Amendment date: 28 June 2017

	Title of measure	**Improved Regulation of the River Murray**
	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. The proposed rule change will take into account recent improvements in the River Murray operational loss performance which result in a significant reduction in the estimated operational loss compared to losses required under the benchmark scenario, meaning that more water will be available for allocation to meet environmental and consumptive water requirements.
3.	**Description of the works or measure**	
	It is proposed that the recent observed improvement in operational loss efficiency be locked in, and recognised by putting in place revised arrangements for estimating the operational loss requirements needed to run the River Murray system.	
4.	**Geographical location of the measure**	
	River Murray system, in particular along the Murray River reach from Hume Dam to SA Border.	
5.	**Details for representing the measure in the MDBA's assessment framework**	
	The proposal can be represented in the MSM-BigMod model by revising the existing operational loss configuration in the model to better reflect the improvements to system operational losses observed in recent years. Agreed coefficients and monthly constants for MSM OPLOSS Regression Function are shown below.	

Item	Coefficient/ Constant
Order	0
Diversions*Rainfall	0.00280
Kiewa+Ovens flow	-0. 1119
NSW+Vic Allocation	0.00803
Jan	36.48
Feb	41.40
Mar	20.48
Apr	-10.72
May	-13.19
Jun	-17.04
Jul	25.88
Aug	62.33
Sep	43.07
Oct	106.89
Nov	89.00
Dec	52.40

6. Details for the representation of each operating strategy, policy or rule change proposed.

The method for estimating operational losses has been revised to reflect the recent improvements to system operational loss performance and is outlined in the business case (**Attachment A**).

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 juristictions on apportioning the supply contribution, which will be required in coming months.

9. Details of relevant constraint measures

It is expected that the benefits of this SDL proposal will not be reduced by implementation of the Constraints Management Strategy. Any removal of the current capacity constraints below Hume Dam would be unlikely to negatively impact on operational losses required to effectively manage the system.

Attachments:

A	DELWP, 2016	Business case for improved regulation of the River Murray

Business case for improved regulation of the River Murray

A Sustainable Diversion Limit Adjustment Measure

Environment, Land, Water and Planning

Acknowledgements

This business case was prepared by Alluvium Consulting Australia, RM Consulting Group and DG Consulting under contract from the Department of Environment, Land, Water and Planning (DELWP).

Significant advice and review was provided by representatives from a variety of other cross-jurisdictional agencies, most notably including DELWP and Goulburn-Murray Water.

Cover image of Lake Hume by Michael Bell, October 2004. Photo courtesy of MDBA image gallery.

Contents

Glossary

AHD	Australian Height Datum
CMA	Catchment Management Authority
CMS	Constraints Management Strategy
DELWP	Department of Environment, Land, Water and Planning
EC	Electrical Conductivity
FEWS	Flood Early Warning System
GL	Gigalitre (1,000,000,000 litres)
GST	Goods and Services Tax
ICC	Icon site Coordinating Committee
MEP	Monitoring and Evaluation Plan
MDBA	Murray-Darling Basin Authority
ML	Megalitre (1,000,000 litres)
NSW	New South Wales
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
WLWG	Water Liaison Working Group
WRP	Water Resource Plan

Executive summary

Operating rule change for SDL adjustment

This business case for the improved regulation of the River Murray sets out proposals for locking in recent improvements in water system management techniques, and implementing an updated approach for estimating the operational loss requirements for the River Murray system. The outcome will 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 Assessment Guidelines published by the SDL Adjustment Assessment Committee (SDLAAC).[1]

Operational losses

In order to deliver water at the times and in the volumes required by water users, system operators need to plan what releases are required from storages. Release planning must also take into account the current and expected future state of the system in relation to changes in demands, inflows from tributaries and travel times (etc.). Most of these factors are uncertain and changing, so in order to manage the risk of not being able to meet demands, operators make conservative assumptions about these factors. If actual conditions in the system turn out to be more favourable than these conservative assumptions, operators will have released more water than was actually required to meet demands.

This difference between the actual releases made and releases required if perfect knowledge of future system conditions was available is called 'operational loss'. It represents a necessary risk management factor to ensure water user needs and minimum flow targets can be reliably met.

Operational losses are represented in the Murray-Darling Basin Authority (MDBA) system models in order to understand how the water system may perform under a range of scenarios. Understanding the future operational loss requirements allows the amount of water available for use by consumptive and environmental entitlement holders to be simulated.

The proposal

Leading up to and following the millennium drought, there has been a significant water reform program and a shift in long-term river operational practices. There has been a large investment in better, more efficient management of water systems, which has enabled operational losses to be reduced.

The proposed change involves locking in place recent observed improvements in operational loss performance, and recognising the improved performance by revising arrangements for estimating the operational loss requirements needed to run the River Murray system.

The proposal can be represented in the model by applying a regression equation in the same form that is currently used by the MDBA to estimate water required for operational losses. The regression coefficients and constants have been revised to better reflect the expected enduring system operations under the improved operational management capability of river operators to meet future demand conditions.

The proposed rule change will result in a significant reduction in the estimated operational loss compared to losses required under the benchmark scenario, meaning that more water will be available for allocation to meet environmental and consumptive water requirements.

There are two key elements of the proposed changes to operating rules associated with this proposal:

1. Implementation of measures to lock in the improved system operating performance
2. Adoption of revised and updated operational loss estimation techniques

Implementation of measures to lock in the improved system operating performance

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

The improvements in operational loss performance since 1999 were achieved in a period of significant change in delivery patterns due to extreme drought and increased demand for environmental water deliveries. The tools and procedures that are proposed as part of this measure will provide operators with significantly improved capability to detect and respond to changing demand patterns, whilst still maintaining system operational loss performance.

The business case proposes a range of actions which provide a high degree of certainty that improved system performance and reduced operational losses can be consistently delivered. These actions are grouped into two main categories of activity – improved system operational tools and performance monitoring and management actions.

In order to manage the system with reduced operational losses there needs to be a high degree of confidence that this improved performance can be locked in as the business as usual standard for River Murray operations, and that lower operational losses can be delivered with repeatability, year in and year out. The Water Liaison Working Group has considered this issue and advised that operating the river in the manner proposed in this business case to achieve lower operational losses is feasible, and it is expected that ongoing improvements to forecasting and management tools will continue to assist in improving operations.

Adoption of revised and updated operational loss estimation techniques
The proposed rule change applies the same principles and general approach to estimation of operational losses that has been used for many years by the MDBA and has proved to be an effective component of the modelling process.

The modelling undertaken to date, coupled with the assessment of ongoing improvements in river operations practice that support more efficient system management have demonstrated the change in loss behaviour over recent years. The focus on managing system performance and the availability of improved data collection and analysis tools demonstrate the feasibility of this rule change.

Despite the good performance of the revised operational loss estimation technique over a wide range of conditions, there is no guarantee that future demand patterns will not change further in response to external factors including climate change, continued development of environmental watering practices and the ongoing restructuring of irrigated agriculture. For these reasons, it is also proposed that as part of the implementation phase of this project, procedures will be developed for monitoring ongoing operational loss performance. Recommended review timings and triggers will also be developed to ensure that the operational loss estimation procedures in the models are regularly updated to reflect prevailing practices.

Costs

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

Impact assessment

A structured risk assessment was undertaken in accordance with the requirements of the Phase 2 Assessment Guidelines. The assessment 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 assessment confirmed that the proposed changes should generate outcomes that are broadly neutral. The priority risks, concerns and outcomes are identified in the table below.

Issue	Concern	Comment
Environment	That historic and forecast levels of operational loss may create environmental benefits which will be lost under the changes.	Modelling confirms that the changes significantly enhance environmental outcomes.
Loss reductions may not be enduring.	The reductions in historic operational loss observed from 2000 onwards may not be an enduring change.	The MDBA has put in place improved planning processes and tools, and the implementation program for this proposal includes a range of actions to ensure improved performance continues to be "locked in".
Evidence base	The evidence base may not be sufficient to conclude that system operational loss has changed.	An expert panel identified a range of reform measures/initiatives that have contributed to improved water system management. Detailed numeric analysis of loss data also supported the finding that there has been a reduction in system operational losses. Water Liaison Working Group has advised the proposal is technically feasible and it is expected that ongoing improvements to forecasting and management tools will continue to assist in improving operations.
Third parties downstream	That South Australia's needs will be impacted	Modelling confirms that SA's rights to flows volumes and quality are protected
Qualification as an SDL measure	This proposal may not meet the criteria for an SDL adjustment measure.	Detailed review of the principles for supply measures and assessment of this proposal against those principles confirms that this is a legitimate SDL adjustment measure.

The business case advises that 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 interdependencies 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* proposal to increase the maximum channel capacity downstream of Hume Dam from its current limit of 25,000 ML/day to close to 40,000 ML/day would affect this proposal. The assessment indicated the outcome of the Constraints Management Strategy would be unlikely to negatively impact on operational losses required to effectively manage the system.

Governance and 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. It is appropriate that the MDBA should assume project management responsibilities for implementing the change once it has been approved as an SDL adjustment measure.

1. Introduction

1.1. SDL 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 Murray-Darling Basin (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. The operation of the water system under that SDL value has been modelled and the level of environmental outcome achieved has been assessed. 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 quantum of operational loss required to effectively operate the River Murray system under expected future demand conditions. This is an 'Operating rule change' that achieves equivalent environmental outcomes with less water providing an opportunity to deliver a SDL adjustment. This business case has been prepared in accordance with the Phase 2 Assessment Guidelines (refer Appendix 1). It also addresses the requirements for a Phase 1 submission (refer Appendix 2).

[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 specified the terms of reference for this initiative as:

"Investigate regulation of the River Murray post 2000 to identify factors that have contributed to enduring changes to system operational losses and refine the benchmark model to represent these enduring changes. Preliminary modelling indicates that if refinements to the benchmark model were made to bring the operational losses in line with recent system changes it would result in a net increase in environmental watering events".

This is an '*Operating Rule Change*' under the terms of the Phase 2 Assessment Guidelines as it involves a proposal to recognise recent changes in the infrastructure for managing tributary and return flows from irrigation areas and developments in the collection, storage and analysis of operational data on river flows and water demands to support improved planning of the reservoir releases needed to meet future demands. The outcome of this change will be to enable the river to be run with lower levels of operations loss than were forecast under the Basin Plan based on historic system performance, thereby delivering equivalent environmental outcomes as proposed in the Basin Plan but with less water, so generating an SDL offset.

1.3. Background to the proposal

1.3.1. River Murray System operations

The MDBA plans and directs the operation of the River Murray system in order to harvest and store inflows to reservoirs and then release water from storage in a timely manner to meet water requirements in Victoria, NSW and South Australia.

A river system like the River Murray is a complex operational challenge. Water must be delivered across a vast physical river network, which also involves significant temporal scale due to the time it takes for water to flow down the network. The entry of unregulated flows or planned releases from tributary storages further complicates the task of delivering the required volume of water at the desired time.

The key decision the operators can control is determining how much water must be released from storage each day to meet the estimated demands across the system. Lake Hume is one of the key sites in the supply system, and releases from this storage strongly influence flow patterns along the length of the river. The assessment of the required release volumes must include allowance for losses that will be incurred in operating the river. There are two key components of total losses in the network:

- **Transmission losses:** This is the water physically lost as flows travel down the river, due to processes including seepage and evaporation etc.
- **Operational losses:** Operational loss is the term applied to the water that must be released over and above the estimated volume of orders for water to allow for the range of uncertainties that may affect river operations, so as to ensure that likely water demands can be met.

Operational losses represent the risk management premium that must be released to account for uncertainty and changing conditions in the river system. Modelling results show it is a significant component of the water balance of the system, accounting for an average release volume of around 630 GL/year over the period 1983 – 2011.

It should be noted that the data on operational loss referred to in this business case is based on releases from Lake Hume in excess of the volumes needed to meet downstream commitments. Some of the water that makes up operational loss at Lake Hume may be able to be re-harvested into Lake Victoria or other off-stream storages, and subsequently used to help meet water user demands.

1.3.2. Environmental assets

River flows that result from the operation of Lake Hume and other major storages affect the health of important environmental features along the River Murray system. One of the objectives of the Basin Plan is to protect and restore these important ecosystems. Figure 1 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 3.3.2.

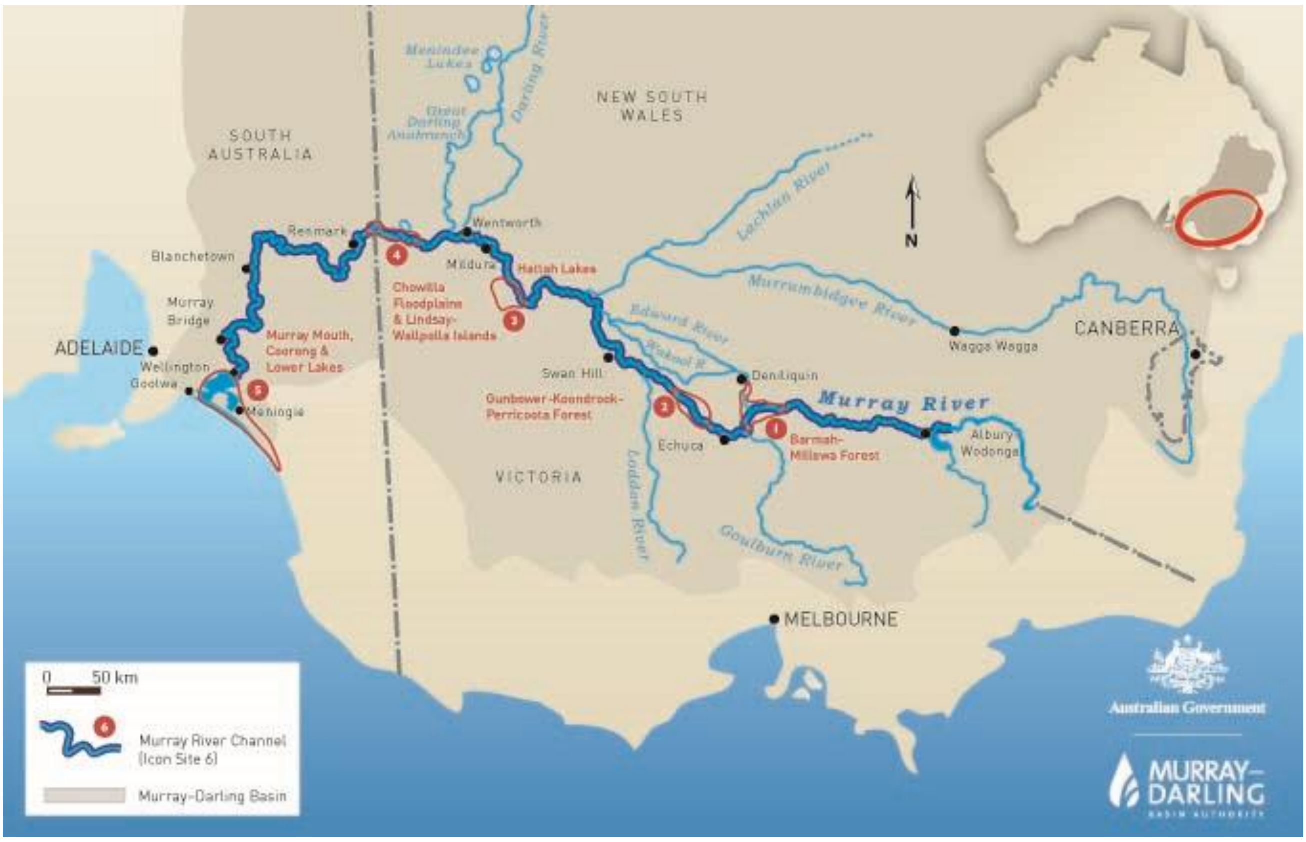

Figure 1. River Murray channel controlled by Hume Dam

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 (O&O document)*
- *Operational Procedures* and reference manuals

These operating rules specify a range of outcomes which the management of the River Murray system must achieve, whilst delivering services to water users downstream. The key objectives for MDBA river operations in relation to water storage, delivery and accounting are set out in the O&O document as[3]:

(i) *To operate the River Murray System efficiently and effectively in order to deliver State water entitlements, while conserving water and minimising undesirable losses.*

(ii) *To maximise the water available to the Southern Basin States, after providing for operating commitments in the River Murray System.*

In order to deliver water at the times and in the volumes required by water users, system operators need to plan what releases from storages are required. Release planning must also take into account the current and expected future state of the system in relation to changes in demands, inflows from tributaries and travel times (etc.). Most of these factors are uncertain and changing, so in order to manage the risk of not being able to meet demands, operators make conservative assumptions about these factors. If actual conditions in the system turn out to be more favourable than these conservative assumptions, operators will have released more water than was actually required to meet demands.

This difference between actual releases made, and releases required if perfect knowledge of future system conditions was available, is called operational loss. It represents a necessary risk management factor to ensure water user needs and minimum flow targets (etc.) can be reliably met.

Leading up to, during and following the millennium drought, efficient system operation was given a high priority by water users. Simultaneously, a range of projects were implemented to reduce losses in distribution systems to maximise water availability in the drought and to create on-going water savings which could be redirected to environmental watering needs. This combination of drivers has enabled improvements in system operational efficiency to be achieved. Assessment of operational losses over the decade from 2000 to 2011 indicates that operational losses have declined compared to prior levels (refer Table 1 for details).

