Barrage Operating Strategy

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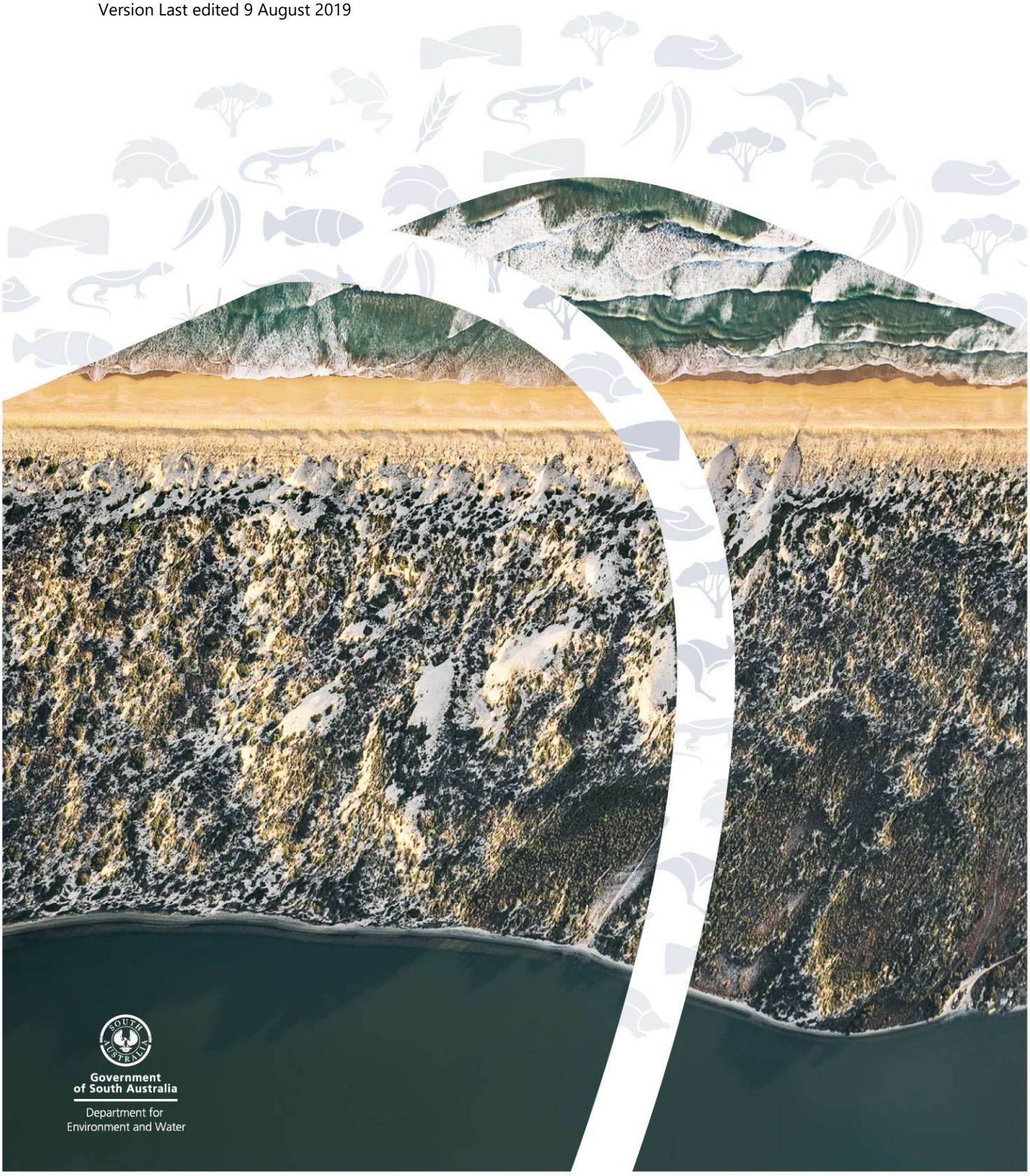

Government of South Australia

Department for Environment and Water

Acknowledgements

Ngarrindjeri people are the descendants of the original inhabitants of the lands and waters of the River Murray, Lower Lakes, Coorong and adjacent areas. Ngarrindjeri have occupied, enjoyed, utilised and managed these traditional homelands since time immemorial.

The South Australian Government acknowledges that Ngarrindjeri are the Traditional Owners of the land and that according to their traditions, customs and spiritual beliefs its lands and waters remain their traditional country. The South Australian Government also acknowledges and respects the rights, interests and obligations of Ngarrindjeri to speak and care for their traditional country, lands and waters in accordance with their laws, customs, beliefs and traditions.

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Acronyms

AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
BMA	Barrage Management Actions
BOAG	Barrage Operations Advisory Group
BOS	Barrage Operating Strategy
BWEWS	Basin Wide Environmental Watering Strategy
BWLMP	Barrage and Water Level Management Policy
CAP	Community Advisory Panel
CEWH	Commonwealth Environmental Water Holder
CEWO	Commonwealth Environmental Water Office
CLLMM	Coorong, Lower Lakes and Murray Mouth
CMP	Condition Monitoring Plan
CPUE	Catch Per Unit Effort
Cth	Commonwealth
DAWR	Department of Agriculture and Water Resources
DEF	Drought Emergency Framework
DEW	Department for Environment and Water
DoEE	Department of Environment and Energy
EC	electrical conductivity
ECD	Ecological Character Description
EPA	Environment Protection Authority
EWMP	Environmental Watering Management Plan
EWR	Environmental Watering Requirements
GL	Gigalitre (1 GL = 1 billion litres)
KNYA	Kungun Ngarrindjeri Yunnan Agreement
LAC	Limits of Acceptable Change
LLCMM	Lower Lakes, Coorong and Murray Mouth
LMRIA	Lower Murray River Irrigation Area
LTEWP	Long Term Environmental Watering Plan
MDB	Murray-Darling Basin
MDBA	Murray-Darling Basin Authority
NRA	Ngarrindjeri Regional Authority
NRM	Natural Resource Management
PEA	Priority Environmental Assets

PPT	Parts per Thousand (eg g/L)
RMO	River Murray Operations
RMP	Ramsar Management Plan
RMW	River Murray Waters
RMWAF	River Murray Water Allocation Framework
SA Water	South Australian Water Corporation
SA	South Australia
SAG	Scientific Advisory Group
SCBEWC	Southern Connected Basin Environmental Water Committee
SOM	Site Operating Manual
TLM	The Living Murray
VLP	Variable Lakes Project

1 Introduction

Water level management and associated barrage management in the Coorong, Lower Lakes and Murray Mouth (CLLMM) region is highly complex and often influenced by a range of competing interests and factors such as local weather conditions, which may result in trade-offs or the potential for sub-optimal delivery of water. With the increased return of environmental water to the Murray-Darling Basin through the Basin Plan and The Living Murray program, the volumes provided to South Australia for environmental use has also increased. This water provides multiple environmental and socio-economic benefits to South Australia, but also increases the complexity of decision making processes with respect to Coorong and Lower Lakes water management. To ensure management decisions are transparent, robust and evidence based, the Barrage Operating Strategy (BOS) has been developed to inform and optimise barrage management actions undertaken by the Department for Environment and Water (DEW) and SA Water.

2 Background

There are a number of strategies and processes that guide both barrage management actions and operations. However, prior to the Barrage and Water Level Management Policy (BWLMP) and BOS, South Australia did not have an endorsed policy or strategy for integrated water level and barrage discharge management. Greater documentation of the operations and management of the Lower Lakes is required to ensure water management is adaptive, outcome driven and provides optimal ecological benefits to the region. Through the Variable Lakes Project (VLP), DEW documented an adaptive, evidence-based, decision making process to formalise water management of the CLLMM region, including management of water levels through barrages manipulation.

The BWLMP, produced and implemented through the VLP, provides the principles and critical operating limits for the practical management of water levels and the barrages. It also provides a mechanism for prioritising multiple, and at times competing, objectives that may be achieved through barrage management actions (BMAs). This BOS informs barrage operations to support the BWLMP and outlines the governance arrangements, consultation processes, drivers and legislative considerations involved in the decision making process. A decision making framework (DMF) for structured and accountable decision making processes is also detailed within this strategy.

Both the BWLMP and BOS are supported by a *Literature Review* and *Considerations Report* that form part of the documented information generated by the VLP. Both these documents can be referred to for further background and historical site management information.

