other businesses in the region) from reduced tourism because of increased flooding.

Contribution to Loch Garry operation and maintenance as constraints flows are relying on the structure to be in place and remain in good condition.

River bank erosion and avulsion control as a consequence of increased flooding.

Easements

How would easement acquisitions be negotiated?

Local community reference groups should provide input into the design and implementation of the easement acquisition process, if it occurred.

Vulnerable landholders (e.g. the elderly and people with mental health issues) should be considered in the design and implementation of the easement acquisition process.

There was concern easement acquisitions would not stay voluntary and would become compulsory.

Affected landholders should be provided with access to independent farm and legal advice at an individual property level.

Other

Exacerbated flood risk (risk of making a follow up flood worse) continues as a key community issue all along the Goulburn River. This relates to uncertainty around how tightly flows can be managed

during an event, whether the buffers are of sufficient size, whether the mapping is accurate at a local level, and for the lower Goulburn how much the filling up of the floodplain storage (wetlands) could affect the severity of a follow up flood.

People in the mid-Goulburn were unhappy that tributary impacts were only recognised as needing further work and were not included in any cost estimates in the business case; work this year showed limited impact on backing up and tributary time to drain which doesn't match with landholder views.

Participants in the sessions were unhappy that governments are making decisions without all the information being in place.

The assumption of predominantly public infrastructure reinstatement rather than upgrade is considered risky by some councilors. View was put that where properties and business could be isolated for seven days or more, infrastructure should be upgraded.

There was some thought that a real time river level monitoring phone app with advance notification capability would assist affected landholders and communities, however there was concern on any reliance of BoM to provide accurate weather predictions prior to flood events.

Council views

Consultation with councils has been undertaken during the development of the business case and is ongoing. Council concerns include thee potential economic, environmental, and social impacts arising from increased environmental flows.

Appendix I January 2016 Community Open House Sessions

Introduction

On behalf of the Victorian Government, the Goulburn Broken Catchment Management Authority with the support of the Murray-Darling Basin Authority developed the Goulburn River Constraints Management Business Case between May 2015 and February 2016. The business case assessed the feasibility of adding reservoir releases to natural flow events in the Goulburn River to increase the frequency of low level flooding along the lower Goulburn River floodplain to improve the health of riverine ecological values. The business case also assessed the public and private impacts of the increased flows and the cost to government to mitigate or offset these impacts.

Consistent with the communications and engagement plan developed for the Goulburn River Constraints Management Business Case, public meetings (open house sessions) were held in August 2015 to inform and seek feedback from the local community on the rationale and aims of the project.

In January 2016, a second series of 18 open house sessions were held to discuss and seek feedback from the local community on the target flow rates identified in the final business case and the costs to mitigate or offset potential impacts. Overall, 246 people attended the sessions (approximately 25% more people than the August 2015 sessions) with some people attending more than one session. The location, date and time of each sessions is outlined in the table below along with the total number of attendees.

Location	Date	No. of sessions	Time of sessions	Total no. of attendees
Murchison	Friday 15th January 2016	1	2.00 pm 3.00 pm	12 2
Yea	Saturday 16th January 2016	2	11.00 am 2.00 pm	25 7
Molesworth	Monday 18th January 2016	3	12.00 pm 3.00 pm 6.00 pm	21 10 8
Alexandra	Tuesday 19th January 2016	3	12.00 pm 3.00 pm 6.00 pm	22 8 3
Shepparton	Wednesday 20th January 2016	2	12.00 pm 3.00 pm	11 13
Undera	Wednesday 20th January 2016	1	7.00 pm	19
Bunbartha	Thursday 21 January 2016	2	12.00 pm 3.00 pm	19 9
Kotupna	Thursday 21 January 2016	1	7.00 pm	29
Seymour	Friday 22nd January 2016	2	12.00 pm 3.00 pm	23 5

People were advised of the open house sessions via: a direct mail out to landowners along the Goulburn River and along various tributaries (over 1200 letters sent); an email was sent to people who were involved in the project or attended the August 2015 open house sessions; advertisements placed in local newspapers; and word of mouth.

This document summarises the key points raised at open house sessions and the results of the feedback forms.

Key points raised at open house sessions

The following is a summary of the key points raised at the sessions grouped by theme. The points are not direct community quotes but summaries made by agency staff who attended or ran the sessions.