Table 1: Average monthly operational losses for various periods .[4].

	1983-2011	1983-1999	1999-2011
Average monthly historical losses (GL)	49	60	31

Operational losses are represented in the MDBA's system models in order to understand how the water system may perform under a range of scenarios. Understanding the future operational loss requirements allows the amount of water available for use by consumptive and environmental entitlement holders to be simulated.

The operational loss requirements for the River Murray system are estimated in the modelling process by using a complex regression equation that seeks to represent operational loss through reference to a range of relevant factors including rainfall, diversions, water orders and tributary inflows. The MDBA periodically revises the operational loss estimation and adjusts the regression equation to reflect the current system operational loss behaviour. This is effectively a process which seeks to "integrate" and explain operator planning decisions by correlating them to relevant physical variables.

1.4.2. The proposal in context

The period from 2000 onwards has been one of significant change for water systems operations. The millennium drought meant system operators had to critically scrutinise system operations to reduce losses

[3] MDBA 2014, *Objectives and Outcomes for River Operations in the River Murray System*, Murray Darling Basin Authority, Canberra, p 4.

[4] Data for each period is based on the water year of July to June with the exception of 2011 where the period of record ends in December 2011. Months when Lake Victoria transfers and known historic environmental releases occur have been excluded from the data.

and maximise water available for use. In tandem, the push for recovery of water for the environment started in earnest, with significant expenditures in water saving projects including improvements to the monitoring and management of regulated river systems and irrigation delivery networks. These water saving projects also often reduced unmeasured and unplanned outfalls from irrigation networks that contributed to tributary inputs to the River Murray system.

The current operational loss estimates used in MDBA water system models have been developed to explain the behaviour of the system over the period from 1983 to 2009. Whilst these equations performed reasonably well, this period was dominated by water deliveries for consumptive purposes. There were only very limited deliveries for environmental purposes during the calibration period.

When these same regression equations are used with future environmental demands, which follow a significantly different pattern to historic irrigation demands, the predicted volumes of water required for system operational losses increases significantly[5].

This forecast behaviour is at odds with recent observed improvements in operational loss performance and is attributed to the fact that future demand conditions with 2,750 GL of current consumptive use recovered for environmental watering are outside the range of conditions that the current operational loss estimation equations have been developed for. It is considered extremely unlikely that the changing demand patterns for environmental water deliveries will result in system operators requiring an average of over 100 GL of extra operational losses each year to effectively operate the system.

It was considered realistic that overall average annual operational losses under future demand conditions should be similar to recent performance for delivery of consumptive demands. The volume of entitlements on issue will be the same and the key difference is the changed distribution of this same demand across the water year.

This business case proposes that the estimates of operational losses required to operate the river system should be revised to reflect realistically expected system operations under future demand conditions and the improved operational management capability of river operators.

DELWP considered a wide range of alternative options for the revision of the regression equations to estimate operational loss requirements. The equations needed to be able to reproduce “historic” operational loss volumes effectively and also generate realistic estimates of loss under future demand conditions. A range of options were examined and tested, and the proposed approach presented in this business case was arrived at using statistical analysis techniques to optimise the equation fit and provide a sound correlation.

1.4.3. 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 – the constraints strategy, and other operating rule changes and works and measures initiatives.

Constraints strategy

The MDBA released a Constraints Management Strategy (CMS) at the end of 2013, with a target of agreeing on 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 operational loss provisions under future demand conditions.

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[5] Jacobs 2016 found hat the average annual operational loss in the baseline run over the period from 1895 to 2009 was 782GL/year while in the revised benchmark run it was 892GL/year.

The assessment indicated that any removal of the current capacity constraints below Hume Dam would be unlikely to negatively impact on operational losses required to effectively manage the system. Full details of the relationship between order volumes and operational losses are provided in Section 2 of this report. Based on this assessment, it is expected that the benefits of this SDL proposal will not be reduced by implementation of the CMS.

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.

1.4.4. A new measure

The project outlined in this business case is not an anticipated measure, or part of the benchmark conditions of development. This proposal is a 'new measure' under the Phase 2 Assessment 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 River Murray system is a vast, complex, interconnected system of storages, weirs and irrigation supply channels. It receives inflows from catchments, tributary streams and storages, drainage schemes and local runoff and water is diverted at major irrigation offtakes, irrigation and urban pumping stations and individual household pumps.

Water in the River Murray covers a distance of 1,585 km after its release from Lake Hume before it reaches the South Australian border. Within South Australia, the River Murray extends for a further 640 km before the waters reach the Southern Ocean at the Murray mouth.

Despite the scale and complexity of this system, the key decision the operators can control is determining how much water must be released from storage each day to meet the estimated demands across the system. Lake Hume is one of the key sites in the supply system, and releases from this storage strongly influence flow patterns along the whole length of the river.

In order to deliver water requirements to users, the system operators must develop a release plan for Lake Hume (and other storages) which determines how much water will be released each day from the storage. The release plan is reviewed and updated daily to reflect the changing condition of the system.

Releases are planned to meet:

- Explicit orders placed at various locations along the system.
- Estimated demands, especially in lower reaches with long travel times from storages where explicit orders have not yet been placed or confirmed.
- Minimum flows required at key points.
- Transmission losses, which is the water physically lost as flows travel down the river (seepage, evaporation etc.).

In addition, the release plan must have regard for the current and forecast condition of the river system downstream of the storage. The types of issues that must be factored in and allowed for in planning releases include:

- Inflows from river tributaries.
- Travel times in the river, and how they are influenced by prevailing conditions.
- Potential changes to orders/demands/transmission losses over the plan period.
- External factors that may influence these parameters, such as:
    - Rainfall;
    - Temperature and evapotranspiration;
    - Water user behaviour and likely response to changes in these factors.

Most of these factors are uncertain and changing, so in order to manage the risk of not being able to meet water demands over the planning period, operators are often required to make conservative assumptions which may include assuming that tributary inflows will be at the lower end of the estimated range, and transmission losses will be at the higher end of the possible range.

If the actual system conditions are more favourable than the 'worst case' assumptions made, then more water will have been released from storage than was actually required to meet demands. The difference between the releases that would have been required with perfect knowledge of future conditions and the release actually made allowing for the uncertainties is called operational loss. It should be noted that the actual levels of operational loss that occur can only be determined in hindsight after releases have been made.

The volume of water required to cover transmission and operational losses needs to be estimated by the MDBA and set aside in storage to ensure that the river system can be operated and available water can be delivered to entitlement holders at the times and in the volumes they may require throughout the water year. Estimates of the reserves required to cover transmission and operational losses are also critical inputs to the states' seasonal determination processes which determine the water available for allocation to individual entitlement holders.

Operational losses also need to be represented in the MDBA's system models in order to understand how the water system may perform under a range of scenarios. Understanding the future operational loss requirements allows the amount of water available for allocation to entitlement holders to be simulated. This in turn enables future consumptive and environmental water deliveries to be modelled, and therefore the likely extent of ecological benefit from environmental water deliveries to be estimated.

Operational losses are estimated in the Monthly Simulation Model (MSM) of the River Murray system by a regression equation which forecasts monthly operational losses based on a range of statistically significant variables. The key regression equation is in the following form:

Equation 1: Operational loss regression equation

*Operational Loss (GL/mth) = **A***(Diversions)*(Rain) - **B***(Inflows) - **C***(Orders) + Valmon*

Where:

- *Diversions* are the gross monthly diversions made by NSW and Victoria.
- *Rain* is the monthly rainfall at Deniliquin.
- *Inflows* are the monthly inflows from the Kiewa River and Ovens River.
- *Orders* are the total monthly orders at Lake Hume for the Murray system. Total orders at Hume are calculated in MSM by working up the river from the downstream end adding demands (consumptive and non-consumptive), transmission losses and subtracting tributary inflows to calculate the total order for release from Lake Hume. This order volume also includes volumes required to meet monthly entitlement flows at the SA border.
- ***A, B** and **C*** are regression coefficients. The same coefficients apply in all months for estimation of operational losses.
- ***Valmon*** is a monthly constant. A different value has been determined for Valmon for each of the 12 months across the water year.

The values for the coefficients used in the benchmark and baseline models[6] are shown in Table 2. The monthly values for the Valmon constant used in the benchmark model are detailed in Appendix 3.

[6] The **baseline** is the modelling scenario used to represent the operating conditions of the Murray system as at 30 June 2009 MDBA model run R845. The **benchmark** model is a modelling scenario based on the baseline model, but it assumes that the 2,750 GL SDL reduction has been implemented in full and is used to meet environmental demands. The benchmark run referred to in this document is Jacobs Run R23006, which is a re-run of the MDBA revised benchmark run R983.

Table 2: Values for regression coefficients used in the benchmark model

Coefficient	Value used in benchmark model
A	0.00139
B	0.06264
C	0.30672

In determining the actual estimate of operational losses used in the MSM, the loss volume calculated from Equation 1 is constrained to a maximum value of 264 GL/month and a minimum value of 0 GL/month (i.e. operational losses can't be negative).

Experience during the millennium drought showed that under periods of very low water availability, operational losses were much lower than the values calculated by the regression equation (Equation 1). To allow for this, the operational loss calculated may be further limited to a maximum value (less than the upper maximum of 264 GL) which reduces as available water reduces. When water availability falls below predetermined monthly minimum levels, operational losses are set to zero.

The following relationship (Equation 2) is used to calculate the maximum value for operational losses when water availability is low.

Equation 2: Maximum operational losses under low water availability

Maximum Ops. Loss (GL/mth) = ***Oplmax*(****Allocations -* ***Watavailmin****)/(****Watavailmax*** *-* ***Watavailmin****)*

Where:

- ***Oplmax*** is a monthly constant.
- *Allocations* is the total NSW and Victorian allocation for the year.
- ***Watavailmin*** *and* ***Watavailmax*** are monthly constants.

The monthly values for the constants ***Oplmax, Watavailmin*** *and* ***Watavailmax*** used in the benchmark model are detailed in Appendix 3.

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 2,388 GL at 30 November2015.

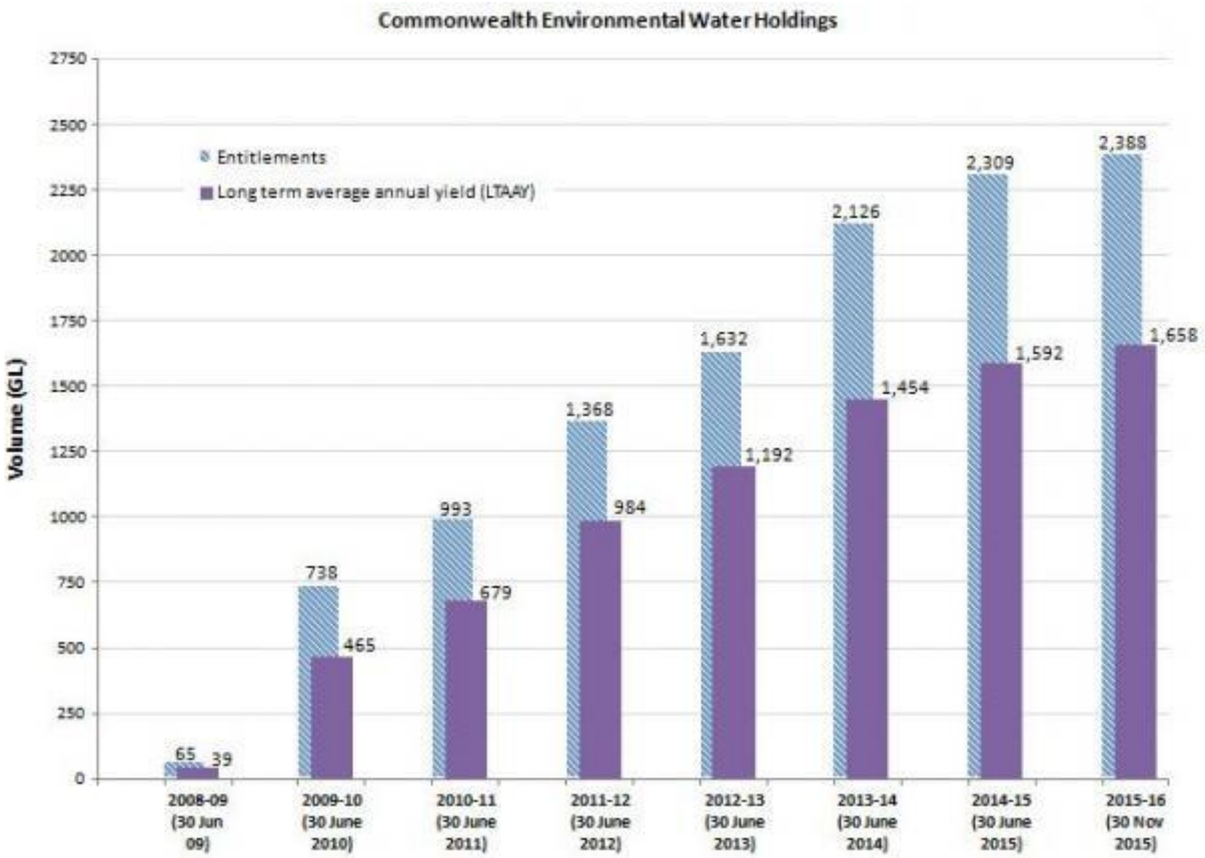

Figure 2. Commonwealth environmental water holdings over time[7]

2.2.2. Change in release patterns

Historically, releases from Lake Hume have been made to respond to demand patterns from consumptive users. 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 significant effect of the increased environmental water 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 3 shows the average change in water orders across the year that is expected to occur when the full 2,750 GL of water is recovered for environmental purposes, as compared to the baseline which represents previous usage patterns (as at 2009). In future, there will be a significant increase in water demands in winter/spring compared to previous conditions, with reduced demands in the summer/autumn. This represents a significant change in the operational dynamics of the River Murray system.

The proposed future patterns of water delivery are significantly different to those that underpinned the development of current operational loss estimates in the MSM.

[7] CEWH 2015. About Commonwealth environmental water: http://www.environment.gov.au/water/cewo/about-commonwealth-environmental-water

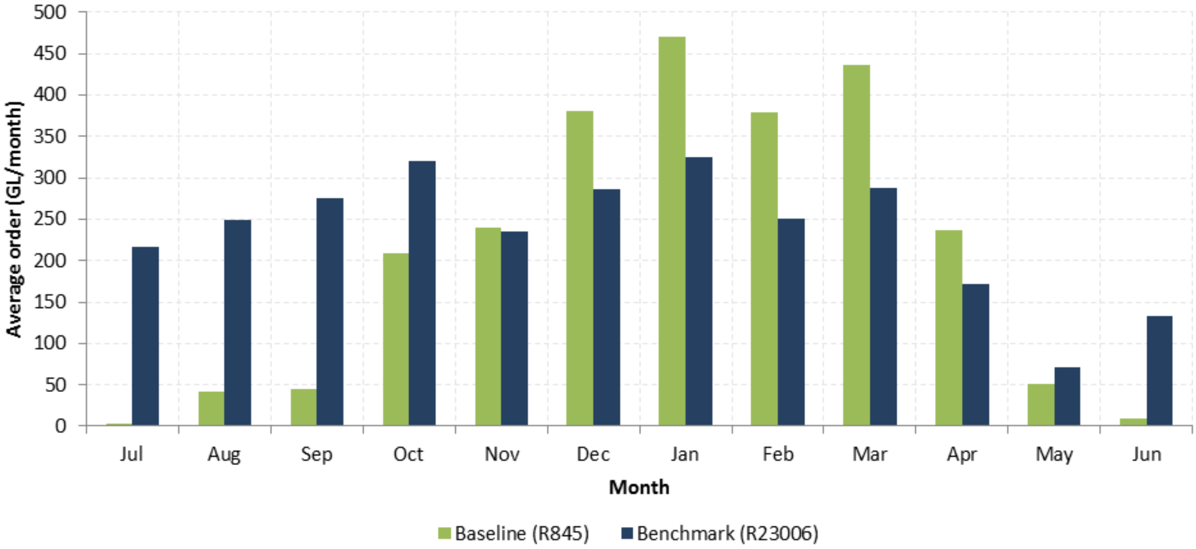

Figure 3. Average monthly orders at Albury in baseline run (R845) and benchmark run (R23006)

2.2.3. Changing operational practices

There has been a significant investment over recent years in better management of water systems. Much of the investment was targeted at improving irrigation distribution system operations and reducing losses to create water savings for environmental flows for the Snowy and Murray Rivers. These type of projects often included measures to reduce unplanned outfalls from distribution systems (which frequently ended up as unmeasured inflows to the River Murray or its tributaries) and to improve the planning of water deliveries to meet demand, coupled with improved monitoring of system performance.

Other National Water Initiative reform actions around better specification of water entitlements spurred investment in metering and water accounting activities to underpin entitlement attributes and support trading.

These type of investments help support improved monitoring and management of the River Murray system, which can reduce operational losses. In tandem with these investment programs, the millennium drought intensified across the 2000s, and significant focus was directed to efficient system operations and minimisation of losses. One of the outcomes of this period was a much improved understanding of system losses and their drivers and enhanced capabilities to operate systems more efficiently.