Operational outcomes that relate to the implementation of the strategy arrangements will be incorporated into the yet to be developed CLLMM Management Action Database (MAD). This process will be undertaken to improve and enhance transparency relating to managing water resources within the Lower Lakes and Coorong and is to be an important resource tool that will assist with future management decisions. Work has been undertaken in 2019 to develop a Business Requirements Document to scope what is required for the MAD.

3 Objectives

The objective of the BOS is to support the principles and implementation of the BWLMP. These principles are:

1. Support legislative objectives
2. Maximise environmental benefits
3. Utilise a risk-based approach
4. Apply the precautionary principle
5. Culturally and socially responsible management
6. Responsive and adaptive management
7. Evidence based and transparent decision making
8. Management for consumptive use

In doing so the BOS supports the achievement of relevant legislative objectives (as documented in the *Considerations* Report) including those under the *Water Act 2007* (including the *Murray-Darling Basin Agreement 2008*). The processes outlined in the BOS apply to all barrage management actions and lake levels. The BOS aims to manage Lower Lakes' water levels in a variable manner within an ideal operating range under normal conditions.

3.1 Variable Lake Water Levels

The preferred water level operating regime for the Lower Lakes, as defined by the BWLMP, is seasonally variable and under normal conditions ranges between +0.5 m AHD and +0.85 m AHD annually, whilst allowing for continued barrage releases. The operating water level range and variability will be dependent on the flows available in the River Murray system. This operating regime is for the benefit of ecological (eg fringing vegetation, fishway connectivity, temporal and spatial estuarine conditions and water quality), social (eg cultural heritage) and economic outcomes (eg irrigation). Lowering water levels to the minimum recommended height should only be implemented if expected flows are likely to enable reinstating water levels. Therefore, consideration of these factors must be made before intentionally reducing water levels to the minimum proposed operating level. Operating below the stipulated operating level is to be avoided unless scientific evidence can be provided to support such an action to achieve an objective (eg for fringing vegetation wetting and drying cycles or acid sulfate soil cycling) and necessary risk assessments and mitigation undertaken. It is important to consider this as an operating range, hence water levels may rarely achieve the upper and lower limits of the range.

Variable water levels within the stipulated operating range will support habitat for threatened fish and maintain and enhance aquatic vegetation (Muller, 2010). Under a variable water level operating regime, fringing aquatic vegetation undergoes wetting and drying cycles that drive beneficial ecological outcomes. It also provides ecological cues, including for migration, for aquatic species including the southern bell frog and small-bodied fish. This range of lake water levels also ensures operation of most fishways is achievable year-round, provides greater connectivity between the Lakes and the Coorong and ensures freshwater can be delivered to the Coorong via barrage releases. This range also enables salt loads to be exported from the Murray-Darling Basin out through the Murray Mouth.

3.2 Barrage Management Action Options and Priorities

In seeking to meet multiple and often competing objectives, BMA options must be prioritised. Undertaking BMAs requires the assessment and consideration of multiple trade-offs. Such trade-offs include the management of water levels in the Lower Lakes versus releases through the barrages. Any decision to manage both water levels and releases must consider the requirements of the Murray-Darling Basin Plan and the nominated water levels for the Lower Lakes, the Murray-Darling Basin Ministerial Council Drought Emergency Management Framework (noting the BWLMP and BOS do not seek to override the Drought Emergency Framework, but instead complement it), and BWLMP and BOS objectives.

Decisions relating to water level management and discharge operations must also consider any specific obligations placed on the delivery of environmental water, including any special arrangements as determined by environmental water holders such as the Commonwealth Environmental Water Holder (CEWH). DEW agrees to an annual CLLMM Watering Schedule, which is prescriptive on the use and management of Commonwealth environmental water.

Generally when water levels are at or below +0.4m AHD, the barrages will be closed. As more water is made available and water levels increase, the operating priorities for managing water levels and enabling discharges are:

1. ensure water levels can be maintained above 0.0m AHD 100% of the time and above +0.4m AHD 95% of the time, as per the Murray-Darling Basin Plan
2. increase lake water levels to create sufficient driving head to enable barrage opening as soon as possible, subject to local tide and weather conditions
3. open fishways to reinstate connectivity and enable fish passage. The order in which each barrage is opened will be discussed with fish ecologists from SARDI and DEW environmental water operations staff
4. open additional bays to establish attractant flows for fish migration, SARDI fish scientists will advise on appropriate order and timing
5. open additional bays to achieve other ecological objectives.

Table 1 provides an outline of the operational actions to be undertaken as water availability improves. Under some flow conditions (eg large unregulated flows) the ability to actively manage releases may be limited. As water levels in the Coorong increase due to freshwater flows, the differential head may decrease and therefore restrict additional flows over the barrages, this is particularly relevant to unregulated flows.

Table 1. Typical CLLMM barrage management actions considering water level and availability.

Increasing water level	Increasing water availability		
If water levels less than 0.5m AHD and water availability low	Maintenance of water levels to ensure water does not drop below 0.0m AHD (Basin Plan).	Negotiate additional water from environmental water holders	As water becomes available then commence releases starting with the fishways followed by attractant flows
When water levels increase above 0.5m-0.7m AHD	Assess and model water availability and prioritise releases at the fishways	Provide additional water for attractant flows commensurate with the volumetric requirements	Increase the number of bays/gates open at Goolwa, Mundoo, Boundary Creek, Ewe Island and Tauwitchere barrages to maintain northern Coorong estuarine conditions
Water levels and availability increasing to range of 0.7m-0.85m AHD	Assess smaller-scale priority actions under watering Schedule and Environmental Watering Plan/Proposal. These may include: • Ensure continuous fishway releases with attractant flow to provide passage for diadromous fish • Extending the duration of lake surcharge (ie 0.8 – 0.85 m AHD) until the end of December, for threatened fish and frog breeding outcomes in Lower Lakes fringing wetlands	Assess medium-scale priority actions under watering Schedule and Environmental Watering Plan/Proposal. These may include: • Targeted winter high-flow barrage releases to encourage upstream lamprey migration • Target late spring/early summer barrage releases from the Pelican Point end of Tauwitchere barrage, to ensure maximum benefit to Coorong South Lagoon water levels and salinity for *Ruppia tuberosa* outcomes	Assess what large-scale operational actions can be undertaken (subject to water availability). These may include: • Targeted scouring opportunities at the Murray Mouth (particularly if dredging) • Optimising barrage discharges to improve Coorong salinity levels (both north and south lagoon to promote and maintain habitat and recruitment for estuarine fish species populations) • Water level cycling to increase export of salt from Lake Albert

4 Drought Emergency Framework

The purpose of the Drought Emergency Framework (DEF), approved by the Murray-Darling Basin Ministerial Council in June 2014, is to guide decision making processes for the management of the Lower Lakes during extreme drought. Central to this framework is the development of an early warning indicator which will be triggered when water levels are predicted to fall below +0.4 m AHD. When this trigger is reached, a Murray–Darling Basin inter-jurisdictional High Level Steering Committee will be formed to provide sufficient lead-time to enable a well-considered management approach (MDBA, 2014a).

The underlying management objectives and principles for the Emergency Framework include:

1. avoid irreversible damage through acidification of the Lower Lakes system
2. consider the ecological risks of acid sulfate soil management options and, as far as possible, avoid options that compromise mid to long term options
3. consider the impacts of salinity not only acidity
4. recognise that, as water level decreases, the acid risks increase and so do the costs of management actions
5. prevention of acid sulfate soil (avoiding exposure) is preferable to treatment or neutralisation.

The DEF has a decision support tool to facilitate a timely response to a future drawdown event. This includes two phases: a planning phase (lake levels +0.4 m to 0.0 m AHD) and an emergency actions phase (lake levels 0.0 m to -2.7 m AHD) that incorporates four levels delineating likely impacts and potential management actions (MDBA, 2014a). Under the BOS +0.5m AHD is the preferred minimum level for the Lower Lakes' water levels under most circumstances. Beyond this point the DEF must also be considered in unison with the BOS and BWLMP. **Figure 4-1** shows pumping water into Lake Albert from Lake Alexandrina to maintain lake levels above +0.5m AHD during drought conditions in August 2008.

Figure 4-1. Pumping water into Lake Albert from Lake Alexandrina (August 2008).

5 Barrage Management Actions

Barrage Management Actions (BMAs) represent decisions taken by DEW to meet the objectives of the BWLMP. They aim to ensure the CLLMM water levels and barrage outflows are sufficient to maintain the ecological character of the Coorong and Lakes Alexandrina and Albert Ramsar Wetland, and ensure lake levels are sufficient to allow for delivery of water for Critical Human Water Needs and consumptive entitlement holders in the Lower Murray.

