Amendment date: 22 Sept 2017

	Title of measure	**Operating rule change to Hume Dam airspace management and pre-releases**
	Proponent undertaking the measure	**Victoria/NSW**
	Type of measure	**Supply**
1.	**Confirmation**	
	Date by which the measure entered into or will enter into operation *Must be before 30 June 2024*	The rule changes will be operational by 30 June 2024.
	Confirmation that the measure is not an 'anticipated measure' *'Anticipated measure' is defined in section 7.02 of the Basin Plan to mean 'a measure that is part of the benchmark conditions of development'.*	Yes. It is a new project (not already included in the benchmark conditions).
	Confirmation that the proponent state(s) undertaking the measure agree(s) with the notification *Joint proposals will need the agreement of all proponents*	Yes (Victoria and NSW agree).
2.	**Details of the measure**	
	Capacity of the measure to operate as a supply measure *'Supply measure' is defined in section 7.03 of the Basin Plan to mean 'a measure that operates to increase the quantity of water available to be taken in a set of surface water SDL resource units compared with the quantity available under the benchmark conditions of development'.*	Yes. An operational rule change to include estimates of environmental watering requirements in the forward assessment of projected demands used for the management of the airspace at Lake Hume.
3.	**Description of the works or measure**	
	Rule change to allow future environmental water releases in airspace management. When environmental water releases are anticipated, the revised rules reduce both airspace and pre-release target volumes.	
4.	**Geographical location of the measure**	
	Hume Dam is located approximately 27 kilometres east of Albury, NSW.	
5.	**Details for representing the measure in the MDBA's assessment framework**	
	Under the Benchmark, MSM-Bigmod calculates required airspace at Hume Dam by estimating future inflows and releases to meet supply commitments, mainly irrigation demands. To represent the proposal, forecast releases also include environmental water demands. This update allows the current modelling framework to calculate additional benefits to all users including the environment. ***Current policies or operational rules relevant to proposal*** Currently the monthly airspace target determination involves the likely inflow to the storage and the potential irrigation demands that may be required to be released for the storage. Operators determine how much airspace can be allowed for flood mitigation with a low risk of storage not filling. Thus the target storage volume for each forecast period is calculated by the formula *Target storage volume = full supply volume – (forecast minimum inflow – forecast maximum irrigation releases)* Full operating rules are detailed in Section 2.1 of the business case (**Attachment A**).	

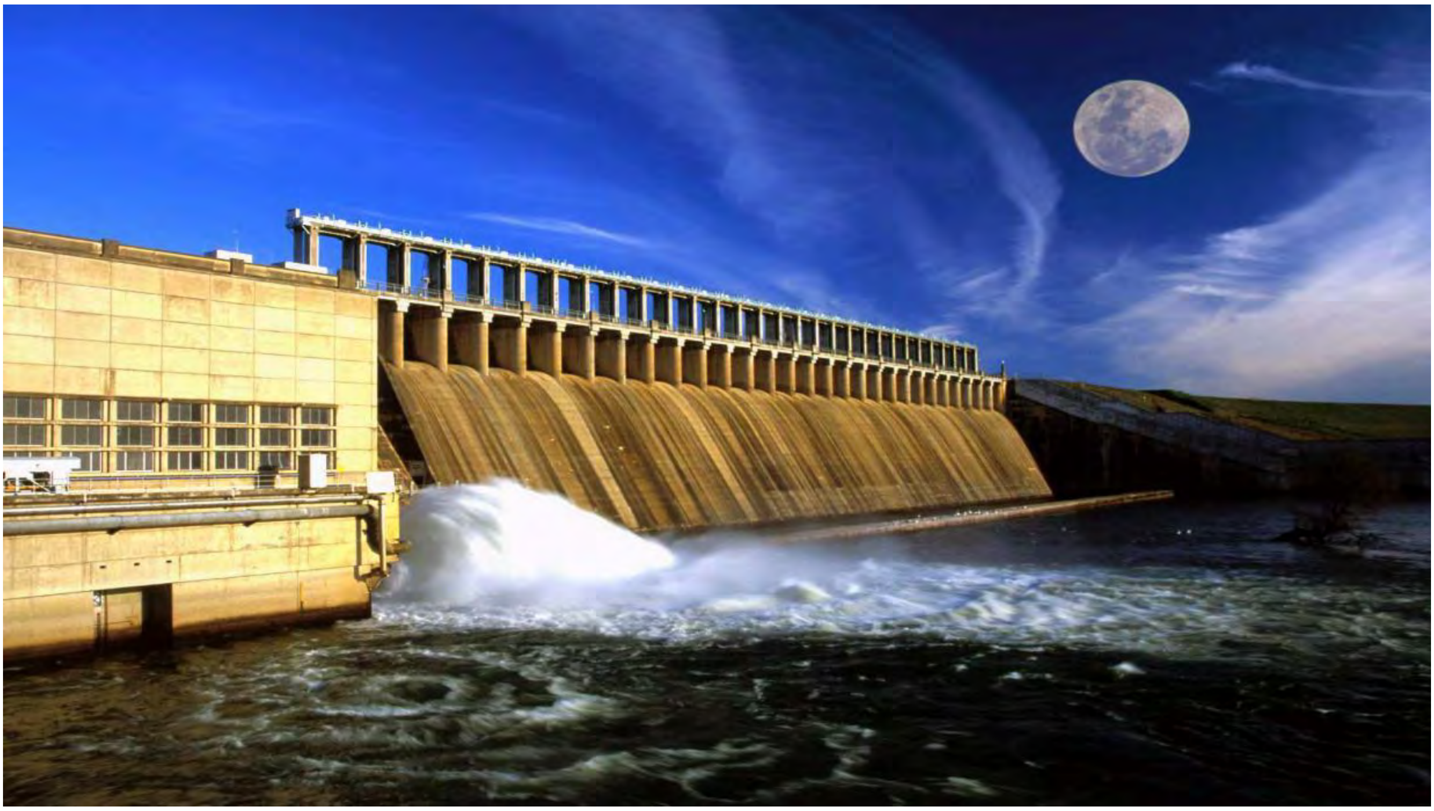
	Proposed policies or operational rules for proposal The proposed change in operating rules is to consider the forecast environmental demands to plan target storage volume and pre-release. The amended formula *Target storage volume = full supply storage volume – (forecast minimum inflow – forecast maximum irrigation releases – forecast average environmental release)* The proposed change is consistent with the O&O document and reflect the inclusion of forecast environmental demand in addition to irrigation demand. The proposed changes in full are detailed in Section 2.3 of the business case (**Attachment A**).
6.	**Details for the representation of each operating strategy, policy or rule change proposed.**
	The operating strategies to be adopted in the modelled assessment are as per the Hume Dam airspace business case (**Attachment A**) submitted on 1 April 2015, and are as follows: Existing rule: *Target storage volume = full supply storage volume – (forecast inflow – forecast irrigation releases)* Proposed rule: *Target storage volume = full supply storage volume – (forecast inflow – forecast irrigation releases – forecast environmental releases)* For implementing the proposed changes, environmental water requirements are estimated. **Attachment B** describes its estimation in more detailed. In summary, it uses a relationship between cumulative unregulated inflow to upper Murray and environmental water requirements to forecast average environmental release. The relationship may need to be revisited in consultation with the project proponents to reflect environmental watering behaviours assumed for the final package assessment.
7.	**Spatial data describing the inundation extent associated with the operation of the measure**
	Not applicable.
8.	**Surface water SDL resource units affected by the measure**
	This measure identifies all surface water resource units in the Southern Basin region as affected units for the purposes of notifying supplying measures. The identification of affected units does not constitute an agreement between jurisdictions on apportioning the supply contribution, which will be required in coming months.
9.	**Details of relevant constraint measures**
	One of the key constraints in the system is the maximum channel capacity downstream of both Hume Dam and Yarrawonga. The MDBA's Constraints Management Strategy (CMS) includes proposals to increase this capacity to 40,000 ML/day. The business case (**Attachment A**) broadly reviewed how this change would affect the proposal to change the pre-release operating rules for Hume Dam. The assessment indicated that any increase to the current capacity constraints below Hume Dam would help promote the outcomes of this proposal as it would reduce the time required to achieve planned pre-release volumes and enable target storage levels to be achieved more regularly without the limitations sometimes experienced under current channel capacity limits. This SDL offset proposal can be supported with confidence that its benefits will not be diminished by other changes driven by the CMS.

Attachments:

A	DELWP, 2015	Business case for operating rule change to Hume Dam airspace management and pre-releases
B	MDBA, 2014	Changes for the current Hume Air Space Management due to future demand condition, MDBA technical report No 2014/23.

Business case for operating rule change to Hume Dam airspace management and pre-releases

A Sustainable Diversion Limit Adjustment Measure



A joint proposal prepared by the Department of Environment, Land, Water and Planning (Victoria) and the Office of Water (NSW)

Department of Environment, Land, Water & Planning

State Government Victoria

Acknowledgements

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Contents

Glossary

AHD	Australian Height Datum
BOC	Basin Officials Committee
CEWH	Commonwealth Environmental Water Holder
CMA	Catchment Management Authority
CMS	Constraints Management Strategy
DELWP	Department of Environment, Land, Water and Planning (Victoria)
EC	Electrical Conductivity (measured in microsiemens/cm)
GL	Gigalitre (1,000,000,000 litres)
GST	Goods and Services Tax
MDBA	Murray-Darling Basin Authority
ML	Megalitre (1,000,000 litres)
MSM-Bigmod	Monthly Simulation Model-Bigmod model
NSW	New South Wales
O&O	Objectives and Outcomes for River Operations in the River Murray System
SDL	Sustainable Diversion Limit
SDLAAC	Sustainable Diversion Limit Adjustment Assessment Committee
SFI	Specific Flow Indicator
SO&O	Specific Outcomes and Objectives
TLM	The Living Murray
VEWH	Victorian Environmental Water Holder

Executive summary

Operating rule change for a Sustainable Diversion Limit adjustment

This business case sets out proposals for an operational rule change to include estimates of environmental watering requirements in the forward assessment of projected demands used for the management of the airspace at Lake Hume. The outcome will be to deliver equivalent environmental outcomes as proposed in the Murray-Darling Basin Plan (Basin Plan) but with less water, so generating a possible Sustainable Diversion Limit (SDL) offset.

The proposal is an '*Operating Rule Change*' under the terms of the Phase 2 Guidelines published by the Sustainable Diversion Limit Adjustment Assessment Committee (SDLAAC)[1].

Lake Hume

Lake Hume is the major operating storage on the River Murray system. The storage regulates the River Murray, and re-regulates water discharged from the Snowy Mountains Hydro-electric Scheme. It also receives water previously held in Dartmouth Dam on the Mitta Mitta River. Releases from Lake Hume supply irrigation, domestic and stock, urban and environmental watering demands to Victoria and New South Wales, and provide about one-third of South Australia's entitlement. Lake Hume also affects the delivery of water to a large number of important environmental assets, including all six of the Icon Sites identified under The Living Murray (TLM) initiative.

The primary purpose of the Murray-Darling Basin Authority (MDBA) reservoirs is to harvest and store water to meet users' needs, however in recognition of the significant flood mitigation benefits that they can also offer, the *Objectives and Outcomes for River Operations in the River Murray System* call for floods to be managed to achieve the following outcomes:

- firstly, protection of the security of River Murray operational assets; then
- secondly, maximising the water available at the end of the relevant flooding episode; and then
- thirdly, subject to achieving the first two outcomes, limiting flood damage to downstream communities and increasing benefits to the environment and public amenity by using unregulated water, for example, by prolonging wetland inundation or by supporting recreational activities.

Flood mitigation benefits to downstream communities are enhanced through a controlled filling process that ensures there is a high probability of just filling the storage before releases are required to meet downstream demands. This controlled filling process enables some airspace in the storage to be maintained to help mitigate flood flows that may occur during the filling process.

The current process for setting targets for the storage volume, which in turn determine how much pre-release is required, relies on using forecasts of future irrigation demands and is represented by the following formula:

Target storage volume = full supply storage volume – (forecast inflow – forecast irrigation releases)

This process does not effectively incorporate forecasts for the growing volumes of environmental releases that will occur in future into the forward planning for pre-releases at Lake Hume.

[1] SDLAAC 2014. *Phase 2 Assessment Guidelines for Supply and Constraint Measure Business Cases*

The proposal

The proposed change to the operating rules is for consideration of forecast environmental demands to be included in the planning of target storage volumes and pre-releases. This can be represented by the following amended formula that it is proposed will be used to determine target storage volumes:

Target storage volume = full supply storage volume – (forecast inflow – forecast irrigation releases – forecast environmental releases)

The proposed rule change is still consistent with the high level outcomes set out in the *Objectives and Outcomes for River Operations* document. It updates the detailed operational procedures and rules to appropriately reflect the shifts in the source of demand for releases from Lake Hume that have and will continue to occur as more water is recovered for environmental use.

Including forecast environmental water release needs into the storage target setting for Lake Hume results in significant reductions in pre-release volumes required to manage flood risks, without significantly increasing the annual spill volumes from the storage. This results in more water being available in Lake Hume for allocation against entitlements to meet irrigation and environmental demands.

Costs

The costs to implement the proposed rule change are relatively modest, particularly in comparison to other proposals that require the construction of physical infrastructure to deliver environmental water to environmental assets.

The key costs to implement this proposal are associated with further development and refinement of the procedures for forecasting environmental demands, documentation of these techniques in relevant operational manuals and consultation with stakeholder groups who have an interest in the outcomes of any changes in the operational management of Lake Hume.

It is suggested that this engagement is delivered as part of a wider regional exercise to consult on a suite of possible SDL adjustment initiatives. That would also help spread shared costs over the wider exercise.

Stakeholder engagement

A major workshop of relevant cross-jurisdictional agencies was held to identify the key issues of concern to regional stakeholders. The workshop identified potential risks of this proposal and interested stakeholder groups.

Direct engagement with those stakeholder groups was not undertaken as part of this stage of the project. It is considered advisable to gain SDLAAC support for the initiative before raising possible concerns with those stakeholders. A targeted and well planned engagement process that includes broader engagement on the topic of SDL adjustment in the Basin is also recommended, rather than consultation on this specific proposal in isolation. This approach is recommended as the likely concerns of other groups relate to not just this one proposal, but the broader SDL adjustment process and the interaction with other proposed measures. The business case provides recommendations for the coverage of the engagement program that will need to be completed as a second stage of the proposal.

Impact assessment

A structured risk assessment was undertaken in line with the requirements of the Phase 2 Guidelines. This was based on the advice of an expert working group from across agencies, followed by a rigorous assessment process. This process identified a suite of potential risks covering a range of issues.

This business case reports on the assessment and modelling undertaken to analyse the likely extent of those potential impacts. This confirmed that the proposed changes should generate outcomes that are at least neutral and in many cases broadly positive. The priority risks, concerns and outcomes are identified in the table below.

Issue	Concern	Comment
Environment	That the changes will adversely impact on environmental outcomes achievable	Modelling confirms that the changes enhance environmental outcomes
Irrigators	Changes to airspace management will impact on the security of the entitlement rights of holders in the storage including spillable accounts	Modelling confirms that rights are protected or enhanced as unnecessary pre-releases are reduced to account for environmental releases that will occur
Inundation risk	That the changes to airspace management will reduce the flood mitigation benefits to downstream communities	Modelling indicates that the proposal has minimal impact on overbank flows between Hume and Yarrawonga compared to the benchmark conditions
Third parties downstream	That South Australia's needs will be impacted	Modelling confirms that SA's rights to flows volumes and quality are protected
Project delivery	That community opposition will impede change	A comprehensive stakeholder engagement exercise is recommended to build understanding and support

The business case advises that with adequate stakeholder engagement, all outcomes are either positive or residual risks are negligible or can be adequately mitigated.

Modelling demonstrates that significantly improved environmental outcomes can be achieved compared to the benchmark modelling, utilising the same 2,750 GL of environmental water recovery. This creates the potential for this rule change to make a positive contribution to a package of measures that could be assessed for SDL adjustment opportunities.

Any potential inter-dependencies between this supply measure and other measures cannot be formally ascertained at this time, until a final package of proposed supply measures is identified and modelled by the MDBA.

This business case broadly reviewed how the *Constraints Management Strategy*'s proposal to increase the maximum channel capacity downstream of Hume Dam from its current limit of 26,000 ML/day to close to 40,000 ML/day would affect the proposal to change the pre-release operating rules for Hume Dam. The assessment indicated the outcome of the Constraints Management Strategy should help promote the outcomes of this proposal. Relaxing this constraint has no other influence on the proposed changes to the procedures for determination of target storage volumes. Therefore this SDL offset proposal can be supported with confidence that its benefits will not be diminished by other changes driven by the Constraints Management Strategy.

Governance & delivery

This business case has been developed as a joint proposal from Victoria and NSW. The detailed business case documentation has been prepared under the oversight of the Victorian Department of Environment, Land, Water and Planning (DELWP).

The operational rule change will require actions to be undertaken by the MDBA in consultation with the inter-jurisdictional Water Liaison Working Group. It is appropriate that the MDBA should assume project management responsibilities for implementing the change once it has been approved as a SDL adjustment measure.

The Basin Officials Committee will exercise overarching oversight of the formal governance responsibilities in relation to approval of specific rule changes affecting river operations. This well-developed governance process, which is codified through the Murray-Darling Basin Agreement and the Objectives and Outcomes for River Operations in the River Murray System document, is an efficient, effective approach to overseeing the implementation of the proposed rule change.

The MDBA's performance in river operations activities is already subject to an annual independent review. This annual review can incorporate a review of the application of the proposed rule change to ensure it is being implemented in line with the approved rule changes.

In addition, the final monitoring and evaluation plan for this supply measure will be informed by and incorporated within broader intergovernmental arrangements for Basin-wide monitoring and evaluation under the Basin Plan.

1. Introduction

1.1. Sustainable Diversion Limit adjustments through operating rule changes

The Murray-Darling Basin Plan (Basin Plan) was prepared by the Murray-Darling Basin Authority (MDBA) and signed into law by the Commonwealth Minister for Water on 22 November 2012, under the Commonwealth *Water Act 2007*. The *Intergovernmental Agreement on Implementing Water Reform in the Murray Darling Basin* subsequently outlined the commitments and responsibilities of the participating jurisdictions and the program for putting the Basin Plan into action.

The Basin Plan sets legal limits on the amount of surface water that can be extracted from the Basin for consumptive use from 1 July 2019 onwards. The sustainable diversion limits (SDLs) for surface water are currently set at a reduction of 2,750 GL on current extraction levels. That SDL value has been modelled to create a certain level of environmental outcome. Under the provision in Chapter 7 of the Basin Plan and in the Intergovernmental Agreement on Implementing Water Reform in the Murray Darling Basin, it was agreed that the Basin Plan should be able to achieve these environmental outcomes by improved use and management of the water, as well as by reducing current extraction levels. That would allow the SDL reduction to be adjusted, reducing impacts on regional communities.

The Basin Plan allows for up to 650 GL of the 2,750 GL SDL reduction to be accounted for through this improved use and management of environmental water. The jurisdictions in the Basin states and the MDBA have established an inter-jurisdictional committee, the SDL Adjustment Assessment Committee (SDLAAC), to manage this process and to evaluate proposed investments.

The Basin states have developed a program to promote initiatives under these processes. SDLAAC has drawn up guidelines to help steer the drafting of business cases for such proposals.[2]

Five different forms of intervention have been identified in the guidelines:

- **Environmental works and measures at point locations**: Infrastructure-based measures to achieve the Basin Plan's environmental outcomes at specific sites along the river using less environmental water than would otherwise be required.
- **Water efficiency projects**: Infrastructure-based measures that achieve water savings by reducing water losses through, for example, modified wetland or storage management.
- **Operating rules changes:** Changes to policies and operating rules that lead to more efficient use of water and savings and contribute to achieving equal environmental outcomes with less water.
- **Physical constraint measures:** Ease or remove physical constraints on the capacity to deliver environmental water.
- **Operational and management constraint measures:** Changes to river management practices.

This business case covers one such initiative, a proposed operational rule change regarding the management of the airspace at Hume Dam. This is an 'Operating rule change' that achieves equivalent environmental outcomes with less water providing an opportunity to deliver a Sustainable Diversion Limit adjustment. This business case has been prepared in accordance with the Phase 2 Guidelines (refer Appendix 1).

[2] SDLAAC 2014. *Phase 2 Assessment Guidelines for Supply and Constraint Measure Business Cases*

1.2. Terms of reference

This business case has been developed as a joint proposal from Victoria and NSW. The detailed business case documentation has been prepared under the oversight of the Victorian Department of Environment, Land, Water and Planning (DELWP). DELWP[3] specified the terms of reference for this initiative as:

> *The Hume Dam Airspace Management and Pre-releases offset proposal, is a SDL adjustment supply measure that would aim to optimise pre-releases from Hume Dam such that environmental outcomes are simultaneously met or enhanced.*

This is an '*Operating Rule Change*' under the terms of the SDLAAC Guidelines as it involves a proposal to change the operational rules, planning and practice for the management of the airspace at Hume Dam rather than the construction of works and measures. The outcome of this change will be to deliver equivalent environmental outcomes as proposed in the Basin Plan but with less water, so generating a SDL offset.

1.3. Background to the proposal

1.3.1. Hume Dam

Lake Hume (Figure 1) is the major operating storage on the River Murray system. The storage regulates the River Murray, and re-regulates water discharged from the Snowy Mountains Hydro-electric Scheme. It also receives water previously held in Dartmouth Dam on the Mitta Mitta River. The construction of the Hume Dam commenced in 1919 and was completed in 1936. The storage was further enlarged to its current capacity in the late 1950s. It has a total capacity of ~ 3,000 GL.

Figure 1. Hume Dam and storage

[3] Note that at the time of commencing development of his business case, DELWP was known as the Department of Environment and Primary Industries.

The operational assets of the River Murray system are controlled by the joint venture formed between the Commonwealth, New South Wales, South Australian and Victorian governments. The operation of Hume Dam is undertaken by the MDBA, with Water NSW (formerly State Water) responsible for its day-to-day operation and maintenance, on behalf of the MDBA and the joint venture.

Releases from Lake Hume supply irrigation, domestic and stock, urban and environmental watering demands to Victoria and New South Wales, and provide about one-third of South Australia's entitlement. Lake Hume follows an annual cycle of filling and drawdown. The storage usually receives inflows during winter/spring and fills by the end of spring each year. Irrigation releases generally occur between December and May, with Hume Dam regularly drawn down to less than half of capacity by the end of autumn.

1.3.2. Environmental assets

The changes in river flows that result from the operation of Hume Dam have affected important environmental features downstream of the storage along the River Murray system. One of the objectives of the Basin Plan is to protect and restore these important ecosystems. Figure 2 below shows the locations along the River Murray that are accepted as Icon Sites under the Living Murray program. Further information on these environmental assets is provided in Section 3.3.1.

Figure 2. River Murray channel controlled by Hume Dam

1.4. Defining the proposal

1.4.1. History and context

The operation of Hume Dam and the other regulating structures and storages in the River Murray system is undertaken in accordance with a range of policies, operating rules and procedures that have been developed and agreed to by the four governments over a number of years. The main documents that set out the provisions for river operations in the Murray system are:

- The *Murray- Darling Basin Agreement*
- *Objectives and Outcomes for river operations in the River Murray System*
- *Operational Procedures* and reference manuals.

These operating rules specify a hierarchy of outcomes which the management of the storage must achieve, in order to support the primary purpose of the assets, which is to deliver services to water users downstream:

- Ensure continuing structural integrity
- Optimise conservation and capture of water resources
- Limit the risks of inundation of downstream communities, increase environmental benefits and enhance public amenity.

The delivery of these multiple outcomes requires trade-offs, in particular between the aim of maximising water capture and the requirement to limit the risks of inundation.

As a result, the storage operator releases water during the storage's filling phase to control the rate of rise of the storage level and thereby retain some airspace to help mitigate flood inflows that may occur during the filling process. The objective is to reduce the risk of uncontrolled spills in late winter and spring which could create risk of inundation below the dam.

1.4.2. Drivers of change

This business case proposes changes to the operating rules for the management of the airspace in the dam to alter the timing and extent of these pre-releases. This change is driven by the fact that the environmental water holders now hold significant entitlements in the storage and their demand changes the traditional release patterns. Historic operating practice assumed that the large majority of releases occurred to supply irrigation demand during the period from December to April. The environmental water holders now seek releases to achieve environmental watering outcomes over a wider time period, with a significant component of this demand occurring in later winter or early spring.

As a result, the releases for the environment reduce some of the need for pre-releases, as they generate additional airspace in the storage in the spring in advance of potential inflows. That helps to achieve the desired outcome of limiting the risk of inundation.

The proposal in this business case is that the operating rules for the management of the airspace should be amended to reflect this changed demand pattern. In particular, that the requirements of the environmental water holders should be formally included in the assessment of demand patterns when calculating the need for pre-releases. This approach implements the adaptive management that has already been adopted by the storage managers over the last five years as the environmental water holders have developed greater certainty in their future demand schedules.

The proposed operating rule change will include environmental watering in the forward assessment of projected demands. This will reduce the volume of pre-releases required, particularly in the period from February to June. Overall this reduction in pre-release volumes, without increasing spill volumes, results in more water being available in Lake Hume for allocation against entitlements to meet irrigation and environmental demands.

1.4.3. The proposal in context

It was important that the terms of reference for the proposal were well specified in order to provide clarity for the analysis and modelling of costs and benefits in the business case.

DELWP and the MDBA considered a wide range of alternative options for the future management of the airspace at Hume Dam and their implications for release patterns and environmental outcomes. This included testing a range of different scenarios that considered the application of different inflow forecasting techniques, limitations on the periods when pre-release operations might be undertaken and the potential to improve pre-release management by consideration of flows in other key downstream locations.

The option ultimately preferred and documented in this business case relies on an inherently robust approach based on incorporating forecasts of future environmental demands into pre-release planning and management.

The proposed rule change has been tested using the initial estimates of environmental demand and associated release patterns to forecast the required future environmental releases[4]. As more experience and knowledge are gained on optimal environmental water requirements, estimates of environmental demands can be revised and improved leading to improved forecasts of environmental releases and improved air space and pre-release planning.

1.4.4. Interaction with other initiatives

The business case also reviewed how far this proposal would interact with other, parallel SDL offset proposals. The assessment covered two classes of initiatives:

- **Other operating rule changes and works and measures initiatives:** Any potential inter-dependencies for this supply measure, in terms of other 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 measure, 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 all likely linkages and inter-dependencies for this measure, including with any constraints measures, will become better understood as the full adjustment package is modelled by the MDBA and a final package is agreed to by Basin governments.

- **Constraints strategy:** The MDBA released a Constraints Management Strategy (CMS) at the end of 2013, with a target of agreeing proposals to address constraints by 2016. In recognition of this, the business case looked at how far any likely outcome of the constraints strategy would interact with this proposal.

  One of the key constraints in the system is the maximum channel capacity downstream of both Hume Dam and Yarrawonga. The CMS includes proposals to increase this capacity to 40,000 ML/day. This business case broadly reviewed how this change would affect the proposal to change the pre-release operating rules for Hume Dam.