A workshop was held with senior agency staff across the jurisdictions with an interest in this proposal (23 March 2015). At the workshop, participants identified some of the key actions and reforms that were likely to have had implications for river operations and operational loss behaviour over the period from 2000 to 2010. A timeline of these key changes in water system management is shown in Figure 4.

It was concluded that leading up to and following the millennium drought, there has been a significant water reform program and a shift in river operational practices. Many of the changes identified were also assessed as being enduring changes, which would continue to influence river management activities beyond the end of the drought.

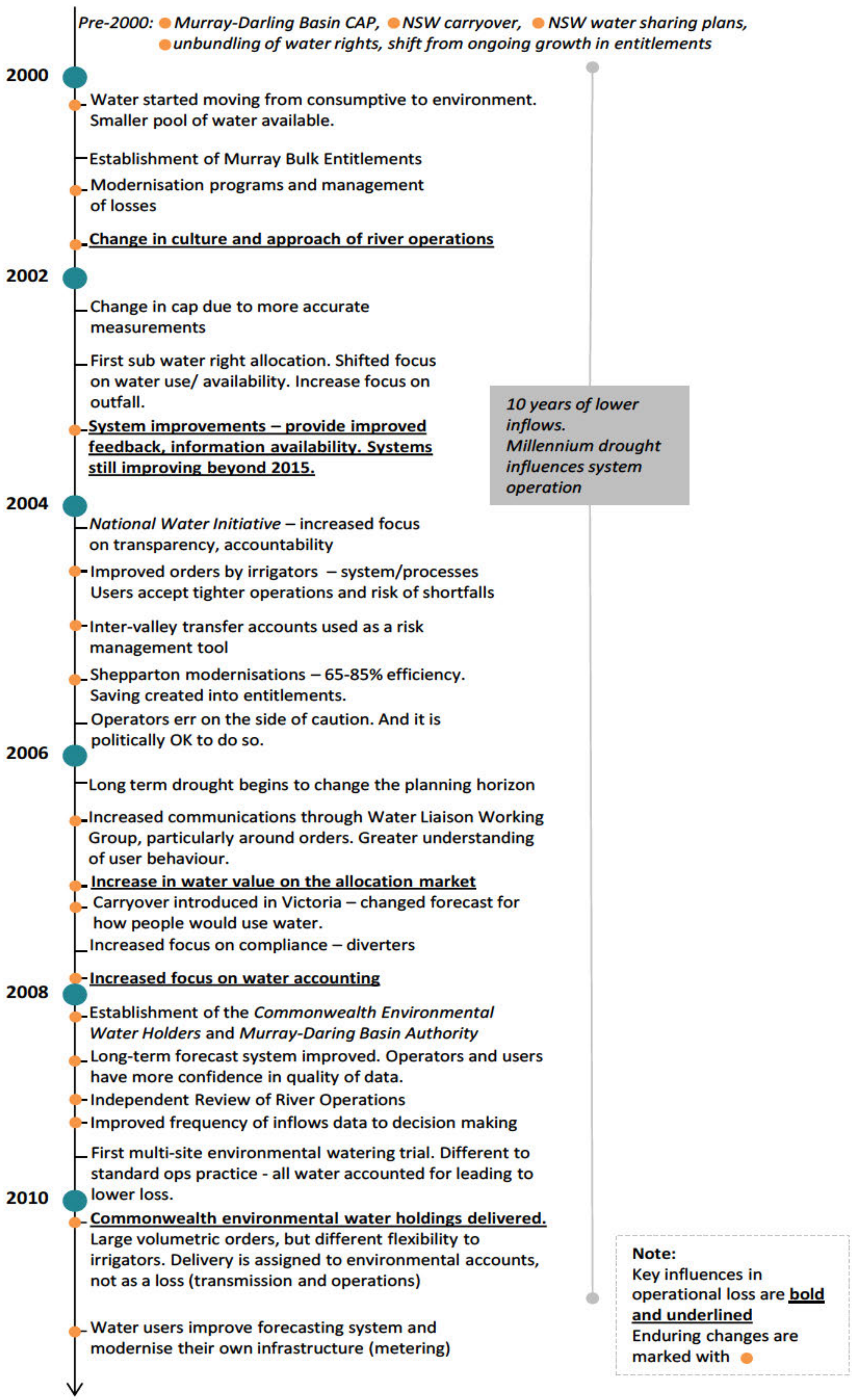

Figure 4. Timeline of key reforms relevant to water system management

2.2.4. Analysing the impact of the change

As noted in Sections 2.2.1, 2.2.2 and 2.2.3, 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 and other storages in the system.

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. The key modelling scenarios that were examined in these studies were:

- **Baseline**: The modelling scenario used to represent the operating conditions of the Murray system as at 30 June 2009 (MDBA 2012). MDBA model run R845 is used for all baseline data in this business case.
- **Benchmark**: A modelling scenario based on the baseline model, but assumes that the 2,750 GL SDL reduction has been implemented in full. Jacobs run R23006 has been used for the benchmark information quoted in this business case. This run is a re-run of the MDBA revised benchmark (R983) in the Jacobs modelling environment, which facilitates "like with like" comparisons to the proposal modelling outputs (R23018).

Comparison of the operation of the system in the benchmark model run to its operation under the baseline model conditions highlighted some interesting differences in operational losses.

Application of the regression equation used to estimate operational loss under the baseline conditions resulted in the modelled estimates of operational loss under the benchmark conditions increasing significantly. Estimated operational losses had increased significantly over the summer/autumn period compared to the baseline conditions (refer Figure 5).

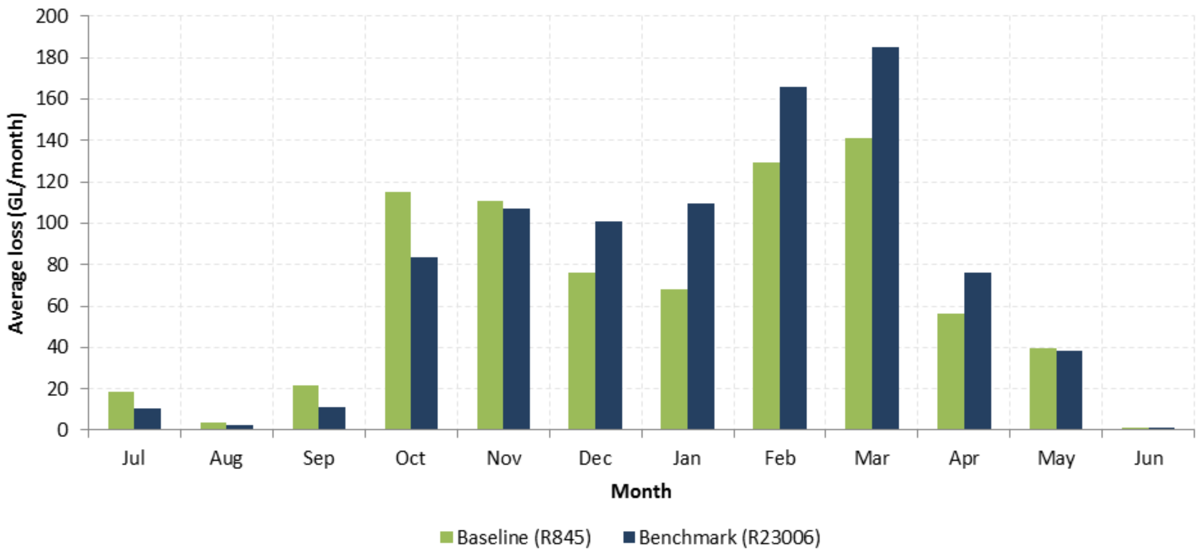

Figure 5. Average monthly operational loss in baseline run (R845) and the revised benchmark run (R23006)

The distribution of these changes in estimated operational losses between years was also considered. Figure 6 shows the average annual operational losses for the baseline conditions and the benchmark scenario.

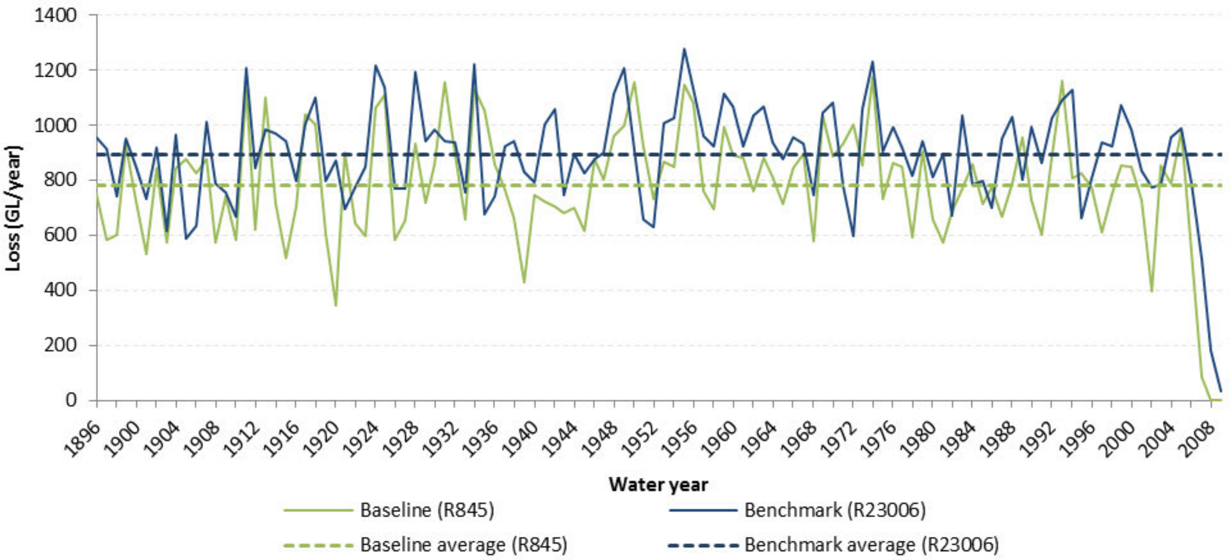

Figure 6. Average annual operational loss in baseline run (R845) and the revised benchmark run (R23006)

As shown in the graph, the average annual operational loss for the baseline conditions was estimated to be 782 GL/year. For the revised benchmark scenario, the estimated annual losses had increased by 110 GL/year on average to 892 GL/year[8].

This observation prompted further analysis of operational loss estimates. The operational loss regression equations were developed based on data which was available from 1983 onwards. Importantly this data included estimates of actual historic operational losses, which had been used to develop the original regression equation in the 1990s. The data set had also been extended up to 2011 as part of the Cap model update.

Figure 7 shows the cumulative operational loss from the baseline/benchmark regression equation (with and without the low water availability reduced limits on operations losses), compared to historic estimated operational losses.

[8] Jacobs 2016, Advanced modelling of improved regulation of the River Murray (Final B), Report prepared by Jacobs for Department of Environment, Land, Water and Planning

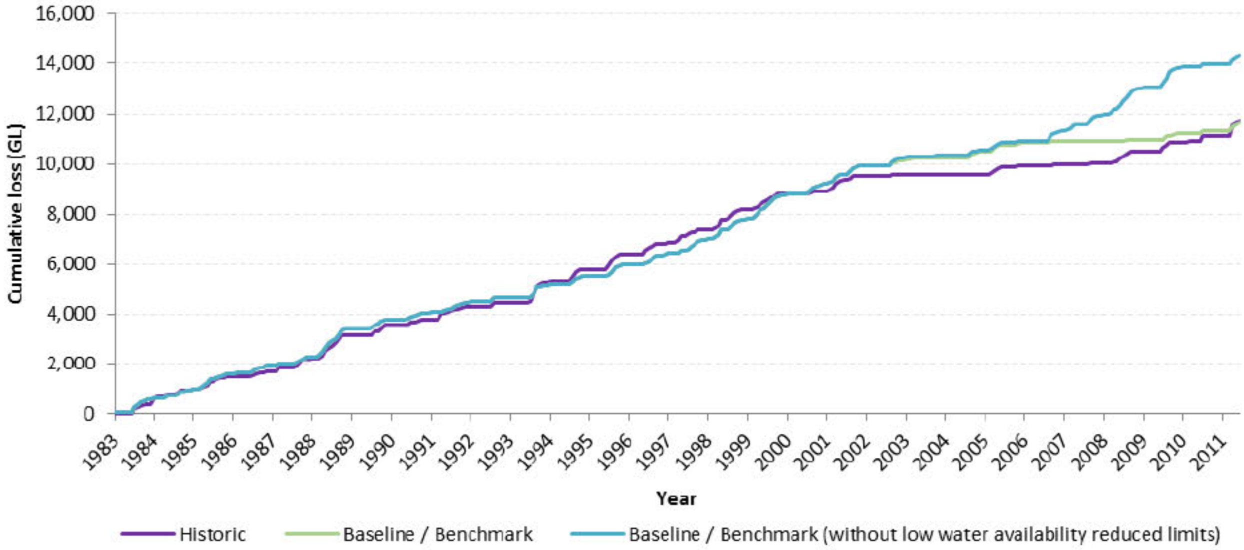

Figure 7. Cumulative operational loss comparisons[9]

The graph highlights a number of important aspects relating to operational loss:

- Historic loss behaviour was fairly consistent from 1983 up to approximately 1999, as indicated by the constant slope of the cumulative plot of historic operational losses.
- Over this period, the regression equation (with or without the low water availability constraint) estimates the volume of operational loss quite effectively.
- From 1999 onwards, historic operational loss behaviour appears to undergo a significant reduction. This is consistent with the advice provided by workshop participants.
- The effect of the low water availability limitation term on operational loss volumes is clearly shown. The green line (regression), which includes this limit, reflects historic behaviour much better than the blue line (regression without maxOL), which is the application of the regression equation without the constraint of the maximum operational loss limit term included.
- Over the period from 1983 to 2011, the cumulative operational loss estimated by the regression equation is quite similar to the calculated historic volume of losses; however for the period from 1999 to 2007 the regression equation overestimates losses compared to historic losses. Then, over the period 2007 to 2011, the regression equation underestimates operational losses. This behaviour is quantified in Table 3, which shows average annual historic losses compared to modelled losses

Table 3: Average monthly operational losses for different periods over the period 1983 – 2011 [10] [11]

	1983-2011	1983-1999	1999-2011	1999-2007	2007-2011
"Historic"	49	60	31	30	32
Benchmark Regression equation (applied to historic demand data)	51	58	40	57	12

[9] The operational losses shown are calculated losses based on applying the various regression equations to estimated historic demands and historic climate data. They are not derived from MSM-Bigmod model runs.

[10] The operational losses shown are calculated losses based on applying he various regression equations to estimated historic demands and historic climate data. They are not derived from MSM-Bigmod model runs

[11] Data for each period is based on the water year of July to June with the exception of 2011 where the period of record ends in December 2011. Months when Lake Victoria transfers and known historic environmental releases occur have been excluded from the data.

As noted earlier, experienced system operators were of the view that overall average annual operational loss under future demand conditions should be similar to recent performance for delivery of consumptive demands, given that the volume of entitlements on issue will be the same and the key difference is the changed distribution of this same demand across the water year. Given the drivers for change noted earlier, there was no strong rationale that could be identified that would explain why operational losses should increase by the magnitude forecast under the benchmark water demand and operating conditions.

In order to look for other lines of evidence in relation to the likely changes in operational losses under increased environmental demands, some common environmental watering delivery scenarios were considered. The following features were identified in relation to environmental deliveries:

- Many major environmental deliveries are initiated from Lake Hume. The practice for delivery accounting is to estimate the planned Hume release required for consumptive (i.e. non-environmental) purposes. All releases in addition to this consumptive demand are fully debited to the environmental account, which means there is no potential for increased operational losses compared to planning for consumptive deliveries alone.
- Where the environment orders water for delivery to a specific location (e.g. the offtake to the Hattah Lakes pump station or delivery through the Torrumbarry system to Gunbower Forest), the order for water and planning for its delivery is equivalent to planning for a consumptive delivery and there is no inherent reason why operational loss should be higher. Indeed, experience has shown that environmental deliveries are more flexible in relation to timing and flow rate than most irrigation demands, and some shortfalls in orders or delays can be tolerated (within limits). This gives operators the scope to manage the river more efficiently and better manage the risk of not meeting consumptive demands, which will help reduce operational losses.

This simple scenario testing gave further weight to the conclusion that there was no strong rationale that would suggest that operational losses should increase significantly under future environmental water demands and operating conditions.

2.3. Proposed operating rules and benefits of change

There are two key elements of the proposed changes to operating rules associated with this proposal:

i. Implementation of measures to lock in the improved system operating performance developed over the last 15 years, which has created the opportunity for reductions in future operational loss requirements, as the 'business as usual' standard.

ii. Adoption of revised and updated operational loss estimation techniques.

2.3.1. Anchoring improved system operational performance

As noted in Section 2.2.3, there has been a progressive shift in river management practices over the last 15 years with a strong focus on the efficiency of operations and the minimisation of losses. The changes have been driven by a range of factors including extended drought and implementation of water savings projects.

These drivers have seen the construction of upgraded water management assets and the installation of expanded data monitoring networks to provide operators with more frequent, accurate information on system operational performance. These upgraded assets and enhanced data collection networks have provided the essential building blocks to allow improvements in operational loss performance to be achieved.