Target flow rates

- The community is relieved the 40,000 ML/day target flow rate in the lower Goulburn and the 20,000 ML/day flow target in the mid-Goulburn are no longer being considered in the business case. However, significant concern about the risk of delivering the revised lower flow targets still remains (how securely events can be managed within the proposed buffer levels).
- Impacts are still felt to be significant and disruptive for Molesworth landholders, mainly at the buffer level (and whether it is adequate), but also at the target flow rate of 10,000 ML/day at Alexandra. This is partially due to uncertainty as to what a 10,000 ML/day flow at Alexandra could turn into by the time it moves downstream to Molesworth.
- The duration of flow events have not been defined tightly enough, especially as it is a major driver of the amount of damage that is done.
- There needs to be safeguards (checks and measures) to ensure decision makers do not increase target flow rates in the future and decrease the protection provided by the buffer levels.

Flow footprint mapping

- The community is concerned the flow footprint mapping in the Molesworth region is not accurate and therefore the number of properties and the size of area affected by the target flow rates and the buffer levels are considered underestimated.

Mitigation and offset costs

- There is a lot of confusion about how you can calculate an upfront cost large enough to pay for a recurrent flood event in perpetuity. Many landholders suggested an event based compensation process would be preferred.
- There was concern the costing assumptions used to determine agricultural land worth and clean-up costs after a flow event were inaccurate or inappropriate.
- The community expressed the need for independent legal and farm advice for affected landholders not just advice at a community reference group level as currently costed in the business case.
- Does the compensation for the decreased production value of the land actually compensate for the decrease in market value (i.e. whether or not more flooding does affect other 'lifestyle' components of market value, not just production value)?
- How is the future potential of the land taken into account, not just its current use?
- How is the contribution of the affected land to the whole farm enterprise costed? The impacted land could be integral to the functioning and feasibility of a farm (primary source of water, stock feed, shelter).
- The following costs have not been detailed in the business case:
  - Impacts on Goulburn River landholders from flow interactions with the Murray River.
  - Impacts on tributary landholders (e.g. Broken Creek and Seven Creeks) from flow interactions with the Goulburn River (also see comment under Other heading below).

- Councils who want some of their public infrastructure assets to be upgraded to maintain access rather than the current costing assumption of reinstatement.
- If property values decrease it could decrease the rate income to councils.
- Flow on effects to the economy and community (other businesses in the region) from reduced tourism because of increased flooding.
- Contribution to Loch Garry operation and maintenance as constraints flows are relying on the structure to be in place and remain in good condition.
- River bank erosion and avulsion control as a consequence of increased flooding.

Easements

- How would easement acquisitions be negotiated?
- Local community reference groups should provide input into the design and implementation of the easement acquisition process.
- Vulnerable landholders (e.g. the elderly and people with mental health issues) should be considered in the design and implementation of the easement acquisition process.
- There was concern easement acquisitions would not stay voluntary and would become compulsory.
- Affected landholders should be provided with access to independent farm and legal advice at an individual property level.

Other

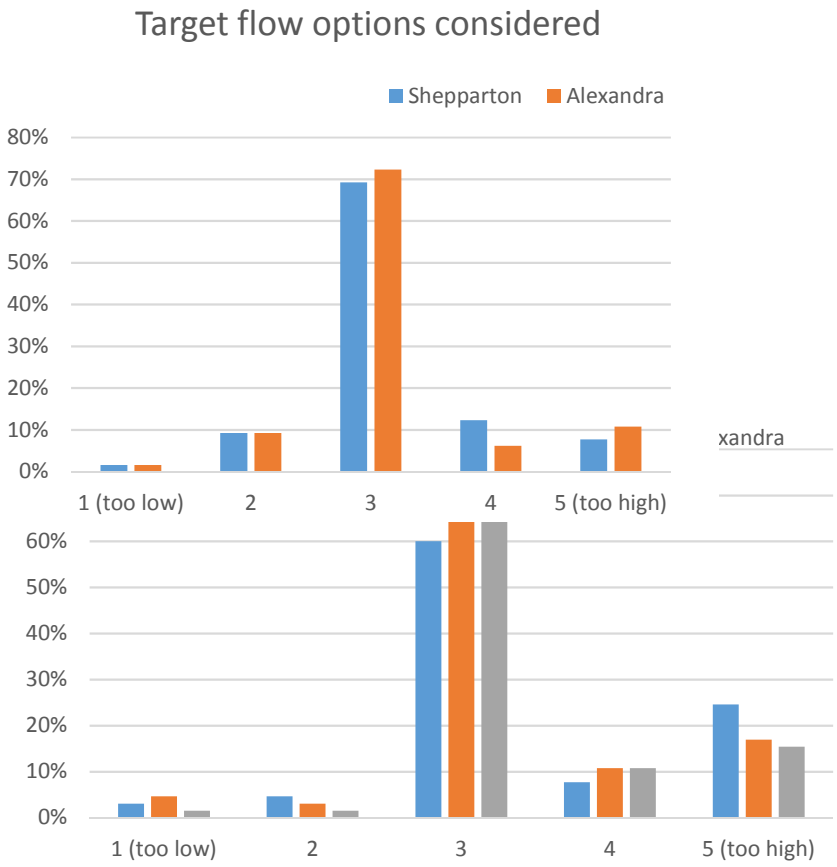
- Exacerbated flood risk (risk of making a follow up flood worse) continues as a key community issue all along the Goulburn River. This relates to uncertainty around how tightly flows can be managed during an event, whether the buffers are of sufficient size, and for the lower Goulburn how much the filling up of the floodplain storage (wetlands) could affect the severity of a follow up flood.
- People in the mid-Goulburn were unhappy that tributary impacts were only recognised as needing further work and were not included in any cost estimates in the business case (as work this year showed limited impact on backing up and tributary time to drain which doesn't match with landholder views).
- Unhappy that governments are making decisions without all the information being in place.
- The assumption of predominantly public infrastructure reinstatement rather than upgrade is considered risky by some councillors. View was put that where properties and business could be isolated for seven days or more, infrastructure should be upgraded.
- The development of a real time river level monitoring phone app with advance notification capability would assist affected landholders and communities.