BMAs are determined via a Decision Making Framework (DMF) described in Section 6. The DMF is applied to each BMA. Given the spectrum of BMAs possible, from short term, simple actions involving a few barrage gates to long term, complex actions involving multiple barrages, BMAs are categorised as minor, moderate or major. BMA categories are defined in **Table 2** along with examples. Generally, minor BMAs are associated with lower water management volumes and lower associated risks, whereas major BMAs are associated with higher water management volumes and/or higher risk.

Table 2. BMA category definition and examples.

BMA Category	Event type	Example
Minor	Daily or regular events	Fishway management and attractant flows.
Moderate	Monthly or targeted events	Murray Mouth scouring, large fish migration release event and water level cycling events.
Major	Yearly, flood or low/no flow periods	Unregulated flow event, major release event, large scale water level cycling or water availability is extremely limited.

Implementation of BMAs is described in Section 6 with associated consultation processes described in Section 7 of this document. Reporting requirements for BMAs are described in Section 5.7 of the DMF.

6 Decision Making Framework

The DMF is a critical component of the BOS. The DMF is a management tool that facilitates transparent, efficient and adaptive decision making for all BMAs that are applied to achieve the relevant social, economic, cultural and environmental objectives for the CLLMM region (Section 4). The DMF is a top down process involving consideration of issues relevant to BMAs. The DMF has seven (7) key phases that together constitute an iterative management method for control and adaptive management. The 7 phases are shown in **Figure 6-1** and each phase consists of a number of steps. Between certain phases there are 'check points' designed to allow decision makers to take stock of the BMA process and to determine, based on the information available, the objective targeted or the resources (eg flow volumes) available and whether or not the process should proceed.

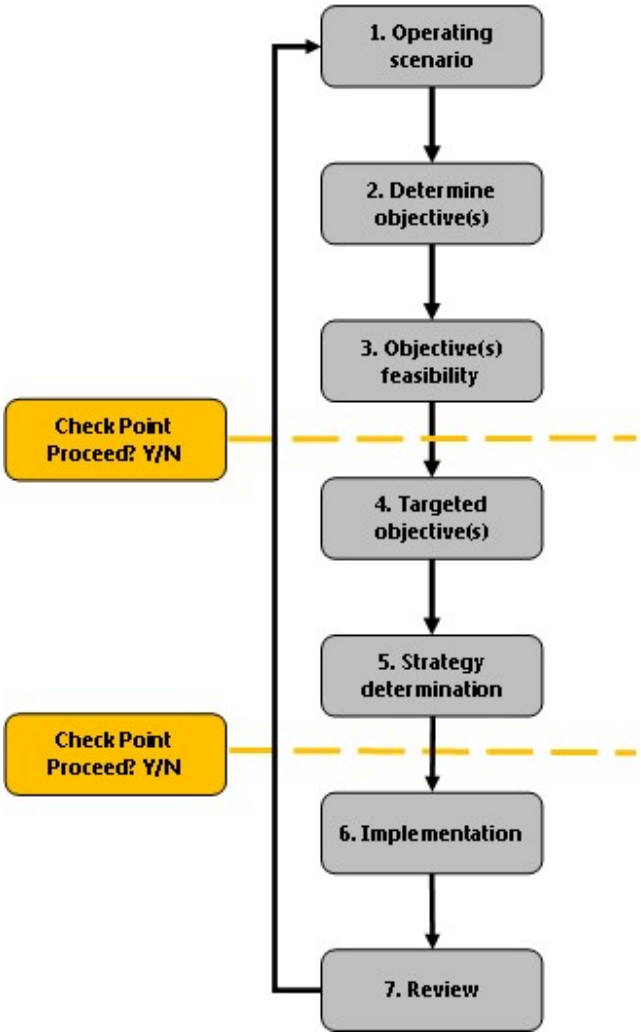

Figure 6-1. Key phases of Decision Making Framework.

6.1 Operating scenario

The first phase in the DMF determines the operating scenario within which the proposed BMA will be undertaken. Forecast operating scenarios are routinely used by the MDBA and others to plan for water availability within the River Murray system (see *Considerations Report*). For the BOS there are three possible operating scenarios that can apply:

1. low flow (less than Entitlement Flow) including environmental water (if available)
2. entitlement flow (1 850 GL) plus environmental water
3. unregulated flow.

Defining which operating scenario applies requires a preliminary assessment of the system's status ie the Lower Lakes, Coorong and Basin-wide current and forecast status. The assessment process is described in **Figure 6-2** and includes examination of the current flow volumes, storage and water levels, as well as forecast system conditions (including the MDBA forecast scenarios). This phase also identifies opportunities to utilise environmental water or stored water and flows from the South East (via SEFRP, see Section 8.6). Additional water may assist in the delivery of objectives that are not possible with the current and/or forecast flows in the system. Modelling of current and future conditions at this phase may help determine the operating scenario and consultation can assist in determining the likelihood of additional water eg consultation with the CEWO. An important step within this phase is consideration of lessons learnt, which arise from the review process shown in **Figure 6-5** and considered in Section 5.7 and provide an opportunity to implement improvements ie adaptively manage, based on prior experience.

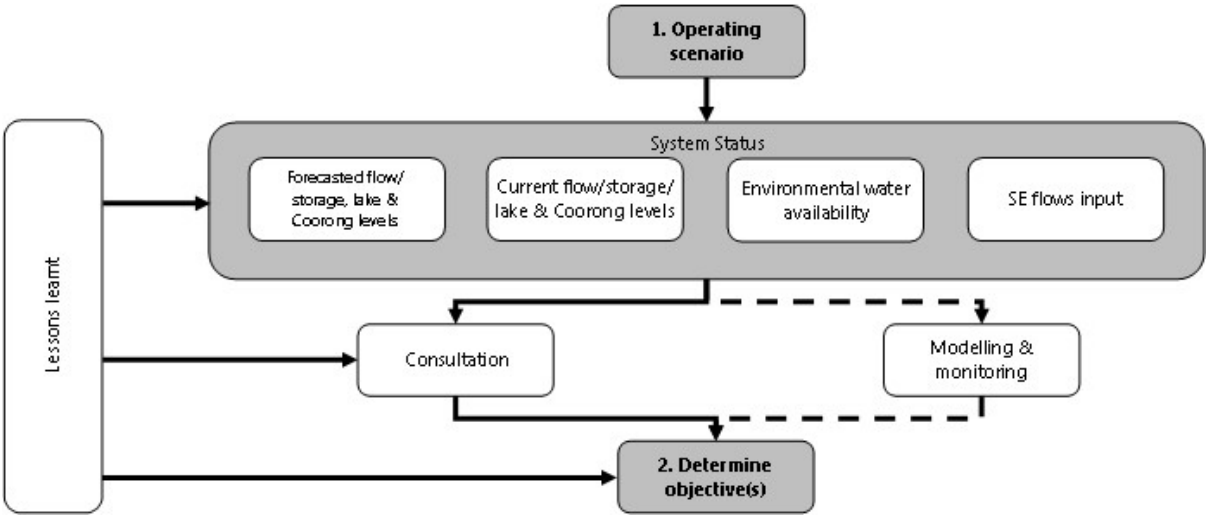

Figure 6-2. Operating scenario phase.

6.2 Determine objective(s)

Once the operating scenario and expected flow regime (from South Australian border to the Lower Lakes) has been defined, the next phase in the DMF involves determining the objective(s) that may be targeted by the BMA. The objective(s) may be derived from a range of legislated and non-legislated instruments, including the Basin Plan, the Basin-wide environmental watering strategy, TLM LLCMM *Long Term Watering Plan* (LTWP), the *South Australian Long Term Watering Plan*, the *Ramsar Management Plan* and others. When water availability is constrained (eg during low flow or drought scenarios) then the objective(s) achievable will be constrained. When water availability increases, such as through South Australia receiving unregulated flows, additional objectives can be achieved. Note that where environmental water is available, it must be used for environmental outcomes.

6.3 Objective(s) feasibility

Once the objective or objectives have been selected, their feasibility or suitability is assessed within the context of the operating scenario. Within this phase there are a number of stages that are detailed in **Figure 6-3**.