In order that the volumes of water that need to be set aside each year to cover operational losses can be revised downwards, there needs to be a high degree of confidence that this improved performance can be locked in as the business as usual standard for River Murray operations, and that lower operational losses can be delivered with repeatability, year in and year out.

The Water Liaison Working Group, which brings together river management experts from all jurisdictions across the southern connected Basin to review and provide advice to the MDBA on systems operations and water accounting issues, has considered this issue. It has advised that operating the river in the manner proposed in this report to achieve lower operational losses is feasible, and it is expected that ongoing improvements to forecasting and management tools will continue to assist in improving operations[12].

A range of actions have been developed and are proposed to be implemented to provide a high degree of certainty that improved system performance and reduced operational losses can be consistently delivered. These actions can be grouped into two main categories of activity – improved system operational tools and performance monitoring and management actions.

Improved system operational tools:

- Implementation of the Source modelling platform for system operational planning.
  The Source modelling platform is a sophisticated modelling environment that is being widely adopted as the consistent tool for simulation modelling of water systems in Australia. This modelling tool has been developed with strong involvement from the MDBA and Basin jurisdictions. Unlike traditional simulation models, which function solely as long-term scenario modelling tools, Source includes rainfall-runoff routing routines and has the capability to be run in "operational" mode to support real time decision making on water systems management. These sophisticated capabilities will support a range of improvements to system operations, including better forecasting of the timing and volume of tributary inflows, improved estimation of travel times and access to a range of demand forecasting algorithms. (*Note: Implementation of Source modelling capabilities is already included in the MDBA's river operations forward program*).

- Implementation of the Flood Early Warning System (FEWS) tool for the collection and management of operation data on river flows and diversions, etc. This tool will automate access to water data for operational activities and water accounting. FEWS will also support the capture and management of the operational data necessary to enable the use of the Source modelling tools. (*Note: Implementation of FEWS is already included in the MDBA's river operations forward program*).

- Improved data sharing and integration with state water management agency system planning and operations on tributaries and Murray main stem. This will support the provision of additional data on tributary flows and forecast water demands to feed into the improved analysis and operational management capabilities available through the Source operational management tools.

- Revision of criteria and guidelines for use supplementary water sources.
  There are a range of water sources available to supplement releases from the upper Murray storages in order to meet demands in the River Murray.
  Inter Valley Transfer (IVT) accounts have been established on major tributaries to track and manage volumes of water "owed" from the tributaries to the River Murray system. These water obligations largely arise through water trade from the tributaries to the Murray. The River Murray system operator is able to call water out from these accounts to assist in meeting demands in the system. Supplementary water supplies can also be accessed from Lake Victoria, Menindee Lakes and the Victorian mid-Murray storages.
  In combination, these supplementary water sources can used to minimise the risk of shortfalls in meeting water demands if the River System is being run more efficiently with smaller operational loss buffers available. It is proposed that new procedures will be developed to optimise the risk management potential of these supplementary water sources. It is expected that these procedures will be codified in the O&O document, and will also require collaborative effort with the jurisdictions, as IVT rules are established and managed by the relevant jurisdictions.

[12] *'Improved Regulation of the River Murray proposal - WLWG response to the SDLAAC's request for advice'*, correspondence from meeting #175 on Thursday 18 June 2015

Performance monitoring and management actions:

- Development of routine operational loss KPIs and measurement and monitoring procedures will be undertaken to ensure that oversight of system operation by MDBA and Water Liaison Working Group can include regular assessment of operational loss performance.
  The implementation of a number of water savings projects has involved development of techniques to make sure that savings are real and continue to be achieved. It is proposed that this bank of experience in the jurisdictions will be drawn on to support development of monitoring and accountability measures.
  For example, the establishment of loss allowances has been used to lock in improved system efficiencies in the Goulburn system and provide a basis for accountability and transparency in reporting on system performance. The inclusion of features such as seasonally adjusted cumulative loss allowances can also provide sufficient flexibility to allow operators to respond to specific seasonal challenges, whilst still remaining within the overall limits set for long term operational loss performance.
  It is proposed that the specific form and details of loss allowances and performance monitoring systems will be developed and agreed during the implementation phase of the project.

Further details on the estimated costs for these activities are provided in Section 2.4.1.

The assessment of system operational changes that have occurred since 1999 (refer Section 2.2.3) strongly supports the position that system operators will strive to manage the system as efficiently as possible, and the proposed development of system loss allowances coupled with a focus on monitoring system performance metrics and application of continuous improvement philosophies to system operations will mean that any trend towards increased operational losses will be detected and addressed.

There is also the prospect that demand patterns will continue to change in the future. Whilst this is certainly a possibility, the improvements in operational loss performance since 1999 were achieved in a period of significant change in delivery patterns due to extreme drought and increased demand for environmental water deliveries. The tools and procedures that are proposed to be implemented as part of this measure will provide operators with significantly improved capability to detect and respond to changing demand patterns, whilst still maintaining system operational loss performance.

2.3.2. Adoption of revised operational loss estimation techniques

The second key element of the proposed rule changes to implement this proposed measure is for the estimation of operational losses required to run the River Murray system be updated to better reflect both recent improvements in operational loss performance and the range of consumptive and environmental water demands expected under future conditions.

The proposed rule change will still use a regression equation of the form as Equation 1 to calculate monthly operational loss estimates, however the coefficients and the Valmon monthly constant term have been recalibrated for the period from July 1999 to December 2011 to better reflect the current, more efficient river operations practices. The consumptive demands during this period were also lower than during previous periods due to a combination of drought and the buy-back of entitlements for the environment, which is likely to be more representative of future demand patterns[13].

Equation 3: Proposed operational loss regression equation

*Operational Loss (GL/mth) = **A***(Diversions)*(Rain) - **B***(Inflows) - **C***(Orders) + Valmon*

(Note: form of equation is the same as existing regression Equation 1)

[13] Full details of the process used for reviewing and recalibrating the process for estimates of opera ional losses is provided in Jacobs 2016, Advanced modelling of improved regulation of the River Murray (Final B), Report prepared by Jacobs for Department of Environment, Land, Water and Planning

The recalibrated regression coefficients A, B and C that are proposed to be used under this rule change are shown in Table 4. The coefficients used in the benchmark model are also included in this table for comparison purposes.

Table 4: Proposed revised regression coefficients

Coefficient	Value used in benchmark model	Value for proposed rule change
A	0.00139	0.00051
B	0.06264	0.31203
C	0.30672	0.19658

The values for the Valmon monthly constant have also been revised, and are detailed in Appendix 3.

It is also proposed that the same general approach to constraining the maximum volume of monthly operational losses should continue to apply in future. The key features proposed are as follows:

- The loss volume calculated from Equation 3 is constrained to an upper maximum value of 264 GL/month and a minimum value of 0 GL/month. This is unchanged from the benchmark model.
- The same approach will be used to further limit the maximum value (less than the upper maximum of 264 GL) for monthly operational losses when water availability is low. Equation 2 will continue to be used. The values for the constants ***Oplmax, Watavailmin*** *and* ***Watavailmax*** used to calculate the maximum monthly losses under low water availability have been revised and are detailed in Appendix 3.

The limiting factor on maximum operational loss when water availability is low ensures that the model will be able to adequately represent operational losses during periods of drought without underestimating operational losses during periods of medium to high water availability. This results in the long term average annual operational loss in this proposal scenario (covering the modelled period 1895-2011) being higher than the average annual operational loss in the calibration period (1999-2011), due to the calibration period being heavily influenced by the millennium drought.

The proposed rule change applies the same principles and general approach to estimation of operational losses that has been used for many years by the MDBA and has proved to be an effective component of the modelling process. The key change is to revise the coefficients and values of key constant terms used in the calculations to better represent current system operator performance and expected future demand conditions.

The modelling undertaken to date, coupled with the assessment of ongoing improvements in river operations practice that support more efficient system management have demonstrated the change in loss behaviour over recent years. The focus on managing system performance and the availability of improved data collection and analysis tools demonstrate the feasibility of this rule change.

It is considered that the analysis supports the contention that an additional 110 GL/year of operational losses will not be required to run the system under future environmental demands.

The revised loss estimation technique has been able to effectively replicate the historic loss over the period from 1999 to 2011, which includes extreme drought and a period of higher availability (and flooding) following the end of the Millennium drought. This period also included significant changes in demand patterns as consumptive use patterns changed in response to drought and changes to irrigated agriculture, and major environmental water demands emerged as significant water recovery was implemented.

Despite the good performance of the revised operational loss estimation technique over a wide range of conditions, there is no guarantee that future demand patterns will not change further in response to external factors including climate change, continued development of environmental watering practices and the ongoing restructuring of irrigated agriculture. For these reasons, it is also proposed that as part of the implementation phase of this project, procedures will be developed for monitoring ongoing operational loss performance. Recommended review timings and triggers will also be developed to ensure that the operational loss estimation procedures in the models are regularly updated to reflect prevailing practices.

2.3.3. Expected outcomes of the proposal

The expected outcomes of this proposal are that enduring savings in operational losses will be achieved and that the estimation of required operational losses will more closely replicate the actual operating losses that will be incurred in running the water system.

In order to assess how well the proposed loss estimation process performed, the revised regression equation (together with the revised low water availability loss cap) was tested over the period 1999 to 2011. The comparison process involved using the benchmark regression equation to estimate operational losses over the same period and then using the proposed new loss estimation equation. Both versions of the equation were applied to the same data set of historic values for orders, rainfall, diversions and Kiewa and Ovens River inflows, and were compared to the calculated historic operational loss values that had actually occurred under these historic operational conditions.

A graph of the cumulative losses for this period is shown in Figure 8, which demonstrates that the revised proposal approach replicates historic operational loss behaviour very closely. It is clearly a much better fit to historic data than the benchmark model regression approach.

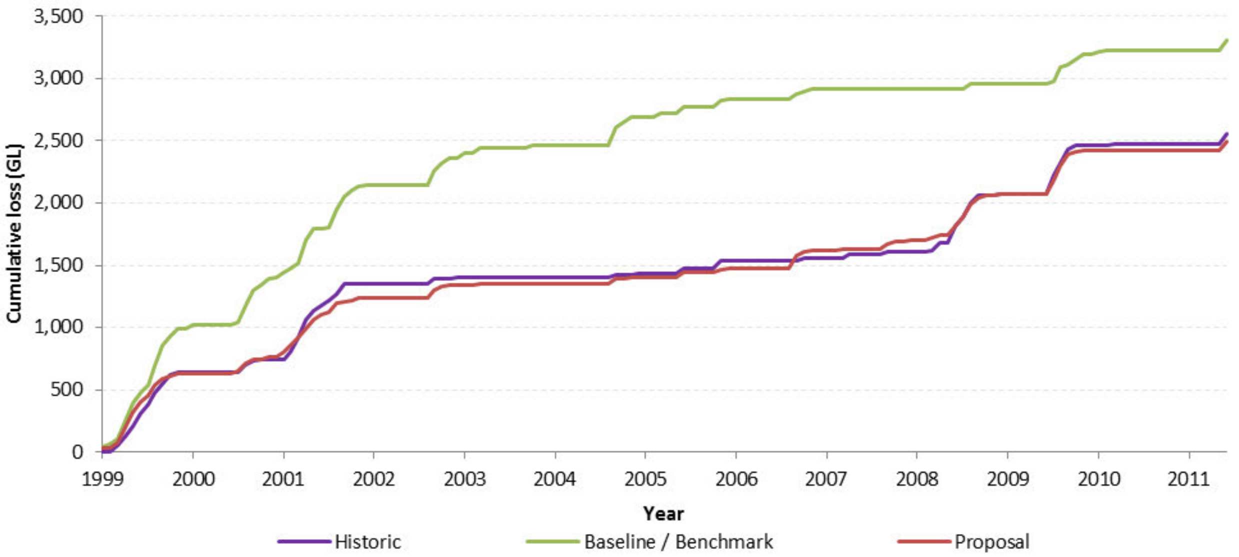

Figure 8. Cumulative plot of monthly operational loss July 1999 – December 2011[14]

This comparison demonstrated that the proposed rule change could replicate historical behaviour over recent years, which was encouraging. This was also not entirely unexpected, as this was the period and the data set used to develop the revised regression equation.

To assess the robustness of the revised loss estimation technique, which had been calibrated using data from the period 1999 – 2011, the period 2012 – 2014 was used to validate the revised regression equation's performance.

[14] The operational losses show are calculated losses based on applying the various regression equations to estimated historic demands and historic climate data. They are not derived from MSM-Bigmod model runs.

The validation process involved extending the data set in MSM-Bigmod data set from 2011 to include data up to the end of the 2013/14 water year. The extended data set was used to determine historical operational losses for this period. Operational losses were then estimated by applying the proposed revised regression equation to the estimated historic demands and historic climate data over this same period. The estimated operational losses were then compared to the historic operational losses to validate the performance of the proposed revised technique. The results of this comparison are shown in Figure 9.[15]

In addition operational losses were also separately estimated using the baseline/benchmark regression equation. The estimated losses from this equation are also shown on Figure 9 for comparison purposes.

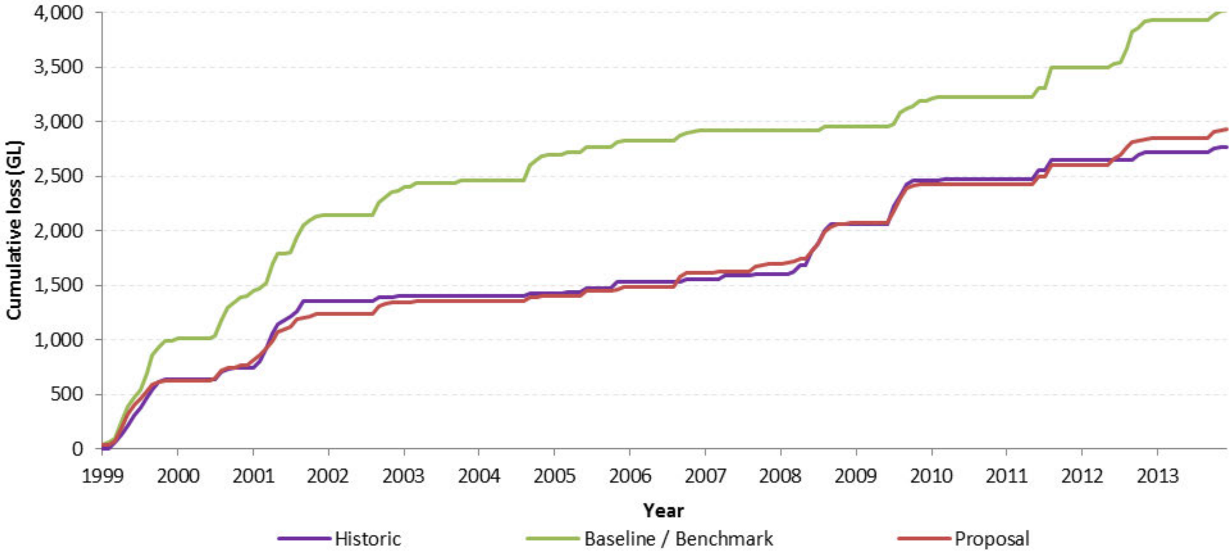

Figure 9. Cumulative plot of monthly operational loss July 1999 - June 2014

It can be seen that the proposed revised regression equation performs quite well over the period and is significantly more accurate in predicting historic operational losses than the benchmark/baseline regression equation. It is noted, however that the proposed approach does overestimate operational loss from January 2012 to June 2014 when compared with historical operational loss.

In order to examine the performance of the proposed loss estimation equation more closely over this period, the outcomes are shown in Figure 10. This shows the extent that the proposed method overestimates losses during only the 2012 – 2014 period. It is noted that the proposed approach is significantly more accurate than the benchmark/baseline equation over this period. In addition, the overestimate of losses for this validation period indicates that the proposed method is conservative. This is preferable to an alternative method that underestimates losses. .

[15] Refer file note "Advanced modelling of improved regulation of the River Murray under future demand conditions" prepared by Jacobs Pty Ltd, 10 July 2105.