  The assessment indicated that any increase to the current capacity constraints below Hume Dam would help promote the outcomes of this proposal as it would reduce the time required to achieve planned

[4] MDBA 2014a. *Changes for the current Hume Airspace Management due to future demand conditions*, MDBA Draft Technical Report No. 2014/23, Murray-Darling Basin Authority, Canberra.

pre-release volumes and enable target storage levels to be achieved more regularly without the limitations sometimes experienced under current channel capacity limits. Relaxing this constraint has no other influence on the proposed changes to the procedures for determination of target storage volumes.

In this regard, it is expected that the benefits from changes to the determination of target storage levels and required pre-release volumes will still be achieved, even if actions are implemented to remove the constraint on maximum channel capacity downstream of Hume Dam. Therefore this SDL offset proposal can be supported with confidence that its benefits will not be diminished by other changes driven by the Constraints Management Strategy.

1.4.5. A new measure

This proposal is a 'new measure' under the Phase 2 Guidelines and so is eligible for full or partial Commonwealth Supply Funding as no funding has been provided or committed to-date by the Commonwealth or has already been approved by another organisation.

2. Proposal

2.1. Current operating rules

The primary purpose of Hume Dam is to regulate the flows in the River Murray system. The dam creates Lake Hume and allows water to be harvested and stored in the reservoir during wetter periods, and then released to meet downstream water needs in drier periods.

The operational assets of the River Murray system are controlled by the joint venture formed between the Commonwealth, New South Wales, South Australian and Victorian governments. The operation of Hume Dam and the other regulating structures and storages in the River Murray system is undertaken by the MDBA in accordance with a range of policies, operating rules and procedures that have been developed and agreed to by the four governments over a number of years. The main documents that set out the provisions for river operations in the Murray system are:

- **The Murray- Darling Basin Agreement (the Agreement)**
  - This is the high level "contract" entered into by the relevant governments that establishes the framework and principles for the construction, operation and maintenance of assets and the sharing of water in the River Murray system.
- **Objectives and Outcomes for river operations in the River Murray System**
  - The Agreement empowers the Basin Officials Committee (BOC) to make high level decisions in relation to river operations. In addition to making decisions on specific river operations issues referred to it, BOC can establish objectives and outcomes that the MDBA is required to achieve in undertaking river operations.
  - The Objectives and Outcomes for River Operations in the River Murray System (O&O) document sets out 10 general objectives that the MDBA should seek to achieve, and 26 target outcomes that are to be delivered in support of these objectives. These general objectives are grouped under five main themes of:
    - Water storage and delivery accounting
    - River Murray Operations assets
    - People and communities
    - Environment, and
    - Communications and information management
  - In addition to the general objectives and outcomes, some 45 Specific Outcomes and Objectives (SO&Os) have been developed. The SO&Os are consistent with the general O&Os and provide sufficient detail to understand the objective(s) that are intended to be achieved at each key location in the River Murray system or through each key activity. The expected outcomes that will signify achievement of the objectives are also described, together with a clear interpretation of the physical activities that will be undertaken, or the operations processes that will be implemented in order to deliver the required outcomes.
- **Operational procedures and reference manuals**
  - The MDBA has developed a range of more detailed procedures and manuals to guide staff on specific operational tasks at various sites throughout the River Murray System. These procedures and manuals provide detailed guidance for staff on how operational activities and processes should be undertaken so as to meet the MDBA's responsibilities under the Agreement and to achieve the general and specific outcomes and objectives.

The MDBA operates a number of large storages. When these reservoirs are at low levels major inflow events can be stored, offering significant flood mitigation benefits to downstream communities. As the storage level rises closer to its full supply level, it is no longer possible to store all inflows and large flow events must be passed through the storage and released downstream, with much more limited flood mitigation benefits.

The primary purpose of the MDBA reservoirs is to harvest and store water to meet users' needs, however in recognition of the significant flood mitigation benefits that they can also offer, the general O&Os call for floods to be managed to achieve the following outcomes:

- firstly, protection of the security of River Murray operational assets; then
- secondly, maximising the water available at the end of the relevant flooding episode; and then
- thirdly, subject to achieving the first two outcomes, limiting flood damage to downstream communities and increasing benefits to the environment and public amenity by using unregulated water, for example, by prolonging wetland inundation or by supporting recreational activities.

In order to achieve these outcomes at Lake Hume, detailed procedures have been developed and refined over many years to put in place a controlled filling process that ensures there is a high probability that the storage will be full just before downstream demands rise to a level that will require drawing on the stored water. This controlled filling process enables some airspace in the storage to be maintained to help mitigate flood flows that may occur during the filling process.

The SO&O for airspace management at Lake Hume allows for the target airspace for flood mitigation purposes to range between 30 GL and 386 GL and requires that "post flood operations, based on transitioning to worst-case planning water resource assessment, Hume Reservoir should be effectively full (99% of the total capacity at full supply level) when downstream demands exceed inflows"[5].

In order to determine the actual amount of airspace to be provided, operators determine monthly airspace targets for Lake Hume. If the storage is above the target level, pre-releases are undertaken to bring the storage back down to the target level. Pre-releases are undertaken at rates which will result in total flows in the Hume to Yarrawonga reach of the river not exceeding 25,000 ML/d, which is the regulated channel capacity of the River Murray downstream of Hume Dam.

The determination of monthly airspace targets involves consideration of the likely inflows to the storage, and the potential irrigation demands that may be required to be released from the storage to determine how much airspace can be provided for flood mitigation with a low risk of the storage not filling.

Each month from January onwards, the target end-of-month storage volume (and hence the target airspace to be provided) is calculated for a range of different forecast periods[6]. The shortest forecast period is one month long, and each forecast period is one month longer than the previous forecast period, up to the point where the longest forecast period extends from the current month to the end of November. The lowest end of the current month storage level target determined from all the different forecast periods is selected as the actual target level for the end of the current month, and pre-releases are planned to achieve this target level. The longest forecast period only extends to the end of November because after this time it is highly unlikely for Lake Hume to spill. This is because inflows decline with the onset of summer and irrigation demands increase significantly and usually exceed inflows.

The target storage volume for each forecast period is calculated by subtracting the net difference between the forecast inflows and the forecast irrigation release from the maximum storage volume at full supply level. This can be represented by the following formula:

[5] MDBA 2014b, *Objectives and Outcomes for River Operations in the River Murray System,* Murray-Darling Basin Authority, Canberra.

[6] The description of target storage volume determination provided is adapted from the draft MDBA Draft Technical Report No. 2014/23, *Changes for the current Hume Airspace Management due to future demand conditions*, prepared in December 2014 (MDBA 2014a).
Fur her detail on target storage volume determination can also be found in the draft report *Preliminary Modelling Investigation: Optimisation of Hume Dam Airspace Management and Pre-releases and Lake Hume to Lake Victoria transfers to Contribute to Environmental Outcomes* prepared by SKM for DEPI in January 2013 (SKM 2013).

Target storage volume = full supply storage volume – (forecast inflow – forecast irrigation releases)

In order to ensure that there is a low chance that the storage will not subsequently fill if the storage is lowered to the target storage level, the inflows assumed for each forecast period are the lowest inflows that are likely to be received, and the irrigation releases used are the highest forecast releases that are likely to be experienced.

The forecast inflows are the sum of the forecast releases from the Snowy scheme and Lake Dartmouth, plus the forecast unregulated inflows from the catchment upstream of Lake Hume. The expected future natural inflows to Lake Hume are strongly correlated to the level of actual natural inflows experienced in the past month. With the aid of detailed statistical analysis of over 100 years of historic inflow data, the actual natural inflows for the past month are used to forecast the minimum expected natural inflows over the various forecast periods under consideration. In combination with consideration of similar issues at Lake Dartmouth, the unregulated inflows to Lake Hume and releases from Dartmouth can also be forecast.

Analysis of historic irrigation demands has also shown that irrigation releases from Hume Dam are reasonably well correlated to the unregulated inflows to the storage. The inflow forecasts from the calculations described above can therefore also be used to estimate maximum likely irrigation release for each forecast period.

These operational rules for determining target storage levels and required pre-releases have been incorporated into the baseline model of the River Murray system, which represents the behaviour of the system with the water sharing arrangements and infrastructure in place as at June 2009[7], prior to the recovery of 2,750 GL of water for the environment as proposed under the Basin Plan.

The same operational rules for determining target storage levels and required pre-releases from Lake Hume were also included in the benchmark model, which simulates the behaviour of the system following the recovery and application of an average of 2,750 GL of water per year to achieve environmental outcomes in accordance with the Basin Plan and the Basin-wide environmental watering strategy.

2.2. Drivers for change

2.2.1. Growth in environmental entitlements

The last eight years have seen a significant growth in the volume of water held as environmental entitlements. The formal framework for this was established with the passing of the *Water Act 2007* which created the Commonwealth Environmental Water Holder (CEWH) and Environmental Water Holdings, under Part 6 of the Act.

The environmental entitlements were created through buyback under the initiative *Restoring the Balance in the Murray-Darling Basin*, and through a range of investment programs in irrigation system modernisation such as the *Sustainable Rural Water Use and Infrastructure Program.*

The outcome has been to see a remarkable increase in the volume of entitlements held by the CEWH to promote environmental watering programs. The increase is confirmed in the chart below which shows the growth in the CEWH's holdings from 65 GL in June 2009 to the latest value of 2,248 GL at the end of December 2014.

[7] MDBA 2012. Hydrologic modelling to inform the proposed Basin Plan - methods and results, MDBA publication no: 17/12, Murray-Darling Basin Authority, Canberra

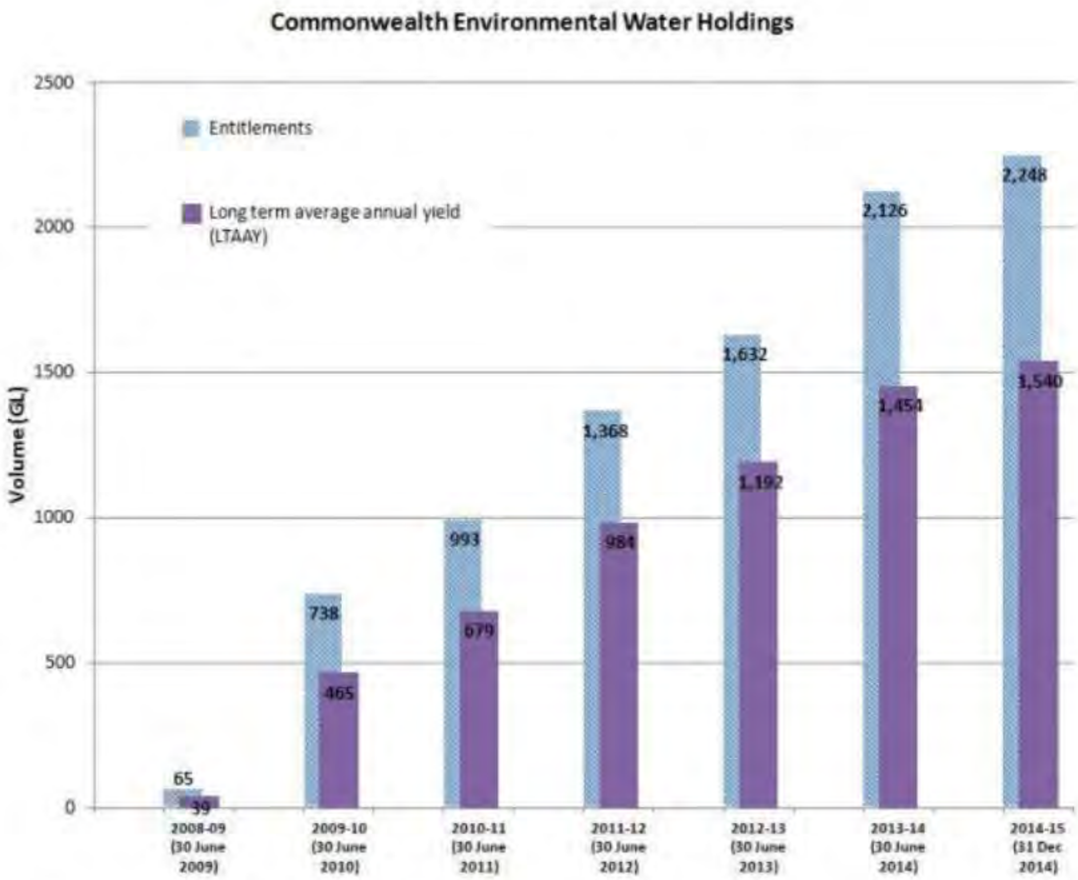

Figure 3. Commonwealth environmental water holdings over time[8]

In terms of the Lake Hume, Table 1 shows the entitlements held by the CEWH in the River Murray.

Table 1. CEWH holdings in the River Murray[9]

State	Entitlement type	Volume (ML)
NSW	High Security	15,408
	General Security	327,051
Victoria	High Security	287,640
	Low Security	20,117

There are also significant additional volumes held as part of the Living Murray initiative and by the Victorian Environmental Water Holder.

[8] CEWH 2014. About Commonwealth environmental water: http://www.environment.gov.au/water/cewo/about-commonwealth-environmental-water

[9] CEWH 2015. Environmental water holdings: http://www.environment.gov.au/water/cewo/about/water-holdings

2.2.2. Change in release patterns

Historically, releases from Lake Hume have been made to respond to demand patterns from irrigators. The majority of that demand has occurred during the peak irrigation seasons from December through until May, to support crop demands over the summer.

One other significant effect of the increased environmental entitlement holdings has been to change the pattern of this demand. In addition, the quantum of irrigation based demand has reduced as entitlements have been recovered from the consumptive sector and redirected to environmental needs.

Figure 4 below confirms the projected pattern of releases for the Goulburn system. The environmental releases from the Murray can be expected to follow similar patterns. Figure 4 shows significant releases in the winter and spring, outside the traditional irrigation season. The new demand pattern changes storage planning, airspace management and decisions on pre-releases as it adds in an extra new demand at the time of year when historically the storage would have been fullest and when there was low demand for irrigation releases.

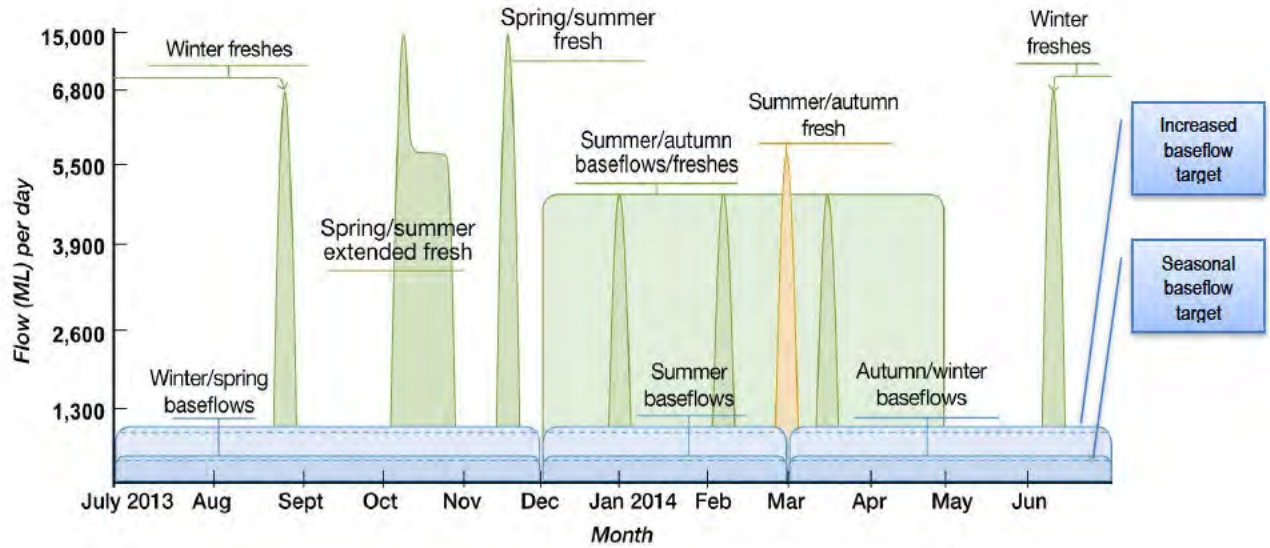

Figure 4. Indicative priority watering actions for the Goulburn system (Source: VEWH)[10]

2.2.3. Analysing the impact of the change

As noted in Sections 2.2.1 and 2.2.2, there has been a significant growth in environmental entitlements, which will continue until the water recovery targets under the Basin Plan are achieved. This shift in entitlement use has and will continue to change release patterns from Lake Hume.

In order to understand how these fundamental changes in release patterns were likely to affect future storage operations, modelling studies of the storage behaviour were analysed. Figure 5 outlines the three key modelling scenarios that were examined in these studies.

[10] VEWH 2013. *Seasonal Watering Plan 2013-14*, page 113

Baseline: The modelling scenario used to represent the operating conditions of the Murray system as at 30 June 2009 (MDBA 2012).

Benchmark: A modelling scenario based on the baseline model, but assumes that the 2,750 GL/yr SDL reduction has been implemented in full.

Proposal: A modelling scenario based on the benchmark model, but assumes that the initiative outlined in this business case has been implemented in full.

Figure 5. Important terminology of modelling scenarios

Initial comparison of the operation of Hume Dam in the benchmark model run to its operation under the baseline model conditions highlighted some interesting differences. Further consideration of the differences in the timing and volume of pre-releases and spills from Lake Hume under the benchmark conditions compared to the baseline model identified the following important changes in system behaviours:

- The average annual volumes of water spilled from Lake Hume were lower under the benchmark conditions. This behaviour can be expected with the introduction of significant environmental releases that are often triggered to augment natural flow events that occur in spring, leaving the storage at a lower level than under the baseline conditions in spring, and thereby reducing spills from the storage.
- During the months of December to May, irrigation demands were lower under benchmark conditions, as large volumes of water had been recovered from the consumptive sector for environmental use.
- Under benchmark conditions there were higher pre-releases being made than were required under the baseline conditions, particularly in the months of March, April and May.
- Despite the reduction in overall annual average spill volumes and the higher pre-release volumes under the benchmark conditions, there were also higher average spill volumes occurring over the period March – May in the benchmark model than under baseline conditions.
- These higher pre-releases and spills in the March – May period didn't coincide with the key periods when flow events are required to achieve the environmental outcomes targeted in the Basin Plan, so were unlikely to be creating environmental benefits, and were also occurring at a time that was not historically the highest risk period for flooding downstream of Hume Dam.

It was also noted that the detailed rules and procedures used to set storage target volumes and manage pre-release had not been changed in the benchmark modelling and still used the same detailed rules as were applied in the baseline conditions. These observations suggested that the setting of target storage volumes and the management of pre-releases could be improved.

2.3. Proposed operating rules and benefits of change

The proposed change to the operating rules is for consideration of forecast environmental demands to be included in the planning of target storage volumes and pre-releases. This can be represented by the following amended formula that it is proposed will be used to determine target storage volumes:

Target storage volume = full supply storage volume – (forecast inflow – forecast irrigation releases – forecast environmental releases)

Importantly, this proposed rule change is still consistent with the high level outcomes set out in the O&O document, but updates the detailed operational procedures and rules to appropriately reflect the shifts in the source of demand for releases from Lake Hume that have and will continue to occur as more water is recovered for environmental use.

The key change to the operational rule is the proposed inclusion of forecast environmental demands in addition to irrigation demands. All other parameters for inflows and irrigation demands will continue to be calculated using the same methodologies as currently apply. Once a new target storage level is determined using this amended rule, the required pre-releases to achieve the target storage level would continue to be undertaken at rates up to a maximum of 25,000 ML/d, which is the regulated channel capacity of the River Murray downstream of Hume Dam as per current arrangements.

In this regard, it is expected that the benefits from changes to the determination of target storage levels and required pre-release volumes will still be achieved, even if actions are implemented to remove the constraint on maximum channel capacity downstream of Hume Dam. If the maximum regulated release can be increased above 25,000 ML/d in future, this provides the opportunity to reduce the time required to achieve planned pre-release volumes and will enable target storage levels to be achieved more regularly without the limitations sometimes experienced under current channel capacity limits. Relaxing this constraint has no other influence on the proposed changes to the procedures for determination of target storage volumes.

For such a rule change to be feasibly implemented, a practical and robust methodology needs to be available to forecast environmental demands across the range of forecast periods required. The MDBA has considered this issue and developed a workable methodology.

The starting point was examination of the environmental watering sequence that is used to drive environmental water releases in the benchmark model. The additional releases required over and above the baseline flows to create the desired watering sequences at each key site were determined and assumed to be met by additional releases from Lake Hume, creating a time series of environmental demands. These demands were graphed against the cumulative unregulated inflows to Lake Hume for the range of forecast periods that need to be considered. It was found that there is some correlation, albeit a weak one, between the levels of unregulated flow and environmental water releases.

This enables an estimate of future environmental releases to be derived from the estimated future inflows to Lake Hume, in a parallel process to that applied to the estimation of future irrigation releases. The MDBA modelling team were able to develop this forecasting approach to the point where it could be converted into an operating rule and a procedure that was able to be represented in the MSM-Bigmod model of the system.

Overall it is concluded that this “proof of concept” work undertaken by the MDBA modelling team demonstrates that the proposed rule change can be further developed and is feasible to implement into day-to-day operational planning processes for use within the MDBA’s River Management Division. As noted by MDBA modelling staff, the environmental demand patterns used to estimate the future environmental releases are the initial estimate of how environmental objectives can be met in future[11]. As more experience and knowledge are gained on optimal environmental water requirements, estimates of environmental demands can be revised and improved leading to improved forecasts of environmental releases.

2.3.1. Expected outcomes of the proposal

Simulation of system behaviour showed that by including forecast environmental water release needs into the storage target setting for Lake Hume resulted in significant reductions in pre-release volumes required to manage flood risks (Table 2). Average annual spill volumes from Lake Hume are also less than the volumes under baseline conditions (Table 2), but spill volumes would increase in the wettest periods (Table 2). The pattern of changes to pre-releases and spills is further explored in Section 3.4.

[11] MDBA 2014a. *Changes for the current Hume Airspace Management due to future demand conditions*, MDBA Draft Technical Report No. 2014/23, Murray-Darling Basin Authority, Canberra.

Table 2. Annual average pre-release and spill volumes from Lake Hume

Metric	Baseline (R845)	Interim Benchmark	Proposal
Spill volumes (GL/year)	1,152	1,047	1,036
Pre-release volumes (GL/year)	135	189	91

Table 3. Maximum annual pre-release and spill volumes from Lake Hume in any year

Metric	Baseline (R845)	Interim Benchmark	Proposal
Spill volumes (GL/year)	9,440	9,961	10,046
Pre-release volumes (GL/year)	1,166	1,457	1,116

Overall this reduction in pre-release volumes, without increasing spill volumes, results in more water being available in Lake Hume for allocation against entitlements to meet irrigation and environmental demands.

The modelling also shows that with the proposed rule change in place, significantly improved environmental outcomes can be achieved compared to the benchmark modelling, utilising the same 2,750 GL of environmental water recovery (Section 3 explores this finding). This creates the potential for this rule change to make a positive contribution to a package of measures that could be assessed for SDL adjustment opportunities, and modelling studies have confirmed the potential for this rule change to contribute significantly to SDL adjustment volumes.

2.4. Costs

The costs to implement this proposed rule change are relatively modest, particularly in comparison to other proposals that require the construction of physical infrastructure to deliver environmental water to environmental assets.

Many of the costs will involve the commitment of staff resources from the MDBA and state agencies which will already be covered within existing budgets, but nevertheless there will need to be a re-allocation of priority to implementation of this measure in preference to other potential implementation activities.

There are two major areas of activity associated with implementation of this proposed rule change. The first activity is the further development and refinement of the procedures for forecasting environmental demands and documentation of these techniques in relevant operational manuals. The second is consultation with stakeholder groups who have an interest in the outcomes of any changes in the operational management of Lake Hume, and may be concerned about the potential for third party impacts.

Estimates of these costs are summarised in Table 4 and described in Sections 2.4.1 and 2.4.3 below.

Table 4. Projected implementation costs

Category	Activity	Cost ($'000s)
Modelling environmental release forecasting methods.	External contracts	[redacted]
Update operational manual content.	External contracts	[redacted]
Consultation	Staff salaries	[redacted]
	Goods and services	[redacted]
Total		[redacted]

Note: All costs are exclusive of Goods and Services Tax (GST)

2.4.1. Further development of environmental release forecasts

In order to develop the processes for forecasting environmental demands, it is suggested that the following activities may be required:

- Review of environmental demands and confirmation of optimal watering requirements.
- Statistical analysis of environmental demands, testing correlations with unregulated inflows.
- Refining and testing environmental releases forecasting techniques.
- Documentation of forecasting procedures and design of monitoring and review processes to support continuous improvement of the methodology and forecasts.

Whilst the MDBA has the skills internally to undertake this work, if external resources were required, consulting fees for this work may be in the order of [redacted].

2.4.2. Updating operational manuals

Once the forecasting techniques have been further developed and refined, the rule change and these new techniques need to be embedded into the business processes of the MDBA system operations team. The following activities may be required:

- Review of background information and content in current manuals
- Minor modelling studies to refine/confirm methodology.
- Draft proposed updates for air-space planning and pre-release management section of the relevant manual,
- Seek feedback from Water Liaison Working Group and system operations staff, and then finalise amendments to manuals.

As noted above, whilst the MDBA has the skills internally to undertake this work, if external resources were required, consulting fees for this work may be in the order of [redacted].

2.4.3. Stakeholder consultation

Section 4 of this report details the stakeholders likely to be interested in this issue and the engagement processes that may need to be employed. For the purposes of cost estimation, it has been assumed that all consultation and engagement activities are directly managed and delivered by the MDBA and state agency staff. The key activities required for a comprehensive consultation program include:

- Design and production of consultation materials.
- Conducting a series of well planned community engagement meetings. The number of meetings required will depend on the final form of the proposed rule change and how wider consultation processes on other SDL adjustments and Basin plan implementation issues are managed. For the purposes of this estimate, it is assumed that up to 18 meetings may be required to engage concerned stakeholders.
- Managing enquiries and liaison with media etc.

Overall, it is estimated that a comprehensive consultation program delivered by MDBA and agency staff could cost in the order of [redacted]. [redacted].

These costs have been developed on the basis of a stand-alone consultation process for this proposal; however as noted in Section 4 it is recommended that consultation should occur as part of a broader engagement program addressing SDL adjustment processes and the interaction with other proposed measures. Under such a scenario, the consultation costs for this measure would be incorporated as part of the overall cost for the broader engagement program covering a number of proposals.

3. Outcomes

3.1. Risk assessment overview

The SDL Phase 2 Guidelines cover three risk categories:

- **Adverse ecological effects** (clause 4.4.2: If relevant, business cases need to include an assessment of potential adverse ecological impacts resulting from the operation of the proposed measure)
- **Impacts from the operation of the measure** (clause 4.7: All business cases need to include a risk assessment and risk management strategy for the proposed operating regimes or proposed operating rules changes)
- **Project development and delivery risks** (clause 4.11.4: The business case needs to include a risk assessment and risk management strategy for risks to project development and delivery)

The guidelines confirm that the business case will be assessed on the basis that:

- All significant project development and delivery risks and impacts have been identified, adequately described and analysed and robust treatments and mitigations proposed;
- The risk management strategy complies with the AS/NZS ISO 31000:2009 Risk management— Principles and Guidelines; and
- All residual risks are negligible or can be adequately mitigated.