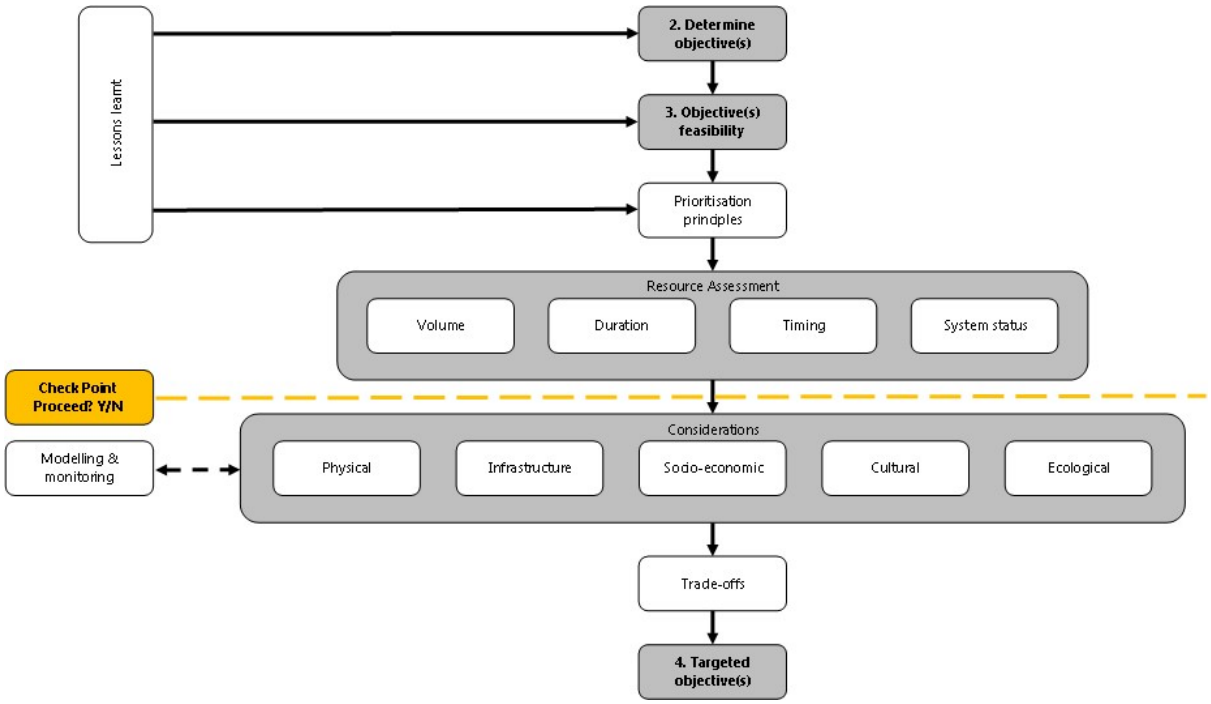

Figure 6-3. Objective(s) feasibility phase.

6.3.1 Prioritisation principles

Where more than one objective is considered possible, given the operating scenario and water availability, then the first step in the objective feasibility analysis is to prioritise the objectives based on the principles and prioritisation criteria in the BWLMP. These should be considered along with the principles under the Basin Plan's Division 1—Principles to be applied to determine priorities s8.53 to s8.59.

6.3.2 Resource assessment

This step describes the metrics of the available water and represents the current status of the water resources expected to be managed by barrage operations. Where the operating scenario determination stage involves a Basin wide assessment, the resource assessment is specific to the available water for a BMA. This includes the volume, duration and timing of water delivery, regardless of the source and type of water.

6.3.3 Considerations

This stage assesses considerations for the proposed operating scenario or flow regime to achieve desired objective(s). Some physical considerations, such as climatic conditions, have a temporal influence on the efficacy of a BMA and must be assessed on a case by case basis. Operational considerations are discussed in more detail in Section 8.

6.3.4 Trade-offs

Where more than one objective is considered for a BMA, there are likely to be trade-offs or complementation. For example, some objectives may be complementary eg barrage releases for salinity targets in the Coorong estuary will also improve water levels for *Ruppia*, whereas other objectives may involve trade-offs eg surcharging water levels to wet riparian vegetation over discharges for fish migration attractant flow. More examples of known trade-offs are detailed in the *Consideration Report*. Determining potential trade-offs and the priority of particular objectives is undertaken through consultation with other interested parties including groups detailed in **Table 4** (eg BOAG). The following prioritisation principles based on the BWLMP help to determine priority objectives during this stage:

1. **Critical need and water demand**: The need for a particular hydrological regime for a targeted objective should be informed by the condition of the environmental asset to be targeted and its consumptive demands.
2. **Water resource availability**: This includes the current and future availability of River Murray water resources informed by the MDBAs projections of South Australia's Entitlement and all sources of flow to South Australia, operational considerations, water held in storage and the availability of environmental water.
3. **Operational feasibility**: Operators will seek to achieve the highest priority objectives possible for the given resource availability and barrage management action operating conditions.
4. **Lessons learned**: Prioritisation will consider the outcomes of previous barrage management actions through transparent barrage management action review processes.

6.4 Targeted objective(s)

The last stage in the objective(s) feasibility phase is the determination of the targeted objective(s). With due consideration to the above stages in this phase, an appropriate objective(s) can be selected and advanced to the next phase, thus determining the most appropriate BMA strategy to achieve the targeted objective(s) (refer *Considerations Report*, Section 7 Policy Objectives and Linkages).

6.5 Strategy determination

Figure 6-4 describes the various stages within the BMA strategy determination phase that are needed to achieve the targeted objective(s).

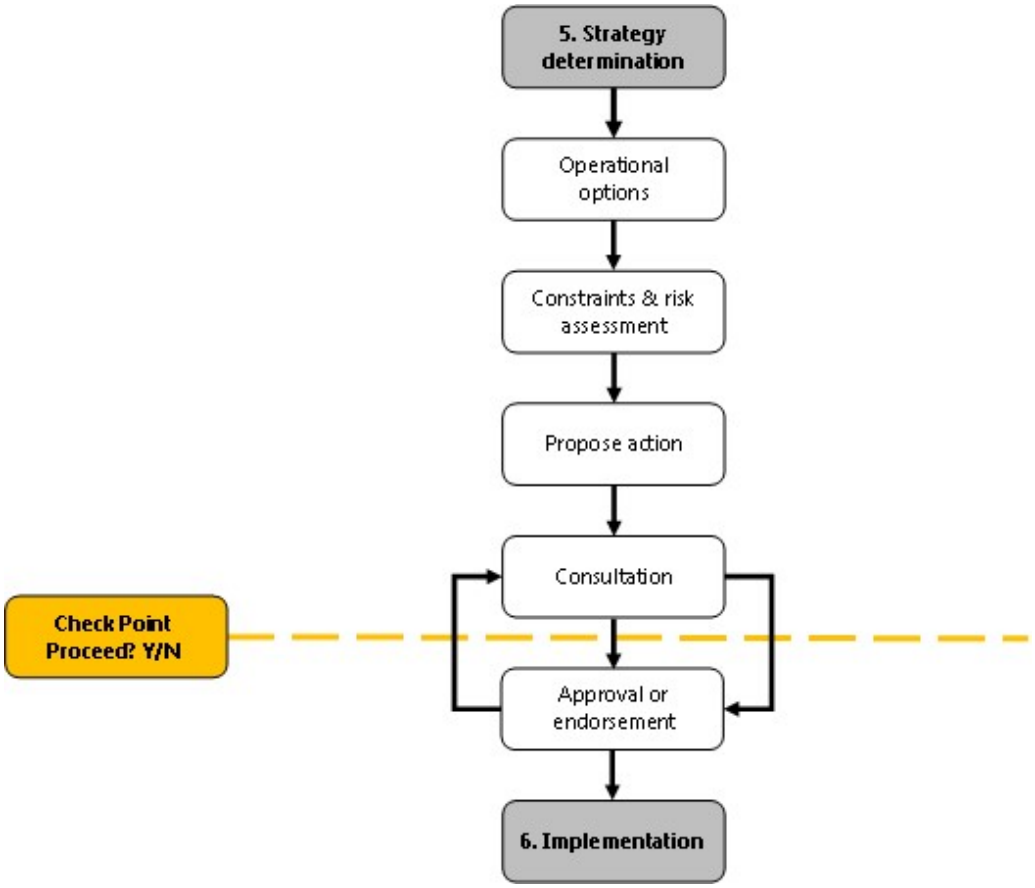

Figure 6-4. Strategy determination phase.

6.5.1 Operational options

To achieve a targeted objective(s), there may be multiple operational actions that can be undertaken eg different barrage release timings, barrage splits or pulses vs steady flows. Each potential option should be considered and whether or not the operating scenario will make it viable. This phase may also require modelling to determine the viability or effectiveness of a proposed action.