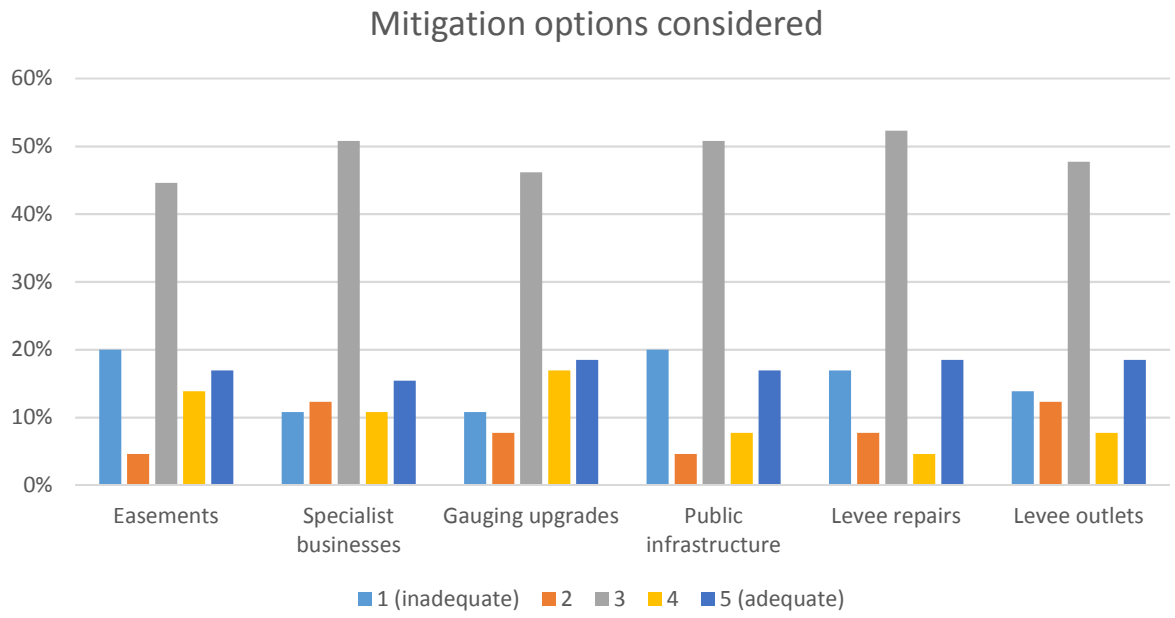
Feedback sheets

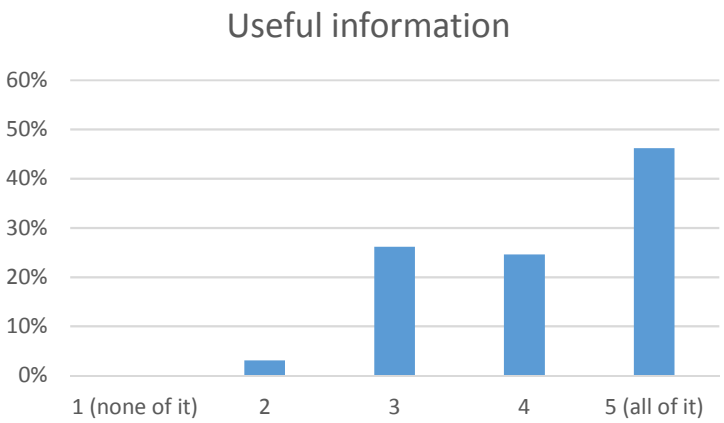
Feedback sheets were made available to session attendees. A total of 57 completed feedback sheets have been received by the GBCMA to date. The feedback sheets asked the following seven questions:

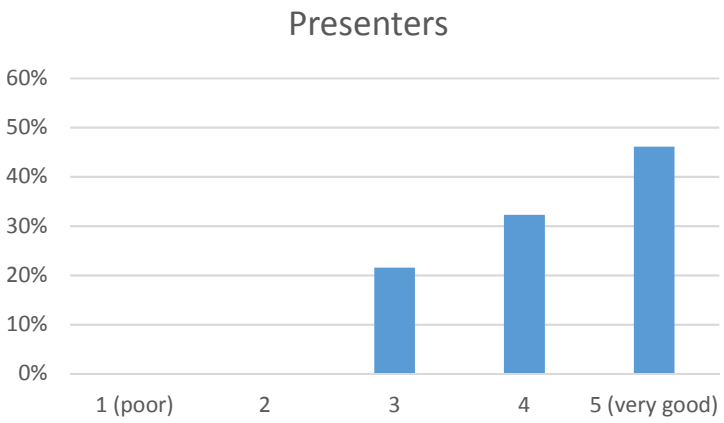
- How did you hear about the event?
- What do you think about the target flow options being considered?
- What do you think about the buffer flow options being considered?
- What do you think about the package of mitigation options being considered?
- Please rate the information provided?
- How satisfied were you with opportunities to ask questions and the answers to your questions?
- Do you have any other comments or feedback?

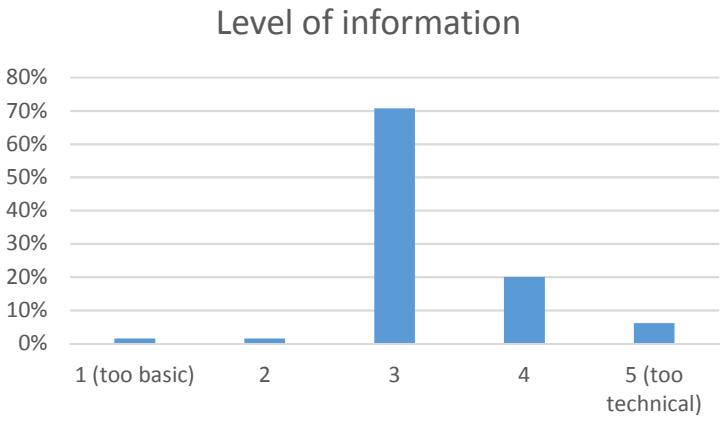
The questions were a combination of multiple choice and free text. A summary of the multiple choice answers received are provided in the graphs below.

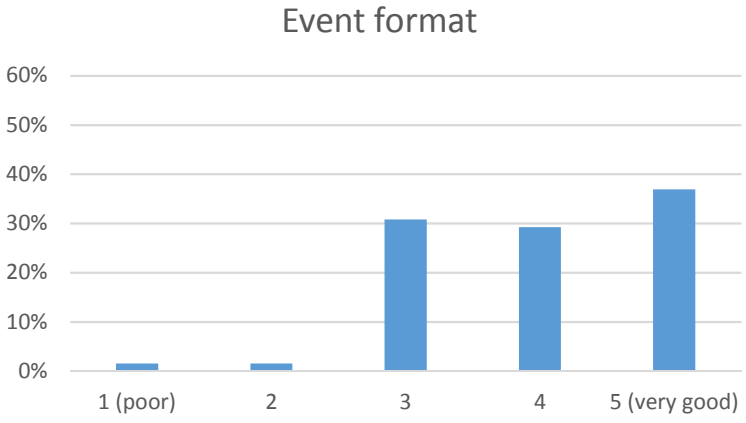

Target flow options considered
Shepparton
Alexandra
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 (too low)
2
3
4
5 (too high)
xandra
60%
50%
40%
30%
20%
10%
0%
1 (too low)
2
3
4
5 (too high)


Mitigation options considered
60%
50%
40%
30%
20%
10%
0%
Easements
Specialist businesses
Gauging upgrades
Public infrastructure
Levee repairs
Levee outlets
1 (inadequate)
2
3
4
5 (adequate)


Useful information
60%
50%
40%
30%
20%
10%
0%
1 (none of it)
2
3
4
5 (all of it)


Presenters
60%
50%
40%
30%
20%
10%
0%
1 (poor)
2
3
4
5 (very good)


Level of information
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 (too basic)
2
3
4
5 (too technical)


Event format
60%
50%
40%
30%
20%
10%
0%
1 (poor)
2
3
4
5 (very good)