The business case fully implements these requirements. This section of the business case sets out a generic risk management framework that has been applied across all impacts. The section covers the issues related to potential 'adverse ecological effects' and 'impacts from the operation of the measure'. The risks associated with 'project development and delivery' are dealt with below in Section 5.

3.2. Risk management framework

A risk assessment of the impacts of the proposed change was completed in line with AS/NZS ISO 31000:2009 (as required under the guideline requirements). This assessed both the likelihood of an event occurring and the severity of the outcome if that event occurred. This methodology generates a risk matrix in line with the AS/NZS ISO 31000:2009 standard. Table 5 shows the risk matrix and definitions used in this risk assessment.

Table 5. AS/NZS ISO 31000:2009 Risk prioritisation matrix

		Consequence			
Likelihood	Negligible	Minor	Moderate	Major	Extreme
Rare	Low	Low	Low	Moderate	High
Unlikely	Low	Low	Moderate	High	High
Possible	Low	Moderate	Moderate	High	Very High
Likely	Low	Moderate	High	Very High	Very High
Almost Certain	Moderate	Moderate	High	Very High	Very High

The risk assessment process comprised two main elements:

- **Expert panel:** A workshop was held with senior agency staff across jurisdictions representing the key constituencies with an interest in the proposal. That group identified the key issues from implementing the proposal and allocated priorities to those risks. Appendix 3 reports the outcomes of that workshop.
- **Professional judgement:** Members of the project team then made judgments on the range of risks and their likely characteristics in-line with AS/NZS ISO 31000:2009, informed by experience of working on very similar projects related to environmental watering proposals.

The outcome was a listing of possible risks with a ranking based on the AS/NZS ISO 31000:2009 methodology.

In each case the mitigation strategy comprised two main elements:

- Analysis and modelling to confirm that the evidence showed either neutral or positive outcomes,
- Adequate community engagement to ensure understanding and contributions from affected stakeholders.

The listing of the risks and the assessment of their significance is provided in Table 6 below. The risk level refers to the severity of the risk prior to the application of any mitigation actions. With these controls in place, the analysis that follows in this business case covering environmental outcomes (Section 3.3) and third party impacts (Section 3.4) demonstrates that any residual risk is acceptably low.

Table 6. Risk assessment listing and ranking

	Risk	Rating[12]	Potential issue	Risk assessment (prior to mitigation)			Detailed commentary provided in
				Likelihood	Consequence	Risk rating	
1	Feasibility	24	The changes are challenging to implement in practice	Unlikely	Moderate	Moderate	Section 5.2
2	South Australia's rights	7	The change will reduce South Australia's rights	Rare	Minor	Low	Section 3.4.4
3	Constraints Management Strategy	10	Implementation of the CMS reduces the benefits of this proposal	Rare	Minor	Low	Section 1.4.1
4	Lake Victoria	3	The change will affect the operation of Lake Victoria	Rare	Minor	Low	Section 3.4.4
5	Entitlement security	10	The change will affect the security of entitlement holders	Unlikely	Moderate	Moderate	Sections 3.4.1 and 3.4.2
6	Inundation	13	The change will increase the frequency and extent of inundation	Rare	Moderate	Moderate	Section 3.4.3
7	Spillable water accounts	4	Reducing pre-releases will increase spills	Unlikely	Minor	Low	Section 3.4.2
8	Terminology	3	The terms used will not distinguish between managed and uncontrolled releases	Rare	Minor	Low	Section 2.1
9	Water accounting	7	The proposal involves accounting but not real savings	Unlikely	Minor	Low	Sections 2.2 and 2.3
10	Guidelines		The business case does not reflect the requirements of the Phase 2 Guidelines	Rare	Minor	Low	Section 1 & Appendix 1

[12] The rating column reports the relative score allocated to each issue by the expert working group to reflect the anticipated level of stakeholder concern. The higher the rating, the greater the anticipated extent of concerns

The risk assessment identified the following priority issues and outcomes for review:

- Environmental outcomes: how changes will impact on environmental outcomes
- Inundation risks: how the change will impact on risks of inundation downstream
- Entitlement rights: how the changes to airspace management will impact on the security of the entitlement rights of holders in the storage including spillable accounts
- Downstream impacts: whether the change impacts on the rights of water holders and other stakeholders downstream of the storage.

The analysis and consideration of these priority issues is outlined below. It should also be noted that the modelling that supports the analysis of the proposal's outcomes was conducted by the MDBA[13].

3.3. Environmental outcomes

3.3.1. Context for the assessment

Appendix 8 of the SDL Guidelines confirms that this section is concerned to minimise:

> *The risks associated with accurately understanding, predicting and delivering ecological objectives at the site, within the reach and to downstream locations.*

The primary intention of the aforementioned section of the SDL Guidelines is to ensure that the business case predicts and controls the impact of new structural works and measures on ecological systems. By contrast, this proposal involves an operating rule change (i.e. rather than structural works and measures) to consider forecast environmental demands in the planning of target storage volumes and pre-releases from Lake Hume. As the proposed changes involve only changes in operating rules there will be no risks regarding the construction of major works and measures.

At present, the benchmark conditions often result in pre-releases and spills in the March – May period that do not coincide with the key periods when flow events are required to achieve the environmental outcomes targeted in the Basin Plan. These pre-releases and spills may result in sub-optimal environmental outcomes in two key ways:

- they are unlikely to be creating direct environmental benefits as they do not coincide with the timing required for important ecological assets
- they may be reducing entitlement reliability (for both environment and consumptive entitlement holders - refer Section 3.4.1), reducing the volume of allocation available for planned environmental watering.

The intention of the proposed rule change is to ensure better integration of environmental demands into the management of Hume Dam. This should increase the level, extent and focus of environmental benefits as were assumed in the benchmark modelling for the Basin Plan.

Modelling has been undertaken to test the environmental outcomes that could be achieved from this rule change. The modelling has examined the environmental outcomes of the proposal in two principal ways:

- how the proposal affects the achievement of Specific Flow Indicators (SFIs – refer Table 9) over the long-term
- whether the proposal compromises any of the limits of acceptable change outlined in Schedule 6 (Section S6.07) of the Basin Plan.

[13] MDBA 2014a. *Changes for the current Hume Airspace Management due to future demand conditions*, MDBA Draft Technical Report No. 2014/23, Murray-Darling Basin Authority, Canberra.

The next section provides an overview of the environmental assets of the Murray system (Section 3.3.2) which is followed by discussion of the results of modelling environmental outcomes at these assets (Section 3.3.3).

3.3.2. Environmental assets

There are six key environmental assets between Lake Hume and the mouth. An overview of these assets is provided below (Table 7).

Table 7. Key environmental assets between Lake Hume and the Murray Mouth

Asset	Description
Barmah–Millewa Forest	The Barmah–Millewa Forest icon site is the largest river red gum forest in Australia. Located in New South Wales and Victoria, the forest covers 66,000 ha of wetlands, and is home to many threatened native plants and animals. It is also a significant breeding site for waterbirds and an important native fish habitat.
Gunbower–Koondrook–Perricoota Forest	Gunbower–Koondrook–Perricoota Forest icon site consists of two forests — Gunbower Forest and Koondrook–Perricoota Forest — that together comprise Australia's second largest river red gum forest. Located in New South Wales and Victoria, the combined Gunbower–Koondrook–Perricoota Forest covers around 50,000 ha. It is home to many threatened native plants and animals, and its wetlands are important breeding places for waterbirds and native fish.
Hattah Lakes	The Hattah Lakes icon site forms part of the 48,000 ha Hattah–Kulkyne National Park. Located in Victoria, this icon site includes over 20 semipermanent freshwater lakes that support river red gum communities and a variety of native plants and animals. They are also important breeding places for waterbirds.
Chowilla Floodplain and Lindsay–Wallpolla Islands	The Chowilla Floodplain component of this icon site covers over 17,000 ha across New South Wales, Victoria and South Australia. Because of its remote location, Chowilla is relatively unaffected by irrigation and other development and much of its natural character has been preserved. Included in this icon site are the Lindsay–Wallpolla Islands, including Mulcra Island, and their floodplains. Together this part of the icon site covers almost 20,000 ha and supports many threatened native plants, animals and fish species.
Lower Lakes, the Coorong and Murray Mouth	The Lower Lakes, Coorong and Murray Mouth icon site — where the River Murray meets the Southern Ocean — is in South Australia. Covering over 140,000 ha, it includes 23 different wetland types that range from very fresh water to saltier than the sea. As a complex estuarine environment, this site is one of 10 major Australian havens for large concentrations of wading birds and is recognised internationally as a breeding ground for many species of waterbirds and native fish.
River Murray Channel	The River Murray Channel is the main artery of the river. Extending over 2,000 km from the Hume Dam in Victoria to Wellington in South Australia, the channel links the forests, floodplains, wetlands and estuaries along the River Murray. It provides habitat for many native plants, fish and animals, while its banks support river red gum forests of high natural and cultural value.

3.3.3. Limits of acceptable change and Specific Flow Indicators

Schedule 6 (Section S6.07) of the Basin Plan identifies the limits of acceptable change in score or outcome from the benchmark environmental outcomes (i.e. those achieved by the unadjusted SDL) that ensure environmental outcomes are maintained within identified limits. The limits of acceptable change are defined at the region and reach-scale.

For each region: no reduction in the benchmark scores, although some reductions in individual elements may be permitted if they are offset by increases in other elements.

For each reach, limits of acceptable change are based on the Specific Flow Indicators (SFIs) developed for each hydrologic indicator sites:

- Where the benchmark model run achieves or exceeds the target frequency range for a flow indicator, achievement of the target frequency range must be retained and the frequency result must not vary by more than 10% of the benchmark result
- Where the benchmark model run does not achieve the target frequency range for a flow indicator, the frequency result must not vary by more than 10% of the benchmark result, and not fall below the baseline model result
- Where the benchmark model run provides little improvement in frequency for a flow indicator (less than 50% progress toward the target range from the baseline model result), the frequency result must not vary by more than 15% of the benchmark result, and not fall below the baseline model result
- Where a supply measure or combination of measures can achieve the ecological outcomes sought by the plan as represented by an ecological target or targets, and a flow indicator or indicators and associated benchmark model results, then the three dot points above do not apply to that flow indicator or indicators.

For the Coorong, Lower Lakes and Murray Mouth—maintenance or improvement of the following:

- Lake Alexandrina salinity: less than 1500 Electrical Conductivity (EC) for 100% of the time and less than 1000 EC for 95% of days;
- Barrage flows: greater than 2000 GL per year on a three year rolling average basis with a minimum of 650 GL in any year, to be achieved for 95% of years
- Barrage flows: greater than 600 GL over any two year period, to be achieved for 100% of the time
- Coorong salinity: South Lagoon average daily salinity less than 100 grams per litre for 96% of days
- Mouth openness: Mouth open to an average annual depth of 1 metres (-1.0 m Australian Height Datum (AHD)) or more for at least 90% of years and 0.7 metres (-0.7 m AHD) for 95% of years
- For all base flows and fresh requirements within each reach—no reduction in outcomes achieved in the benchmark run.

Modelling of the River Murray system with the proposed changes in place[14] found that the proposal does not result in any breach of the limits of acceptable change for the region (Table 8), the individual reaches (Table 9) and/or the Coorong, Lower Lakes, Murray Mouth (Table 10).

[14] MDBA 2014a. *Changes for the current Hume Airspace Management due to future demand conditions*, MDBA Draft Technical Report No. 2014/23, Murray-Darling Basin Authority, Canberra.

In comparison to the benchmark, the proposal results in a net increase in the number of successful events[15] across the Barmah-Millewa Forest, Hattah Lakes, Chowilla floodplain and Edward Wakool sites over the modelled record, while the net number of successful SFI events at Gunbower-Koondrook-Perricoota does not change. There is a net decrease of one event in the Lower Darling reach. All SFIs experience the same or greater number of net successful events (Table 11), with the exception of event G3 which decreases from 44 to 43 successful events over the record and D1 which decreases from 67 to 66. The most benefited SFI events are B2, H2 and E3 which experience an increase of greater than two additional events over the record. It should also be noted that the changes in the net number of successful events are not uniform at all sites along the river due to the different flow and durations for SFIs at each site, together with the fact that the number of successful events may also be influenced by the interaction between changed River Murray flows regimes and tributary inputs.

These results confirm that the proposed change to the operating rules improve the environmental outcomes that are generated overall. By implication, the proposed change will allow equivalent environmental outcomes to those available under the benchmark conditions to be achieved with lower total water requirements.

Once more experience is gained in the delivery of environmental water under the Basin Plan, there may be further opportunities identified for improving and optimising the integration of environmental and consumptive demands. In the meantime, this rule change offers a positive contribution to a package of measures that could be assessed for SDL adjustment opportunities.

Table 8. Results of the testing of limits of acceptable change for the region (from MDBA, 2014)

Limit of acceptable change	Interim Benchmark	Proposal
Regional Ecological Elements Score	0.5006	0.5034

[15] Note, the term 'successful event' is used throughout this document to describe events that achieve the intended hydrologic conditions of each SFI (e.g. B1 requires 12.5 GL/d for 70 days, between June and November, with a minimum of 7 consecutive days). A variety of other non-flow related factors influence whether an event achieves the intended ecological response. Therefore a hydrological 'successful event' should not be interpreted as necessarily being an ecologically successful event.

Table 9. Testing of Specific Flow Indicators and limits of acceptable change for each reach (from MDBA, 2014)

						FREQUENCY			LIMITS OF CHANGE
	Indicator Description	Minimum consecutive days	Start month	End month	Target	Baseline (R845)	Interim Benchmark	Proposal	Test result
MURRAY - BARMAH-MILLEWA FOREST									passed
B1	12.5 GL/d for 70 days	7	Jun	Nov	70 - 80 %	50%	78%	78%	passed
B2	16 GL/d for 98 days	7	Jun	Nov	40 - 50 %	30%	52%	54%	passed
B3	25 GL/d for 42 days	7	Jun	Nov	40 - 50 %	30%	46%	46%	passed
B4	35 GL/d for 30 days	7	Jul	Jun	33 - 40 %	24%	36%	37%	passed
B5	50 GL/d for 21 days	7	Jul	Jun	25 - 30 %	18%	17%	18%	passed
B6	60 GL/d for 14 days	7	Jul	Jun	20 - 25 %	14%	12%	13%	passed
B7	15 GL/d for 150 days	7	Jun	Dec	30%	11%	36%	36%	passed
MURRAY - GUNBOWER-KOONDROOK-PERRICOOTA									passed
G1	16 GL/d for 90 days	7	Jun	Nov	70 - 80 %	31%	67%	67%	passed
G2	20 GL/d for 60 days	7	Jun	Nov	60 - 70 %	34%	66%	66%	passed
G3	30 GL/d for 60 days	7	Jul	Jun	33 - 50 %	25%	39%	38%	passed
G4	40 GL/d for 60 days	7	Jul	Jun	25 - 33 %	11%	22%	23%	passed
G5	20 GL/d for 150 days	7	Jun	Dec	30%	7%	27%	27%	passed
MURRAY - HATTAH-KULKYNE LAKES									passed
H1	40 GL/d for 60 days	7	Jun	Dec	40 - 50 %	30%	46%	46%	passed
H2	50 GL/d for 60 days	7	Jun	Dec	30 - 40 %	19%	30%	33%	passed*
H3	70 GL/d for 42 days	7	Jun	Dec	20 - 33 %	11%	19%	19%	passed
H4	85 GL/d for 30 days	7	Jul	Jun	20 - 30 %	10%	12%	13%	passed
H5	120 GL/d for 14 days	7	Jul	Jun	14 - 20 %	8%	9%	10%	passed
H6	150 GL/d for 7 days	7	Jul	Jun	10 - 13 %	5%	6%	6%	passed
MURRAY - RIVERLAND CHOWILLA FLOODPLAIN									passed
C1	20 GL/d for 60 days	60	Aug	Dec	71 - 80 %	43%	71%	71%	passed
C2	40 GL/d for 30 days	7	Jun	Dec	50 - 70 %	37%	57%	57%	passed
C3	40 GL/d for 90 days	7	Jun	Dec	33 - 50 %	22%	39%	39%	passed
C4	60 GL/d for 60 days	7	Jun	Dec	25 - 33 %	12%	27%	27%	passed
C5	80 GL/d for 30 days	7	Jul	Jun	17 - 25 %	10%	13%	13%	passed
C6	100 GL/d for 21 days	1	Jul	Jun	13 - 17 %	6%	8%	9%	passed
C7	125 GL/d for 7 days	1	Jul	Jun	10 - 13 %	4%	5%	5%	passed
MURRAY - EDWARD WAKOOL RIVER SYSTEM									passed
E1	1,500 ML/d for 180 days	1	Jun	Mar	99 - 100 %	96%	93%	93%	passed
E2	5 GL/d for 60 days	7	Jun	Dec	60 - 70 %	39%	65%	65%	passed
E3	5 GL/d for 120 days	7	Jun	Dec	35 - 40 %	22%	33%	37%	passed*
E4	18 GL/d for 28 days	5	Jun	Dec	25 - 30 %	15%	17%	18%	passed
E5	30 GL/d for 21 days	6	Jun	Dec	17 - 20 %	12%	12%	14%	passed
LOWER DARLING - LOWER DARLING FLOODPLAIN									passed
D1	7 GL/d for 10 days	10	Jan	Dec	70 - 90 %	57%	59%	58%	passed
D2	17 GL/d for 18 days	18	Jan	Dec	20 - 40 %	18%	22%	22%	passed
D3	20 GL/d for 30 days	30	Jan	Dec	14 - 20 %	10%	10%	10%	passed
D4	25 GL/d for 45 days	45	Jan	Dec	8 - 10 %	8%	8%	8%	passed
D5	45 GL/d for 2 days	2	Jan	Dec	7 - 10 %	7%	7%	7%	passed

Note. The frequency columns have been colour codes to show more frequent events in darker shades of green and with less frequent events in lighter shades of green.

*The limits of change test result for H2 and E3 indicates that these two SFIs do not meet the requirements of subclause ii because the proposal modified the level success of each SFI by more than 10% of the benchmark result. However, in this case, the level of success for both SFIs actually increases (by more than 10%) and has therefore been interpreted as a positive outcome. The level of success for both SFIs is within the target frequency range.

Table 10. Testing of limits of acceptable change for the Coorong, Lower Lakes and Murray Mouth (from MDBA, 2014)

	Indicator Description	Start month	End month	Target	FREQUENCY Baseline (R845)	Interim Benchmark	Proposal	LIMITS OF CHANGE Test result
COORONG, LOWER LAKES, MURRAY MOUTH INDICATORS								passed
1	Lake Alexandrina salinity: Percentage of days that Lake Alexandrina salinity is less than 1,500 EC	Jul	Jun	100%	96%	100%	100%	passed
1	Lake Alexandrina salinity: Percentage of days that Lake Alexandrina salinity is less than 1,000 EC	Jul	Jun	95%	89%	100%	100%	passed
2	Barrage flows: Percentage of years that barrage flows are greater than 2,000 GL/yr (measured on a three year rolling average) with a minimum of 650 GL/yr	Jul	Jun	95%	75%	97%	97%	passed
3	Barrage flows: Percentage of years that barrage flows are greater than 600 GL for any two year period	Jul	Jun	100%	98%	100%	100%	passed
4	Coorong Salinity: South Lagoon average daily salinity 96th percentile (grams per litre)	Jul	Jun	100	112	65	65	passed
5	Mouth Openness: Percentage of years mouth open to an average annual depth of 1.0 meters (-1.0 m AHD) or more	Jul	Jun	90%	76%	94%	93%	passed
5	Mouth Openness: Percentage of years mouth open to an average annual depth of 0.7 metres (-0.7 m AHD) or more	Jul	Jun	95%	84%	97%	97%	passed

Note: The frequency columns have been colour coded to show events that exceed the target in green, and events that do not meet the target in orange.

Table 11. Net increase in number of successful events and maximum duration of dry spells for each SFI (from MDBA, 2014)

	Indicator Description	Minimum consecutive days	Start month	End month	NUMBER OF SUCCESSFUL EVENTS Interim Benchmark	Proposal	Net increase	MAXIMUM DRY SPELL (YEARS) Interim Benchmark	Proposal	Net increase
MURRAY - BARMAH-MILLEWA FOREST										
B1	12.5 GL/d for 70 days	7	Jun	Nov	89	89	0	4	4	0
B2	16 GL/d for 98 days	7	Jun	Nov	59	62	3	6	6	0
B3	25 GL/d for 42 days	7	Jun	Nov	53	53	0	6	6	0
B4	35 GL/d for 30 days	7	Jul	Jun	41	42	1	14	14	0
B5	50 GL/d for 21 days	7	Jul	Jun	19	21	2	22	22	0
B6	60 GL/d for 14 days	7	Jul	Jun	14	15	1	22	22	0
B7	15 GL/d for 150 days	7	Jun	Dec	41	41	0	9	9	0
MURRAY - GUNBOWER-KOONDROOK-PERRICOOTA										
G1	16 GL/d for 90 days	7	Jun	Nov	76	76	0	6	6	0
G2	20 GL/d for 60 days	7	Jun	Nov	75	75	0	6	6	0
G3	30 GL/d for 60 days	7	Jul	Jun	44	43	-1	11	13	2
G4	40 GL/d for 60 days	7	Jul	Jun	25	26	1	21	17	-4
G5	20 GL/d for 150 days	7	Jun	Dec	31	31	0	14	14	0
MURRAY - HATTAH-KULKYNE LAKES										
H1	40 GL/d for 60 days	7	Jun	Dec	52	53	1	9	9	0
H2	50 GL/d for 60 days	7	Jun	Dec	34	38	4	13	13	0
H3	70 GL/d for 42 days	7	Jun	Dec	22	22	0	21	21	0
H4	85 GL/d for 30 days	7	Jul	Jun	14	15	1	22	22	0
H5	120 GL/d for 14 days	7	Jul	Jun	10	11	1	22	22	0
H6	150 GL/d for 7 days	7	Jul	Jun	7	7	0	24	24	0
MURRAY - RIVERLAND CHOWILLA FLOODPLAIN										
C1	20 GL/d for 60 days	60	Aug	Dec	81	81	0	4	4	0
C2	40 GL/d for 30 days	7	Jun	Dec	65	65	0	9	9	0
C3	40 GL/d for 90 days	7	Jun	Dec	44	45	1	13	13	0
C4	60 GL/d for 60 days	7	Jun	Dec	31	31	0	19	19	0
C5	80 GL/d for 30 days	7	Jul	Jun	15	15	0	22	22	0
C6	100 GL/d for 21 days	1	Jul	Jun	9	10	1	22	22	0
C7	125 GL/d for 7 days	1	Jul	Jun	6	6	0	34	34	0
MURRAY - EDWARD WAKOOL RIVER SYSTEM										
E1	1,500 ML/d for 180 days	1	Jun	Mar	106	106	0	4	4	0
E2	5 GL/d for 60 days	7	Jun	Dec	74	74	0	4	4	0
E3	5 GL/d for 120 days	7	Jun	Dec	38	42	4	13	13	0
E4	18 GL/d for 28 days	5	Jun	Dec	19	21	2	22	22	0
E5	30 GL/d for 21 days	6	Jun	Dec	14	16	2	22	22	0
LOWER DARLING - LOWER DARLING FLOODPLAIN										
D1	7 GL/d for 10 days	10	Jan	Dec	67	66	-1	7	7	0
D2	17 GL/d for 18 days	18	Jan	Dec	25	25	0	29	29	0
D3	20 GL/d for 30 days	30	Jan	Dec	11	11	0	29	29	0
D4	25 GL/d for 45 days	45	Jan	Dec	9	9	0	29	29	0
D5	45 GL/d for 2 days	2	Jan	Dec	8	8	0	29	29	0

Note: 'Successful events' are those that achieve the intended hydrologic conditions of each SFI. Given that a variety of other non-flow related factors influence whether an event achieves the intended ecological response, a hydrological 'successful event' should not be interpreted as necessarily being an ecologically successful event.

3.4. Third party impacts

Third party impacts arise when individuals, who were not involved in a decision by others to undertake an action, incur costs (or benefits) as a result of that action. Third party impacts, which are also sometimes called externalities, are often a point of concern in water resource management when transactions between two willing parties such as a water trade, may give rise to an impact on a "third party" not involved in the transaction.

Projects such as this one, which proposes changes in the operating rules for Hume Dam, will inevitably give rise to a range of concerns about the potential for such changes to create third party impacts. The key areas where concerns may arise have been identified as relating to the overall reliability of water entitlements, specific impacts that changing pre-release rules may have on entitlements that are affected by reservoir spills and the effects that the proposed rule change may have on flood behaviour and frequency downstream of Hume Dam. Additionally, with a complex supply system such as the River Murray, changes in the operation of Hume Dam can have the potential to create flow on changes in other areas such as operation of Lake Victoria and management of the quality and quantity of flows to South Australia.

3.4.1. Entitlement reliability

The key element of the proposed operating rule change is to explicitly include estimates of future environmental demands into the setting of target storage volumes and the planning of pre-releases.

This has the effect of reducing the volume of pre-releases that would occur in future once large volumes of water are recovered for the environment, compared to the situation that would prevail if the existing rule that only considered irrigation releases continued to be applied. Figure 6 and Figure 7 examine the volume and pattern of pre-releases with and without this rules change.