6.5.2 Risk assessment

Each BMA will have a level of risk associated with it. Reviewing and undertaking a risk assessment where applicable will limit the potential options, or alternatively, determine the mitigation option required to undertake the action. Risk is determined in accordance with the AS/NZS ISO 31000:2009 *Risk Management – Principles and guidelines*. A summary of the risk matrix and identified potential risks is provided in the *Considerations Report* (see Table 10 of *Considerations Report*).

6.5.3 Propose action

Given consideration of the operational options, constraints and any necessary assessment of risk, the appropriate BMA may be formulated and approved consistent with the governance arrangements outlined below. The form of the proposal will vary depending on the category of BMA to be undertaken (eg moderate BMAs may require an event management plan).

6.5.4 Consultation

The proposed BMA, BMA proposal and the associated targeted objective(s), may require consultation with relevant stakeholders (eg environmental water holders) or area experts (such as the CLLMM SAG and CAP). This supports why a particular BMA strategy is being proposed and gives stakeholders an opportunity to provide feedback. The proposed BMA may be refined and re-proposed to relevant stakeholders based on their comments.

6.5.5 Refine and endorse

Once the BMA strategy is determined and has undergone the consultation process, it will be refined and endorsed by the appropriate stakeholder(s). The appropriate endorsee for each BMA category of operation is detailed in Section 7 and **Table 4**.

6.6 Implementation and monitoring

The implementation and monitoring phase ensures that proposed and endorsed BMAs are undertaken and, where appropriate, monitored to evaluate their success. The type and scale of monitoring is dependent on the scale of the BMA. Minor actions will likely only require basic operational monitoring of telemetered stations and barrage data, whereas a moderate or major action may require more detailed monitoring and evaluation, including intervention monitoring, subject to the availability of funds and resources. Monitoring is important for the adaptive management of BMAs and where possible will be coordinated with ongoing monitoring programs such as those undertaken as part of The Living Murray condition and intervention monitoring projects.

6.7 Evaluate

This stage involves reviewing the implemented BMA and any associated monitoring information (**Figure 6-5**) and evaluating its efficacy and success. Reviewing can range from documented internal discussions to documenting the BMA. This stage will also facilitate continuous improvement of the DMF, BWLMP and the BOS.

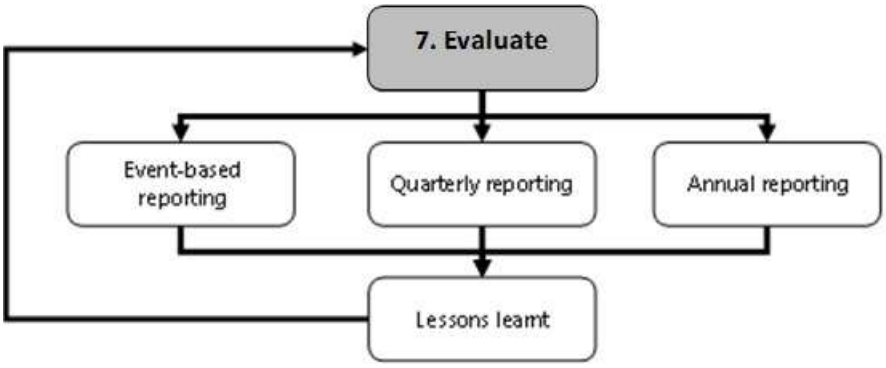

Figure 6-5. Implementation and evaluation phase.

The reporting and evaluation process will differ based on the scale of the BMA. The current reporting requirements for BMAs is illustrated in **Table 3**. Some event based reporting of minor BMAs may occur via email from operators to key stakeholders.

Table 3 Reporting requirements for BMAs.

BMA Category	Reporting requirements
Minor	• weekly flow reports
Moderate	• weekly flow reports • monthly CEWO reports • Parliamentary Briefing Notes (PBNs) • Annual reporting
Major	• weekly flow reports • monthly CEWO reports • Parliamentary Briefing Notes (PBNs) • Annual reporting

6.7.1 Lessons learnt

Lessons learnt is a critical step in the adaptive management and continuous improvement cycle of BMAs. They will be documented on an as needs basis in the reporting requirements for BMAs, including in monthly environmental water use reports. In addition to documenting lessons learnt, they should be considered at the beginning of the DMF process. Monitoring and reporting also assists in the development and documentation of BMAs and their outcomes. Future operations will take into account the lessons learnt, particularly given the dynamic nature of operating in the CLLMM region.

7 Governance for Implementation

7.1 Barrage Operations

The BMAs for the Lower Lakes and Coorong are the responsibility of DEW, with input from stakeholders (including environmental water holders and interest groups). Under appointment by the Minister for Water and the River Murray, SA Water is responsible for the physical operation of River Murray Assets. These include operating weirs, locks and barrages as well as other regulating structures. River Murray Assets are controlled through the Joint Venture between South Australia and the Commonwealth (through the MDBA). Governance arrangements include engagement with other agencies, such as SA Water, the MDBA and the Commonwealth Environmental Water Office.

Governance arrangements for BMAs are shown in **Table 4** and include stakeholders involved in BMAs as well as decision makers. Responsibility for endorsement or approval of BMAs varies depending on the complexity of the action(s) being undertaken. An 'X' in **Table 4** indicates the position responsible for endorsing or approving decisions depending on the BMA category. All operational decisions and instructions to SA Water associated with BMAs are the responsibility of the Minister for Environment and Water's delegate. In executing the delegated authority for BMAs, the Director (Water Infrastructure and Operations) must have regard for water, environment and infrastructure. Moderate and Major BMAs also require written notification up to the Executive Director, Water and River Murray, the DEW Chief Executive and through to the Minister for Environment and Water. Additional consultation requirements are detailed in Section 8.

Table 4. Governance arrangements for each BMA category.

Position	Agency	BMA category		
		Minor	Moderate	Major
Chief Executive, DEW	DEW			
Executive Director, Water and River Murray	DEW			
Director, Water Infrastructure and Operations	DEW		X	X
Manager, Environmental Water	DEW			
Assets General Manager	MDBA		*	
Senior Manager, River Murray Operations	SA Water			
Manager, Water Delivery	DEW	X		
Coordinator, Lower River Murray	SA Water			
Coordinator, River Murray Operations	SA Water			

X = Position accountable for BMA approval or endorsement.
* = notification for moderate flow actions while dredging at the Murray Mouth.

7.2 Environmental water use

There are multiple sources of environmental water that are available to contribute to environmental outcomes in the CLLMM. Each of these sources of water has different decision-making processes. The delivery of environmental water to the Lower Lakes and Coorong has a number of requirements at both a Basin and state level. These are summarised below.

Product	Delegate	Process
The Living Murray, River Murray Increased Flows, River Murray Unregulated Flows	Joint governments (Australian, New South Wales, South Australian and Victorian governments) through the Southern Connected Basin Environmental Water Committee (SCBEWC)	State government agencies develop environmental water proposals prior to the start of the water year. These are prepared for a range of climatic scenarios and for each site outline objectives, water requirements, risks and alignment with the Basin-wide environmental watering strategy and the Basin annual environmental watering priorities. The proposals are collated by the Murray-Darling Basin Authority, with coordination opportunities identified and an assessment of water availability (supply) to meet identified demands. An operational scenarios document is produced for consideration by SCBEWC. SCBEWC then reviews and approves a commitment of the available water to the agreed watering actions. These are periodically reviewed and where necessary revised throughout the year. With respect to unregulated flows, upstream states should not access water that is destined for high priority objectives to be met in SA where proposed and approved by SCBEWC.
Commonwealth environmental water holdings	CEWH	The Commonwealth Environmental Water Office develops Portfolio Management Plans at the start of each water year, which identify broad environmental demands within a catchment and the how the water portfolio can be managed in response to these demands. These plans are developed based on input from state government agencies, river operators, local communities, scientists and past learnings. The CEWH commits volumes of Commonwealth environmental water to specific activities, based on an assessment against five criteria (http://www.environment.gov.au/water/cewo/publications/criteria-assessing-options-cew-use). These decisions are then given effect by watering schedules, which are agreed with the relevant state agency and outline targeted objectives, the possible volumes available, delivery timing, operations/management and reporting requirements. The water supplied by the CEWH and provided to South Australia will be utilised for the activities documented and agreed to under these schedules.
Victorian environmental water (return flows)	The Victorian Environmental Water Holder (VEWH)	The VEWH makes decisions on the use of their water for outcomes within Victoria. Under certain circumstances, 'return flows' from these actions are made available for use in South Australia. Where return flows are available, these are transferred onto the South Australian Minister's licence by trade and use of this water is determined by SA DEW.