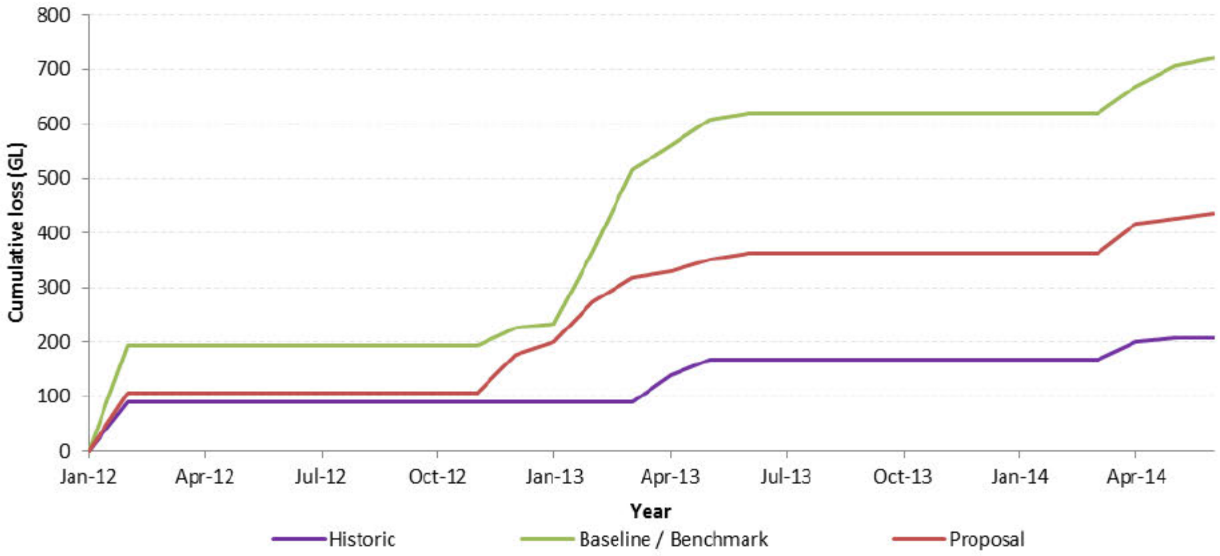

Figure 10. Cumulative plot of monthly operational loss January 2012 – June 2014

In order to further test the robustness of the proposed rule change, the MSM-Bigmod model was used to simulate the benchmark environmental water demands, but using the revised regression equation for the estimation of operational loss. The results of this model run are shown in Table 5, which compares operational losses for the proposed rule change (with future environmental demands) to the benchmark (with future environmental demands) and to the operational losses for the baseline conditions (modelled "historic" irrigation demands). The historic operational losses are also included for comparison[16].

Table 5: Average monthly operational loss comparisons for the period July 1999 – June 2009

Scenario	Average Monthly Operational Loss (GL/month)
Historical	30
Baseline Model (R845)	38
Benchmark Model (R983 – an approximation of R23006)	51
Proposal Model (23018)	35

Table 5 shows that in order to meet future environmental demands the proposed rule change estimates that the operational loss volumes required will be quite similar to those estimated to meet current (as at 2009) irrigation demands for the same climatic conditions (i.e. the baseline). These loss estimates are also reasonably consistent with the calculated historic operational losses. In contrast the benchmark estimated that operational losses would need to be over 50% higher than historic losses to meet future environmental demands under the same climatic conditions.

The significant reduction in the estimated operational loss requirements under benchmark environmental demands achieved with the proposed rule change means that more water will be available for allocation to

[16] It should be noted that the operational loss comparisons presented in the table exclude 6 months where environmental releases were known to have occurred. For full details refer to Jacobs 2016, Advanced modelling of improved regulation of the River Murray (Final B), Report prepared by Jacobs for Department of Environment, Land, Water and Planning

meet environmental and consumptive water requirements. As noted in Section 1.3.1, not all the volumes shown as operational loss are ultimately lost to the system, as some portion may be re-harvested in Lake Victoria, so the improvement in volumes available for consumptive and environmental uses will be less than the quoted reductions in operational losses.

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 major physical infrastructure to deliver environmental water to environmental assets. Given the large volumes of water potentially available through this rule change, it represents excellent value for money.

There are two major areas of activity associated with implementation of this proposed rule change. The first activity is the further testing and refinement of the proposed new techniques for estimating operational loss requirements for running the River Murray system. The second is anchoring in place the necessary procedures and improved operational tools and techniques to ensure that the recent improvements (reductions) in operational losses are locked in as the "business as usual" foundation required to sustain this performance into the future.

Estimates of these costs are summarised in Table 6 and described in Sections 2.4.1 and 2.4.2.

Table 6. Projected implementation costs

Category	Activity	Cost ($'000s)
Further testing and refinement of the operational loss estimation	External contracts	[redacted]
Anchoring improved system operator performance	External contracts	[redacted]
	Internal project officer	[redacted]
Total		[redacted]

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

2.4.1. Anchoring improved system operator performance

In addition to refining and improving the operational loss estimation technique, it is essential that the good system operating performance developed over the last 15 years, which forms the basis for the rule change, is locked into place as the business as usual standard.

The MDBA has a number of initiatives in place and included within existing budgets that will be important elements of this improved performance agenda, including the implementation of the Source modelling platform for operational planning and the Flood Early Warning System (FEWS) tool for the collection and management of operation data on river flows and diversions, etc. The following activities may be required:

- Implementation of Source modelling tools for system planning (already in plans and budgets)
- Implementation of FEWS for data collection and management (already in plans and budgets).

- Improving data sharing and integration with state water management agency system planning and operations on tributaries and Murray main stem.
- Review and develop new operational guidelines for the use of Inter Valley Transfer (IVT) accounts, the Victorian Mid-Murray Storage and Lake Victoria to ensure that these water sources can function as effective risk management tools to offset the risk of shortfalls in meeting water demands as the river is operated more "tightly" to reduce operational losses.
- Develop routine operational loss KPIs and measurement and monitoring procedures to ensure that oversight of system operation by MDBA and Water Liaison Working Group can include regular assessment of operational loss performance.
- Creation of a new two-year project officer role in the River Murray Operations section of the MDBA to work with river operators to document best practice system operations procedures in relation to operational loss management (estimated cost [redacted]).

Consulting fees for this work (not including the project officer role in the last dot point) may be in the order of [redacted]). Total costs for anchoring improved system operator performance are estimated to be [redacted].

2.4.2. Further testing and refinement of the operational loss estimation technique

Studies done to support the development of this business case have identified the proposed rule change and suggested revised regression coefficients; however it will be necessary to undertake further studies and refinements to the proposal before it is able to be used in "business as usual" situations by the MDBA. In order to further develop and test the proposed processes for estimating future operational losses, it is suggested that the following activities may be required:

- Refine, recalibrate and retest operational loss estimation techniques as required to finalise an optimised process for inclusion in future modelling.
- Documentation of the calibration and validation processes undertaken and the goodness of fit achieved for the correlation, etc. Design and documentation of procedures required for monitoring ongoing operational loss performance and recommended review timings and triggers to ensure that the operational loss estimation procedures in the models are regularly updated to reflect prevailing practices.

Whilst the MDBA has the skills internally to undertake this work, it is likely that its skilled modelling resources will be heavily committed to a range of higher priority Basin Plan modelling tasks, so this work has been costed on the basis of it being undertaken by external resources. Estimated consulting fees for this work are [redacted]. It is expected that this work will involve several discrete projects, which may extend over several years. This work will also need to be co-ordinated and integrated with studies to develop and optimise an overall package of SDL adjustment measures.

2.5. Operation date for proposal

The project can be implemented as soon as the package of SDL measures is approved by SDLAAC. It is assumed that all operating rule change projects, where possible, will be implemented in parallel to ensure minimum duplication of implementation activities including consultation with stakeholders. Implementation of the project is expected to require a maximum of three years total duration. The Phase 2 Guidelines indicate that by 30 June 2016 SDLAAC will determine the package of project proposals that will advance to Phase 3. Therefore, the measures are expected to enter into operation by 30 June 2018.

The expected implementation schedule for the projects is illustrated below (Figure 11). The implementation schedule outlined is highly conservative and includes a significant contingency allowance. The project could be fast-tracked if and as required by SDLAAC.

	Quarter starting							
	Jul-16	Oct-16	Jan-17	Apr-17	Jul-17	Oct-17	Jan-18	Apr-18
Task	1	2	3	4	5	6	7	8
SDLAAC announces project proposals that will advance to Phase 3								
Development of implementation plan								
Undertake consultation with stakeholder groups								
Development and refinement of procedures, operational manuals, accounting systems and associated documentation, including MDBA agreement								
Contingency period								
Measure enters into operation								

Figure 11. Proposed implementation timeframe for the project

3. Outcomes

3.1. Risk assessment overview

The Phase 2 Assessment 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 7 shows the risk matrix and definitions used in this risk assessment.

Table 7. 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 associated with implementing the proposal. Appendix 5 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.

The listing of the risks and the assessment of their significance is provided in Table 8 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 8. Risk assessment listing and ranking

	Risk	Potential issue	Risk assessment (prior to mitigation)			Detailed commentary provided in
			Likelihood	Consequence	Risk rating	
1	Qualification as an SDL measure	This should be reflected in a change to the benchmark model rather than being considered as an SDL adjustment measure.	Possible	Moderate	Moderate	Section 3.5
2	Loss reductions not ongoing	The reduction in historic operational loss observed from 2000 onwards may not be an enduring change.	Possible	Major	High	Sections 2.2, 2.3 and 2.4
3	Evidence base	The evidence base may not be sufficient to conclude that system operational loss has changed	Unlikely	Major	High	Section 2.2
4	South Australia's rights	The change will reduce South Australia's rights	Unlikely	Minor	Low	Section 3.4.3
5	Entitlement reliability	The change will affect the reliability for entitlement holders.	Unlikely	Moderate	Moderate	Sections 3.4.1
6	Environmental impacts	Operational losses may be creating environmental benefit that will be lost if losses are reduced.	Possible	Minor	Moderate	Section 3.3
7	Form of saving	If the savings in operational losses are not	Unlikely	Moderate	Moderate	Section 5.2

	Risk	Potential issue	Risk assessment (prior to mitigation)			Detailed commentary provided in
			Likelihood	Consequence	Risk rating	
		effectively recognised they may not be available for use				
8	Guidelines	The business case does not reflect the requirements of the Phase 2 Assessment Guidelines	Unlikely	Minor	Low	Appendix 1

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

- Environmental outcomes: how changes will impact on environmental outcomes
- Entitlement rights: how the changes to operational loss estimates will impact on the security of the entitlement held in the system, including SA rights
- Qualification as an SDL adjustment measure: Is this proposed change to the estimated quantum of operational losses required under future demand conditions really an SDL adjustment measure, or should it be considered an adjustment to the benchmark model.

The analysis and consideration of these priority issues is outlined below.

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 improve the estimation of operational loss volumes required to run the river system under future environmental and consumptive demands. As the proposed changes involve only changes in operating rules and practices, there will be no risks regarding the construction of major works and measures.

At present, the benchmark conditions assume/estimate that increased operational losses will be required in the December to April period compared to the baseline, largely as a result of decreasing levels of consumptive orders, which has traditionally been associated with increased losses. This is a period that does not coincide with the key flow events periods that are required to achieve the environmental outcomes targeted in the Basin Plan. If these increased operational losses were to occur, they 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 estimates are made of the actual volumes of water required to cover operational losses in future, which will be lower than estimates under the current benchmark assumptions. This should increase the water available for use under environmental entitlements, with consequent improvements in ecological outcomes.

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 11) 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.

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

The project is expected to affect the River Murray downstream of Lake Hume through to the mouth. This includes the following SDL resource units: NSW Murray (SS14), Victorian Murray (SS2), SA Murray (SS11). There are six key environmental assets between Lake Hume and the mouth. An overview of these assets is provided below (Table 9).

Table 9. 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, which 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	The Lower Lakes, Coorong and Murray Mouth icon site — where the River Murray

Asset	Description
Coorong and Murray Mouth	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, 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[17] found that the proposal does not result in any breach of the limits of acceptable change for the region (Table 10), the individual reaches (Table 11) and/or the Coorong, Lower Lakes, Murray Mouth (Table 12).

In comparison to the benchmark, the proposal results in a net increase in the number of successful events[18] across the Barmah-Millewa Forest, Gunbower-Koondrook-Perricoota, Hattah Lakes, Chowilla floodplain and Edward Wakool sites over the modelled record. There is no change in the number of successful events in the Lower Darling reach. All SFIs experience the same or greater number of net successful events (Table 13), with the exception of event B2 which decreases from 60 to 59 successful events over the record and E2 which decreases from 75 to 71. The most benefited SFI events are B6, H2 and E4 which experience an increase of four 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.

This rule change offers a positive contribution to a package of measures that could be assessed for SDL adjustment opportunities.

Table 10: Results of the testing of limits of acceptable change for the region (DELWP preliminary estimate using the MDBA scoring tool)

Limit of acceptable change	Benchmark (R23006)	Proposal (R23018)
Regional Ecological Elements Score	0.4989	0.5113

[17] Jacobs 2016, Advanced modelling of improved regulation of the River Murray (Final B), Report prepared by Jacobs for Department of Environment, Land, Water and Planning

[18] 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 11: Testing of specific flow indicators and limits of acceptable change for each reach (DELWP preliminary estimate using the MDBA scoring tool)

	Indicator Description	Minimum consecutive days	Start month	End month	Target	FREQUENCY Baseline (R845)	Benchmark (R23006)	Proposal (R23018)	LIMITS OF CHANGE Test result
MURRAY - BARMAH-MILLEWA FOREST									passed
B1	12.5 GL/d for 70 days	7	Jun	Nov	70 - 80 %	50%	78%	80%	passed
B2	16 GL/d for 98 days	7	Jun	Nov	40 - 50 %	30%	53%	52%	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%	36%	passed
B5	50 GL/d for 21 days	7	Jul	Jun	25 - 30 %	18%	17%	19%	passed*
B6	60 GL/d for 14 days	7	Jul	Jun	20 - 25 %	14%	11%	15%	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%	39%	passed
G4	40 GL/d for 60 days	7	Jul	Jun	25 - 33 %	11%	21%	24%	passed*
G5	20 GL/d for 150 days	7	Jun	Dec	30%	7%	27%	28%	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%	18%	19%	passed
H4	85 GL/d for 30 days	7	Jul	Jun	20 - 30 %	10%	11%	12%	passed*
H5	120 GL/d for 14 days	7	Jul	Jun	14 - 20 %	8%	9%	9%	passed
H6	150 GL/d for 7 days	7	Jul	Jun	10 - 13 %	5%	6%	7%	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%	26%	28%	passed
C5	80 GL/d for 30 days	7	Jul	Jun	17 - 25 %	10%	13%	14%	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%	6%	passed*
MURRAY - EDWARD WAKOOL RIVER SYSTEM									passed
E1	1,500 ML/d for 180 days	1	Jun	Mar	99 - 100 %	96%	94%	94%	passed^
E2	5 GL/d for 60 days	7	Jun	Dec	60 - 70 %	39%	66%	62%	passed
E3	5 GL/d for 120 days	7	Jun	Dec	35 - 40 %	22%	33%	35%	passed
E4	18 GL/d for 28 days	5	Jun	Dec	25 - 30 %	15%	17%	20%	passed*
E5	30 GL/d for 21 days	6	Jun	Dec	17 - 20 %	12%	12%	15%	passed*
LOWER DARLING - LOWER DARLING FLOODPLAIN									passed
D1	7 GL/d for 10 days	10	Jan	Dec	70 - 90 %	51%	60%	60%	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	8 - 10 %	8%	7%	7%	passed

Note 1. The frequency columns have been colour codes to show more frequent events in darker shades of green and - less frequent events in lighter shades of green.

Note 2. *The limits of change test result for B5, B6, G4, H2, H4, C7 E4 and E5 indicates that these SFIs do not meet the requirements of subclause ii/iii because the proposal modified the level success of each SFI by more than 10%/15% of the benchmark result. However, in this case, the level of success for these SFIs actually increases (by more than 10%/15%) and has therefore been interpreted as a positive outcome.

Note 3. ^The limits of change test result for E1 indicates that this SFI may not meet the requirements of subclause iii, as the frequency result falls below the baseline model result. However, in this case, the benchmark result also falls below the baseline result, while the proposal either meets or exceeds the benchmark result, providing a positive outcome relative to the benchmark.

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Table 12: Testing of limits of acceptable change for the Coorong, Lower Lakes and Murray Mouth (DELWP preliminary estimate using the MDBA scoring tool)

	Indicator Description	Start month	End month	Target	FREQUENCY Baseline (R845)	Benchmark (R23006)	Proposal (R23018)	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%	99%	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	69	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%	95%	92%	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%	96%	passed

Note 1. 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 13: Net increase in number of successful events and maximum duration of dry spells for each SFI (DELWP preliminary estimate using the MDBA scoring tool)

	Indicator Description	Minimum consecutive days	Start month	End month	NUMBER OF YEARS WITH SUCCESSFUL EVENTS			MAXIMUM DRY SPELL (YEARS)		
					Benchmark (R23006)	Proposal (R23018)	Net increase	Benchmark (R23006)	Proposal (R23018)	Net increase
MURRAY - BARMAH-MILLEWA FOREST										
B1	12.5 GL/d for 70 days	7	Jun	Nov	89	91	2	4	4	0
B2	16 GL/d for 98 days	7	Jun	Nov	60	59	-1	6	4	-2
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	41	0	14	14	0
B5	50 GL/d for 21 days	7	Jul	Jun	19	22	3	22	22	0
B6	60 GL/d for 14 days	7	Jul	Jun	13	17	4	24	22	-2
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	44	0	9	9	0
G4	40 GL/d for 60 days	7	Jul	Jun	24	27	3	21	21	0
G5	20 GL/d for 150 days	7	Jun	Dec	31	32	1	14	13	-1
MURRAY - HATTAH-KULKYNE LAKES										
H1	40 GL/d for 60 days	7	Jun	Dec	52	52	0	9	9	0
H2	50 GL/d for 60 days	7	Jun	Dec	34	38	4	13	12	-1
H3	70 GL/d for 42 days	7	Jun	Dec	21	22	1	22	21	-1
H4	85 GL/d for 30 days	7	Jul	Jun	12	14	2	22	22	0
H5	120 GL/d for 14 days	7	Jul	Jun	10	10	0	22	22	0
H6	150 GL/d for 7 days	7	Jul	Jun	7	8	1	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	30	32	2	13	13	0
C5	80 GL/d for 30 days	7	Jul	Jun	15	16	1	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	7	1	34	28	-6
MURRAY - EDWARD WAKOOL RIVER SYSTEM										
E1	1,500 ML/d for 180 days	1	Jun	Mar	107	107	0	4	3	-1
E2	5 GL/d for 60 days	7	Jun	Dec	75	71	-4	4	5	1
E3	5 GL/d for 120 days	7	Jun	Dec	38	40	2	13	9	-4
E4	18 GL/d for 28 days	5	Jun	Dec	19	23	4	22	22	0
E5	30 GL/d for 21 days	6	Jun	Dec	14	17	3	22	22	0
LOWER DARLING - LOWER DARLING FLOODPLAIN										
D1	7 GL/d for 10 days	10	Jan	Dec	68	68	0	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 (reductions) in the estimated volume of water required to cover operational losses involved in running the River Murray system, 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 and changes in the volume and frequency of spills from Lake Hume. Additionally, with a complex supply system such as the River Murray, changes in the management of operational losses 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 and the ability to meet water demands across the system.