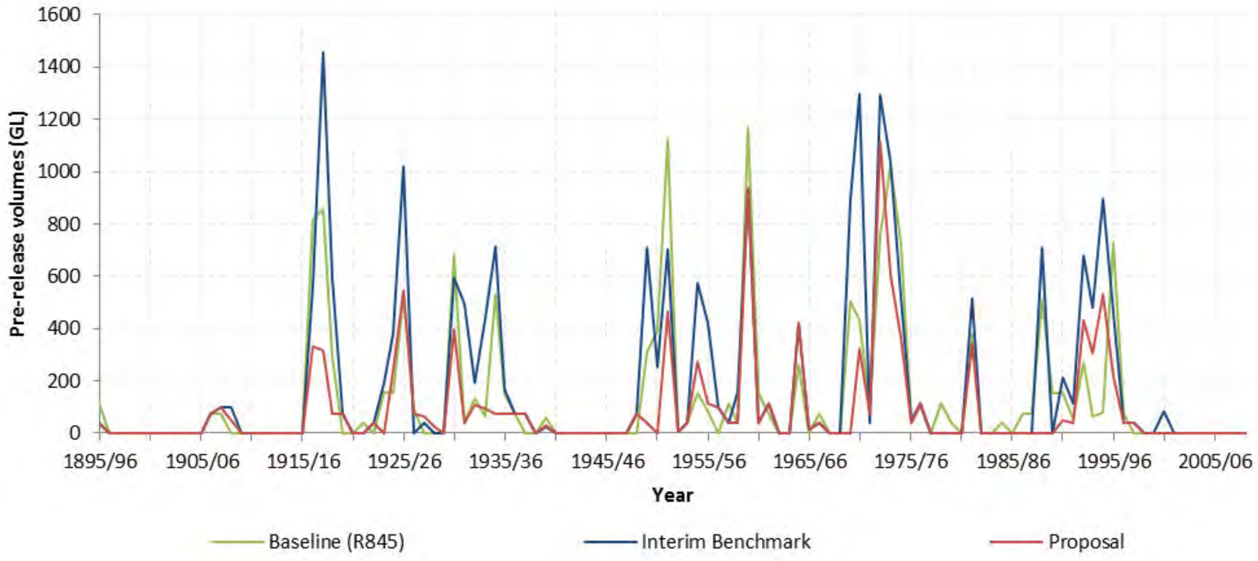

Figure 6. Total pre-releases from Lake Hume in each season

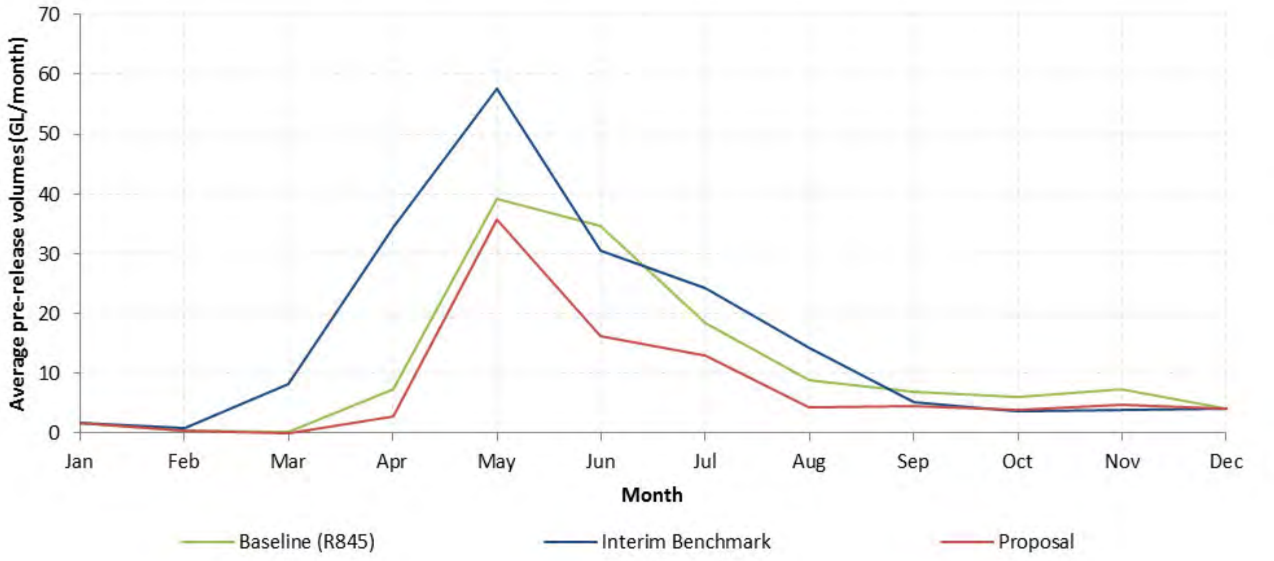

Figure 7. Monthly averaged pre-releases from Lake Hume

Once water is pre-released from Lake Hume, it is not able to be included in the assessments of water available to NSW and Victoria (known as state shares) under the water sharing arrangements in the Agreement. The water available to NSW and Victoria under state shares is used to first meet the shared obligation to provide South Australia's entitlements, and then is available for allocation against retail entitlements issued by each jurisdiction.

Since the overall impact of reduced pre-release volumes is to retain more water in storage, this is expected to be positive in relation to the water available for allocation to water entitlements compared to the situation that would apply if the rule change wasn't implemented.

Modelling has shown some minor variations in a number of statistics associated with water availability compared to the baseline/benchmark conditions but overall confirmed that there are no significant impacts on reliability[16].

Focusing too much on model outcomes associated with system reliability for individual projects can be misleading as the model outcomes associated with these estimates may well vary when packaged and modelled with other projects. This outcome occurs because projects interact with each other. In some cases, the positive impacts of one project will be magnified by the positive impacts of another. In other cases, the reverse occurs where the positive impacts of one project will be diminished when modelled collectively with one or more other projects.

3.4.2. Spillable water accounts

There are a number of water accounts held in MDBA reservoirs that are debited when water spills from the storage. These spillable accounts exist at the wholesale and retail water accounting levels. Examples of spillable water accounts at the wholesale level include:

- South Australia's Storage right
- Barmah-Millewa Forest Environmental Water Allocation
- River Murray Increased Flows in Hume account.

[16] Note, DELWP are providing the detailed results and data from the modelling to relevant jurisdictions to inform the assessment of this business case

At the retail level, allocations against several types of entitlement can be debited in response the amount of spill that occurs. These accounts include:

- NSW Adaptive Environmental Water Accounts
- Victorian Spillable Water Accounts.

Debits to these accounts occur as a result of a physical spill from the storage, and may also follow from internal spills from the Victorian or NSW half share of the reservoir volume, depending on the rules governing the specific entitlement type.

As noted above, the fundamental effect of the proposed rule change is to reduce the volume of pre-releases that would occur in future once large volumes of water are recovered for the environment, compared to the situation that would occur if the existing rule that only considered irrigation releases continued to be applied.

Since pre-releases are treated as spills for water accounting purposes, this proposed rule change can be expected to be positive from the point of view of its impact on any water accounts.

In addition to pre-release volumes, the other flows that result in debits to spillable water accounts are physical spills from the storage. Under both the benchmark and the proposed rule change, physical spills are expected to be lower than experienced under baseline conditions (Table 2). Figure 8 shows a comparison of average monthly spill volumes.

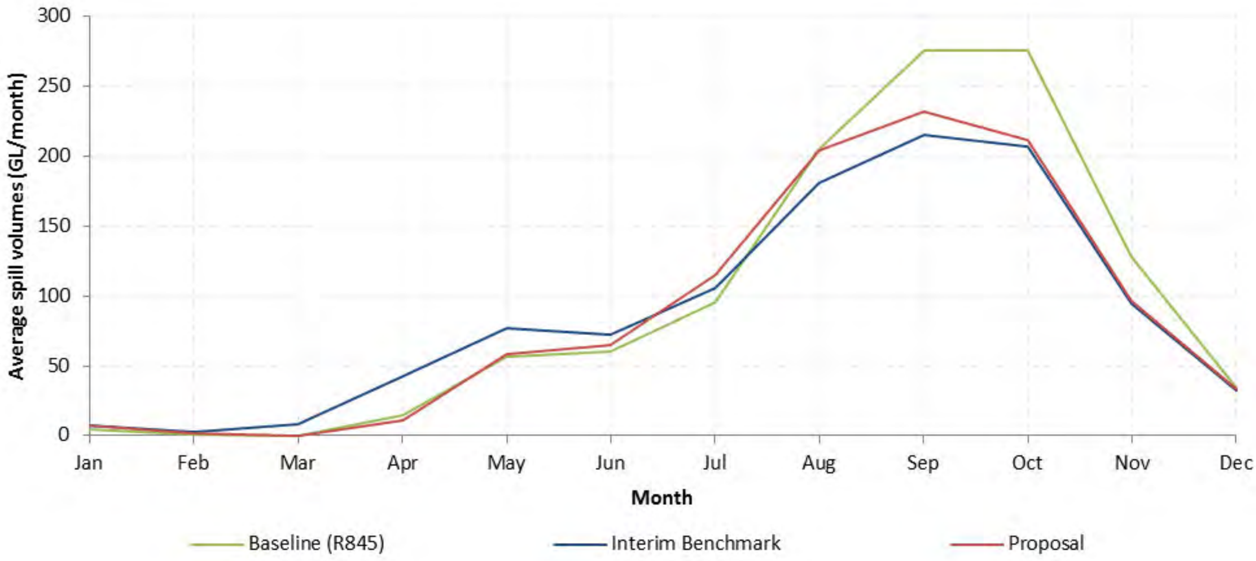

Figure 8. Monthly averaged spills from Lake Hume

In relation to internal spills, it is quite complex to assess the effects on the proposal of internal spill behaviour. Nevertheless, the fact that significant environmental demands will be released in winter-spring (which does not occur under the baseline conditions) in combination with the overall decrease in average pre-release volumes and spill volumes suggests that there is unlikely to be significant adverse effects on internal spill behaviour.

This is not to suggest that the behaviour of the system will remain static and pre-releases and spills will not change in future. Factors such as demand patterns and the timing and size of inflow events will inevitably impact on the amount of pre-release required and the level of uncontrolled spills that also occur. The key consideration here is that regardless of the underlying trends in pre-releases and spills due to these macro-influences, the proposed rule change will more accurately include future total water demands in storage target level planning, and will therefore mean that overall pre-releases will be lower than if likely environmental demands were not included in operational planning. This is also borne out by the modelling comparisons set out in Table 2.

3.4.3. Flood mitigation downstream of Hume Dam

Historically, the flood mitigation benefits available to communities downstream of Hume Dam have been provided subject to the storage being able to meet its primary water supply functions. As noted in Section 2 the general principles that have guided flood mitigation and airspace management activities are that they are provided to the extent possible, subject to firstly protecting the security of the assets, and then secondly maximising the water available at the end of the relevant flooding episode.

For Hume Dam, this principle will continue to guide airspace management and flood mitigation operations. The proposed rule change incorporates the shifts in the source of demand for releases from Lake Hume by including estimated environmental releases together with estimated irrigation releases in the determination of target storage levels.

This ensures the same principles will govern the management of airspace at the storage in future as have been applied in the past. Communities adjacent to the river should be indifferent to whether a release being used in planning target storage levels is for irrigation use, environmental use or urban use.

Modelling indicates that the proposal will result in slightly fewer days of overbank flows between Hume and Yarrawonga (i.e. flows in excess of 25,000 ML/d) compared to the benchmark conditions over the course of the year (Figure 9). The number of days of overbank flow is reduced in autumn in particular, but this decrease is somewhat offset by a marginal increase in overbank flow frequency in spring, resulting in an overall average reduction throughout the year from 41 to 39 days (Figure 9).

Modelling also indicates that the number of days of minor flooding (i.e. flows in excess of 44,000 ML/d) marginally increases under the proposal compared to the benchmark, from an average of 7.7 days/year to 8.4 days/year (Figure 10). This increase is typically during the spring period.

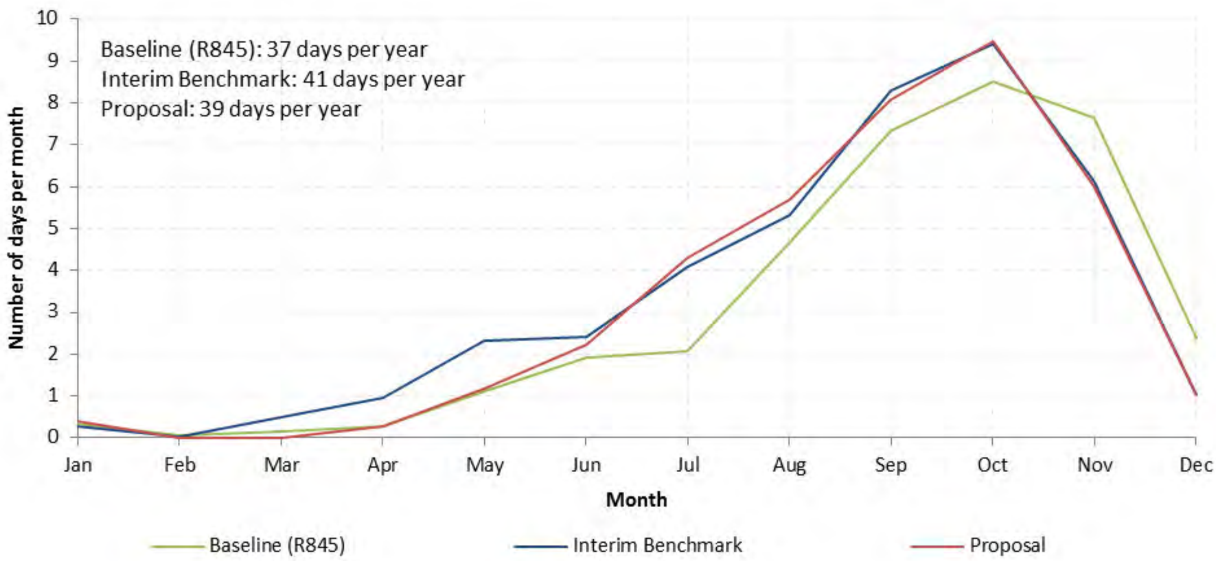

Figure 9. Average number of days per month with flows in excess of 25,000 ML/d at Doctors Point

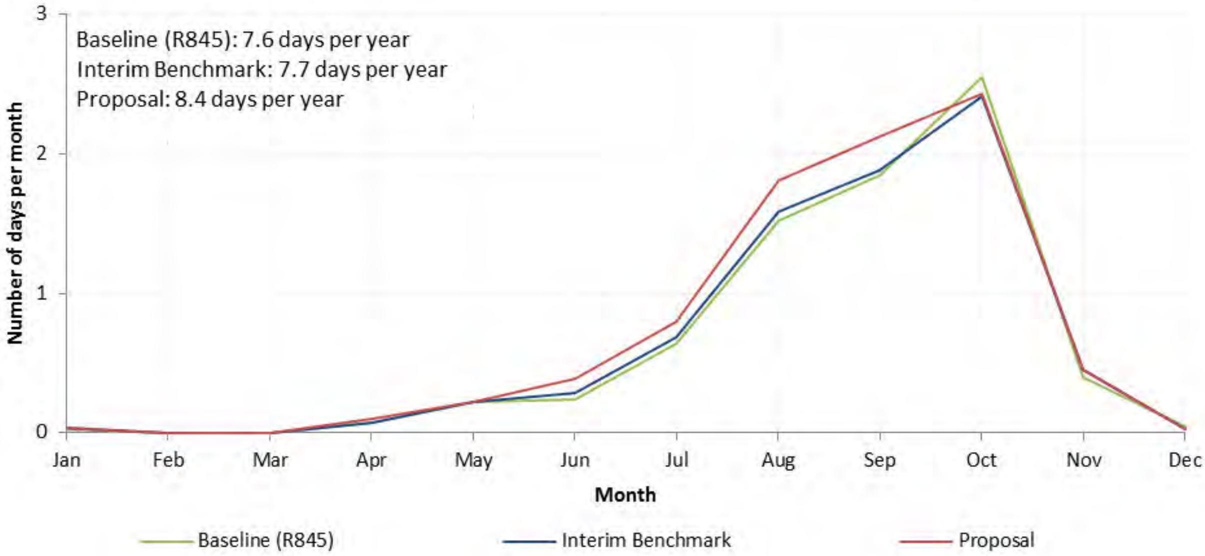

Figure 10. Average number of days per month with flows in excess of 44,000 ML/d at Doctors Point

From a practical implementation perspective, the quality of future release forecasts will determine the usefulness of long term determinations of storage level targets. The MDBA will need to ensure it continues to develop the techniques for forecasting environmental demands to improve the accuracy of their forecasts. It will also need to continue to do the same for future irrigation demands as they change in response to the recovery of water for the environment and changes in the structure of irrigated agriculture.

The other broader implication of increasing environmental deliveries is that in future these large releases will often be triggered by catchment flow events in spring. Historically, wetter spring periods have generally been associated with low irrigation demands. This is likely to mean that in future, managed releases from Lake Hume are likely to be higher in the spring than previously. It is anticipated that these releases will seek to extend the duration of flow events within the agreed constraint levels on regulated releases from Lake Hume.

Modelling supports this finding, demonstrating that adoption of the Basin Plan, with or without the proposed SDL Adjustment, will result in higher flows downstream of Hume Dam in June, July, August and September than occurred previously (Figure 11). This will contribute to the creation of airspace and therefore maintaining or potentially enhancing flood mitigation for minor flooding downstream of the storage. The MDBA will also continue to manage its operational practices to balance the provision of flood mitigation benefits with enhancing environmental outcomes and providing for recreational activities.

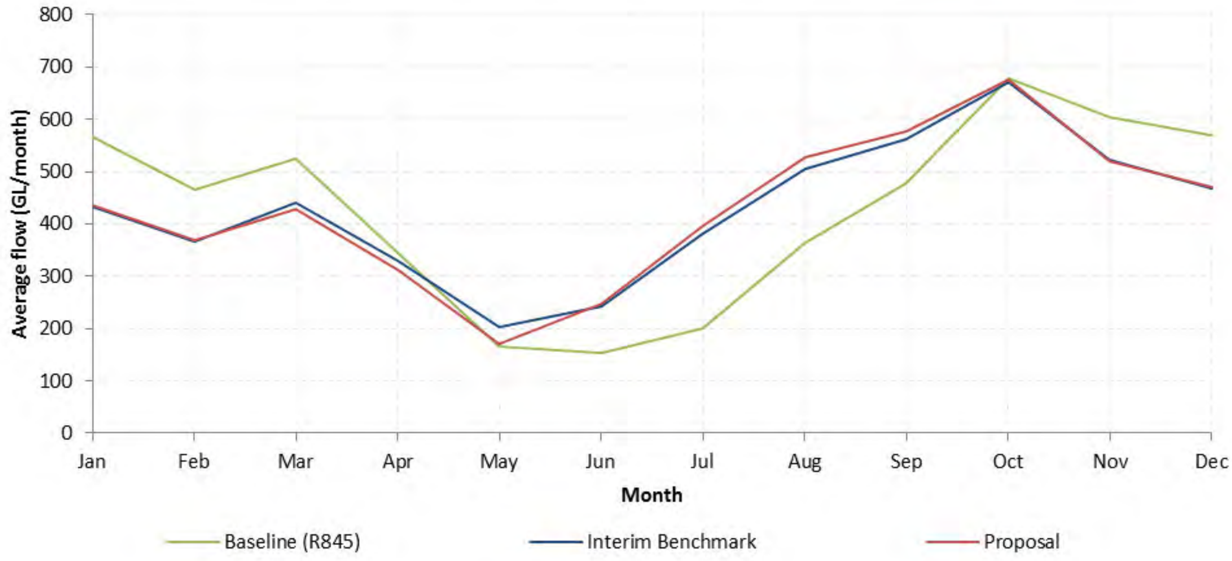

Figure 11. Average monthly flow at Doctors Point

3.4.4. Flows to South Australia

Given the distances involved, specific changes to flow patterns immediately downstream of Lake Hume are somewhat attenuated by the time they reach the South Australian border. Figure 12 shows that under both the benchmark and the proposed rule change, monthly flows to South Australia are considerably higher than the historic situation represented by the baseline. Average annual flows to South Australia under the proposed rule change are equivalent to those under the benchmark conditions, while the timing of flows sees a slight increase in spring and slight decrease in autumn (Figure 12).

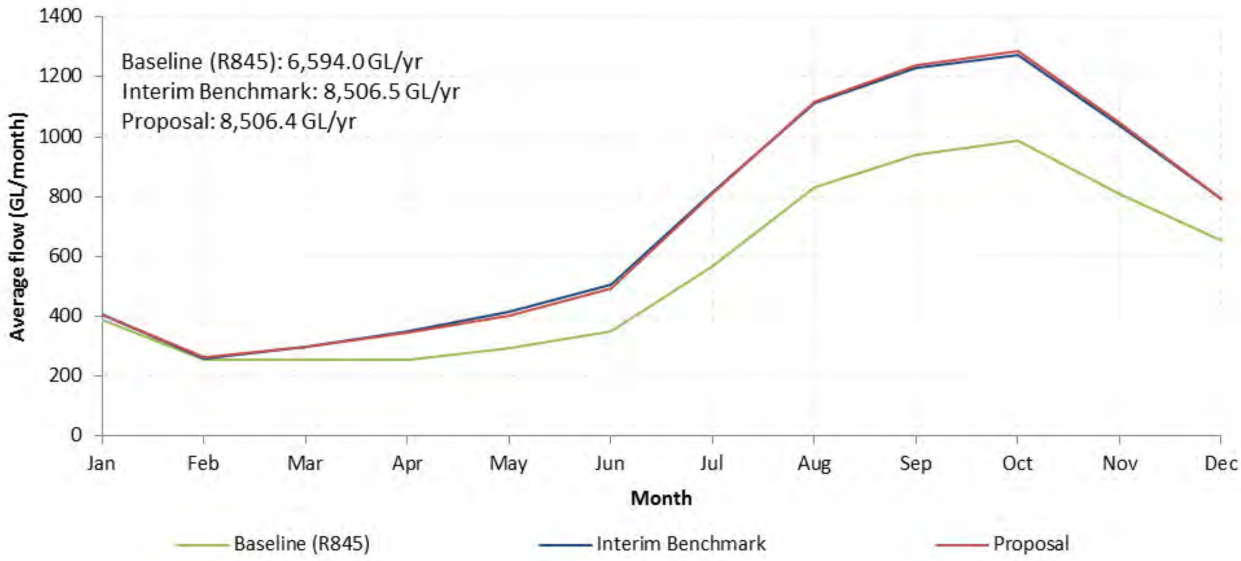

Figure 12. Average flow to South Australia each month

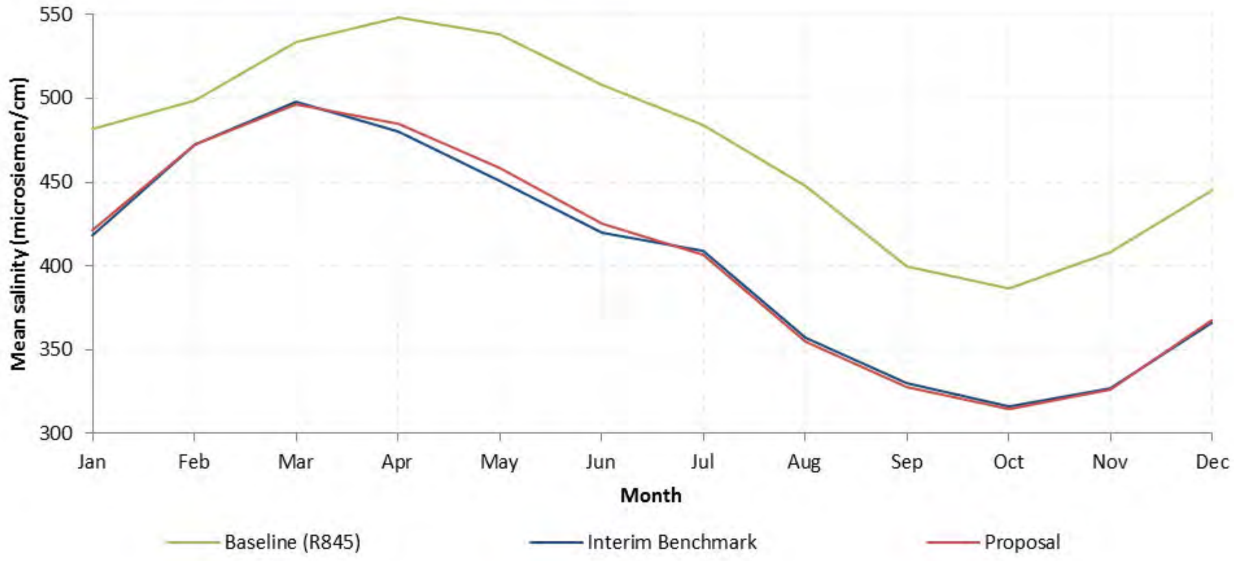

Figure 13. Mean salinity levels at Morgan each month

The benchmark and the proposed rule change also demonstrate the improved salinities associated with higher flows to South Australia for environmental purposes compared to the baseline (Figure 13, Figure 14). Salinities under the proposed rule change are very similar to the benchmark conditions, with a slight increase in salinity in autumn and slight decrease in spring (Figure 13). Figure 14 shows the annual 95th percentile salinities at Morgan.

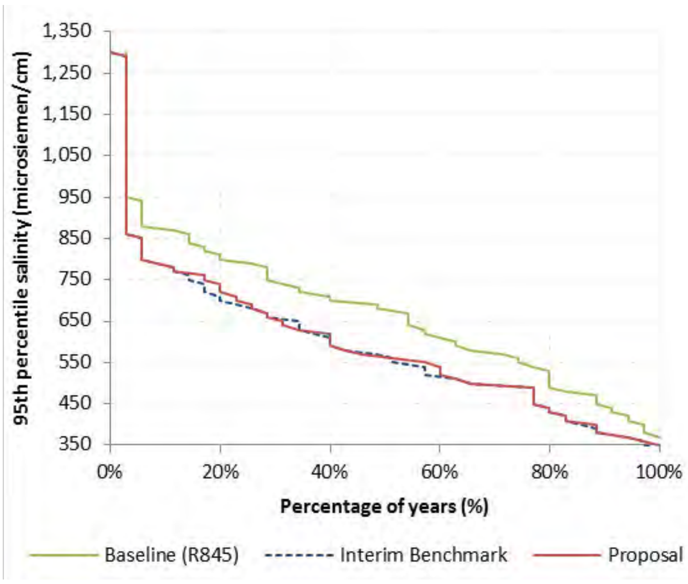

Figure 14. Percentage of years that the annual 95th percentile salinity level at Morgan exceeds a given level

Figure 15 shows that the performance of Lake Victoria is also very similar under both the benchmark and the proposed rule change. These options both see Lake Victoria generally holding more water than would have been the situation under the historic baseline conditions.

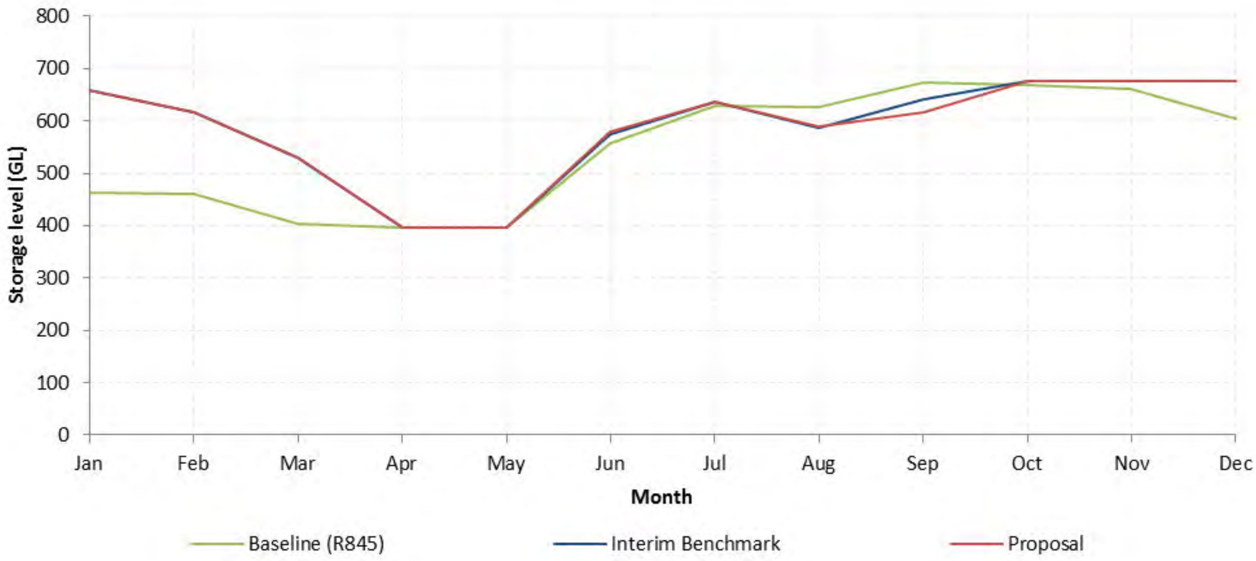

Figure 15. Storage levels in Lake Victoria in each year

In addition to the above analysis of flow rates and salinity levels, South Australian representatives suggested a broader and more detailed suite of modelling output metrics for consideration in this business case. Appendix 2 provides the detailed results of the assessment against each matter raised by the South Australian representatives. Appendix 2 demonstrates that on every measure of flow and salinity the proposal provides conditions that are equivalent to the benchmark conditions, aside from an improvement identified for the maximum salinity in the Coorong Southern Lagoon. When compared to the baseline, the proposal provides an improvement on every measure.