DEW provides updates to environmental water holders through multiple mechanisms, including:

- quarterly plans for barrage operations over the next three months
- fortnightly updates through Barrage Operations Advisory Group

- monthly reports including volume of environmental water delivered over the barrages, any outcomes and lessons learnt
- annual reporting processes for environmental water holders and as per the Basin Plan.

8 Consultation Processes

Engagement arrangements with stakeholders associated with BMAs are indicated in **Table 5**. The level of engagement will vary depending on the scale and complexity of the BMA. For BMAs categorised as minor, engagement with stakeholders may involve only the provision of basic information (such as FYI) via email, or more in-depth consultation when environmental water is utilised. For BMAs categorised as moderate or major, the level of engagement may increase to include consultation, where feedback on the BMA is sought, or active involvement in decision making, where stakeholder concerns are reflected and feedback is provided on how stakeholder input influenced the BMA. Communication in these instances will typically be face-to-face with confirmation in writing supplied afterwards. Consultations will be undertaken to align with scheduled meetings and feedback documented as required.

Table 5. Stakeholder engagement arrangements for BMAs.

Name	BMA Category		
	Minor	Moderate	Major
Scientific Advisory Group (SAG)	✓*	✓	✓
CLLMM Community Advisory Panel (CAP)		✓	✓
Southern Fishermen's Association	✓*	✓	✓
Boating and Tourism Group		✓	✓
NRA	✓*	✓	✓
Barrage Operations Advisory Group (BOAG)	✓	✓	✓
PIRSA Fisheries	✓*	✓	✓
MDBA	✓	✓	✓
Environmental Water Holders[1]	✓*	✓*	✓*

*As required.
[1] to be consulted when environmental water utilised.

Other plans and agreements will have their own consultation processes that influence or provide guidance for BOS consultations, such as in the Kungun Ngarrindjeri Yunnan Agreement (KNYA). Under the KNYA the South Australian Government has agreed to a number of acknowledgements and conditions that must be adhered to and considered during decision making. Through the KNYA, the Ngarrindjeri are acknowledged as the Traditional Owners of the lands and waters (in accordance with the Ngarrindjeri and Others Native Title Claim/ Federal Court Action No. SG 6027/98). Under the KNYA, support is provided by DEW and other organisations to the Ngarrindjeri Regional Authority (NRA) to increase communication and knowledge sharing with the South Australian Government (detailed under Section 5: Consultation of the KNYA). Other additional plans and agreements that are relevant to the BOS engagement are detailed in **Table 6**.

Table 6. BMA consultation and engagement processes and agreements.

Document	Consultation Requirements	Appropriate Representatives
Kungun Ngarrindjeri Yunnan Agreement	Section 5 of the KNYA stipulates consultation requirements that include: • subject matters • timing • reporting.	Ngarrindjeri Regional Authority (NRA)
Basin Plan 2012	Consultation requirements are provided in a number of sections within the Plan including for: • s8.15 Preparation of a Basin-wide environmental watering strategy • s8.20 Preparation of long-term watering plans • s8.35(b) and 8.39 Principles to be applied in environmental watering • s8.29 Preparation of Basin annual environmental watering priorities • s10.53 Consultation and preparation of a water resource plan.	Appropriate representatives include: • Basin States • local communities • MDBA • CEWH • persons materially affected by the management of environmental water • river operators • managers of planned environmental water • relevant Indigenous organisations.
SA Long Term Watering Plan	Currently same as Basin Plan but will be reviewed following accreditation of SA River Murray Water Resource Plan	• Community Advisory Panel (CLLMM CAP) • Scientific Advisory Group (CLLMM SAG) • NRA
• Lower Lakes, Coorong and Murray Mouth: Environmental Water Management Plan (EWMP) • The Lower Lakes, Coorong and Murray Mouth Community Engagement and Communications Strategy	Implementation of the EWMP includes the engagement and communications Strategy. This document identifies key stakeholders and the level of engagement.	• Community Advisory Panel (CLLMM CAP) • Scientific Advisory Group (CLLMM SAG) • NRA
Ecological Character Description and Ramsar Management Plan	Documents are currently being prepared, this section will be updated upon completion e	• DEW site Manager
Lakes and Coorong Fisheries Management Plan	Consultation requirements are given effect via governance described in the Plan.	• Southern Fishermen's Association • Lakes and Coorong Fishery Management Advisory Committee

9 Operational Considerations

The operational considerations for the BOS are described in detail in the following sections and include considerations and constraints that may influence the management and DMF processes for water level and barrage management.

9.1 Legislation

Supporting legislated objectives is an important principle of the BWLMP and BOS. Key pieces of legislation and associated legislative instruments provide regulatory guidance for the management of water resources either including, or specifically for, the River Murray and the CLLMM region. The legislation relevant to BMAs and the CLLMM region are described in more detail in the *Considerations Report* and presented in **Table 7** below.

Table 7. Water resource management relevant legislation for the Lower Lakes and Coorong.

Legislation	Description	CLLMM region related objectives	Relevant sections
***Water Act 2007* (Cth)**	Provides for the management of Murray-Darling Basin water resources and for other matters of national interest in relation to water and water information, and for related purposes. This includes the establishment of the MDBA, CEWH and the requirements to develop the Basin Plan.	Facilitates the management of the basin through elements such as the development of the Basin Plan and the Murray-Darling Basin Agreement. In developing the Basin Plan, according to Division 1, Subdivision B, Section 21(3) of the *Water Act 2007* (Cth), the Murray-Darling Basin Authority is required to give effect to the Ramsar Convention (and a number of other international environmental agreements), and to promote the wise use of all the basin water resources and the conservation of declared Ramsar wetlands. The CEWH must manage the Australian Government's environmental water holdings to protect or restore environmental assets, to give effect to relevant international agreements (which includes wetlands listed under the Ramsar Convention).	Part 2 – Management of Basin water resources Part 6 – Commonwealth Environmental Water Holder
The Murray-Darling Basin Plan (the Basin Plan)	The Basin Plan is a statutory instrument that has obligations for governments to sustainably manage and use the waters of the Murray–Darling Basin under the *Water Act 2007* (Cth). The Basin Plan came into effect in November 2012, and will be reviewed and revised throughout a seven year implementation phase.	The Basin Plan's overall objectives and outcomes, the environmental watering plan and water quality and salinity management plan include objectives and targets relevant to the CLLMM. Chapter 8 outlines principles to be applied to environmental watering, which includes watering consistent with the objectives, maximising outcomes, having regard to local views, Indigenous values, social and economic outcomes, cost of environmental watering, risks, relevant international agreements and applying adaptive management. The environmental watering plan also requires the development of the Basin-wide environmental watering strategy, long-term watering plans for water resource areas, as well as Basin and state annual watering priorities (all of which relate to the CLLMM management). The Basin Plan requires the Water Resource Plan for the region include specific arrangements for environmental watering, water quality and Indigenous values and uses.	Chapter 5 – Objectives Chapter 8 – Environmental Watering Plan Chapter 9 – Water Quality and Salinity Management Plan Chapter 10 – Water Resource Plan requirements Chapter 13 – Monitoring and Evaluation