3.4.1. Entitlement reliability

The key element of the proposed operating rule change is to explicitly recognise recent improvement in system operational planning practices which result in more efficient operation of the system and reduce the estimates of operational loss volumes required compared to the estimates under benchmark conditions.

This has the effect of reducing the volume of operational losses that would be required in future once large volumes of water are recovered for the environment, compared to the situation of continuing to use the existing rule that estimates the required operational loss volumes based on system performance and demand patterns that existed prior to 2000. Figure 12 and Figure 13 show the volume and pattern of operational loss volumes with and without this proposed rule change.

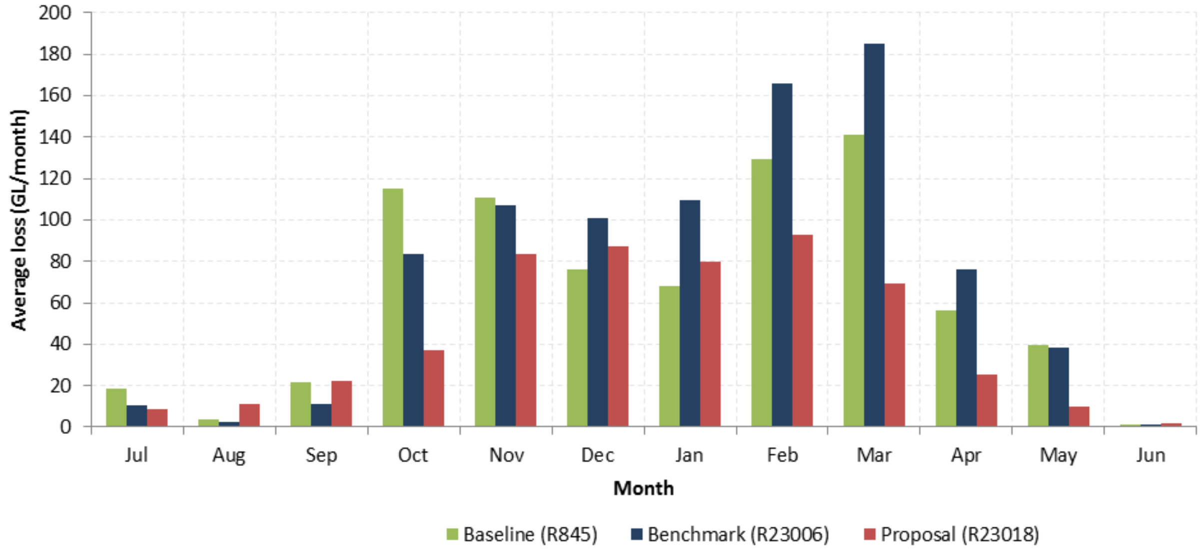

Figure 12: Average monthly operational losses

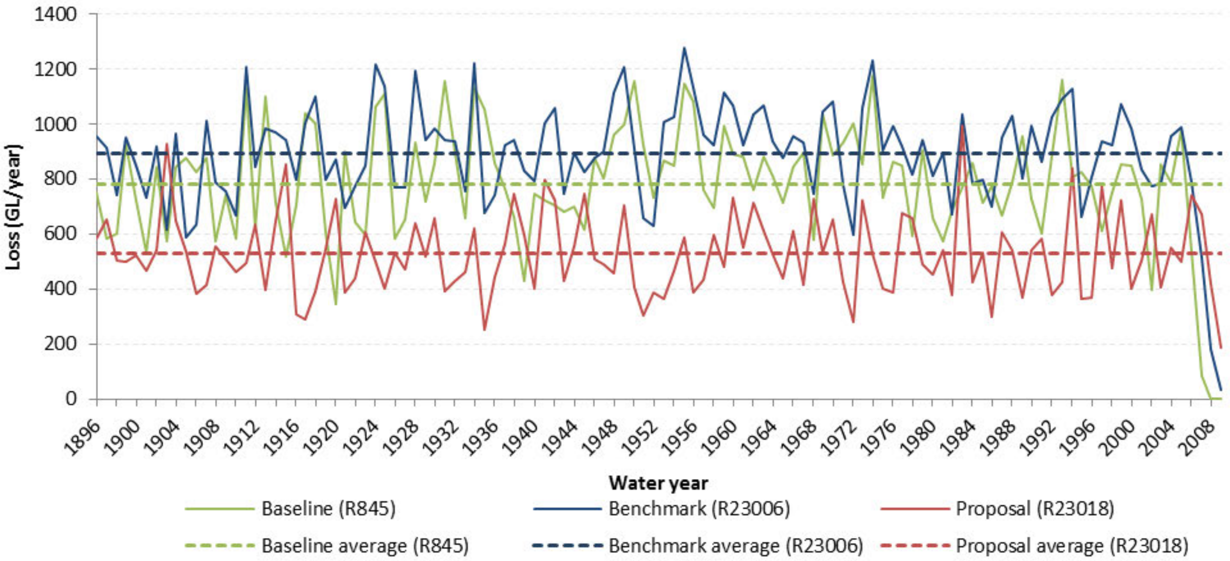

Figure 13. Average annual operational losses

As shown in the graph, the average annual operational loss for the baseline conditions was estimated to be 782 GL/year. For the revised benchmark scenario, the estimated annual losses had increased by 110 GL/year on average to 892 GL/year. The proposal results in an average annual operational loss of 528 GL/year.

If operational losses increase under future demands as forecast in the benchmark conditions, more water will be released than is required to meet downstream water requirements and to manage the risks of shortfalls arising from uncertainty associated with tributary inflows and future demands. Once water is released from Lake Hume and becomes operational losses, if it is not able to be re-regulated it cannot be included in the assessments of water available to NSW and Victoria (known as state shares) under the water sharing arrangements in the Murray Darling Basin 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 operational losses 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[19].

Focusing too much on model outcomes associated with system reliability for individual project 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.

[19] Note, DELWP will provide the detailed results and data from the modelling to relevant jurisdictions to inform the assessment of this business case

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
- River Murray Increased Flows in Hume Account
- Barmah-Millewa Forest Environmental Water Allocation.

At the retail level, allocations against several types of entitlement can be debited in response to 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 operational losses that would be required in future once large volumes of water are recovered for the environment, compared to the situation if the existing rule continued to be used that estimates the required operational loss volumes based on system operational performance and demand patterns that existed prior to 2000.

If less water is released for operational losses, storages will be at higher levels on average compared to the benchmark assumptions, with implications for spill behaviours. However, under the proposed rule change the average annual volume of operational losses is expected to be very similar to recent performance under baseline water demand conditions. Figure 14 provides a comparison of spill volumes. It can be seen that the proposal results in somewhat higher spill volumes during the summer and autumn than the benchmark or the baseline. Spill volumes in the winter and spring are similar to the baseline conditions.

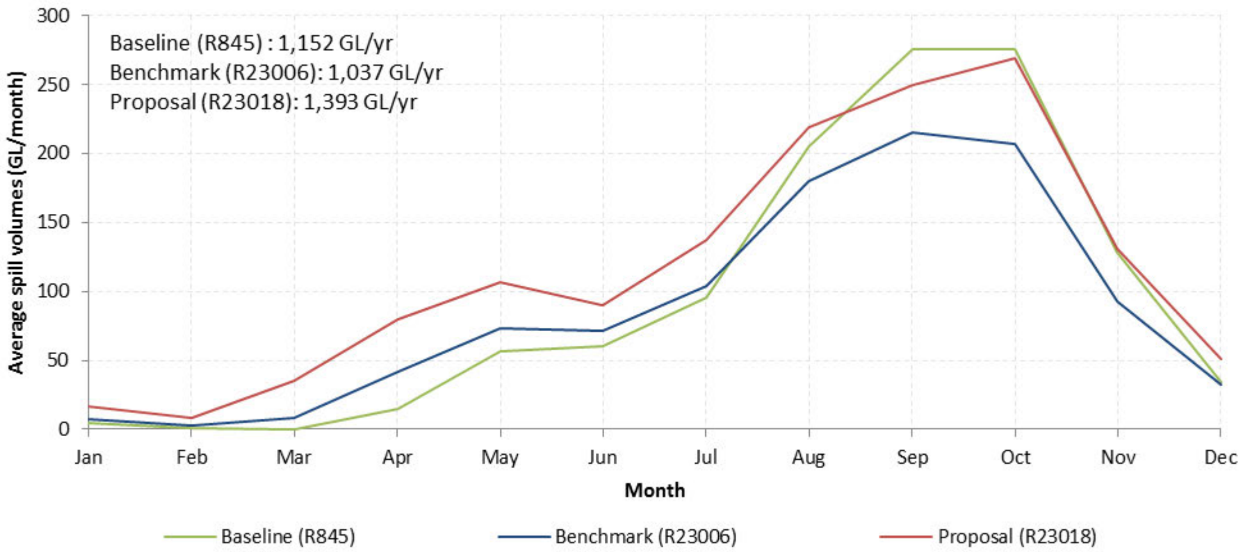

Figure 14. Monthly average spills from Lake Hume

The potential impact of these higher spill volumes on flood mitigation downstream of Lake Hume has also been assessed. Modelling indicates that the proposal will result in slightly more 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 15). On average, it is estimated there will be three more days per year of flows above 25,000 ML/d at Doctors Point than under baseline conditions.

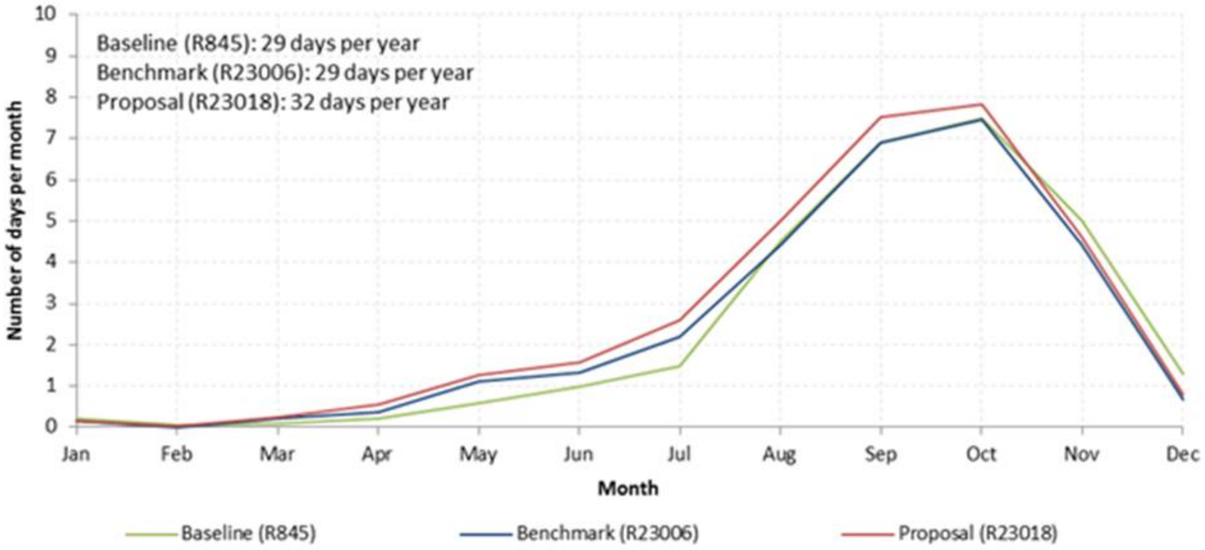

Figure 15. Average number of days per month with flows in excess of 25,000 ML/d at Doctors Point:

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 7.6 days/year to 8.5 days/year (Figure 16).

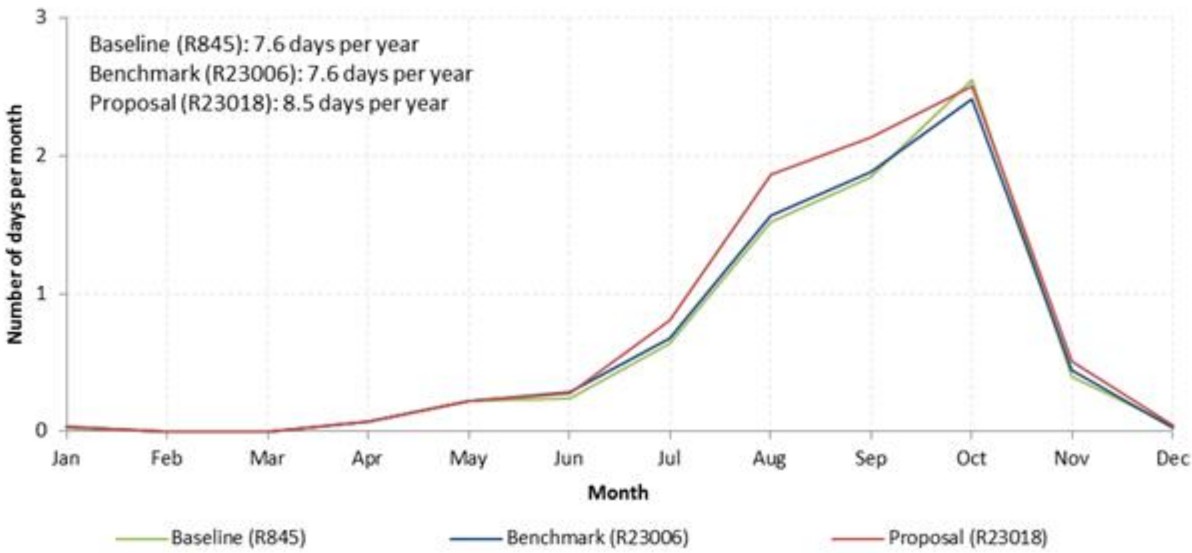

Figure 16. Average number of days per month with flows in excess of 44,000 ML/d at Doctors Point

3.4.3. Flows to South Australia

Given the distances involved, specific changes to releases from the upper Murray and Menindee Lakes storages are somewhat attenuated by the time they reach the South Australian border. Figure 17 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 slightly lower than those under the benchmark conditions due to lower operational losses, while the timing of flows sees a slight increase in spring and slight decrease in autumn (Figure 17).