3.5. Outcomes conclusions

The assessment of the outcomes of the project suggests that the proposed change will generate greater environmental benefits than were estimated for the benchmark model.

Overall, the proposal’s effects on entitlement reliability are generally very similar to those expected under the benchmark conditions. Holders of water entitlements in the storage should see a slight increase in the security of the entitlements compared to baseline conditions as:

- The reduction in pre-releases should mean a larger volume is retained in storage benefiting the allocation available for all entitlement holders
- An increase in releases for the environment in late winter and early spring should mean that there is greater airspace in the storage to capture higher flows in the spring which then add to the volume available for later allocation.

Landholders downstream should see no significant alteration in the risks of inundation.

4. Stakeholders

4.1. Engagement process

All agencies materially affected by the proposal have been consulted in the development of this business case. These agencies include:

- Murray-Darling Basin Authority
- Water NSW
- Office of Environment and Heritage (NSW)
- NSW National Parks and Wildlife Service
- Parks Victoria
- Department of Environment (Commonwealth)
- Department of Environment, Water and Natural Resources (South Australia)
- Victorian Environmental Water Holder
- Goulburn Broken Catchment Management Authority (CMA)
- Goulburn-Murray Water.

A workshop was held on 15 January 2015 (at DELWP Attwood) and representatives of the state and Commonwealth agencies listed above were informed of the proposal for changes to the management of Lake Hume airspace and invited to attend. All agencies were represented at the workshop, except for apologies from the NSW National Parks and Wildlife Service and Goulburn Broken CMA. Goulburn Broken CMA was subsequently consulted on the detailed proposals. The workshop attendees identified the potential risks of this proposal and interested stakeholder groups. The risks identified in the workshop have been addressed in this business case (Section3).

Due to the scope and scale of the proposal (operational rule changes), DELWP has not embarked on a detailed consultation process with local landholders and interest groups. Engagement undertaken to date has involved consultation with key agencies and providing information to other interested parties on the proposal.

It is prudent, given the larger scale of this SDL adjustment measure (as opposed to a works measure for example), to undertake further consultation with other interested groups following approval of this business case. This approach is recommended as the likely concerns of other groups relate to not just this one proposal, but the broader SDL adjustment process and the interaction with other proposed measures. A targeted and well planned engagement process that includes broader engagement on the topic of SDL adjustment in the Basin is recommended if this measure is to proceed beyond this business case. It is recommended that the consultation should take place once the proposed package of operational rules changes has been confirmed and their interactions assessed.

DELWP proposes to engage further with key stakeholders, in collaboration with partners in SDLAAC including MDBA and Commonwealth, and has costed engagement into this business case (Section 2.4). Costing includes:

- Development of detailed engagement plan
- Meetings with interested groups (see Section 4.2).

4.2. Stakeholder map

Table 12 lists the interested stakeholders with an interest in this proposal. Engagement with all stakeholders listed is proposed following approval of this business case.

Table 12. Map of agencies, groups and individual stakeholders with an interest in the SDL adjustment proposal, including their interface with proposal and potential areas of concern

Stakeholder	Role / responsibility	Interface with the proposal	Likely areas of concern	Awareness of proposal
Murray-Darling Basin Authority	Operations planning Constraints management Hydrological modelling Water policy	River operator The Living Murray coordinator / icon site management	Impacts to state water shares Operational planning and management of Lake Hume Achievement of ecological outcomes	Consulted in development of business case
NSW Office of Water	Water policy/planning and water resource allocation	Water resource manager	Impacts on state water shares Impacts on NSW water users and riparian communities	Consulted in development of business case. Co-sponsor of proposal
Water NSW	Local storage operations	Water manager	Impacts to other water users	Consulted in development of business case
Office of Environment and Heritage (NSW)	NSW Environmental policy/planning	Environmental water planning	Achievement of ecological outcomes Interface with other environmental water use	Consulted in development of business case
Department of Environment (Commonwealth)	Support management of Commonwealth environmental water portfolio	Environmental water planning	Achievement of ecological outcomes Interface with other environmental water use	Consulted in development of business case
Department of Environment, Water and Natural Resources (South Australia)	Management of water and environment (South Australia)	Water planning Downstream water user	Implications of proposal on downstream assets and water supply	Consulted in development of business case

Stakeholder	Role / responsibility	Interface with the proposal	Likely areas of concern	Awareness of proposal
			(quantity and quality)	
Commonwealth Environmental Water Holder	Management of Commonwealth environmental water portfolio	Environmental water planning	Achievement of ecological outcomes Interface with other environmental water use	Aware of proposal
Goulburn-Murray Water	Storage operator. Victorian water entitlements and allocation	Allocations and water system planning	Impacts to Victorian water allocations and entitlements, Implications for future management of Victorian storages	Consulted in development of business case.
Victorian Environmental Water Holder	Management of environmental water entitlements (Vic)	Environmental water planning	Achievement of ecological outcomes Interface with other environmental water use	Consulted in development of business case
Goulburn Broken CMA North East CMA Mallee CMA	Waterway manager	Environmental water planning	Achievement of ecological outcomes	Consulted in development of business case
Murray Local Land Services	Catchment manager - NSW	Catchment management	Interface with land assets	Aware of proposal To be engaged following approval of business case
NSW National Parks and Wildlife Service	Land manager (NSW)	Land manager – downstream sites	Site management implications	Aware of proposal To be engaged following approval of business case
Parks Victoria	Land manager (Victoria)	Land manager – downstream sites	Site management implications	Aware of proposal To be engaged following

Stakeholder	Role / responsibility	Interface with the proposal	Likely areas of concern	Awareness of proposal
				approval of business case
NSW Fisheries	Fishery stock manager	Stock management - Lake Hume, River Murray	Impacts of proposal on fisheries	Aware of proposal To be engaged following approval of business case
Local councils • Moira • Wodonga • Indigo • Albury • Greater Hume • Corowa • Berrigan • Murray River Group of Councils (MRGOC) • Riverina & Murray Region of Councils (RAMROC)	Local government authorities	Local asset manager (levees, roads etc.)	Flooding of local assets	Aware of proposal To be engaged following approval of business case
Environment groups: • Wentworth Group • Australian Conservation Foundation • Victorian National Parks Association • Environment Victoria • Goulburn Valley Environment Group • Inland Rivers Network • NSW National Parks Association • 'Friends of' groups	Environmental advocates	Ecological outcomes at a local, reach and basin-scale	Achievement of ecological outcomes	Aware of proposal To be engaged following approval of business case
Local action groups: • Murray River Action Group • Bullatale and Wakool community groups	Local community advocates	Represent local community	Third party impacts of proposal	Aware of proposal To be engaged following approval of

Stakeholder	Role / responsibility	Interface with the proposal	Likely areas of concern	Awareness of proposal
• Hume/Yarrawonga Advisory Committee • Coorong Lower Lakes Murray Mouth Community Advisory Panel				business case
Irrigation groups: • Murray Irrigation • Southern Riverina Irrigators • NSW Irrigators Council • South Australia Water Recovery Advisory Group • Goulburn-Murray Water - Water Services Committees • Victorian Farmers Federation	Irrigator advocates	Impacts on irrigator water rights at a local, reach and basin-scale	Interface with irrigation water demand Share of storages Flooding impacts	Aware of proposal To be engaged following approval of business case
Local State & Federal members	Local community advocates	Represent local community	Third party impacts of proposal	To be engaged following approval of business case
Indigenous groups	Advocate for indigenous water and cultural interest	Changes to watering on sites of indigenous significance	Impacts on indigenous land and water use	To be engaged following approval of business case

5. Project delivery

5.1. Project delivery risks

The overarching approach and methodology to the risk assessment requirements of the Phase 2 Guidelines are more fully set out in Sections 3.1 and 3.2 above. That also reports on the review of risks related to adverse ecological impacts and risks from operation of the measure. This section reports on the risks related to the development and delivery of the project.

Appendix 8 of the Guidelines confirms that the primary risks anticipated for 'Project development and delivery' are:

- design risks
- risks to project completion on time
- the risk of project failure
- the inability to deliver the project within budget.

These risks are applicable where works and measures require the construction of major infrastructure. However, these risks are largely immaterial for this proposal as the business case involves an operating rule change.

The main sources of risk for this project are associated with the effective engagement with stakeholders and the provision of appropriate information to resolve any concerns associated with potential third party impacts. Section 4 outlined a proposed stakeholder engagement strategy. The implementation of that strategy is outside the terms of this business case.

The minor project development and delivery risks are described in more detail, together with the proposed mitigation actions in Table 13. The proposed mitigation actions are expected to be able to reduce all identified risks to acceptably low levels.

Table 13. Risk assessment and mitigation actions

	Risk	Potential issue	Risk assessment (prior to mitigation)			Mitigation actions
			Likelihood	Consequence	Risk rating	
1	Failure to engage effectively	Stakeholder communities are not engaged in information/consultation processes, resulting in opposition to proposed changes such that project doesn't proceed.	Likely	Moderate	Medium	Well-designed stakeholder engagement program, including the following features: • Interactions held close to affected stakeholders • Timing designed to facilitate attendance by interested parties. • Alternative opportunities and accessible information available for individuals that can't attend interactions. • Meeting program well communicated/advertised, and linked to existing community networks.
2	Community opposition to measures	Community members attend engagement interactions, but are not convinced that proposals are sound/without acceptable impacts and project is opposed.	Likely	Moderate	Medium	Communication and consultation information/interactions carefully designed to clearly communicate issues: • Advice/input gained from experienced agency staff on likely key issues and material designed to clearly address possible questions/concerns. • Preliminary consultation undertaken to test material and approach with stakeholder leaders. • Consultation interactions are delivered by senior staff experienced in these issues. • Issues raised in interactions are logged and feedback provided on how they have been addressed/resolved. • Ensure engagement takes balanced position to cover positive and negative outcomes of changes.

	Risk	Potential issue	Risk assessment (prior to mitigation) Likelihood	Consequence	Risk rating	Mitigation actions
3	Legal/ legislative risks	BOC unable to reach agreement that the measures should be implemented.	Unlikely	Moderate	Medium	• Thorough development of proposals and review by SDLAAC. • Engagement of state agency representatives in business case development. • Extensive stakeholder engagement program design to identify issues and allow them to be addressed. • Detailed modelling and review by Water Liaison Working Group to provide confidence measures will deliver expected benefits.
4	Modelling of environmental demands	Suitably accurate relationships can't be developed to forecast environmental demands to the satisfaction of all stakeholders concerned about impacts.	Possible	Moderate	Medium	• Initial modelling undertaken by MDBA has developed proof of concept to point where it can be modelled. • Project implementation cost estimates allow for specialist consultancy inputs to develop details of forecasting methods required for implementation. • Will only affect longer term target storage level determination. • Setting target levels for the coming 1-2 months will use best estimates of likely demand provided by env. managers and state water agencies (irrigation) rather than modelled forecasts, so method and rule change should still be robust, despite limitations on accuracy of forecasts.

	Risk	Potential issue	Risk assessment (prior to mitigation)			Mitigation actions
			Likelihood	Consequence	Risk rating	
5	Project delivery	Detailed development of design of operational changes cannot be undertaken in a timely fashion, so project fails to proceed with other measures.	Possible	Moderate	Medium	• Roles and responsibilities for project development and implementation clearly assigned within MDBA and jurisdictions. Project manager assigned to manage delivery program. • Project implementation cost estimates allow for specialist consultancy inputs to develop details of forecasting methods required for implementation. • Integration of consultation with wider programs for SDL adjustment and constraints program will minimise calls on staff time for stakeholder engagement and ensure project advances in parallel with other elements of a "package" • Initial MDBA modelling and assessment of measures completed.

5.2. Legal and regulatory requirements

Once a package of SDL measures is approved under the provisions set out in the Basin Plan and the Intergovernmental Agreement on Implementing Water Reform in the Murray Darling Basin (2013), this rule change can be implemented.

As detailed in Section 2, the proposed rule change is consistent with the provisions of the Agreement and the general objectives and outcomes and the specific Lake Hume objectives and outcomes set out in the O&O document approved by BOC.

The key changes that would be required to implement the rule change are:

- Detailed procedures and manuals will need to be updated to reflect the approved rule change. It is expected that these changes will fall within the delegated authority of MDBA senior officers.
- The MDBA's water resource assessment model (and probably the water accounting model) will need to be updated to reflect the approved rule change for determining target storage levels and pre-release volumes. The specific objectives and outcomes in the O&O document incorporate specific provisions around the updating of these models, which will need to be followed. This will require the detailed proposed changes to the model to be reviewed and endorsed by the MDBAs inter-jurisdictional Water Liaison Working Group. For a change of this nature, it is likely that the specific changes proposed to these key river management models would also need to then be referred to BOC for formal approval.

The operational arrangements for the River Murray system are continually evolving and amendments to the operational procedures and water resource assessment and accounting models occur from time to time. Consequently it is not anticipated that there will be any significant legal or regulatory approval barriers to implementation of this rule change, once the change has been adopted as a SDL adjustment measure.

5.3. Governance and project management

This operational rule change will require actions to be undertaken by and within the MDBA, so it is appropriate that the MDBA should assume project management responsibilities for implementing the change once it has been approved as a SDL adjustment measure.

Whilst the allocation of specific project management roles and responsibilities is a matter for the MDBA, it is suggested that these would be best undertaken within the River Management Division, probably through the operation group.

This rule change has significant similarities to other rule change processes that are frequently undertaken by the Operations group. The usual model for managing these changes is for the Water Liaison Working Group to monitor project progress and provide advice to the MDBA on issues that may arise, under the overarching oversight of BOC which will exercise formal governance responsibilities in relation to approval of specific rule changes affecting river operations. This well-developed governance process, which is codified through the Agreement and O&O document, is an efficient, effective approach to overseeing the implementation of the proposed rule change.

5.4. Monitoring and evaluation

The key monitoring and evaluation requirements are to ensure that the approved rule change is being implemented in accordance with the approved provision in the O&Os and the operating procedures, and that it is working as intended in relation to improving the management of Lake Hume airspace.

The O&O document already incorporates provisions for an annual independent review of the MDBA's performance in river operations activities and that their compliance with the general and specific outcomes and objectives for river operations practices has regard to any matters that are relevant.

This annual review can and should incorporate review of the implementation and application of the proposed rule change. The review process also supports continuous improvement of operational practices, which occur as the MDBA reviews and reports on its own performance and then addresses any recommendations arising from the independent review.

More broadly, the final monitoring and evaluation plan (MEP) for this supply measure will be informed by broader intergovernmental arrangements for Basin-wide monitoring and evaluation under the Basin Plan. This measure is expected to contribute to the achievement of outcomes under two key Chapters of the Plan, namely:

i) the delivery of ecological outcomes under Chapter 8; and

ii) under Chapter 10, meeting the relevant sustainable diversion limit/s, which must be complied with under the states' relevant water resource plan/s (WRPs) from 1 July 2019.

While the MDBA has specific responsibilities regarding evaluation of outcomes at the Basin scale, the states are responsible for reporting on relevant matters once implementation of specific Basin Plan Chapters commence within a state. With regard to this supply measure, this will include five yearly reporting on environmental outcomes at an asset scale (Chapter 8), and annual reporting on WRP compliance (Chapter 10). Victoria's participation in the MDBA's monitoring and evaluation framework will effectively allow for outcomes under both Chapters to be effectively assessed and reported.

This approach closely aligns with agreed arrangements under the *Basin Plan Implementation Agreement*, where implementation tasks are to be as streamlined and cost-efficient as possible.

6. Conclusion

This business case confirms that the proposed operating rule change will achieve the intended aim of incorporating consideration of forecast environmental demands in the planning of target storage volumes and pre-releases from Lake Hume.

That will allow a reduction in pre-release volumes from Lake Hume, without increasing spill volumes, resulting in more water being available in Lake Hume for allocation against entitlements to meet irrigation and environmental demands. The proposed rule change also result in significantly improved environmental outcomes compared to the benchmark modelling, utilising the same 2,750 GL of environmental water recovery. This creates the potential for this rule change to make a positive contribution to a package of measures that could be assessed for SDL adjustment opportunities, and modelling studies have confirmed the potential for this rule change to contribute significantly to SDL adjustment volumes.

Modelling has identified that third party impacts will be broadly neutral or positive in outcome, with reliability of entitlements being maintained without significant impacts as a result of this proposal. Under the proposal overall annual average volumes of pre-release and spill from Lake Hume are reduced, indicating there is unlikely to be an adverse impact on spillable water accounts held in the storage. Modelling also indicates that overall the proposal will result in slightly fewer days of overbank flows between Hume and Yarrawonga (i.e. flows in excess of 25,000 ML/d) compared to the benchmark conditions, with a marginal increase in the duration of flows above minor flood level at Doctor's Point.

Projected flows across the border to South Australia also meet current and projected values in terms of flow and water quality.

The project will be low cost to implement as a rule change and is subject to robust governance and project management controls.

The business case recommends that a comprehensive stakeholder engagement exercise is rolled-out to ensure community understanding and support for the proposal and minimise risk of local opposition.

7. References

CEWH 2014. About Commonwealth environmental water: http://www.environment.gov.au/water/cewo/about-commonwealth-environmental-water

CEWH 2015. Environmental water holdings: http://www.environment.gov.au/water/cewo/about/water-holdings

MDBA 2012. Hydrologic modelling to inform the Basin Plan: Methods and results, Feb 2012.

MDBA 2014a. Changes for the current Hume Airspace Management due to future demand conditions, MDBA Draft Technical Report No. 2014/23, Murray-Darling Basin Authority, Canberra.

MDBA 2014b. Objectives and Outcomes for River Operations in the River Murray System, Murray-Darling Basin Authority, Canberra

MDBA 2014c. River Murray from Hume Dam to Yarrawonga Weir Reach report: Constraints Management Strategy

SDLAAC 2014. Phase 2 Assessment Guidelines for Supply and Constraint Measure Business Cases

SKM 2013. Preliminary Modelling Investigation: Optimisation of Hume Dam Airspace Management and Pre-releases and Lake Hume to Lake Victoria transfers to Contribute to Environmental Outcomes. Prepared by SKM for DEPI, January 2013.

VEWH 2013. Seasonal Watering Plan 2013-14.

Appendices

Appendix 1. Summary of response to the Phase 2 Assessment Guidelines

This section confirms how this business case delivers against each of the relevant requirements of the SDLAAC Phase 2 Guidelines. The following table lists the requirements and then records where the issue is dealt with in this business case.

Table 14. Concordance - Phase 2 Guidelines and Business Case

Guidelines Section	Heading	Requirement	Business Case Section
3.1.1	Supply measure definition	Defines the requirements for supply measures to: • operate to increase the quantity of water • achieve equivalent environmental outcomes with a lower volume of water • have no detrimental impacts	2, 3.3 & 3.4
3.1.2	Measures not included in the benchmark conditions of development	Confirm that the measure was not in the benchmark conditions of development	1.4
3.2	Constraint measure requirements	Defines application of guidelines to constraint measure initiatives	Not applicable to this business case
3.3	Operational by June 2024	The measure must be capable of entering into operation by 30 June 2024	2.3
3.4.1	The measure is a 'new measure'	Confirm the measure has not received funding or have funding approved	1.4.5
3.4.2	Compliance with the purposes of the Water for the Environment Special Account	Defines funding eligibility for constraint measure initiatives	Not applicable to this business case
4.1	Project details	Key project details and overview	1 & 2
4.2	Ecological values of the site	Description of the ecological values of the site	2.2 & 3.3
4.3	Ecological objectives and targets	Confirm objectives and targets	2.2 & 3.3
4.4.1	Anticipated ecological benefits	proposed outcomes from the investment	3.3
4.4.2	Potential adverse ecological impacts	Assessment of potential adverse impacts	3.3

Guidelines Section	Heading	Requirement	Business Case Section
4.5.1	Current hydrology and proposed changes	Clear articulation of current and proposed hydrology	2.2 & 3.3
4.5.2	Environmental water requirements	Water requirements of new inundated areas	3.3
4.6	Operating regime	Explanation of the role of each operating scenario	2.3
4.7	Assessment of risks and impacts of the operation of the measure	Assessment of risks and mitigation options	3
4.8	Technical feasibility and fitness for purpose	Evidence that the project infrastructure is technically feasible	Not applicable to this rule change business case
4.9	Complementary actions and interdependencies	Confirm interaction with other initiatives	1.4
4.10	Costs, Benefits and Funding Arrangements	Detailed costing and listing of benefits	2.4 & 3
4.11.1	Stakeholder management strategy	Confirm stakeholder list and stakeholder management strategy	4
4.11.2	Legal and regulatory requirements	Legal and regulatory requirements	5.2
4.11.3	Governance and project management	Governance and project management	5.3
4.11.4	Risk assessment of Project Development and Delivery	Risks from project development and delivery	5.1
Appendix 6	Summary of key evaluation criteria	Listing of evaluation criteria and Guideline reference	All
Appendix 8	Categories of risk and impact that should be considered in business case development	Categories of risk and impact that should be considered in business case development	3 & 5.1

Appendix 2. Detailed assessment of matters raised by South Australia

Environmentally Sustainable Level of Take (ESLT) flow and salinity indicators for Coorong, Lower Lakes and Murray Mouth	Baseline	Interim Benchmark	Proposal
Average salinity (g/L) in Coorong southern lagoon over model period	62	41	41
Maximum salinity (g/L) in Coorong southern lagoon over model period	291	91	90
Max period (days) salinity in Coorong southern lagoon is greater than 130 g/L	323	0	0
Proportion of years salinity in Coorong southern lagoon is < 100 g/L	82%	100%	100%
Average salinity (g/L) in Coorong northern lagoon over model period	29	21	21
Maximum salinity (g/L) in Coorong northern lagoon over model period	148	48	48
Max period (days) salinity in Coorong northern lagoon is greater than 50 g/L	604	0	0
Proportion of years 3 year rolling average barrage flow greater than 1,000 GL/y	91%	99%	99%
Proportion of years 3 year rolling average barrage flow greater than 2,000 GL/y greater than 95%	79%	98%	98%

Lakes metrics	Baseline	Interim Benchmark	Proposal
% days Lake Albert salinity exceeds 2000 EC	6%	0%	0%
% days Lake Alexandrina salinity exceeds 1000 EC	11%	0%	0%
% days Lake Alexandrina level below 0.4 m	18%	4%	4%

Appendix 3. Outcomes of key issues workshop - 15 January 2015

This section records the key issues raised by the cross-jurisdictional workshop at Attwood held to engage key agency stakeholders in the proposed SDL adjustment business cases for the operating rule change supply measure for Hume Dam pre-releases. These issues are recorded in a tabular form in Table 6 above. The numbers after each sub-heading report the number of votes allocated to that issue by the workshop participants.

The issues raised are addressed in Section 3 above.

Operational Feasibility (24)

- Can the proposed changes be implemented in practice?
- Scale effect: How far can we extend current minor adjustments to larger scale changes?
- Will the changes increase pressure on operators – leading to an increased risk of failure?

Impact on SA rights (7)

- Change to spills from Hume and Dartmouth
- Change on flows across the SA border
- Impact on Coorong Flows
- SA to advise metrics
- Scale effects

Interdependency with constraints strategy (10)

- If the Constraints Management Strategy is implemented how will this impact on the value of this proposal?
- Could the impact be complementary/synergistic - noting that any changes from the Constraints strategy take precedence and are considered prior to any SDL adjustment measures?

Impact on Lake Victoria operations (3)

- Will changes in releases from Hume affect the operation of Lake Victoria?
- Is there a risk of substitution of one parcel of water for another (10)
- The controlled pre-releases do not come out of any entitlement account
- Will a change in pre-release rules change the security of different entitlements? In particular will the environment risk losing water more often?

Flooding impacts (13)

- Will the change in pre-release rules result in greater risk of frequency and extent of inundation of:

  − Land

  − Recreation assets/activities

Impacts on spillable water Accounts (4)

- If the Hume storage is held at a higher level will this lead to more uncontrolled spills?

  – NSW AEA

  – Vic spillable accounts

Terminology / confusion between pre-release & spill (3)

- Need to clarify the difference between:

  – Managed pre-releases

  – Uncontrolled spills

Is it just creative accounting, not real saving? (7)

- Is this a real water saving or just creative water accounting around the modelling of the 2750GL benchmark?

What is the interaction with other AGMT provisions or rules? (2)

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Attachment B

Changes for the current Hume Air Space Management due to future demand condition

Version 1

[redacted]

Basin Plan modelling
River Management Division

December 2014

Technical Report No 2014/23

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1 Introduction

Sections 23A and 23B of The Water Act (2007) allows the Sustainable Diversion Limits (SDLs) adjusted when supply measures allow equivalent environmental outcomes to be achieved without needing to reduce consumptive take as much as originally anticipated in the Basin Plan. Schedule 6 of the Basin Plan outlines the default method for calculation of supply contribution along with principles to calculate ecological element scores for testing equivalent environmental outcomes.

The Basin States have been put forward a number of potential projects and more to be proposed in coming months. As per Schedule 6 of the Basin Plan, MDBA is currently reviewing and codifying the proposals. In general, the proposals can be classified into two types – TLM-like work projects and policy/rule changes. The TLM-like work projects are relatively well known given previous experience in TLM icon site modelling. However, the policy/rule changes are potentially requiring a great deal of consideration even before codifying the changes. This is mostly because of limited information and data to know what would happen when the environmental water is fully recovered.

Recently, MDBA has trialled the default method using the TLM works and changes to Hume air-space management (MDBA, 2014). This was to demonstrate whether the default method can be used to determine the volume of SDL adjustments. At that time, the Hume air-space proposal has been modelled as one of simplistic options from the Phase 1 proposal by Vic and NSW (SKM, 2014) due to limited time available. The option tested was delaying pre-releasing until July.

This report is to develop a plausible management option when the Basin Plan is fully operational from 2019. This work is based on the premise that river operators will conceive environmental demands same as other irrigation demands from air-space management perspective. Traditionally storages are operated to achieve a number of outcomes. In priority order, they are:

1. Protecting the structural integrity and safety of the storage;
2. Maximising water in the storage at the start of irrigation season to meet irrigation demands; and then
3. Limiting flood damage to downstream communities and increasing environmental benefits.

The current SDL benchmark mirrors the second and third priorities based on the forecast of future inflows and irrigation demands. This work is to include further environmental demands so that the model can take into account irrigation demands as well as environmental demands to decide pre-release volume.