Legislation	Description	CLLMM region related objectives	Relevant sections
		The Basin Plan sets a number of reporting requirements, including in relation to environmental assets and environmental watering.	
***River Murray Act 2003* (SA)**	Provides for the protection and enhancement of the River Murray and related areas and ecosystems.	Ensures that all reasonable and practicable measures are taken to protect, restore and enhance the River Murray in recognition of its critical importance to the South Australian community and its unique value from environmental, economic and social perspectives.	Part 2 - Objects of the *River Murray Act 2003* and statutory objectives
***Aboriginal Heritage Act 1988* (SA)**	Provides a legislative basis for recognising and protecting Aboriginal heritage, specifically in relation to culturally significant sites, objects or remains on all land and waters.	This legislation gives effect to the Meeting of the Waters registered heritage site, which is central to the life and culture of the Ngarrindjeri people, who continue to live on their traditional country. It also gives effect to the Kungun Ngarrindjeri Yunnan Agreement 2009 and Speaking As Country Deed 2014.	Part 3-Protection and preservation of Aboriginal heritage Division 6-Aboriginal heritage agreements
***National Parks and Wildlife Act 1972* (SA)**	Provides for the establishment and management of reserves for public benefit and enjoyment; to provide for the conservation of wildlife in a natural environment; and for other purposes	Facilitates the preservation and management of wildlife and preservation of historic sites, objects and structures including within the Coorong National Park.	Section 37 - Objectives of Management Schedule 3 - National Parks
***Environment Protection and Biodiversity Conservation Act 1999* (Cth)**	Provides for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance	Stipulates what areas are considered wetlands of international significance under the Ramsar Convention. Provides for the protection of the CLLMM as a Ramsar listed wetlands, including through requiring approval of activities likely to have a significant impact on the ecological character of a Ramsar wetland.	Subdivision B -Wetlands of international importance (Section 16-17B)
Environment Protection and Biodiversity Conservation Regulations 2000 (Cth)	For subsection 335 (1) of the Act, the Australian Ramsar management principles for the management of wetlands included in the List of Wetlands of International Importance kept under the Ramsar Convention are set out in Schedule 6.	.Schedule 6 describes the general principles, management planning actions and environmental impact assessment and approval requirements for actions undertaken in a Ramsar declared area. These include the need to describe the ecological character (ECD) for the Ramsar site.	Environment Protection And Biodiversity Conservation Regulations 2000 - Schedule 6, 1. General principles

Legislation	Description	CLLMM region related objectives	Relevant sections
***Environment Protection Act 1993* (SA)**	Provides for the protection of the environment; to establish the EPA and define its functions and powers; and for other purposes.	Protects the South Australian environment from point source pollution including the protection of Water Protection Areas.	Part 8 - Special environment protection provisions Division 1 - Water quality in water protection areas Division 2 - Contravention of mandatory provisions 34 - Offence to contravene mandatory provisions of policy
***Environment Protection (Water Quality) Policy 2015* (SA)**	A mandatory provision of policy under the *Environment Protection Act 1993* (SA).	Outlines the protection of South Australian waters including the Coorong and Lower Lakes.	3 – Interpretation Part 2 - Water quality measures
***Natural Resources Management Act 2004* (SA)**	Promotes sustainable and integrated management of the State's natural resources (including the CLLMM region). Provides the basis upon which allocations are granted to River Murray water access entitlement holders in South Australia via the River Murray Water Allocation Plan.	Protects biological diversity and, insofar as is reasonably practicable, to support and encourage the restoration or rehabilitation of ecological systems and processes that have been lost or degraded. Protection and management of catchments and the sustainable use of land and water resources and, insofar as is reasonably practicable, seeks to enhance and restore or rehabilitate land and water resources that have been degraded.	Division 1 - Regional NRM Plans Division 2 - Water allocation plans
***South Eastern Water Conservation and Drainage Act 1992* (SA)**	Provides for the conservation and management of water and the prevention of flooding of rural land in the South East.	Manages surface waters and drainage in the south east, and releases of drainage waters into the South Lagoon of the Coorong pursuant to the Upper South East Drainage Network Management Strategy.	Objects of the Act: the SEWCD Board must act consistently with the objects of the *River Murray Act 2003* (SA) and the objectives for a healthy River Murray in that Act when taking actions within, or in relation to, any part of the Murray-Darling Basin within the meaning of the *Murray-Darling Basin Act 1993* (Cth)

9.2 Climate and Physical

The climatic conditions and physical characteristics of the CLLMM can influence the success of BMAs to achieve targeted objectives. Wind, sea level changes, photoperiod (hours of daylight/night time) and tide actions are important climatic drivers within the CLLMM region and these will alter across seasons and years (eg El Nino and La Nina events). The geomorphic and hydrological characteristics can also inhibit or enhance BMA outcomes.

9.2.1 Wind

Wind strength, duration and direction can influence the Lower Lakes and Coorong differential head through the effect it has on water levels (seiching) upstream and downstream of the barrages. Mean wind speeds peak during summer and are dominated by southerlies (**Figure 9-1**). North-west to south-west winds generally increase water levels in the Coorong. Winter winds are predominantly from the north-west through west to north-east (**Figure 9-2**). Wind direction has a strong influence on the efficacy of BMAs for specific objectives. For example, for a BMA Murray Mouth Scouring objective, winds from a north to north westerly direction are preferred. Whereas winds from a north-west to south westerly direction are preferred for a BMA Coorong salinity objective. Other considerations such as barrage splits (the distribution of water releases between the barrages) in conjunction with wind direction will also influence BMA efficacy. Wind direction can also inhibit the effectiveness of some BMAs and cause potentially undesirable outcomes such as reverse flows that may be more likely to occur when southerlies are prevailing. When determining preferred BMAs, predicted wind conditions should be assessed to determine the opportunities and risks they potentially pose.

The combination of high velocity winds and the shallow depth of the Lower Lakes can also increase wave action and wind seiche. Seiching is the wind driven movement of water and can cause mixing of the water column, erosion in the littoral zones and resuspension of sediments. Wind direction and seiching play an important and often significant role in the hydrodynamics of the Lower Lakes as well as connectivity or water exchange between the Lower Lakes and Coorong. Together they influence the exchange of freshwater between the Lower Lakes, Coorong and the seawater entering via the Murray Mouth.

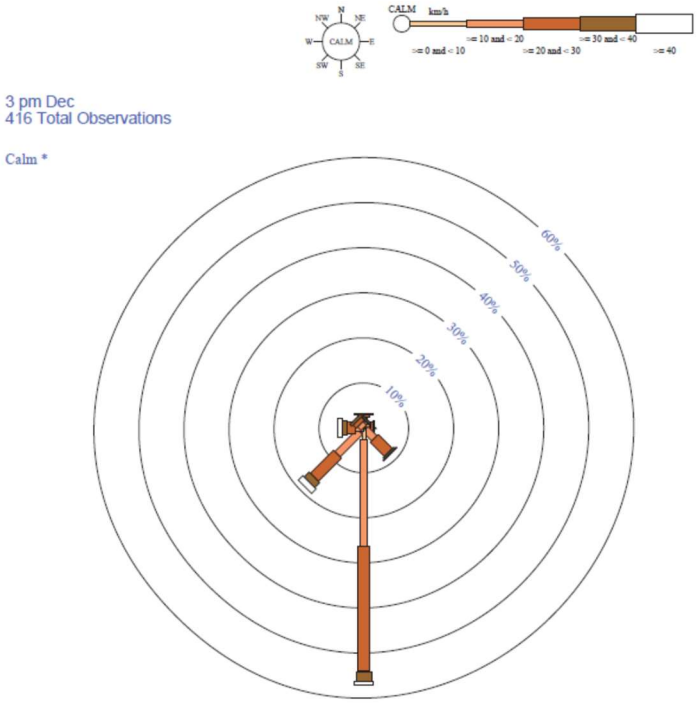

Figure 9-1: Wind rose direction versus wind speed in km/h (01 June 1989 to 24 Jan 2003) for December at Goolwa (Hindmarsh Island Marina)

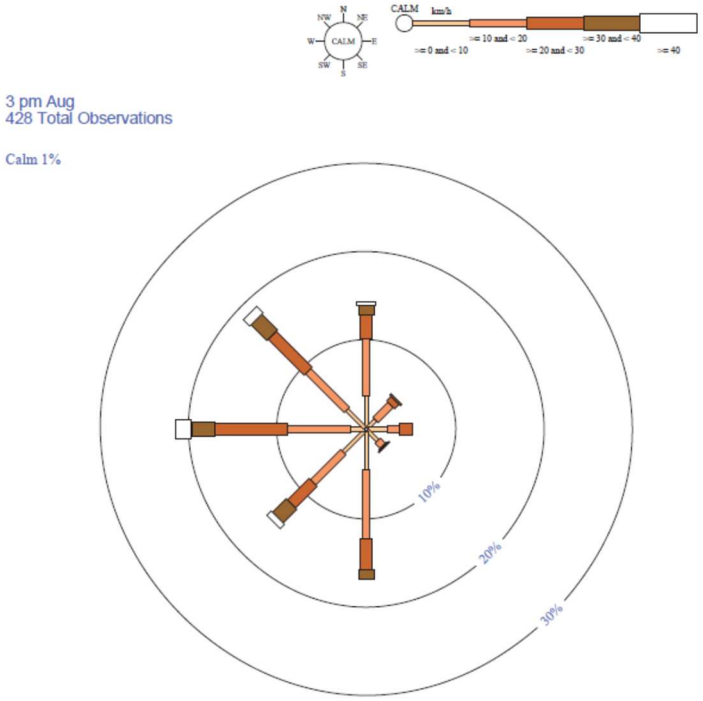

Figure 9-2: Wind rose direction versus wind speed in km/h (01 June 1989 to 24 Jan 2003) for August at Goolwa (Hindmarsh Island Marina)

9.2.2 Tide and Storm Surges

The northern Coorong is estuarine, meaning it is a zone where freshwater discharged from the barrages meets tidal inflows through the Murray Mouth. The height of tidal events dictate the extent of mudflat exposure or submergence, which in turn influences physio chemical and ecological processes. Tidal variability within the Coorong estuary occurs primarily on a diurnal frequency. Due to the Murray Mouth restricting inflows, the influence of daily tidal change is lower in the Coorong as compared to the open ocean coast line, with decreasing impact to water levels progressively south. Tidal variability alters the differential head between the Coorong and Lake Alexandrina, decreasing the gradient during high tides and increasing the gradient during low tides. Persistent storm surges similarly can alter the differential head between the Coorong and Lake Alexandrina, typically elevating Coorong water levels during autumn and winter.