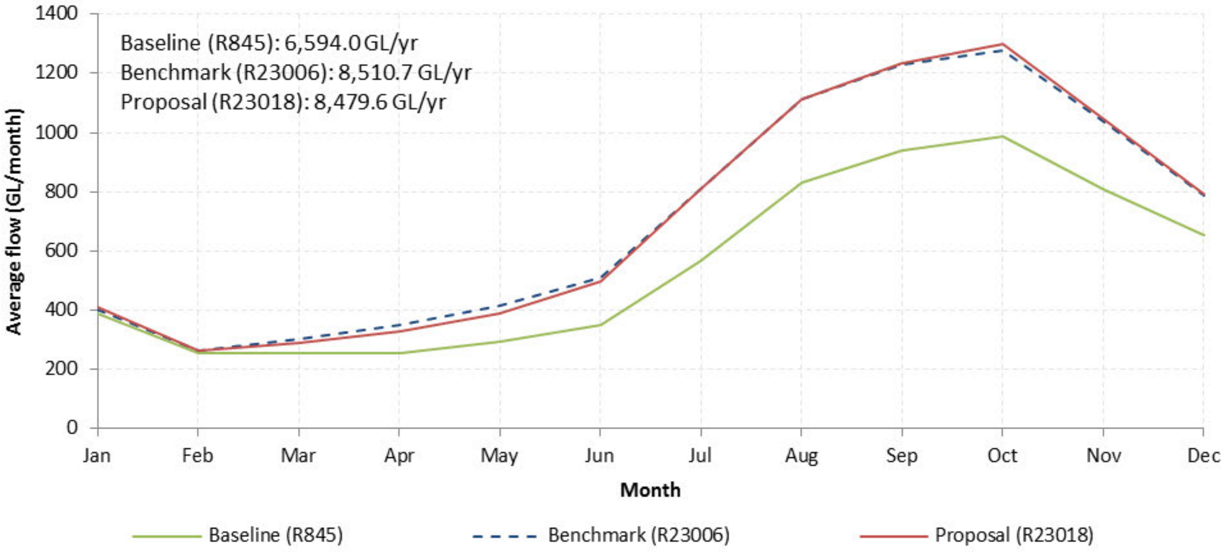

Figure 17: Average flow to South Australia each month

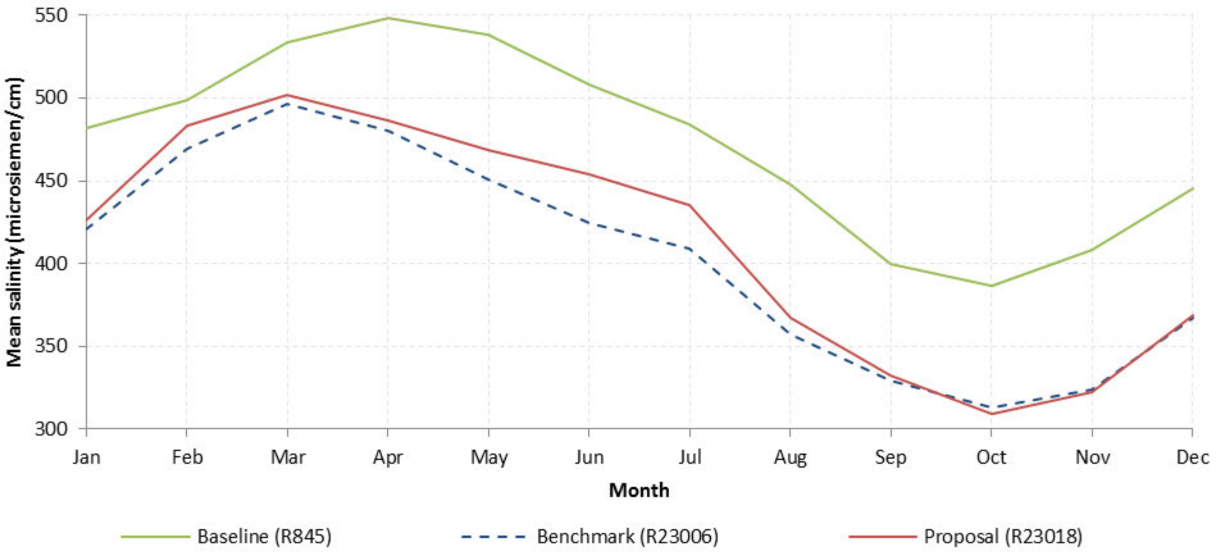

Figure 18: Mean salinity levels at Morgan each month

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 18, Figure 19). Mean monthly salinities under the proposed rule change are slightly higher than those forecast under benchmark conditions, with a slight decrease in salinity in October and November (Figure 18). Figure 19 shows the annual 95th percentile salinities at Morgan, with similar outcomes for the benchmark and the proposal. Both are below the baseline 95th percentile salinity levels.

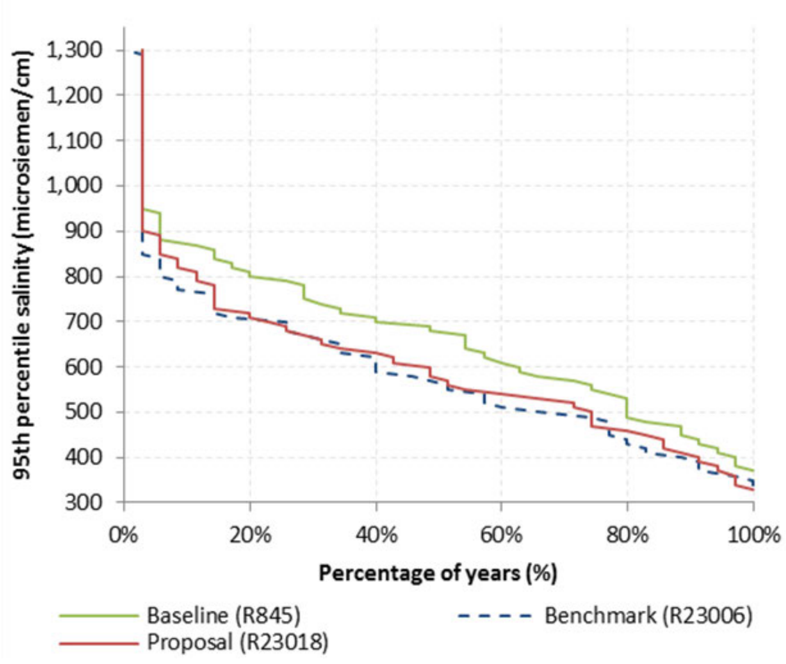

Figure 19: Percentage of years that the annual 95th percentile salinity level at Morgan exceeds a given level

Figure 20 shows that the performance of Lake Victoria under the proposal is similar to the benchmark during late spring to autumn (i.e. October to May), but Lake Victoria would hold less water under the proposal from June to September. Compared to baseline conditions, the proposal would see Lake Victoria hold more water during October to April and hold less water from June to September.

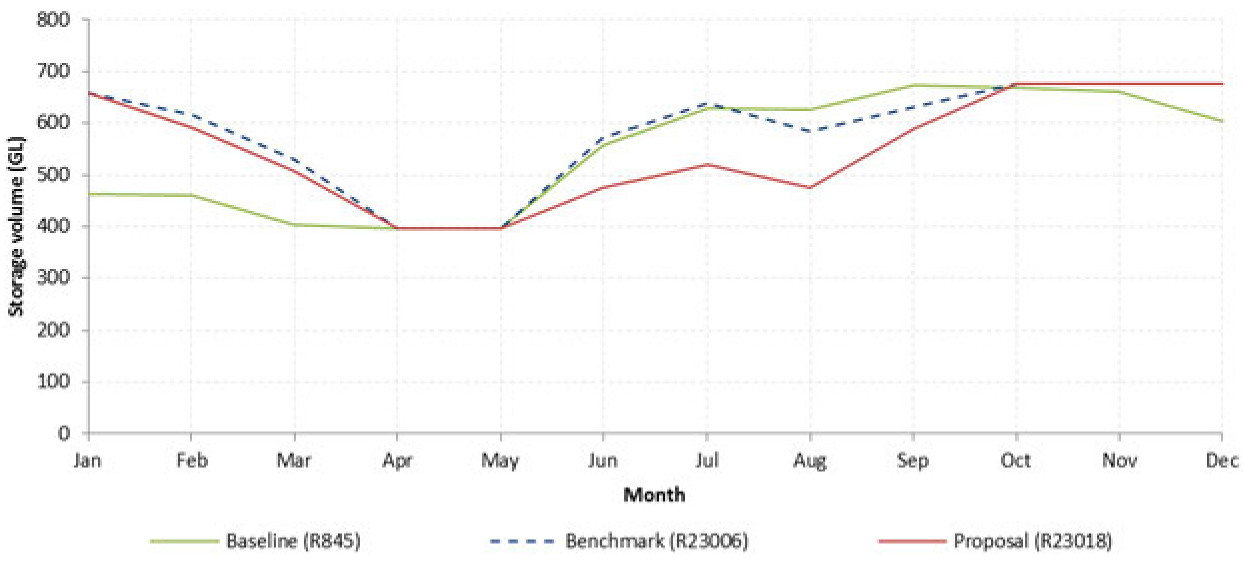

Figure 20. Storage levels in Lake Victoria in each year

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 4 provides the detailed results of the assessment against each matter raised by the South Australian representatives. Appendix 4 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. Classification as an SDL adjustment measure

At the jurisdictional agency workshop (23 March 2015), the question was raised as to whether this proposed rule change should be considered to be an SDL adjustment measure. There were two areas of uncertainty raised:

i) Should the change to the processes to estimate the future operational loss requirements be treated as a rule change supporting an SDL adjustment, or should it be treated as an update to the benchmark model.

ii) The changed operating behaviour that supports the rule change occurred from 2000 onwards, so it predates the Basin Plan and should be part of the baseline and benchmark, rather than an SDL adjustment.

These are valid queries, as this is a complex proposal dealing with operational losses which can only be identified and understood in hindsight.

The Basin Plan was developed and approved on the basis of a number of key elements:

- The MDBA undertook significant analysis and considered multiple lines of evidence to determine the proposed environmentally sustainable level of take (ESLT).
- The reduction in diversions that was required to achieve the ESLT was determined, and hydrologic modelling was used to determine the environmental outcomes that could be achieved with this reduction in diversions. The reduction in diversion selected was an average of 2,750 GL/year
- Modelling of the environmental outcomes associated with a reduction in diversions of 2,750 GL/year was based on the knowledge (or best assumptions in lieu of full knowledge) available at the time in relation to the water demands of environmental assets, the manner in which water could be delivered to those assets and the expected eco-hydraulic response to environmental water deliveries. This knowledge was coded into a model known as the benchmark model.
- As part of the negotiations around the Basin Plan, it was recognised that there may be scope to identify means to deliver water more efficiently to environmental assets. It was agreed that if this was possible through construction of works or changes in the manner in which the water system was operated and equivalent environmental outcomes could be achieved with less water than the proposed 2,750 GL reduction in diversions, than an SDL adjustment could be approved to reflect this. The preamble to Chapter 7 of the Basin Plan notes, *"a 'supply measure' is a measure that increases the quantity of water available before take for consumptive use. The measure may do this either by making water available for environmental management without reducing consumptive take (e.g. through reducing evaporation losses at a storage) or by allowing environmental managers to achieve the same outcomes more efficiently, thus reducing the amount of water needed for the environment. Supply measures allow the same overall environmental outcomes to be achieved without needing to reduce consumptive take as much as originally anticipated in the Basin Plan".*

The key principle underpinning this process was that the level of environmental outcome achievable was determined based on the level of knowledge available in 2012 when the Basin Plan was approved. It was understood that this knowledge was not perfect and if improved knowledge came to hand that showed the equivalent level of outcome could be achieved with less water than assumed under the benchmark, the recovery target could be adjusted down accordingly.

The changes to Hume Dam airspace management and pre-releases rules were accepted for further development as a legitimate SDL adjustment measure under Phase 2, as they complied with these principles. That rule change was based on the observation that the pre-release rules used in the benchmark model did not adequately allow for future environmental demands. It was recognised that the estimation of pre-release requirements in the benchmark, which was based on the processes used when the only demands were for consumptive purposes, could be improved by developing a better understanding of how environmental water releases would interact with and affect required pre-releases. This in turn led to the opportunity to reduce pre-releases and generate an SDL adjustment.

This current rule change proposal has strong parallels to the Hume air space management proposal. It was observed that the estimates of operational loss required in the benchmark model did not adequately allow for future environmental demands. It was recognised that the estimation of operational loss requirements in the benchmark, which was based on the processes used when the only demands were for consumptive purposes, could be improved by developing a better understanding of how environmental water releases would interact with and affect required operational losses. This has identified an opportunity to reduce releases which would contribute to operational losses and generate an SDL adjustment.

The reduction in water required to achieve an equivalent environmental outcome as a result of this operational loss rule change is based on knowledge and analysis which was not available at the time when the benchmark model was finalised, so it is legitimately an SDL adjustment measure.

In relation to the timing question, whilst the “on ground” operator behaviours that supported the analysis and development of a new loss estimation technique were occurring prior to the benchmark modelling, they were not understood and included in the benchmark model. This is analogous to the situation around the TLM works and measures, where the works were known and were being installed prior to the benchmark, but an understanding of how they would deliver water more efficiently to environmental assets was not included in the benchmark, so these projects are now being accepted as legitimate SDL adjustment measures. Additionally, whilst many of the changes to river management noted may have been initiated and observed before 2009, the proposed actions in Section 2.3.1 and 2.3.2 are required to ensure that these benefits are enduring and can be confidently relied on as an SDL adjustment measure.

3.6. Outcomes conclusions

The assessment of the outcomes of the project suggests that the proposed change will generate significantly 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 operational loss requirements should mean a larger volume is retained in storage benefiting the allocation available for all entitlement holders.

It is also concluded that the proposal is consistent with the principles underpinning the SDL adjustment provisions in the Basin Plan and IGA, and is analogous to other rule changes that have been accepted and endorsed as legitimate SDL adjustment measures.

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)
- Department of Environment (Commonwealth)
- Department of Environment, Water and Natural Resources (South Australia)
- Victorian Environmental Water Holder
- Goulburn-Murray Water.

A workshop was held on 23 March 2015 (at DELWP Attwood) and representatives of the state and Commonwealth agencies listed above were invited to attend. All agencies were represented at the workshop. The workshop attendees identified the drivers of change to operational loss, potential risks of this proposal and interested stakeholder groups.

Since the workshop in March 2015, DELWP have continued discussions in regards to this business case with the agencies listed. In addition, the proposal has been discussed with Water Liaison Working Group in relation to operational feasibility.

Due to the scope and scale of the proposal (operational loss 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.

It is prudent, given the nature 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. However, due to the operational nature of this proposal, it is not anticipated that consultation will be required beyond the agencies already consulted. Further consultation will be required with different groups within the agencies (and cross-agency working groups) 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.

4.2. Stakeholder map

Table 14 lists the interested stakeholders with an interest in this proposal. Engagement with all stakeholders listed is proposed following approval of this business case.

Table 14. 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	River operator The Living Murray	Impacts to state water shares Operational planning	Consulted in development of business

Stakeholder	Role / responsibility	Interface with the proposal	Likely areas of concern	Awareness of proposal
	Hydrological modelling Water policy	coordinator / icon site management	and management of Lake Hume Achievement of ecological outcomes	case
Water Liaison Working Group	Advise to MDBA on systems operations and water accounting issues in Southern connected Basin	Advisory group	Technical feasibility	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 (quantity and quality)	Consulted in development of business case
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	Consulted in development of business case.

Stakeholder	Role / responsibility	Interface with the proposal	Likely areas of concern	Awareness of proposal
			future management of Victorian storages	
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

5. Project delivery

5.1. Project delivery risks

The overarching approach and methodology to the risk assessment requirements of the Phase 2 Assessment Guidelines are more fully set out in Sections 3.1 and 3.2 above. Section 3 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 minor project development and delivery risks are described in more detail, together with the proposed mitigation actions in Table 15. The proposed mitigation actions are expected to be able to reduce all identified risks to acceptably low levels.

Table 15. Risk assessment and mitigation actions

	Risk	Potential issue	Risk assessment (prior to mitigation)			Mitigation actions
			Likelihood	Consequence	Risk rating	
1	Legal/ legislative risks	BOC unable to reach agreement that the measures should be implemented.	Possible	Moderate	Moderate	• Thorough development of proposals and review by SDLAAC. • Engagement of state agency representatives in business case development. • Detailed modelling and review by SDLAAC to provide confidence measures will deliver expected benefits and are legitimate SDL adjustments.
2	Modelling of environmental demands	Suitably accurate relationships can't be developed to forecast operational losses to the satisfactions of all key stakeholders.	Possible	Moderate	Moderate	• Initial modelling undertaken by DELWP has developed proof of concept to point where it can be modelled. • Project implementation cost estimates allow for specialist consultancy inputs to further refine and validate loss revised estimation techniques. • 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.
3	Project delivery	Detailed development of revised operational loss processes cannot be undertaken in a timely fashion, so project fails to proceed with other measures.	Possible	Moderate	Moderate	• 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 the loss estimation methods required for implementation. • Initial MDBA modelling of proposed changes completed as part of business case development.

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 1.4, the proposed rule change is consistent with the provisions of the Murray-Darling Basin Agreement and the general 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:

- The MDBA's key MSM-Bigmod model will need to be updated to reflect the approved rule change for estimating the volumes of water required to cover operational losses in future modelling studies. This will require the detailed proposed changes to the model to be reviewed and endorsed by SDLAAC Technical Working Group and by BOC before adoption by the MDBA.
- A range of existing and new procedures will need to be updated to lock in the improved system operating performance developed over the last 15 years as the business as usual standard. This also includes the implementation of a number of new water system planning and management tools. It is expected that these changes will fall within the delegated authority of a MDBA senior officer.

The operational arrangements for the planning and modelling the River Murray system are continually evolving and amendments to the operational procedures and 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 an 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 an SDL adjustment measure.

Whilst the allocation of specific project management roles and responsibilities is a matter for the MDBA, a significant component of the changes relates to the work practices of the operations group, so this may be a suitable area to assume overall responsibility for implementation of the rule changes. It is also likely that the operations group will have responsibility for a number of rule change SDL adjustment measures, so overall project implementation and co-ordination of resourcing, etc. may also be more efficiently managed within the same group. Consideration could also be given to allocating some of the tasks to jurisdictions for delivery. For example, DELWP has already developed a strong understanding of the operational loss estimation techniques and may be able to manage some of the consultancy studies.

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 Basin Officials Committee 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, and that management of the water system operational losses remains in line with recent performance which has formed the basis for the rule change. The implementation program includes allowance for the development of formal loss allowances together with routine operational loss KPIs and measurement and monitoring procedures. This will ensure that oversight of system operation by MDBA and Water Liaison Working Group can include regular assessment of operational loss performance. The development of the revised loss estimation techniques includes provision for the design and documentation of procedures required for monitoring and recommending review timings and triggers to ensure that the operational loss estimation procedures in the models are regularly updated to reflect prevailing practices.