2 Pre-release calculation in the SDL benchmark

In order to estimate pre-release from Hume with very little risk of not filling, MSM takes a conservative approach to calculate the monthly pre-release (airspace) target with inflow and irrigation water demand in Hume Dam forecasted in 'worst case' scenarios (i.e. driest on record).

Each month (the earliest one in a calendar year being January), MSM calculates a series of target storage volumes for various forecast periods. These forecast periods start from the same month (the start of the current month or the next month) and have different ending months. The ending month will advance one month from the end of the forecast starting month until the end of November – the time after which it is very unlikely for Hume to spill as demands almost always exceed inflows. The lowest target over all the forecast periods defines the pre-release target for the month.

If the starting month of forecast is the start of the current month, the start of month pre-release target for the current month is obtained. If the starting month of forecast is the start of the next month, the end of month pre-release target for the current month is obtained.

Each month, the target storage volume for a forecast period is calculated using the formula:

$$\text{Target storage volume} \\ = \text{full supply storage volume} - (\text{forecast inflow} - \text{forecast irrigation release}) \qquad (1)$$

It should be noted that this conservative calculation looks at 'worst case' scenarios (i.e. driest on record) into the future with minimum forecast airspace (i.e. minimum forecast inflow minus maximum forecast irrigation release) for flood mitigation, so that the risk of impacting due to pre-release on the security of water supply to downstream users is minimal. The forecasts for Hume inflow and irrigation release are made based on statistics of the modelled historical inflows and irrigation releases. The steps involved are:

- Inflows in the upper Murray catchments show strong 'serial correlation' – the inflow in one month (e.g. July) is strongly correlated to the inflows in the subsequent months (e.g. August – October). The scatterplot of the last month's natural inflow against the cumulative natural inflow over a specific forecast period is obtained from an analysis of the modelled natural inflows from 1895 to 2009. The lower bound envelop of the scatterplot defines the serially correlated minimums of the cumulative natural inflow. The minimum forecast cumulative natural inflow for the specific forecast period results from the serially correlated minimum corresponding to the last month's natural inflow.
- The exceedance matrices for natural and unregulated cumulative inflows are derived from modelled data. With the exceedance probability corresponding to the minimum cumulative natural inflow forecasted above, the minimum forecast cumulative unregulated inflow for the same forecast period is calculated using the exceedance matrices.
- There is also a reasonable correlation between the irrigation release from Hume and the inflow to the storage. The correlation between the cumulative unregulated inflow and the cumulative irrigation release in a forecast period is developed from the data of an MSM current conditions output file (benchmark run 18 December 1997). The maximum forecast cumulative irrigation release correlated with the minimum cumulative unregulated inflow forecasted above is obtained from the upper boundary of the correlation.
- The minimum forecast inflow is equal to the sum of the minimum forecast unregulated inflow and the forecast regulated releases from the Snowy Scheme and Dartmouth Reservoir.

Once the target storage volume for pre-release is calculated, MSM attempts to make pre-release from Hume to achieve the end of month target level, subject to not exceeding channel capacity constraint at Doctor's Point. The end of month pre-release target calculated at the start of the month is revised after day 10 of the month by estimating the end of month storage. The pre-release for the 2/3 months left is updated using the target estimated after day 10. Pre-release can be increased if the revised target is lower.

3 Correlation to environmental demands

Similar to the relationship between unregulated inflow and regulated demands, a new relationship between unregulated inflow and environmental demands is derived. Knowing that the environmental demands in future are unknown and potentially highly variable, the environmental watering sequence that is currently used for the SDL benchmark would be a logical choice at least for the SDL adjustment purpose in order to develop the relationship. It should be noted that this environmental watering sequence is only one possible way out of a huge combination in real life to deliver environmental water. Therefore this relationship should be re-visited when more data becomes available in future.

To develop the relationship, it is necessary to take into account only additional release required to meet environmental demands on top of other release. This is because the environmental watering sequence has been developed to reinstate events removed from without development to current conditions rather than creating an environmental event from scratch. Therefore including the demands fully would over estimate water requirement. In addition, the sequence is developed to meet environment needs along the river to achieve multiple outcomes. In order to incorporate the principles applied to develop the environmental watering sequence, additional water needs are estimated as volume required in addition to baseline flows at each site and the maximum volume among the sites is taken as additional releases from Hume Dam. An example is presented at Figure 1 which a scatter plot between accumulated unregulated flow from May to November and environmental need for the same period. This plot indicates that there is weak correlation showing a number of outliers. Therefore a simple averaging method is used to tabulate the relationship as per Table 1 and presented at Figure 1 in red dots.

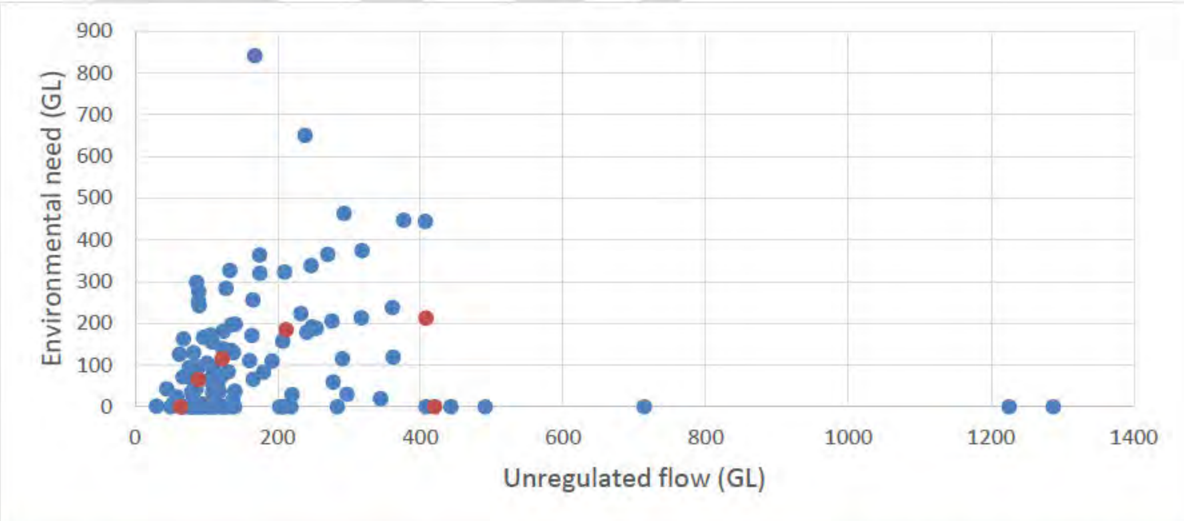

Figure 1: Relationship between accumulated unregulated flow and environmental demands from May to November (blue dots: raw data, red dots: average values for selected ranges)

Table 1: An averaging method used to derive a relationship between unregulated flow and environmental need

Unregulated flow (GL)	Environmental need (GL)
5 %-ile	0
25 %-ile	Average between 5 %-ile and 25%-ile
50 %-ile	Average between 25 %-ile and 75%-ile
75 %-ile	Average between 50 %-ile and 95%-ile
95 %-ile	Average between 75 %-ile and 95%-ile + 10 GL
95 %-ile + 10 GL	0

With the derived relationship, future environmental need is forecasted similar to forecasting irrigation release and the target storage volume reflects the environmental water release. This changes Equation (1) to

$$\begin{aligned}\text{Target storage volume} \\ &= \text{full supply storage volume} - (\text{forecast inflow} - \text{forecast irrigation release} \\ &\quad - \text{forecast environmental release}). \qquad (2)\end{aligned}$$

4 Comparison of spill behaviours and environmental outcomes

In order to review the revised Hume air storage management rule, two model runs are compared – one with the existing rule and another with the revise rule. Figure 2 presents the changes of pre-release volume in monthly average showing that the pre-release from Hume has been reduced significantly, a reduction of 100 GL (from 163 GL to 63 GL) in long term annual average. Compared to the method applied for the trial stage, the revised rule allows water being pre-released between April and June which in turn reduces spill slightly along the Upper Murray riparian area (Figure 3).

Even after water being pre-released between April and June, Figure 4 shows that Hume Dam reaches its full capacity a couple of months later. The period between 1973 and 1975 in this figure is years when air-space at Hume is actively managed leading to one of largest and most frequent pre-releases over the 114 year modelling sequence.

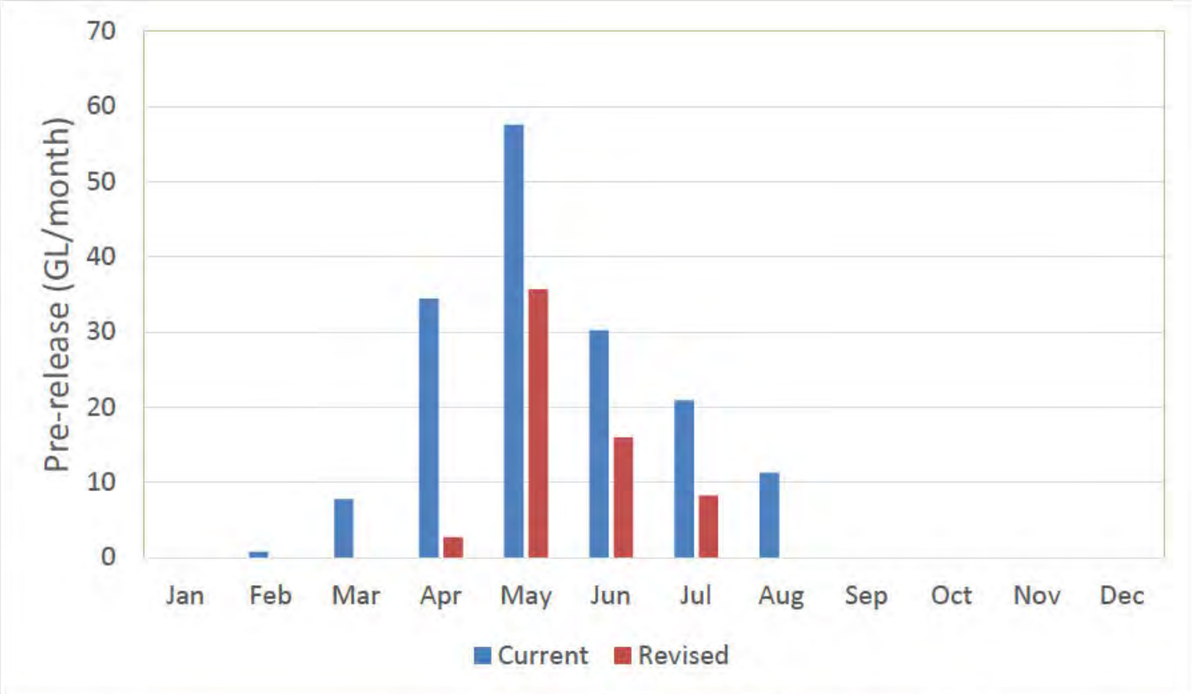

Figure 2: Monthly averaged pre-releases for the exiting and revised Hume air space management rules

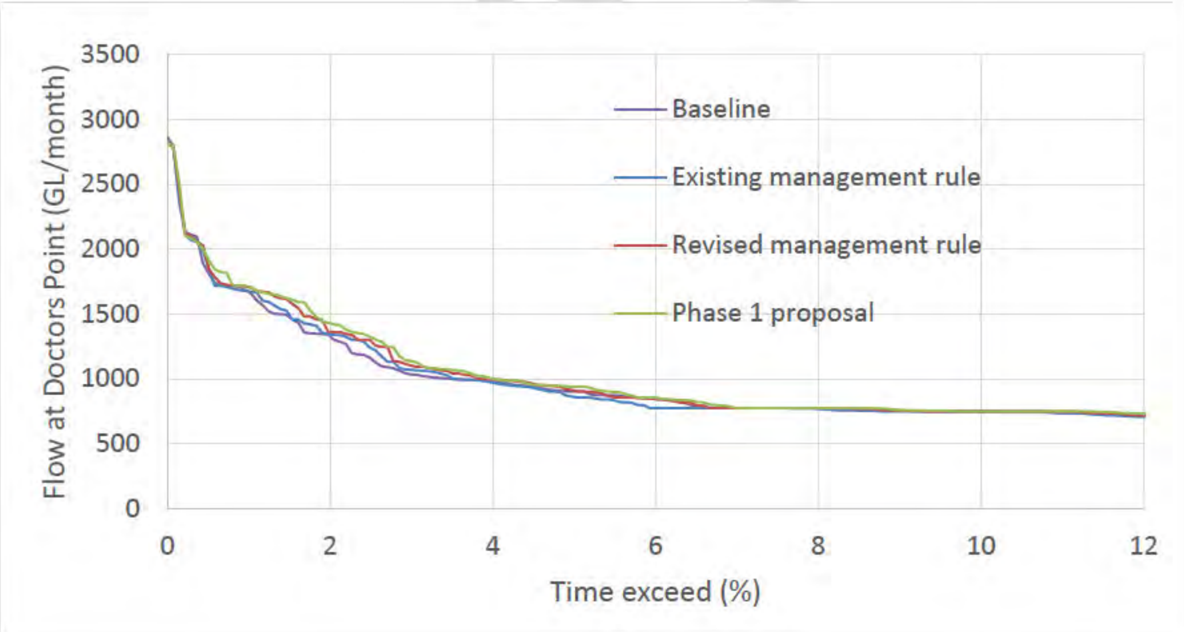

Figure 3: Exceedance plot of flow at Doctors Point with the existing and revised air-space management rules and Phase 1 proposal (SKM, 2014)'s rule (pre-release between July and November)

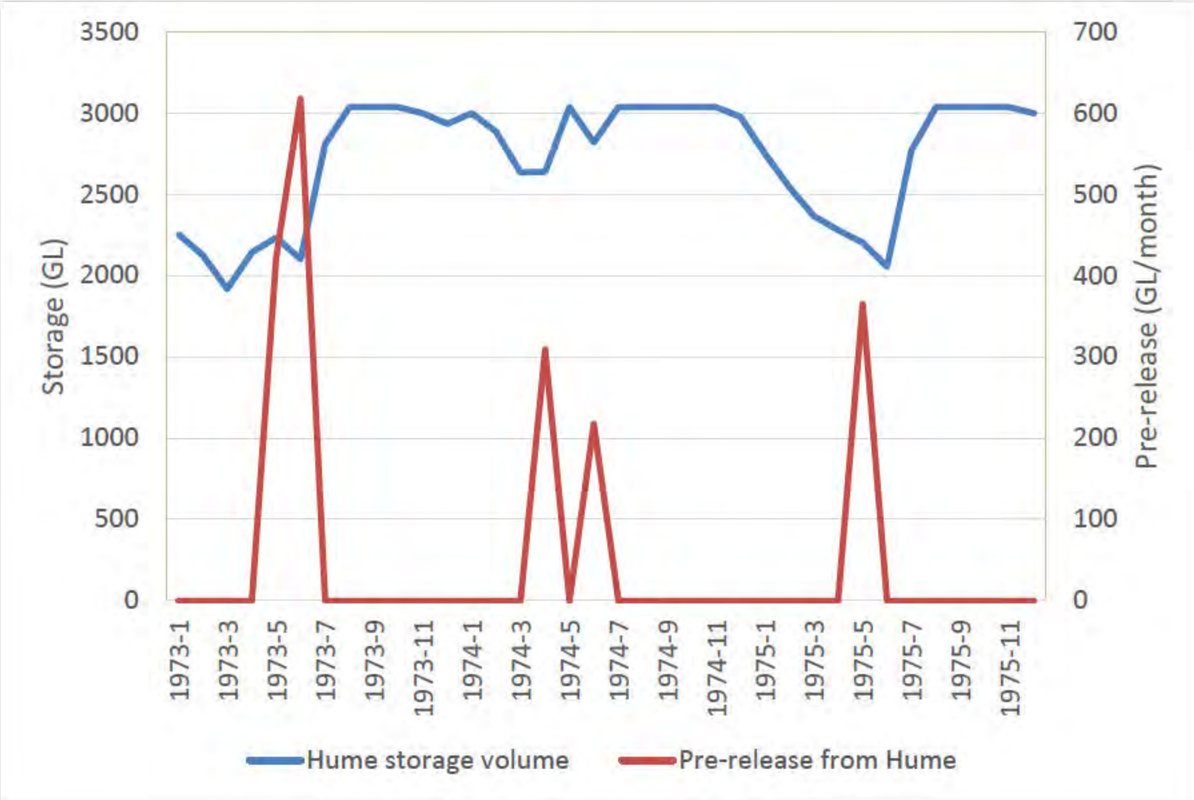

Figure 4: Hume storage volume and pre-release made from Hume using the revised air-space management rule.

Table 2 shows that there are still improved environmental outcomes with the revised rule in place. These additional environmental outcomes are as good as what the Phase 1 (SKM, 2014) found if not better. Full details of environmental outcomes are presented at Appendixes I and II. Due to the increasing environmental indicators achieved, ecological elements scores are improved from 0.5006 to 0.5034. Details of the scores are available at Appendixes III and IV.

Table 2: Relative changes by revising the Hume air space management rule in number of environmental indicators achieved

HIS	SFI						
	R1	R2	R3	R4	R5	R6	R7
Barmah	0	3	0	1	2	1	0
Gunbower	0	0	-1	1	0	-	-
Hattah	1	4	0	1	1	0	
Chowilla	0	0	1	0	0	1	0
Edward-Wakool	0	0	4	2	2	-	-
Lower Darling	-1	0	0	0	0	-	-

5 Conclusion

This report presents a way of taking into account environmental water need in calculating Hume air space target for pre-release. Correlation between unregulated flow and environmental demands used to develop the SDL benchmark is developed and included into the target storage volume calculation in MSM. Given that the correlation is based on the environmental demands used for the SDL benchmark, they should be revised when more information and data are available in future.

6 References

MDBA (2014). Calculating the supply contribution for SDL adjustment: Trial application of the 'default method' – An interim technical report.

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Appendix I: Outcomes against Environmental Indicators with the existing Hume air space management rule

Flow Indicator			Without Development	Baseline		Existing Hume air space management rule							
						Number of years with successful events							
Flow Event - threshold, duration, season (as gauged on the River Murray at Yarrawonga Weir)		Target Proportion of years with a successful event	Proportion of years with a successful event	Proportion of years with a successful event	Number of years with a successful event	Ordered and fully delivered (1)	Ordered and fully delivered within 10% (2)	Other successful events (3)	Baseline events lost (4)	Total additional to baseline (5) = (1+2+3+4)	Number of years with a successful environmental event *	Proportion of years with a successful environmental event *	Number of additional years with events partially delivered (6)
1	12,500 ML/d for a total duration of 70 days (with min duration of 7 consecutive days) between Jun & Nov	70 - 80 %	87%	50%	57	23	0	11	-2	32	89	78.07%	1
2	16,000 ML/d for a total duration of 98 days (with min duration of 7 consecutive days) between Jun & Nov	40 - 50 %	66%	30%	34	17	0	10	-2	25	59	51.75%	16
3	25,000 ML/d for a total duration of 42 days (with min duration of 7 consecutive days) between Jun & Nov	40 - 50 %	66%	30%	34	16	0	4	-1	19	53	46.49%	9
4	35,000 ML/d for a total duration of 30 days (with min duration of 7 consecutive days) between Jun & May	33 - 40 %	53%	24%	27	15	1	1	-3	14	41	35.96%	7
5	50,000 ML/d for a total duration of 21 days (with min duration of 7 consecutive days) between Jun & May	25 - 30 %	39%	18%	20	0	0	1	-2	-1	19	16.67%	2
6	60,000 ML/d for a total duration of 14 days (with min duration of 7 consecutive days) between Jun & May	20 - 25 %	33%	14%	16	0	0	1	-3	-2	14	12.28%	6
7	15,000 ML/d for a total duration of 150 days (with min duration of 7 consecutive days) between Jun & Dec	30%	44%	11%	12	28	0	1	0	29	41	35.96%	11

* Events which were included in the demand timeseries and were within 10% of the flow indicator parameters are considered as successful environmental events.

Flow Indicator			Without Development	Baseline		Existing Hume air space management rule							
						Number of years with successful events							
	Flow Event - threshold, duration, season (as gauged on the River Murray at Torrumbarry Weir)	Target Proportion of years with a successful event	Proportion of years with a successful event	Proportion of years with a successful event	Number of years with a successful event	Ordered and fully delivered (1)	Ordered and fully delivered within 10% (2)	Other successful events (3)	Baseline events lost (4)	Total additional to baseline (5) = (1+2+3+4)	Number of years with a successful environmental event *	Proportion of years with a successful environmental event *	Number of additional years with events partially delivered (6)
1	16,000 ML/d for a total duration of 90 days (with min duration of 7 consecutive days) between Jun & Nov	70 - 80 %	86%	31%	35	28	12	1	0	41	76	66.67%	7
2	20,000 ML/d for a total duration of 60 days (with min duration of 7 consecutive days) between Jun & Nov	60 - 70 %	87%	34%	39	21	11	4	0	36	75	65.79%	4
3	30,000 ML/d for a total duration of 60 days (with min duration of 7 consecutive days) between Jun & May	33 - 50 %	60%	25%	28	4	2	10	0	16	44	38.60%	7
4	40,000 ML/d for a total duration of 60 days (with min duration of 7 consecutive days) between Jun & May	25 - 33 %	39%	11%	13	6	4	2	0	12	25	21.93%	8
5	20,000 ML/d for a total duration of 150 days (with min duration of 7 consecutive days) between Jun & Dec	30%	43%	7%	8	13	8	2	0	23	31	27.19%	7

* Events which were included in the demand timeseries and were within 10% of the flow indicator parameters are considered as successful environmental events.

			Without Development	Baseline		Existing Hume air space management rule							
Flow Indicator			Proportion of years with a successful event	Proportion of years with a successful event	Number of years with a successful event	Number of years with successful events					Number of years with a successful environmental event *	Proportion of years with a successful environmental event *	Number of additional years with events partially delivered (6)
Flow Event - threshold, duration, season (as gauged on the River Murray at Euston Weir)		Target Proportion of years with a successful event				Ordered and fully delivered (1)	Ordered and fully delivered within 10% (2)	Other successful events (3)	Baseline events lost (4)	Total additional to baseline (5) = (1+2+3+4)			
1	40,000 ML/d for a total duration of 60 days (with min duration of 7 consecutive days) between Jun & Dec	40 - 50 %	67%	30%	34	10	2	6	0	18	52	45.61%	7
2	50,000 ML/d for a total duration of 60 days (with min duration of 7 consecutive days) between Jun & Dec	30 - 40 %	47%	19%	22	8	4	0	0	12	34	29.82%	12
3	70,000 ML/d for a total duration of 42 days (with min duration of 7 consecutive days) between Jun & Dec	20 - 33 %	38%	11%	13	3	3	3	0	9	22	19.30%	8
4	85,000 ML/d for a total duration of 30 days (with min duration of 7 consecutive days) between Jun & May	20 - 30 %	33%	10%	11	0	1	2	0	3	14	12.28%	7
5	120,000 ML/d for a total duration of 14 days (with min duration of 7 consecutive days) between Jun & May	14 - 20 %	23%	8%	9	0	0	1	0	1	10	8.77%	3
6	150,000 ML/d for a total duration of 7 days (with min duration of 7 consecutive days) between Jun & May	10 - 13 %	17%	5%	6	0	0	1	0	1	7	6.14%	2

* Events which were included in the demand timeseries and were within 10% of the flow indicator parameters are considered as successful environmental events.

			Without Development	Baseline		Existing Hume air space management rule								
Flow Indicator			Proportion of years with a successful event	Proportion of years with a successful event	Number of years with a successful event	Number of years with successful events					Number of years with a successful environmental event *	Proportion of years with a successful environmental event *	Number of additional years with events partially delivered (6)
Flow Event - threshold, duration, season (as gauged on the River Murray at SA Border)		Target Proportion of years with a successful event				Ordered and fully delivered (1)	Ordered and fully delivered within 10% (2)	Other successful events (3)	Baseline events lost (4)	Total additional to baseline (5) = (1+2+3+4)			
1	20,000 ML/d for 60 consecutive days between Aug & Dec	71 - 80 %	89%	43%	49	0	0	32	0	32	81	71.05%	3
2	40,000 ML/d for a total duration of 30 days (with min duration of 7 consecutive days) between Jun & Dec	50 - 70 %	80%	37%	42	12	6	5	0	23	65	57.02%	6
3	40,000 ML/d for a total duration of 90 days (with min duration of 7 consecutive days) between Jun & Dec	33 - 50 %	58%	22%	25	9	6	4	0	19	44	38.60%	6
4	60,000 ML/d for a total duration of 60 days (with min duration of 7 consecutive days) between Jun & Dec	25 - 33 %	41%	12%	14	4	11	2	0	17	31	27.19%	3
5	80,000 ML/d for a total duration of 30 days (with min duration of 7 consecutive days) between Jun & May	17 - 25 %	34%	10%	11	2	1	1	0	4	15	13.16%	9
6	100,000 ML/d for a total duration of 21 days (with min duration of 1 day) between Jun & May	13 - 17 %	19%	6%	7	0	0	2	0	2	9	7.89%	3
7	125,000 ML/d for a total duration of 7 days (with min duration of 1 day) between Jun & May	10 - 13 %	17%	4%	5	0	0	1	0	1	6	5.26%	2

* Events which were included in the demand timeseries and were within 10% of the flow indicator parameters are considered as successful environmental events.

Flow Indicator			Without Development	Baseline		Existing Hume air space management rule							
						Number of years with successful events							
Flow Event - threshold, duration, season (as gauged on the Edward River at Deniliquin)		Target Proportion of years with a successful event	Proportion of years with a successful event	Proportion of years with a successful event	Number of years with a successful event	Ordered and fully delivered (1)	Ordered and fully delivered within 10% (2)	Other successful events (3)	Baseline events lost (4)	Total additional to baseline (5) = (1+2+3+4)	Number of years with a successful environmental event *	Proportion of years with a successful environmental event *	Number of additional years with events partially delivered (6)
1	1,500 ML/d for a total duration of 180 days (with min duration of 1 day) between Jun & Mar	99 - 100 %	75%	96%	110	0	0	0	-4	-4	106	92.98%	6
2	5,000 ML/d for a total duration of 60 days (with min duration of 7 consecutive days) between Jun & Dec	60 - 70 %	82%	39%	44	0	0	30	0	30	74	64.91%	8
3	5,000 ML/d for a total duration of 120 days (with min duration of 7 consecutive days) between Jun & Dec	35 - 40 %	52%	22%	25	0	0	14	-1	13	38	33.33%	10
4	18,000 ML/d for a total duration of 28 days (with min duration of 5 consecutive days) between Jun & Dec	25 - 30 %	39%	15%	17	0	0	2	0	2	19	16.67%	4
5	30,000 ML/d for a total duration of 21 days (with min duration of 6 consecutive days) between Jun & Dec	17 - 20 %	28%	12%	14	0	0	2	-2	0	14	12.28%	3

* Events which were included in the demand timeseries and were within 10% of the flow indicator parameters are considered as successful environmental events.