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 state's 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 annually 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 details a proposal for locking-in recent efficiency improvements in water system management techniques, which are also supported by an updated approach for estimating the operational loss requirements for the River Murray system.

Operational losses need to be represented in the MDBA's system models in order to understand how the water system may perform under a range of scenarios. Understanding the future operational loss requirements allows the amount of water available for allocation to entitlement holders to be simulated. This in turn enables future consumptive and environmental water deliveries to be modelled, and therefore the likely extent of ecological benefit from environmental water deliveries to be estimated.

The aim of the proposed rule change is to better understand and allow for the likely operational losses that will be incurred in future when delivering large scale environmental water demands. Under the proposed rule change, recent improvements in water system management techniques will be consistently applied to future system operational planning. Modelling indicates that by implementing the proposed rule change, the previously estimated increase of an additional 110 GL/yr of operational loss required for the benchmark conditions (compared to the baseline) can be avoided. Implementation of the proposed rule change will maintain operational losses at levels consistent with recent good performance, which is lower than the long term average operational losses incorporated in the baseline model.

Modelling studies indicate that the proposed rule change also results 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.

Modelling has identified that third party impacts will be broadly neutral, with reliability of entitlements being maintained under this proposal. Under the proposal, overall annual average volumes of spill from Lake Hume increase somewhat over the summer/autumn period compared to the baseline and benchmark scenarios, contributing to some of the improved environmental outcomes. Modelling also indicates that overall the proposal will result in slightly more 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.

7. References

Jacobs 2016, Advanced modelling of improved regulation of the River Murray (Final B), Report prepared by Jacobs for Department of Environment, Land, Water and Planning

Jacobs 2015, File Note: Advanced modelling of improved regulation of the River Murray under future demand conditions – 10 July 2015, File note prepared by Jacobs for Department of Environment, Land, Water and Planning

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

MDBA 2013, Constraints Management Strategy 2013 to 2024. Licensed from the Murray–Darling Basin Authority, under a Creative Commons Attribution 3.0 Australia Licence.

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

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 Assessment Guidelines. The following table lists the requirements and then records where the issue is dealt with in this business case.

Table 16. Concordance - Stage 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	1.4.4
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	1.4.4, 2.5
3.4.1	The measure is a 'new measure'	Confirm the measure has not received funding or have funding approved	1.4.4
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	2
4.2	Ecological values of the site	Description of the ecological values of the site	3.3
4.3	Ecological objectives and targets	Confirm objectives and targets	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
4.5.1	Current hydrology and proposed changes	Clear articulation of current and proposed hydrology	3.3

Guidelines section	Heading	Requirement	Business case section
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	2.1, 2.2, 2.3
4.7	Assessment of risks and impacts of the operation of the measure	Assessment of risks and mitigation options	3.1
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	1.4.3
4.10	Costs, Benefits and Funding Arrangements	Detailed costing and listing of benefits	2.4, 5.3
4.11.1	Stakeholder management strategy	Confirm stakeholder list and stakeholder management strategy	4.1, 4.2
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. Summary of response to the Phase 1 Assessment Guidelines

Guidelines section	Heading	Requirement	Business case section
2.2.2	Description of Proposal	The proponent will need to provide a description of the proposal	2
2.2.3	Qualitative Estimate of the Potential Supply Contribution	The proponents will include a qualitative estimate of the potential supply contribution	2.3
2.2.4	Anticipated Environmental Benefits	The proponents will need to describe the likely environmental benefits resulting from the proposal	3.3
2.2.5	Approvals	A proponent must list the likely approvals required for their proposal and the estimated timeframes to obtain each approval	5.2
2.2.6	Potential Risks to the Environment and Third Parties	Proponents should include a preliminary identification and description of the potential adverse environmental and third party impacts	3.3, 3.4
2.2.7	Links to Other Proposed Measures	The proponent must provide a preliminary description/assessment of links to other measures and the nature and level of dependency/synergy	1.4.3
2.2.8	Complementary Actions Required to Support the Proposal	The proponent must identify any complementary actions that are required to support the proposal	1.4.3
2.2.9	Potential Risks to Project Delivery	Proponents should provide a preliminary list, description and assessment of the potential risks to project delivery	5.1
2.2.10	Costs and Funding	The proponent must provide an estimate of capital cost and in addition indicate whether there would be ongoing costs associated with operation and maintenance post construction	2.4
2.2.11	Consultation and Engagement	A proponent must identify key stakeholders and an approach to consultation	4.1

Appendix 3. Summary of current and proposed equations for estimating operational loss

Figure 21: Operational loss regression equation

Operational Loss (GL/mth) = ***A*****(Diversions)*(Rain) -* ***B*****(Inflows) -* ***C*****(Orders) +* ***valmon***

Table 17: Current and proposed regression coefficients

Coefficient	Value used in Benchmark model	Value for proposed rule change
A	0.00139	0.00051
B	0.06264	0.31203
C	0.30672	0.19658

Table 18: Current and proposed vales for Valmon monthly constant

Month	Value used in Benchmark model	Value for proposed rule change
Jan	194.6	150.2
Feb	232.8	146.5
Mar	276.4	133.1
Apr	128.9	70.0
May	64.0	50.0
Jun	17.9	30.0
Jul	54.5	80.0
Aug	37.9	112.7
Sep	59.7	150.6
Oct	174.6	178.5
Nov	174.6	183.5
Dec	174.6	167.9

Figure 22: Equation for maximum operational losses under low water availability

Maximum Ops. Loss (GL/mth) = ***Oplmax*(****Allocations* - ***Watavailmin)/(Watavailmax*** - ***Watavailmin)***

Table 19: Values for monthly constants in low water limit equation

Month	Value used in Benchmark model			Value for proposed rule change		
	Oplmax	Watavailmin	Watavailmax	Oplmax	Watavailmin	Watavailmax
Jan	260	2000	4000	400	1147	4000
Feb	260	1500	3000	300	860	3000
Mar	270	2000	4100	250	1147	4100
Apr	125	2000	4200	100	1147	4200
May	115	2000	4800	20	1147	4800
Jun	12	2000	2200	20	1147	2200
Jul	80	1000	2200	90	573	2200
Aug	150	1000	1700	65	573	1700
Sep	180	1000	2400	150	573	2400
Oct	218	1500	3200	200	860	3200
Nov	218	1500	2600	300	860	2600
Dec	170	1500	2800	200	860	2800

Appendix 4. 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 (845)	Benchmark (23006)	Proposal (23018)
Average salinity (g/L) in Coorong southern lagoon over model period	62	41	43
Maximum salinity (g/L) in Coorong southern lagoon over model period	291	90	102
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 < 100 g/L	82%	100%	99%
Average salinity (g/L) in Coorong northern lagoon over model period	29	21	22
Maximum salinity (g/L) in Coorong northern lagoon over model period	148	48	55
Max period (days) salinity in Coorong northern lagoon is greater than 50 g/L	604	0	45
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%	97%

Lakes metrics	Baseline (845)	Benchmark (23006)	Proposal (23018)
% days Lake Albert salinity exceeds 2000 EC	6%	0%	0%
% days Lake Alexandrina salinity exceeds 1000 EC	11%	0%	1%
% days Lake Alexandrina level below 0.4 m	18%	4%	6%

Appendix 5. Minutes of workshop - 23 March 2015

Minutes

Meeting	Stakeholder engagement workshop
Date	Monday 23 March 2015
Project	Development of business case for SDL adjustments – Improved Regulation of the River Murray
Attendees	[redacted]
Apologies	[redacted]
Distribution	Meeting attendees

Item	Notes
Introduction	-
Background to the business case [redacted]	Thank you for input to the last two business cased (Hume airspace, BMEWFA). Tight turn around and good, timely feedback. Both business cases will be forwarded to SDLAAc for consideration. Will keep stakeholders informed. The proposal for discussion at the workshop has two components– look at operational loss, not transmission loss. Two components: - Flexible rates of fall in river levels downstream of Hume Dam - Improved River Murray Operational Loss Today's objectives: Objective for component 1. To seek input into the preparation for a business case for the flexible rates of fall in river levels downstream of Hume Dam. Objective for component 2. To discuss the characteristics of the River Murray operational loss in recent years in order to gain a better understanding of the factors which have contributed to the improvement in system operational losses.
Component 1.	Flexible rates of fall in River Levels Downstream of Hume Dam
Preliminary modelling [redacted]	Background to proposal 1. REFER TO SLIDES 6 inch rule has been in place almost 60 years.
Key issues identification [redacted])	Five key issues: 1. Operational loss Driver is rainfall rejection. Ordering practice is important. In the past they used to run Mulwala at FSL to meet peak demands. But now that doesn't happen they are running it lower. "Take the 4 day forecast to the bank". Therefore they are more flexible in operational management. Changes in operating practice. For the business case we are looking at the model loss – changes from benchmark and baseline. Hard to tease out the 6inch rule component – BigMOD is a daily model and MSM is a monthly model. It is a small component of the bigger operational loss. Does the model do the rule justice?? Change to 6 inch rule is small part of total ops loss in MSM – hard to identify uniquely. Not a loss to the system if harvested in Lake Victoria, etc. [redacted] – re-timing of the water. Have used this as the principle in the Murrumbidgee. Water where and when it matters. Its an opportunity to re-time water to better meet needs. 2. Bank slumping Earth Tech study. Trigger for the study – hydro power generation feasibility on Hume. Found that primary driver of bank erosion is fluvial entrainment. Rotational failure is not observed. Report suggests that you can take a less conservative approach to rate of fall. Biggest issue is notching. Potential benefits of flow variability is reduction in notching. MDBA trials. Trialling what DELWP are proposing for SDL adjustment. Suggest that it might still be quite conservative. 4-5 monitoring stations (NSW OoW). Two year trial. This summer and next summer. Hard to test when dry and hot. More of an issue when prolonged wet. MDBA spends quite a bit on bank protection works. Need to make sure that they don't increase these works and $$ required for waterway management.

	3. Ecosystem outcomes Unseasonal flooding of Barmah-Millewa. And also unseasonal inundation of floodplain wetlands. Hume-Yarrawonga modelling – wetland inundation (Jacobs doing this at the moment for NECMA). Potential to get positive result from reduction in floodplain wetland inundation. 4. Third party impacts SA – changes to operational rules can mean a reduction in inflows to Lake Victoria. Water supply offtakes – Albury City Council, NE Water. Office of Water – not heard of any concerns. Can follow up in the development of the business case. 5. Preferred option The proposal isn't that bold. BOC suggested - should be trialling above 25,000ML/d too. Above 25,000 is at flood ops. How is >25,000 treated in the proposed rule change? 6. Other?? SA issues: Would like to see how this proposal might change flows in volume and timing. How will it impact on entitlement flow? Does it change SA storage right? Are there any water quality and salinity impacts to SA? Changing when water is being delivered – is there any detriment to downstream environmental assets? Would the SDL adjustment method pick up any of the in channel ecosystem assets? How do the DELWP propose to ensure that this change is enduring – change to O&O? creation of entitlement??
Clarify and prioritise issues [redacted]	What do we need to address in the business case? - Aim of the proposal is to keep water out of BM - Storms are a key influence – what does this look like under climate change? - Hard to identify the ops loss in the monthly model - Not a loss if harvested in Lake Victoria - Opportunity to re-time water to better meet environmental needs - Current trial collecting data – learning - Waterway management is a big $$ cost in this reach. Must ensure proposal does not impact on efforts and increase spending - Need to understand watering of floodplain wetlands – outputs from 2D modelling - Could affect SA storage rights - There are currently no constraints on flow > 25,000. How is this treated in the rule change? - How does this rule change interact with CMS 40,000 ML/d change - Is Jan-May period aligned fully with BMF negative impacts? - Water quality impacts - Are any environmental outcomes downstream of BMF affected? Local, in channel impacts. - How is the rule change locked in? change to SO&O, creation of entitlement? Preference is SO&O - How does the proposal link to the other SDL proposals? Authority will consider the whole package of proposals. In the business case we identify the potential interactions with other measures and the broad level of influence that this proposal might have on other proposals. - Local community concerns about bank slumping.
Stakeholder mapping [redacted]	*Groups to engage prior to submission of business case:* Environmental managers: Goulburn Broken CMA [redacted]), Parks NSW ([redacted]), OEH [redacted] North East CMA, VEWH, Parks Victoria. Urban water authorities: North East Water. Engage with them through GMW [redacted]). *Groups to engage through broader consultation of business case packages:* Hume to Yarrawonga Advisory Group – Chair: [redacted] Group is an MDBA formed group. Membership comprises Councils, landholders, MRAG. Aware of the trial. Murray River Action Group (MRAG). Chair – [redacted]. Main concern for this group is flooding risk. Aware of the proposal through HYAG. NSW Office of Water works group. Source of knowledge. Undertake monitoring for the trials. Know about proposal.

	Murray Local Land Services – unsure of the direct concern. Linked through NSW interagency communications. Water NSW. [redacted]). Engaged through the trials. No further engagement required at this stage. Diverters: North East Water, Albury City Council, individual irrigators. Engage with water users through GMW ([redacted]). Generally concerned about a rapid rate of rise. Would probably welcome a faster rate of fall. Maritime NSW – water safety/boating on R Murray. Not aware of proposal. Southern Riverina Irrigators – potentially conflicting views – keen to maximise SDL offset. Environment groups: Environment Victoria, Goulburn Valley Environment Group. Potential positive environmental outcomes. A good news story.
Component 2:	Improved River Murray Operational Loss
Overview / background [redacted]	Refer to Slides. The concept of operational loss is not considered in actual operations as it is implicitly included within other key assumptions such as travel times, rainfall forecasts, inflow etc. It is a modelling construct as it needs to take into account all operational decisions to mimic reality. Where it factors into operations is in water balance, explaining the annual review of river ops. Operators don't think about it separately in their forward planning, it is part of the decisions they make to manage uncertainty in operational planning. Assume that PPMs are all in place. Jurisdictions sought early assurances in relation to the key issues, as this would influence SDLAACs decision about progression of the project/s from Phase 1 to Phase 2. Victoria were going to consider whether to separate the two projects or continue with them together for Phase 1 and 2 of the SDL adjustment mechanism.
Mapping out changes that have influenced operational loss	Points coloured blue were identified as 'enduring changes'. The points coloured **<u>blue, bold and underlined</u>** as the key influences in operational loss change. Pre-2000: Cap, NSW carryover, NSW water sharing plans, unbundling of water rights, shift from ongoing growth in entitlements, Cap (now SDL) started to be taken seriously 2000-2001: - establishment of Murray BEs - drought influencing operations. 10 years of lower inflows - water started moving from consumptive to environment. Smaller pool of water available. - Modernisation and management of losses - **<u>Change in operations culture</u>** [redacted]) 2002-2003: - Change in cap due to more accurate measurements in MIL - **<u>System improvements – provide improved feedback, information availability. Systems still improving beyond 2015.</u>** - First sub water right allocation. Shifted focus on water use/ availability. Increase focus on outfall reduction. 2004-2005: - NWI – transparency - Improved orders by irrigators – system/processes - Inter-valley transfers – accounts used as a risk management tool for R Murray ops. - Users accept tighter ops and risk of shortfalls - Shepparton modernisations – 65-85% efficiency. Created into entitlements. - Operators err on the side of caution. And it is politically OK to do so. 2006-2007: - Drought changed the planning horizon - Temporary works – isolating wetlands, i.e. Euston Lakes, Lake Bonney. Tier 2&3 water management. - Increased communications through Water Liaison Working Group. Particularly around orders. Greater understanding of user behaviour. - Push on compliance – diverters - **<u>Increased focus on water accounting. NWI, transparency, accountability.</u>**

	- **Increase in water value on the allocation market.** - 2007 carryover introduced in Victoria – changed forecast for how people would use water. Users might not choose to use it. 2008-2009: - First multi-site environmental watering trial. Different to standard ops practice. All water accounted for, lower loss. - Use of longer term forecast. Forecast improved. Operates and water users have more confidence in quality of data. - Kiewa – improved frequency of data input to decision making - IRORG – reviews of river ops. - Establishment of CEWH, MDBA 2010 onwards: - **Environmental water holding.** CEWH water delivered. Big orders, but different flexibility to irrigators. Delivery is assigned to environmental accounts, not as a loss (transmission and operations) - User getting better at forecasting. E.g. Sunraysia, NSW water corps. Modernising their infrastructure (metering) trend over the last few decades
Key issues	Should this be reflected in a change to the benchmark model? 2000-2009 operator behaviours What is the 'lock in' process that will enable a claim of permanent change? How do you make it an enduring change? What is the quantum of the ops change? How does it impact on reliability? SA storage rights? Does ops loss currently create environmental benefit? How does it meet the Phase 2 guidelines? What benefits does change in ops loss deliver? Re-timing, flexibility? Who, and how, does the saving benefit? What is the real evidence that system management of operations loss has changed? Risk-quantum trade off for volume of any savings in ops loss. What entitlement mix would you be looking at?
Wrap up	Workshop attendees in agreement – as mapped out by these minutes – that leading up to and following the millennium drought period there has been significant water reform and also a shift in river operational practice. Further investigation and work is required by DELWP and the project team to progress the proposals and address the 'key issues' that were identified at workshop.