Flow Indicator			Without Development	Baseline		Existing Hume air space management rule								
Flow Indicator			Proportion of years with a successful event	Proportion of years with a successful event	Number of years with a successful event	Number of years with successful events					Number of years with a successful environmental event *	Proportion of years with a successful environmental event *	Number of additional years with events partially delivered (6)
Flow Event - threshold, duration, season (as gauged on the Darling River at Weir 32)		Target Proportion of years with a successful event				Ordered and fully delivered (1)	Ordered and fully delivered within 10% (2)	Other successful events (3)	Baseline events lost (4)	Total additional to baseline (5) = (1+2+3+4)			
1	7,000 ML/d for 10 consecutive days between Jun & May	70 - 90 %	95%	57%	65	0	0	13	-11	2	67	58.77%	3
2	17,000 ML/d for 18 consecutive days between Jun & May	20 - 40 %	47%	18%	21	0	0	4	0	4	25	21.93%	2
3	20,000 ML/d for 30 consecutive days between Jun & May	14 - 20 %	27%	10%	11	0	0	0	0	0	11	9.65%	6
4	25,000 ML/d for 45 consecutive days between Jun & May	8 - 10 %	14%	8%	9	0	0	0	0	0	9	7.89%	0
5	45,000 ML/d for 2 consecutive days between Jun & May	7 - 10 %	10%	7%	8	0	0	0	0	0	8	7.02%	1

* Events which were included in the demand timeseries and were within 10% of the flow indicator parameters are considered as successful environmental events.

Appendix II: Outcomes against Environmental Indicators with the revised Hume air space management rule

Flow Indicator			Without Development	Baseline		Revised Hume air space management rule							
						Number of years with successful events							
	Flow Event - threshold, duration, season (as gauged on the River Murray at Yarrawonga Weir)	Target Proportion of years with a successful event	Proportion of years with a successful event	Proportion of years with a successful event	Number of years with a successful event	Ordered and fully delivered (1)	Ordered and fully delivered within 10% (2)	Other successful events (3)	Baseline events lost (4)	Total additional to baseline (5) = (1+2+3+4)	Number of years with a successful environmental event *	Proportion of years with a successful environmental event *	Number of additional years with events partially delivered (6)
1	12,500 ML/d for a total duration of 70 days (with min duration of 7 consecutive days) between Jun & Nov	70 - 80 %	87%	50%	57	23	0	11	-2	32	89	78.07%	1
2	16,000 ML/d for a total duration of 98 days (with min duration of 7 consecutive days) between Jun & Nov	40 - 50 %	66%	30%	34	17	0	11	0	28	62	54.39%	13
3	25,000 ML/d for a total duration of 42 days (with min duration of 7 consecutive days) between Jun & Nov	40 - 50 %	66%	30%	34	16	0	4	-1	19	53	46.49%	9
4	35,000 ML/d for a total duration of 30 days (with min duration of 7 consecutive days) between Jun & May	33 - 40 %	53%	24%	27	15	1	1	-2	15	42	36.84%	5
5	50,000 ML/d for a total duration of 21 days (with min duration of 7 consecutive days) between Jun & May	25 - 30 %	39%	18%	20	0	0	2	-1	1	21	18.42%	2
6	60,000 ML/d for a total duration of 14 days (with min duration of 7 consecutive days) between Jun & May	20 - 25 %	33%	14%	16	0	0	1	-2	-1	15	13.16%	5
7	15,000 ML/d for a total duration of 150 days (with min duration of 7 consecutive days) between Jun & Dec	30%	44%	11%	12	28	0	1	0	29	41	35.96%	11

* Events which were included in the demand timeseries and were within 10% of the flow indicator parameters are considered as successful environmental events.

			Without Development	Baseline		Revised Hume air space management rule							
Flow Indicator			Proportion of years with a successful event	Proportion of years with a successful event	Number of years with a successful event	Number of years with successful events					Number of years with a successful environmental event *	Proportion of years with a successful environmental event *	Number of additional years with events partially delivered (6)
Flow Event - threshold, duration, season (as gauged on the River Murray at Torrumbarry Weir)		Target Proportion of years with a successful event				Ordered and fully delivered (1)	Ordered and fully delivered within 10% (2)	Other successful events (3)	Baseline events lost (4)	Total additional to baseline (5) = (1+2+3+4)			
1	16,000 ML/d for a total duration of 90 days (with min duration of 7 consecutive days) between Jun & Nov	70 - 80 %	86%	31%	35	28	12	1	0	41	76	66.67%	7
2	20,000 ML/d for a total duration of 60 days (with min duration of 7 consecutive days) between Jun & Nov	60 - 70 %	87%	34%	39	21	11	4	0	36	75	65.79%	4
3	30,000 ML/d for a total duration of 60 days (with min duration of 7 consecutive days) between Jun & May	33 - 50 %	60%	25%	28	4	2	9	0	15	43	37.72%	8
4	40,000 ML/d for a total duration of 60 days (with min duration of 7 consecutive days) between Jun & May	25 - 33 %	39%	11%	13	6	3	4	0	13	26	22.81%	7
5	20,000 ML/d for a total duration of 150 days (with min duration of 7 consecutive days) between Jun & Dec	30%	43%	7%	8	12	9	2	0	23	31	27.19%	7

* Events which were included in the demand timeseries and were within 10% of the flow indicator parameters are considered as successful environmental events.

			Without Development	Baseline		Revised Hume air space management rule							
Flow Indicator						Number of years with successful events							
Flow Event - threshold, duration, season (as gauged on the River Murray at Euston Weir)		Target Proportion of years with a successful event	Proportion of years with a successful event	Proportion of years with a successful event	Number of years with a successful event	Ordered and fully delivered (1)	Ordered and fully delivered within 10% (2)	Other successful events (3)	Baseline events lost (4)	Total additional to baseline (5) = (1+2+3+4)	Number of years with a successful environmental event *	Proportion of years with a successful environmental event *	Number of additional years with events partially delivered (6)
1	40,000 ML/d for a total duration of 60 days (with min duration of 7 consecutive days) between Jun & Dec	40 - 50 %	67%	30%	34	10	2	7	0	19	53	46.49%	6
2	50,000 ML/d for a total duration of 60 days (with min duration of 7 consecutive days) between Jun & Dec	30 - 40 %	47%	19%	22	9	4	3	0	16	38	33.33%	8
3	70,000 ML/d for a total duration of 42 days (with min duration of 7 consecutive days) between Jun & Dec	20 - 33 %	38%	11%	13	4	2	3	0	9	22	19.30%	8
4	85,000 ML/d for a total duration of 30 days (with min duration of 7 consecutive days) between Jun & May	20 - 30 %	33%	10%	11	0	1	3	0	4	15	13.16%	7
5	120,000 ML/d for a total duration of 14 days (with min duration of 7 consecutive days) between Jun & May	14 - 20 %	23%	8%	9	0	0	2	0	2	11	9.65%	2
6	150,000 ML/d for a total duration of 7 days (with min duration of 7 consecutive days) between Jun & May	10 - 13 %	17%	5%	6	0	0	1	0	1	7	6.14%	3

* Events which were included in the demand timeseries and were within 10% of the flow indicator parameters are considered as successful environmental events.

Flow Indicator			Without Development	Baseline		Revised Hume air space management rule							
#	Flow Event - threshold, duration, season (as gauged on the River Murray at SA Border)	Target Proportion of years with a successful event	Proportion of years with a successful event	Proportion of years with a successful event	Number of years with a successful event	Number of years with successful events: Ordered and fully delivered (1)	Number of years with successful events: Ordered and fully delivered within 10% (2)	Number of years with successful events: Other successful events (3)	Number of years with successful events: Baseline events lost (4)	Number of years with successful events: Total additional to baseline (5) = (1+2+3+4)	Number of years with a successful environmental event *	Proportion of years with a successful environmental event *	Number of additional years with events partially delivered (6)
1	20,000 ML/d for 60 consecutive days between Aug & Dec	71 - 80 %	89%	43%	49	0	0	32	0	32	81	71.05%	3
2	40,000 ML/d for a total duration of 30 days (with min duration of 7 consecutive days) between Jun & Dec	50 - 70 %	80%	37%	42	12	6	5	0	23	65	57.02%	6
3	40,000 ML/d for a total duration of 90 days (with min duration of 7 consecutive days) between Jun & Dec	33 - 50 %	58%	22%	25	9	6	5	0	20	45	39.47%	5
4	60,000 ML/d for a total duration of 60 days (with min duration of 7 consecutive days) between Jun & Dec	25 - 33 %	41%	12%	14	4	11	2	0	17	31	27.19%	3
5	80,000 ML/d for a total duration of 30 days (with min duration of 7 consecutive days) between Jun & May	17 - 25 %	34%	10%	11	2	1	1	0	4	15	13.16%	9
6	100,000 ML/d for a total duration of 21 days (with min duration of 1 day) between Jun & May	13 - 17 %	19%	6%	7	0	0	3	0	3	10	8.77%	3
7	125,000 ML/d for a total duration of 7 days (with min duration of 1 day) between Jun & May	10 - 13 %	17%	4%	5	0	0	1	0	1	6	5.26%	3

* Events which were included in the demand timeseries and were within 10% of the flow indicator parameters are considered as successful environmental events.

Flow Indicator			Without Development	Baseline		Revised Hume air space management rule							
			Proportion of years with a successful event	Proportion of years with a successful event	Number of years with a successful event	Number of years with successful events					Number of years with a successful environmental event *	Proportion of years with a successful environmental event *	Number of additional years with events partially delivered (6)
Flow Event - threshold, duration, season (as gauged on the Edward River at Deniliquin)		Target Proportion of years with a successful event				Ordered and fully delivered (1)	Ordered and fully delivered within 10% (2)	Other successful events (3)	Baseline events lost (4)	Total additional to baseline (5) = (1+2+3+4)			
1	1,500 ML/d for a total duration of 180 days (with min duration of 1 day) between Jun & Mar	99 - 100 %	75%	96%	110	0	0	0	-4	-4	106	92.98%	7
2	5,000 ML/d for a total duration of 60 days (with min duration of 7 consecutive days) between Jun & Dec	60 - 70 %	82%	39%	44	0	0	30	0	30	74	64.91%	8
3	5,000 ML/d for a total duration of 120 days (with min duration of 7 consecutive days) between Jun & Dec	35 - 40 %	52%	22%	25	0	0	17	0	17	42	36.84%	8
4	18,000 ML/d for a total duration of 28 days (with min duration of 5 consecutive days) between Jun & Dec	25 - 30 %	39%	15%	17	0	0	4	0	4	21	18.42%	3
5	30,000 ML/d for a total duration of 21 days (with min duration of 6 consecutive days) between Jun & Dec	17 - 20 %	28%	12%	14	0	0	2	0	2	16	14.04%	2

* Events which were included in the demand timeseries and were within 10% of the flow indicator parameters are considered as successful environmental events.

			Without Development	Baseline		Revised Hume air space management rule							
Flow Indicator						Number of years with successful events							
Flow Event - threshold, duration, season (as gauged on the Darling River at Weir 32)		Target Proportion of years with a successful event	Proportion of years with a successful event	Proportion of years with a successful event	Number of years with a successful event	Ordered and fully delivered (1)	Ordered and fully delivered within 10% (2)	Other successful events (3)	Baseline events lost (4)	Total additional to baseline (5) = (1+2+3+4)	Number of years with a successful environmental event *	Proportion of years with a successful environmental event *	Number of additional years with events partially delivered (6)
1	7,000 ML/d for 10 consecutive days between Jun & May	70 - 90 %	95%	57%	65	0	0	13	-12	1	66	57.89%	5
2	17,000 ML/d for 18 consecutive days between Jun & May	20 - 40 %	47%	18%	21	0	0	4	0	4	25	21.93%	2
3	20,000 ML/d for 30 consecutive days between Jun & May	14 - 20 %	27%	10%	11	0	0	0	0	0	11	9.65%	6
4	25,000 ML/d for 45 consecutive days between Jun & May	8 - 10 %	14%	8%	9	0	0	0	0	0	9	7.89%	0
5	45,000 ML/d for 2 consecutive days between Jun & May	7 - 10 %	10%	7%	8	0	0	0	0	0	8	7.02%	1

* Events which were included in the demand timeseries and were within 10% of the flow indicator parameters are considered as successful environmental events.

Appendix III: Ecological elements Scores with the existing Hume air space management rule

Ecological Elements Score 0.3005

Barmah-Millewa Forest 0.4926 0.4926

		Mean EE-Score per element and SFI							Area Weighted Score per element and SFI							EE-Score	EC-Score
		12.5K*70	16K*98	25K*42	35K*30	50K*21	60K*14	15K*150	12.5K*70	16K*98	25K*42	35K*30	50K*21	60K*14	15K*150	per Reach	per Reach
Bird	Waterbirds - health	0.8842	0.8307	0.7728	0.6360	0.2316	0.1500	0.6474	0.1379	0.0125	0.0872	0.1734	0.0565	0.0275	0.0104	0.5055	0.3005
	Bitterns, Crakes and Rails	0.7360	0.2965	0.1588	0.0851	0.0219	0.0132	0.0570	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0570	0.0570	
	Colonial-Nesting Waterbirds				0.3053							0.3053				0.3053	
	Waterbirds - breeding				0.3342							0.3342				0.3342	
Vegetation	River Red Gum forests	0.8974	0.8816	0.8579	0.7263	0.1868	0.1342	0.7675	0.1054	0.0420	0.1284	0.2334	0.0382	0.0214	0.0000	0.5688	0.4766
	River Red Gum woodlands	0.9000	0.8974	0.8921	0.7684	0.2158	0.1526	0.8219	0.0776	0.0149	0.0806	0.2235	0.0670	0.0314	0.0000	0.4950	
	Blackbox -forests and woodlands	0.9000	0.8974	0.8921	0.7833	0.4211	0.2746	0.8816	0.1078	0.0092	0.0329	0.1006	0.1335	0.1064	0.0000	0.4904	
	Shrublands	0.8342	0.7553	0.7395	0.6184	0.2158	0.1526	0.6395	0.0650	0.0184	0.0517	0.0840	0.1263	0.0163	0.0000	0.3617	
	Tall Grasslands, Sedgelands and Rushlands	0.8316	0.6816	0.5579	0.4184	0.2509	0.2009	0.4474	0.2066	0.0348	0.0761	0.1153	0.0433	0.0233	0.0000	0.4994	
	Benthic Herblands	0.7868	0.5079	0.4763	0.3728	0.2053	0.1702	0.3719	0.1955	0.0260	0.0650	0.1027	0.0354	0.0198	0.0000	0.4443	
Fish	Short-lived Fish	0.8842	0.8368	0.8026	0.7342	0.5289	0.4868	0.7474	0.2197	0.0225	0.1095	0.2023	0.0912	0.0566	0.0181	0.7198	0.7006
	Long-lived Fish	0.8842	0.8421	0.8184	0.7474	0.5395	0.4947	0.7658	0.1379	0.0127	0.0924	0.2037	0.1316	0.0907	0.0123	0.6814	

Gunbower-Koondrook-Perricoota 0.5265 0.5265

		Mean EE-Score per element and SFI						Area Weighted Score per element and SFI						EE-Score	EC-Score
		16K*90	20K*60	30K*60	40K*60	20K*150	>40	16K*90	20K*60	30K*60	40K*60	20K*150	>40	per Reach	per Reach
Bird	Waterbirds - health	0.8763	0.8614	0.6868	0.2851	0.3851	0.2851	0.1597	0.0488	0.1589	0.0779	0.0218	0.0570	0.5241	0.2650
	Bitterns, Crakes and Rails	0.6193	0.6211	0.0982	0.0325	0.0456	0.0325	0.0000	0.0000	0.0000	0.0000	0.0456	0.0000	0.0456	
	Colonial-Nesting Waterbirds				0.2272						0.2272			0.2272	
	Waterbirds - breeding				0.2632						0.2632			0.2632	
Vegetation	River Red Gum forests	0.8974	0.8895	0.7982	0.3447	0.6439	0.3447	0.2454	0.1167	0.2321	0.0719	0.0000	0.0331	0.6992	0.5800
	River Red Gum woodlands	0.9000	0.9000	0.8737	0.5333	0.7535	0.5333	0.0645	0.1096	0.2057	0.1554	0.0000	0.1492	0.6845	
	Blackbox -forests and woodlands	0.9000	0.9000	0.8737	0.5491	0.7605	0.5491	0.1622	0.0691	0.1304	0.1866	0.0000	0.1394	0.6878	
	Shrublands	0.8000	0.7974	0.6974	0.2649	0.4149	0.2649	0.0050	0.0124	0.0290	0.1844	0.0000	0.0638	0.2945	
	Tall Grasslands, Sedgelands and Rushlands	0.7974	0.7579	0.4763	0.3474	0.3658	0.3474	0.2864	0.1028	0.1166	0.0588	0.0000	0.0316	0.5963	
	Benthic Herblands	0.6947	0.6868	0.4096	0.2877	0.3272	0.2877	0.2495	0.0931	0.1003	0.0487	0.0000	0.0262	0.5179	
Fish	Short-lived Fish	0.8763	0.8632	0.7526	0.5842	0.6711	0.5842	0.3148	0.0585	0.1843	0.0990	0.0455	0.0532	0.7552	0.7343
	Long-lived Fish	0.8763	0.8658	0.7737	0.6053	0.6947	0.6053	0.1597	0.0490	0.1790	0.1655	0.0393	0.1209	0.7134	

Hattah-Kulkyne Lakes 0.3911 0.3911

		Mean EE-Score per element and SFI							Area Weighted Score per element and SFI							EE-Score	EC-Score
		40K*60	50K*60	70K*42	85K*30	120K*14	150K*7	>150	40K*60	50K*60	70K*42	85K*30	120K*14	150K*7	>150	per Reach	per Reach
Bird	Waterbirds - health	0.7289	0.4254	0.3263	0.1526	0.0667	0.0518	0.0518	0.1077	0.0393	0.0619	0.0297	0.0177	0.0040	0.0017	0.2619	0.2183
	Bitterns, Crakes and Rails	0.2211	0.0605	0.0333	0.0149	0.0123	0.0105	0.0105	na	na	na	na	na	na	na	na	
	Colonial-Nesting Waterbirds				0.1614							0.1614				0.1614	
	Waterbirds - breeding				0.2316							0.2316				0.2316	
Vegetation	River Red Gum forests	0.8447	0.6061	0.3509	0.1342	0.1342	0.1342	0.1342	0.2438	0.0781	0.0950	0.0215	0.0158	0.0043	0.0003	0.4587	0.3675
	River Red Gum woodlands	0.8868	0.7939	0.4658	0.1526	0.1526	0.1526	0.1526	0.0992	0.0989	0.1323	0.0318	0.0303	0.0088	0.0023	0.4037	
	Blackbox -forests and woodlands	0.8868	0.7991	0.4763	0.2561	0.1588	0.1588	0.1588	0.0366	0.0774	0.0859	0.0537	0.0549	0.0153	0.0048	0.3285	
	Shrublands	0.7316	0.6149	0.3904	0.1684	0.1544	0.1474	0.1474	0.0225	0.0612	0.0856	0.0501	0.0423	0.0115	0.0001	0.2734	
	Tall Grasslands, Sedgelands and Rushlands	0.5667	0.4640	0.3535	0.2325	0.1982	0.1684	0.1684	0.2483	0.0257	0.0706	0.0347	0.0222	0.0039	0.0038	0.4092	
	Benthic Herblands	0.4702	0.3211	0.2553	0.2053	0.1754	0.1500	0.1500	0.2060	0.0178	0.0510	0.0306	0.0197	0.0035	0.0034	0.3319	
Fish	Short-lived Fish	0.7868	0.6658	0.5500	0.4684	0.4342	0.4000	0.4000	0.3448	0.0368	0.1098	0.0699	0.0487	0.0092	0.0090	0.6283	0.5876
	Long-lived Fish	0.8026	0.6921	0.5711	0.4816	0.4447	0.4026	0.4026	0.1185	0.0639	0.1084	0.0936	0.1180	0.0310	0.0134	0.5469	

Riverland Chowilla Floodplain 0.4401 0.4401

		Mean EE-Score per element and SFI								Area Weighted Score per element and SFI								EE-Score	EC-Score
		20K*60	40K*30	40K*90	60K*60	80K*30	100K*21	125K*7	>125	20K*60	40K*30	40K*90	60K*60	80K*30	100K*21	125K*7	>125	per Reach	per Reach
Bird	Waterbirds - health	0.8737	0.8368	0.5693	0.3956	0.1553	0.0553	0.0500	0.0500	0.0000	0.1249	0.0850	0.0500	0.0533	0.0101	0.0024	0.0000	0.3258	0.2523
	Bitterns, Crakes and Rails	0.6842	0.4061	0.0939	0.0474	0.0228	0.0105	0.0105	0.0105	0.0000	0.0000	0.0939	0.0000	0.0000	0.0000	0.0000	0.0000	0.0939	
	Colonial-Nesting Waterbirds					0.2553								0.2553				0.2553	
	Waterbirds - breeding					0.3342								0.3342				0.3342	
Vegetation	River Red Gum forests	0.8921	0.8816	0.8193	0.5237	0.1860	0.1342	0.1342	0.1342	0.0000	0.1207	0.1122	0.1348	0.0645	0.0130	0.0033	0.0000	0.4485	0.4046
	River Red Gum woodlands	0.9000	0.8974	0.8711	0.7281	0.2228	0.1526	0.1526	0.1526	0.0000	0.0512	0.0497	0.2128	0.0970	0.0196	0.0045	0.0000	0.4349	
	Blackbox forests and woodlands	0.9000	0.8974	0.8737	0.7351	0.2667	0.1588	0.1588	0.1588	0.0000	0.0275	0.0268	0.0891	0.1101	0.0489	0.0153	0.0000	0.3178	
	Shrublands	0.8132	0.7711	0.7053	0.4254	0.2079	0.1474	0.1474	0.1474	0.0000	0.0267	0.0244	0.0688	0.1032	0.0334	0.0068	0.0000	0.2632	
	Tall Grasslands, Sedgelands and Rushlands	0.7895	0.6947	0.5237	0.4070	0.2482	0.1754	0.1684	0.1684	0.0000	0.2609	0.1967	0.0344	0.0299	0.0067	0.0009	0.0000	0.5296	
	Benthic Herblands	0.7289	0.5895	0.4140	0.3061	0.1965	0.1588	0.1500	0.1500	0.0000	0.2214	0.1555	0.0259	0.0237	0.0061	0.0008	0.0000	0.4334	
Fish	Short-lived Fish	0.8737	0.8447	0.7526	0.6368	0.4842	0.4289	0.3842	0.3842	0.0000	0.3173	0.2827	0.0539	0.0583	0.0164	0.0021	0.0000	0.7307	0.6635
	Long-lived Fish	0.8737	0.8526	0.7789	0.6605	0.4974	0.4342	0.3895	0.3895	0.0000	0.1273	0.1163	0.0836	0.1706	0.0797	0.0187	0.0001	0.5962	

Edward Wakool River System — 0.4212 | 0.4212

		Mean EE-Score per element and SFI					Area Weighted Score per element and SFI					EE-Score	EC-Score
		1.5K*180	5K*60	5K*120	18K*28	30K*21	1.5K*180	5K*60	5K*120	18K*28	30K*21	per Reach	per Reach
Bird	Waterbirds - health	0.8947	0.8711	0.5044	0.2211	0.1500	0.0000	0.0545	0.0316	0.0600	0.0905	0.2366	0.3361
	Bitterns, Crakes and Rails	0.8702	0.5605	0.0526	0.0219	0.0132	0.0000	0.5605	0.0000	0.0000	0.0000	0.5605	
	Colonial-Nesting Waterbirds			0.2000					0.2000			0.2000	
	Waterbirds - breeding			0.3474					0.3474			0.3474	
Vegetation	River Red Gum forests	0.8974	0.8947	0.7026	0.1868	0.1342	0.0000	0.1284	0.1008	0.0653	0.0488	0.3433	0.3292
	River Red Gum woodlands	0.9000	0.9000	0.7737	0.2158	0.1526	0.0000	0.0785	0.0675	0.0789	0.0702	0.2951	
	Blackbox -forests and woodlands	0.9000	0.9000	0.7807	0.4518	0.2746	0.0000	0.0382	0.0331	0.1204	0.1781	0.3698	
	Shrublands	0.8789	0.7947	0.6009	0.2158	0.1526	0.0000	0.0165	0.0125	0.0609	0.1032	0.1931	
	Tall Grasslands, Sedgelands and Rushlands	0.8763	0.7816	0.4693	0.2509	0.2009	0.0000	0.1920	0.1153	0.0655	0.0498	0.4226	
	Benthic Herblands	0.8737	0.6842	0.3553	0.2053	0.1702	0.0000	0.1681	0.0873	0.0536	0.0422	0.3511	
Fish	Short-lived Fish	0.8947	0.8711	0.7132	0.5342	0.4868	0.0000	0.2140	0.1752	0.1394	0.1206	0.6493	0.5983
	Long-lived Fish	0.8947	0.8711	0.7316	0.5474	0.4947	0.0000	0.0545	0.0458	0.1486	0.2985	0.5474	

Lower Goulburn — 0.8162 | 0.8162

		Mean EE-Score per element and SFI				Area Weighted Score per element and SFI				EE-Score	EC-Score
		2.5K*4x2	5K*14	25K*5	40K*4	2.5K*4x2	5K*14	25K*5	40K*4	per Reach	per Reach
Bird	Waterbirds - health	0.7904	0.8404	0.8921	0.7719	0.0000	0.0000	0.4978	0.3412	0.8390	0.7537
	Bitterns, Crakes and Rails	0.3842	0.3702	0.7939	0.4588	na	na	na	na	na	
	Colonial-Nesting Waterbirds		na				na			na	
	Waterbirds - breeding		0.6684				0.6684			0.6684	
Vegetation	River Red Gum forests	0.8579	0.8816	0.9000	0.8360	0.0000	0.0000	0.5624	0.3136	0.8760	0.8336
	River Red Gum woodlands	0.8868	0.9000	0.9000	0.8842	0.0000	0.0000	0.5194	0.3739	0.8933	
	Blackbox -forests and woodlands	0.8868	0.9000	0.9000	0.8842	0.0000	0.0000	0.3139	0.5758	0.8897	
	Shrublands	0.7553	0.7658	0.8474	0.7684	na	na	na	na	na	
	Tall Grasslands, Sedgelands and Rushlands	0.6526	0.6632	0.8474	0.7184	0.0000	0.0000	0.4874	0.3052	0.7926	
	Benthic Herblands	0.5535	0.5289	0.8079	0.5930	0.0000	0.0000	0.4647	0.2519	0.7166	
Fish	Short-lived Fish	0.8079	0.8421	0.8921	0.8184	0.0000	0.0000	0.5131	0.3477	0.8608	0.8613
	Long-lived Fish	0.8184	0.8447	0.8921	0.8237	0.0000	0.0000	0.4978	0.3641	0.8619	

Lower Darling Floodplain — 0.2924 | 0.2924

		Mean EE-Score per element and SFI					Area Weighted Score per element and SFI					EE-Score	EC-Score
		7K*10	17K*18	20K*30	25K*45	45K*2	7K*10	17K*18	20K*30	25K*45	45K*2	per Reach	per Reach
Bird	Waterbirds - health	0.7895	0.3228	0.0702	0.0570	0.0553	0.0000	0.0874	0.0065	0.0070	0.0284	0.1293	0.1633
	Bitterns, Crakes and Rails	0.3632	0.0289	0.0088	0.0070	0.0070	na	na	na	na	na	na	
	Colonial-Nesting Waterbirds			na					na			na	
	Waterbirds - breeding			0.1974					0.1974			0.1974	
Vegetation	River Red Gum forests	0.8605	0.4061	0.1342	0.1342	0.1342	0.0000	0.2203	0.0124	0.0181	0.0309	0.2817	0.2315
	River Red Gum woodlands	0.8947	0.5114	0.1526	0.1526	0.1526	0.0000	0.1768	0.0127	0.0258	0.0614	0.2767	
	Blackbox -forests and woodlands	0.8947	0.5368	0.1588	0.1588	0.1588	0.0000	0.1157	0.0115	0.0207	0.0924	0.2402	
	Shrublands	0.7763	0.3456	0.1404	0.1333	0.1333	0.0000	0.1000	0.0069	0.0090	0.0792	0.1951	
	Tall Grasslands, Sedgelands and Rushlands	0.6816	0.3061	0.1456	0.1228	0.1228	0.0000	0.1355	0.0205	0.0097	0.0415	0.2071	
	Benthic Herblands	0.5816	0.2728	0.1333	0.1167	0.1167	0.0000	0.1207	0.0187	0.0092	0.0394	0.1881	
Fish	Short-lived Fish	0.8132	0.5632	0.4605	0.4395	0.4237	0.0000	0.2493	0.0648	0.0347	0.1431	0.4918	0.4824
	Long-lived Fish	0.8289	0.5868	0.4605	0.4368	0.4237	0.0000	0.1589	0.0430	0.0535	0.2176	0.4729	

Mid Bidgee 0.5181 0.5181

		Mean EE-Score per element and SFI					Area Weighted Score per element and SFI					EE-Score per Reach	EC-Score per Reach
		26.85K*45	**26.85K*5**	**34.65K*5**	**44K*3**	**63.25K*3**	**26.85K*45**	**26.85K*5**	**34.65K*5**	**44K*3**	**63.25K*3**		
Bird	Waterbirds - health	0.1044	0.8272	0.6526	0.4904	0.0930	0.0244	0.1936	0.0820	0.1993	0.0000	0.4993	0.3007
	Bitterns, Crakes and Rails	0.0105	0.5079	0.2456	0.0246	0.0088	0.0000	0.0000	0.2456	0.0000	0.0000	0.2456	
	Colonial-Nesting Waterbirds			0.2026					0.2027			0.2027	
	Waterbirds - breeding			0.2553					0.2553			0.2553	
Vegetation	River Red Gum forests	0.1518	0.8816	0.7860	0.6482	0.1684	0.0429	0.2492	0.0990	0.2001	0.0000	0.5913	0.5681
	River Red Gum woodlands	0.1737	0.9000	0.8553	0.8070	0.1921	0.0441	0.2285	0.1324	0.2723	0.0000	0.6773	
	Blackbox -forests and woodlands	0.2044	0.9000	0.8579	0.8368	0.1982	0.0516	0.2273	0.1446	0.2730	0.0000	0.6966	
	Shrublands	0.1474	0.7842	0.7044	0.6096	0.1693	0.0238	0.1266	0.1602	0.2742	0.0000	0.5848	
	Tall Grasslands, Sedgelands and Rushlands	0.1912	0.7316	0.6044	0.3860	0.1509	0.0797	0.3048	0.0370	0.0407	0.0000	0.4622	
	Benthic Herblands	0.1746	0.6263	0.4842	0.3167	0.1404	0.0727	0.2610	0.0296	0.0334	0.0000	0.3967	
Fish	Short-lived Fish	0.4868	0.8474	0.7500	0.6737	0.4816	0.2029	0.3531	0.0459	0.0710	0.0000	0.6729	0.6855
	Long-lived Fish	0.5053	0.8526	0.7711	0.6974	0.4947	0.1182	0.1995	0.0968	0.2835	0.0000	0.6981	

Low Bidgee 0.6074 0.6074

		Mean EE-Score per element and SFI						Area Weighted Score per element and SFI						EE-Score per Reach	EC-Score per Reach
		175GL	**270GL**	**400GL**	**800GL**	**1700GL**	**2700GL**	**175GL**	**270GL**	**400GL**	**800GL**	**1700GL**	**2700GL**		
Bird	Waterbirds - health	0.9000	0.8974	0.8947	0.8132	0.4737	0.2333	0.0557	0.0258	0.0461	0.1048	0.1453	0.0985	0.4762	0.4631
	Bitterns, Crakes and Rails	0.8842	0.8491	0.8167	0.4526	0.0412	0.0158	0.0000	0.0000	0.0000	0.4526	0.0000	0.0000	0.4526	
	Colonial-Nesting Waterbirds				0.3132					0.3131				0.3131	
	Waterbirds - breeding				0.6105					0.6105				0.6105	
Vegetation	River Red Gum forests	0.9000	0.9000	0.9000	0.8658	0.6114	0.2816	0.1176	0.0960	0.1637	0.1833	0.1713	0.0251	0.7570	0.5344
	River Red Gum woodlands	0.9000	0.9000	0.9000	0.8895	0.7061	0.4377	0.0946	0.0216	0.0461	0.2478	0.2642	0.0730	0.7473	
	Blackbox -forests and woodlands	0.9000	0.9000	0.9000	0.8895	0.7211	0.4781	0.0428	0.0274	0.0624	0.1404	0.2844	0.1437	0.7010	
	Shrublands	0.8842	0.8632	0.8447	0.7737	0.5649	0.2167	0.0224	0.0033	0.0063	0.0546	0.1588	0.1326	0.3779	
	Tall Grasslands, Sedgelands and Rushlands	0.8842	0.8632	0.8447	0.7105	0.3737	0.2895	0.2783	0.0700	0.0534	0.0880	0.0729	0.0642	0.6269	
	Benthic Herblands	0.8842	0.8526	0.8237	0.5921	0.3281	0.2667	0.2783	0.0691	0.0521	0.0734	0.0640	0.0591	0.5961	
Fish	Short-lived Fish	0.9000	0.8974	0.8947	0.8289	0.6316	0.5632	0.2833	0.0728	0.0565	0.1027	0.1233	0.1249	0.7635	0.7247
	Long-lived Fish	0.9000	0.8974	0.8947	0.8368	0.6605	0.5868	0.0557	0.0258	0.0461	0.1079	0.2026	0.2477	0.6858	

Appendix IV: Ecological elements Scores with the revised Hume air space management rule

Ecological Elements Score — 0.5034

Barmah-Millewa Forest — 0.4995 | 0.4995

		Mean EE-Score per element and SFI							Area Weighted Score per element and SFI							EE-Score	EC-Score
		12.5K*70	16K*98	25K*42	35K*30	50K*21	60K*14	15K*150	12.5K*70	16K*98	25K*42	35K*30	50K*21	60K*14	15K*150	per Reach	per Reach
Bird	Waterbirds - health	0.8842	0.8360	0.7728	0.6412	0.2544	0.1518	0.6474	0.1379	0.0126	0.0872	0.1748	0.0621	0.0278	0.0104	0.5129	0.3043
	Bitterns, Crakes and Rails	0.7360	0.3991	0.1588	0.0798	0.0237	0.0132	0.0570	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0570	0.0570	
	Colonial-Nesting Waterbirds				0.3105							0.3106				0.3106	
	Waterbirds - breeding				0.3368							0.3368				0.3368	
Vegetation	River Red Gum forests	0.8974	0.8816	0.8579	0.7263	0.1868	0.1518	0.7675	0.1054	0.0420	0.1284	0.2334	0.0382	0.0242	0.0000	0.5716	0.4865
	River Red Gum woodlands	0.9000	0.8974	0.8921	0.7684	0.2158	0.1737	0.8219	0.0776	0.0149	0.0806	0.2235	0.0670	0.0357	0.0000	0.4993	
	Blackbox -forests and woodlands	0.9000	0.8974	0.8921	0.7833	0.4939	0.2763	0.8816	0.1078	0.0092	0.0329	0.1006	0.1566	0.1071	0.0000	0.5142	
	Shrublands	0.8342	0.7632	0.7395	0.6211	0.2281	0.1526	0.6395	0.0650	0.0186	0.0517	0.0843	0.1335	0.0163	0.0000	0.3694	
	Tall Grasslands, Sedgelands and Rushlands	0.8316	0.6895	0.5579	0.4632	0.2754	0.2009	0.4474	0.2066	0.0352	0.0761	0.1276	0.0475	0.0233	0.0000	0.5164	
	Benthic Herblands	0.7868	0.5789	0.4763	0.3596	0.2254	0.1702	0.3719	0.1955	0.0296	0.0650	0.0991	0.0389	0.0198	0.0000	0.4478	
Fish	Short-lived Fish	0.8842	0.8421	0.8026	0.7368	0.5474	0.5000	0.7474	0.2197	0.0227	0.1095	0.2030	0.0944	0.0581	0.0181	0.7254	0.7077
	Long-lived Fish	0.8842	0.8474	0.8184	0.7500	0.5632	0.5053	0.7658	0.1379	0.0128	0.0924	0.2045	0.1374	0.0927	0.0123	0.6899	

Gunbower Koondrook-Perricoota — 0.5221 | 0.5221

		Mean EE-Score per element and SFI						Area Weighted Score per element and SFI						EE-Score	EC-Score
		16K*90	20K*60	30K*60	40K*60	20K*150	>40	16K*90	20K*60	30K*60	40K*60	20K*150	>40	per Reach	per Reach
Bird	Waterbirds - health	0.8763	0.8614	0.6605	0.3079	0.3851	0.3079	0.1597	0.0488	0.1528	0.0842	0.0218	0.0615	0.5288	0.2660
	Bitterns, Crakes and Rails	0.6193	0.6211	0.0982	0.0404	0.0456	0.0404	0.0000	0.0000	0.0000	0.0000	0.0456	0.0000	0.0456	
	Colonial-Nesting Waterbirds			0.2263						0.2263				0.2263	
	Waterbirds - breeding			0.2632						0.2632				0.2632	
Vegetation	River Red Gum forests	0.8974	0.8895	0.7746	0.3447	0.6439	0.3447	0.2454	0.1167	0.2252	0.0719	0.0000	0.0331	0.6923	0.5688
	River Red Gum woodlands	0.9000	0.9000	0.8526	0.4667	0.7535	0.4667	0.0645	0.1096	0.2007	0.1360	0.0000	0.1306	0.6414	
	Blackbox -forests and woodlands	0.9000	0.9000	0.8553	0.4816	0.7605	0.4816	0.1622	0.0691	0.1277	0.1636	0.0000	0.1223	0.6449	
	Shrublands	0.8000	0.7974	0.6807	0.2930	0.4149	0.2930	0.0050	0.0124	0.0283	0.2039	0.0000	0.0705	0.3201	
	Tall Grasslands, Sedgelands and Rushlands	0.7974	0.7579	0.4746	0.3640	0.3658	0.3640	0.2864	0.1028	0.1162	0.0617	0.0000	0.0331	0.6002	
	Benthic Herblands	0.6947	0.6868	0.4044	0.2763	0.3272	0.2763	0.2495	0.0931	0.0990	0.0468	0.0000	0.0251	0.5137	
Fish	Short-lived Fish	0.8763	0.8632	0.7368	0.5868	0.6711	0.5868	0.3148	0.0585	0.1805	0.0994	0.0455	0.0534	0.7521	0.7315
	Long-lived Fish	0.8763	0.8658	0.7579	0.6079	0.6947	0.6079	0.1597	0.0490	0.1754	0.1662	0.0393	0.1215	0.7110	

Hattah-Kulkyne Lakes — 0.3982 | 0.3982

		Mean EE-Score per element and SFI							Area Weighted Score per element and SFI							EE-Score	EC-Score
		40K*60	50K*60	70K*42	85K*30	120K*14	150K*7	>150	40K*60	50K*60	70K*42	85K*30	120K*14	150K*7	>150	per Reach	per Reach
Bird	Waterbirds - health	0.7316	0.5246	0.3061	0.1737	0.0982	0.0518	0.0518	0.1081	0.0484	0.0581	0.0338	0.0261	0.0040	0.0017	0.2801	0.2288
	Bitterns, Crakes and Rails	0.2421	0.0912	0.0360	0.0158	0.0132	0.0105	0.0105	na	na	na	na	na	na	na	na	
	Colonial-Nesting Waterbirds				0.1693							0.1693				0.1693	
	Waterbirds - breeding				0.2368							0.2368				0.2368	
Vegetation	River Red Gum forests	0.8447	0.6974	0.3789	0.1342	0.1342	0.1342	0.1342	0.2438	0.0898	0.1026	0.0215	0.0158	0.0043	0.0003	0.4781	0.3740
	River Red Gum woodlands	0.8868	0.8018	0.4588	0.1526	0.1526	0.1526	0.1526	0.0992	0.0999	0.1303	0.0318	0.0303	0.0088	0.0023	0.4027	
	Blackbox -forests and woodlands	0.8868	0.8070	0.4904	0.2561	0.1588	0.1588	0.1588	0.0366	0.0781	0.0884	0.0537	0.0549	0.0153	0.0048	0.3318	
	Shrublands	0.7342	0.6386	0.3842	0.1702	0.1561	0.1474	0.1474	0.0225	0.0636	0.0843	0.0506	0.0428	0.0115	0.0001	0.2755	
	Tall Grasslands, Sedgelands and Rushlands	0.5798	0.5018	0.3509	0.2439	0.2079	0.1684	0.1684	0.2541	0.0277	0.0701	0.0364	0.0233	0.0039	0.0038	0.4193	
	Benthic Herblands	0.4728	0.3342	0.2553	0.2167	0.1851	0.1500	0.1500	0.2072	0.0185	0.0510	0.0323	0.0207	0.0035	0.0034	0.3366	
Fish	Short-lived Fish	0.7895	0.6868	0.5474	0.4737	0.4395	0.4000	0.4000	0.3459	0.0380	0.1093	0.0707	0.0493	0.0092	0.0090	0.6314	0.5918
	Long-lived Fish	0.8053	0.7184	0.5711	0.4868	0.4500	0.4026	0.4026	0.1189	0.0663	0.1084	0.0946	0.1194	0.0310	0.0134	0.5521	

Riverland Chowilla Floodplain — 0.4387 | 0.4387

		Mean EE-Score per element and SFI								Area Weighted Score per element and SFI								EE-Score	EC-Score
		20K*60	40K*30	40K*90	60K*60	80K*30	100K*21	125K*7	>125	20K*60	40K*30	40K*90	60K*60	80K*30	100K*21	125K*7	>125	per Reach	per Reach
Bird	Waterbirds - health	0.8737	0.8368	0.6386	0.3956	0.1447	0.0570	0.0500	0.0500	0.0000	0.1249	0.0953	0.0500	0.0497	0.0105	0.0024	0.0000	0.3329	0.2549
	Bitterns, Crakes and Rails	0.6842	0.4061	0.0956	0.0474	0.0132	0.0105	0.0105	0.0105	0.0000	0.0000	0.0956	0.0000	0.0000	0.0000	0.0000	0.0000	0.0956	
	Colonial-Nesting Waterbirds				0.2570								0.2570					0.2570	
	Waterbirds - breeding				0.3342								0.3342					0.3342	
Vegetation	River Red Gum forests	0.8921	0.8816	0.8219	0.5237	0.1518	0.1342	0.1342	0.1342	0.0000	0.1207	0.1125	0.1348	0.0526	0.0130	0.0033	0.0000	0.4370	0.3943
	River Red Gum woodlands	0.9000	0.8974	0.8711	0.7281	0.1737	0.1526	0.1526	0.1526	0.0000	0.0512	0.0497	0.2128	0.0756	0.0196	0.0045	0.0000	0.4135	
	Blackbox -forests and woodlands	0.9000	0.8974	0.8737	0.7351	0.2596	0.1588	0.1588	0.1588	0.0000	0.0275	0.0268	0.0891	0.1072	0.0489	0.0153	0.0000	0.3149	
	Shrublands	0.8132	0.7711	0.7079	0.4254	0.1614	0.1474	0.1474	0.1474	0.0000	0.0267	0.0245	0.0688	0.0801	0.0334	0.0068	0.0000	0.2402	
	Tall Grasslands, Sedgelands and Rushlands	0.7895	0.6947	0.5289	0.4070	0.2096	0.1754	0.1684	0.1684	0.0000	0.2609	0.1987	0.0344	0.0253	0.0067	0.0009	0.0000	0.5269	
	Benthic Herblands	0.7289	0.5895	0.4167	0.3061	0.1886	0.1588	0.1500	0.1500	0.0000	0.2214	0.1565	0.0259	0.0227	0.0061	0.0008	0.0000	0.4334	
Fish	Short-lived Fish	0.8737	0.8447	0.7553	0.6368	0.4921	0.4421	0.3842	0.3842	0.0000	0.3173	0.2837	0.0539	0.0593	0.0169	0.0021	0.0000	0.7331	0.6668
	Long-lived Fish	0.8737	0.8526	0.7816	0.6605	0.5000	0.4500	0.3895	0.3895	0.0000	0.1273	0.1167	0.0836	0.1716	0.0826	0.0187	0.0001	0.6004	

Edward Wakool River System

		Mean EE-Score per element and SFI					Area Weighted Score per element and SFI				
		1.5K*180	**5K*60**	**5K*120**	**18K*28**	**30K*21**	**1.5K*180**	**5K*60**	**5K*120**	**18K*28**	**30K*21**
Bird	Waterbirds - health	0.8947	0.8711	0.6246	0.2544	0.1956	0.0000	0.0545	0.0391	0.0690	0.1180
	Bitterns, Crakes and Rails	0.8702	0.5605	0.0886	0.0237	0.0149	0.0000	0.5605	0.0000	0.0000	0.0000
	Colonial-Nesting Waterbirds			0.2211					0.2210		
	Waterbirds - breeding			0.3658					0.3658		
Vegetation	River Red Gum forests	0.8974	0.8947	0.7079	0.1868	0.1693	0.0000	0.1284	0.1016	0.0653	0.0616
	River Red Gum woodlands	0.9000	0.9000	0.7737	0.2158	0.1947	0.0000	0.0785	0.0675	0.0789	0.0896
	Blackbox -forests and woodlands	0.9000	0.9000	0.7807	0.4518	0.2956	0.0000	0.0382	0.0331	0.1204	0.1918
	Shrublands	0.8789	0.7947	0.6114	0.2228	0.1719	0.0000	0.0165	0.0127	0.0629	0.1162
	Tall Grasslands, Sedgelands and Rushlands	0.8763	0.7816	0.5088	0.2737	0.2325	0.0000	0.1920	0.1250	0.0714	0.0576
	Benthic Herblands	0.8737	0.6842	0.3684	0.2219	0.1974	0.0000	0.1681	0.0905	0.0579	0.0489
Fish	Short-lived Fish	0.8947	0.8711	0.7289	0.5474	0.5026	0.0000	0.2140	0.1791	0.1429	0.1245
	Long-lived Fish	0.8947	0.8711	0.7421	0.5632	0.5079	0.0000	0.0545	0.0465	0.1528	0.3064

Lower Goulburn

		Mean EE-Score per element and SFI				Area Weighted Score per element and SFI			
		2.5K*4x2	**5K*14**	**25K*5**	**40K*4**	**2.5K*4x2**	**5K*14**	**25K*5**	**40K*4**
Bird	Waterbirds - health	0.7904	0.8404	0.8921	0.7719	0.0000	0.0000	0.4978	0.3412
	Bitterns, Crakes and Rails	0.3842	0.3702	0.7939	0.4588	na	na	na	na
	Colonial-Nesting Waterbirds		na					na	
	Waterbirds - breeding		0.6684					0.6684	
Vegetation	River Red Gum forests	0.8579	0.8816	0.9000	0.8360	0.0000	0.0000	0.5624	0.3136
	River Red Gum woodlands	0.8868	0.9000	0.9000	0.8842	0.0000	0.0000	0.5194	0.3739
	Blackbox -forests and woodlands	0.8868	0.9000	0.9000	0.8842	0.0000	0.0000	0.3139	0.5758
	Shrublands	0.7553	0.7658	0.8474	0.7684	na	na	na	na
	Tall Grasslands, Sedgelands and Rushlands	0.6526	0.6632	0.8474	0.7184	0.0000	0.0000	0.4874	0.3052
	Benthic Herblands	0.5535	0.5289	0.8079	0.5930	0.0000	0.0000	0.4647	0.2519
Fish	Short-lived Fish	0.8079	0.8421	0.8921	0.8184	0.0000	0.0000	0.5131	0.3477
	Long-lived Fish	0.8184	0.8447	0.8921	0.8237	0.0000	0.0000	0.4978	0.3641

Lower Darling Floodplain

		Mean EE-Score per element and SFI					Area Weighted Score per element and SFI				
		7K*10	**17K*18**	**20K*30**	**25K*45**	**45K*2**	**7K*10**	**17K*18**	**20K*30**	**25K*45**	**45K*2**
Bird	Waterbirds - health	0.7868	0.3228	0.0702	0.0570	0.0553	0.0000	0.0874	0.0065	0.0070	0.0284
	Bitterns, Crakes and Rails	0.3588	0.0289	0.0088	0.0070	0.0070	na	na	na	na	na
	Colonial-Nesting Waterbirds			na					na		
	Waterbirds - breeding			0.1974					0.1974		
Vegetation	River Red Gum forests	0.8579	0.4061	0.1342	0.1342	0.1342	0.0000	0.2203	0.0124	0.0181	0.0309
	River Red Gum woodlands	0.8947	0.5114	0.1526	0.1526	0.1526	0.0000	0.1768	0.0127	0.0258	0.0614
	Blackbox -forests and woodlands	0.8947	0.5368	0.1588	0.1588	0.1588	0.0000	0.1157	0.0115	0.0207	0.0924
	Shrublands	0.7737	0.3456	0.1404	0.1333	0.1333	0.0000	0.1000	0.0069	0.0090	0.0792
	Tall Grasslands, Sedgelands and Rushlands	0.6500	0.3061	0.1456	0.1228	0.1228	0.0000	0.1355	0.0205	0.0097	0.0415
	Benthic Herblands	0.5789	0.2728	0.1333	0.1167	0.1167	0.0000	0.1207	0.0187	0.0092	0.0394
Fish	Short-lived Fish	0.8105	0.5632	0.4605	0.4395	0.4237	0.0000	0.2493	0.0648	0.0347	0.1431
	Long-lived Fish	0.8263	0.5868	0.4605	0.4368	0.4237	0.0000	0.1589	0.0430	0.0535	0.2176

Mid-Bidgee 0.5181 0.5181

		Mean EE-Score per element and SFI					Area Weighted Score per element and SFI					EE-Score per Reach	EC-Score per Reach
		26.85K*45	**26.85K*5**	**34.65K*5**	**44K*3**	**63.25K*3**	**26.85K*45**	**26.85K*5**	**34.65K*5**	**44K*3**	**63.25K*3**		
Bird	Waterbirds - health	0.1044	0.8272	0.6526	0.4904	0.0930	0.0244	0.1936	0.0820	0.1993	0.0000	0.4993	0.3007
	Bitterns, Crakes and Rails	0.0105	0.5079	0.2456	0.0246	0.0088	0.0000	0.0000	0.2456	0.0000	0.0000	0.2456	
	Colonial-Nesting Waterbirds			0.2026					0.2027			0.2027	
	Waterbirds - breeding			0.2553					0.2553			0.2553	
Vegetation	River Red Gum forests	0.1518	0.8816	0.7860	0.6482	0.1684	0.0429	0.2492	0.0990	0.2001	0.0000	0.5913	0.5681
	River Red Gum woodlands	0.1737	0.9000	0.8553	0.8070	0.1921	0.0441	0.2285	0.1324	0.2723	0.0000	0.6773	
	Blackbox forests and woodlands	0.2044	0.9000	0.8579	0.8368	0.1982	0.0516	0.2273	0.1446	0.2730	0.0000	0.6966	
	Shrublands	0.1474	0.7842	0.7044	0.6096	0.1693	0.0238	0.1266	0.1602	0.2742	0.0000	0.5848	
	Tall Grasslands, Sedgelands and Rushlands	0.1912	0.7316	0.6044	0.3860	0.1509	0.0797	0.3048	0.0370	0.0407	0.0000	0.4622	
	Benthic Herblands	0.1746	0.6263	0.4842	0.3167	0.1404	0.0727	0.2610	0.0296	0.0334	0.0000	0.3967	
Fish	Short-lived Fish	0.4868	0.8474	0.7500	0.6737	0.4816	0.2029	0.3531	0.0459	0.0710	0.0000	0.6729	0.6855
	Long-lived Fish	0.5053	0.8526	0.7711	0.6974	0.4947	0.1182	0.1995	0.0968	0.2835	0.0000	0.6981	

Low Bidgee 0.6074 0.6074

		Mean EE-Score per element and SFI						Area Weighted Score per element and SFI						EE-Score per Reach	EC-Score per Reach
		175GL	**270GL**	**400GL**	**800GL**	**1700GL**	**2700GL**	**175GL**	**270GL**	**400GL**	**800GL**	**1700GL**	**2700GL**		
Bird	Waterbirds - health	0.9000	0.8974	0.8947	0.8132	0.4737	0.2333	0.0557	0.0258	0.0461	0.1048	0.1453	0.0985	0.4762	0.4631
	Bitterns, Crakes and Rails	0.8842	0.8491	0.8167	0.4526	0.0412	0.0158	0.0000	0.0000	0.0000	0.4526	0.0000	0.0000	0.4526	
	Colonial-Nesting Waterbirds			0.3132						0.3131				0.3131	
	Waterbirds - breeding			0.6105						0.6105				0.6105	
Vegetation	River Red Gum forests	0.9000	0.9000	0.9000	0.8658	0.6114	0.2816	0.1176	0.0960	0.1637	0.1833	0.1713	0.0251	0.7570	0.6344
	River Red Gum woodlands	0.9000	0.9000	0.9000	0.8895	0.7061	0.4377	0.0946	0.0216	0.0461	0.2478	0.2642	0.0730	0.7473	
	Blackbox -forests and woodlands	0.9000	0.9000	0.9000	0.8895	0.7211	0.4781	0.0428	0.0274	0.0624	0.1404	0.2844	0.1437	0.7010	
	Shrublands	0.8842	0.8632	0.8447	0.7737	0.5649	0.2167	0.0224	0.0033	0.0063	0.0546	0.1588	0.1326	0.3779	
	Tall Grasslands, Sedgelands and Rushlands	0.8842	0.8632	0.8447	0.7105	0.3737	0.2895	0.2783	0.0700	0.0534	0.0880	0.0729	0.0642	0.6269	
	Benthic Herblands	0.8842	0.8526	0.8237	0.5921	0.3281	0.2667	0.2783	0.0691	0.0521	0.0734	0.0640	0.0591	0.5961	
Fish	Short-lived Fish	0.9000	0.8974	0.8947	0.8289	0.6316	0.5632	0.2833	0.0728	0.0565	0.1027	0.1233	0.1249	0.7635	0.7247
	Long-lived Fish	0.9000	0.8974	0.8947	0.8368	0.6605	0.5868	0.0557	0.0258	0.0461	0.1079	0.2026	0.2477	0.6858	