Tidal variability and storm surges need to be considered for BMAs as these may influences, inhibit, or enhance, the ability of a BMA to achieve a targeted objective. Some critical considerations for tidal influence include:

- difficulty releasing water during high tides events due to low differential head
- mean daily tidal water levels are highest during winter/spring and lowest during Summer/Autumn
- high tides and storm surges are more common in winter/spring resulting in barrage closures
- high tides and storm surges can cause reverse heads and saltwater intrusion if barrages not closed.

Based on the above considerations, BMAs should be planned to take advantage of lower tides and avoid unfavourable conditions (eg high tides and storm surges). These considerations should be undertaken in conjunction with other climatic conditions (eg wind).

9.2.3 Evaporation

Due to the relatively shallow nature and high surface area to volume ratio of the Lower Lakes and Coorong, they are naturally susceptible to net evaporation, particularly during the hot summer months where rainfall is much lower. The average annual evaporation for the Coorong lagoons is estimated at approximately 96 per cent of the average Coorong water storage or 170 GL per annum.

Evaporation is a major determining factor for water level management and barrage operations between summer and autumn. The evaporation rates contribute significantly to water level and salinity changes in the Lower Lakes and Coorong. Where evaporation exceeds precipitation and freshwater inflows, salinity in the Coorong can increase to several times that of sea water, particularly in the south lagoon when freshwater inputs and exchange are limited. Once fully implemented, the SEFR Project (section 8.6) will provide an additional tool for salinity management in the south lagoon to complement other actions at the barrages to assist with reducing salinity levels when timing is appropriate.

To somewhat counteract the high rates of evaporation, and associated increase in salinity, in summer and periods of high consumptive demand (eg irrigation), surcharging water levels at the beginning of summer in preparation for evaporation reducing water levels is a potential BMA. This helps maintain water levels in the lakes as well as some flows to the Coorong when flows to the Lower Lakes may reduce over the summer period to autumn. This mode of surcharging the lakes will be considered on a case-by-case basis and determined by a combination of factors, including the climate forecast, water availability, River Murray flows (regulated and unregulated conditions), objectives relating to environmental water delivery and outcomes to be achieved in the Coorong.

9.2.4 Hydrology

The hydrology of the CLLMM region is a complex, spatially and temporally variable interaction of inflows from the River Murray, local rainfall, groundwater sources and the Southern Ocean. Lake Alexandrina predominantly receives freshwater from the River Murray entering near the township of Wellington. Other sources of inflow include the Eastern Mount Lofty Ranges, local tributaries, direct rainfall and local run off. Lake Albert is a terminal lake that predominantly receives its inflows from Lake Alexandrina via the Narrung Narrows, as well as from local rainfall. The Coorong receives inflows from multiple sources including the Lower Lakes via the barrages, from the South East via Salt Creek (including from the SEFR project), local rainfall and from the Southern Ocean via the Murray Mouth.

Water levels in the Lower Lakes are critical for undertaking BMAs for targeted objectives. Under the BWLMP, Lake levels will be managed in a variable range and fluctuate seasonally to maintain the ecological character of the site. Targeted operating water levels consider inflow regimes and ecological processes. BMAs do however need to consider River Murray flow conditions, such as large unregulated flows, that may limit options for barrage releases. For example, under a high water release scenario (eg large unregulated flows), the only option may be to open all barrages.

9.2.5 Geomorphology

As an open Murray Mouth is an identified objective of the Basin Plan and LTWP, BMAs need to consider the geomorphology of the CLLMM. The position of the Murray Mouth is dynamic, migrating over 1.6 km since the 1830s, with migrations of up to 6 km over the past 3000 years. Movements of 14 m in 12 hours have been observed under storm (high wave energy) conditions. These documented changes demonstrate the dynamic nature of the River Murray estuary. While sand dredging is an effective intervention tool to maintain an open Murray Mouth during low flow periods, BMAs are essential for reducing the requirement to dredge and achieve the Basin Plan key target to maintain an 'open Murray Mouth', with adequate tidal variations to meet the needs of the Coorong ecosystem. BMAs need to also consider how releases can be utilised to reduce the growth and consolidation of the flood tidal delta (Bird Island) landward of the Murray Mouth.

9.3 Ecological

In 1985, the CLLMM region was designated as a 'Wetland of International Importance', commonly known as a 'Ramsar wetland'. This listing recognises the site's diverse range of wetland ecosystems, habitats and bird, fish and plant species, a number of which are threatened with extinction.. The majority of objectives supported by relevant legislation (**Table 7**) aim to maintain or improve the ecological health of the CLLMM region. BMAs need to consider how operations can be undertaken to maximize ecological outcomes. Volumes, timing and duration should be undertaken to target critical periods for targeted ecological objectives. These include the migrating patterns, breeding and feeding cycles for targeted birds, fish and other fauna in the CLLMM region. Critical periods of vegetation lifecycles, such as for *Ruppia,* need to also be considered. Specific details for environmental watering requirements (EWRs) for ecological processes and values are detailed in the Long term Environmental Watering Plan (LTEWP) for South Australia, which also considers the requirements of the *Basin Wide Environmental Watering Strategy* (MDBA, 2014b). Additional information on ecological metrics are also detailed in the Ecological Character Description (ECD) (Phillips and Muller, 2006). Development of the annual *South Australian River Murray Operating Plan* considers optimal timing of releases and volumes for ecological objectives (eg spring-summer releases for fish migration and attractant flows).

9.3.1 Ecological Character Description

The ECD is the most comprehensive summary of the CLLMM region's ecology as well the processes that influence or effect it and its condition. BMAs targeting ecological objectives should consider the recommendations and information documented in the ECD. Consideration should also be given to the Limits of Acceptable change (LACs) provided in the ECD. The LACs are used to indicate whether a variation in the condition of an ecological parameter or measure is considered acceptable. If the particular measure or parameter moves outside the 'limits of acceptable change' this may indicate a change in ecological character that could lead to a reduction or loss of the values, specifically a value for which the sites was Ramsar listed (**Figure 9-3**). At the time of the development of BOS, the ECD is currently being updated to reflect the current condition of ecological values in the CLLMM region. Once complete, the recommendations of the ECD review should be referred to in the development of BMAs.

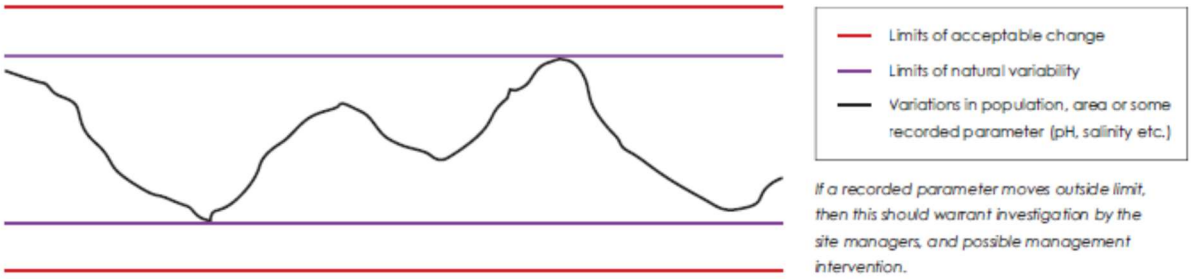

Figure 9-3. The limits of acceptable change concept (Phillips and Muller, 2006).

9.4 Social and economic

Maintaining and promoting a healthy CLLMM Site supports the health of the local communities as well as facilitates economic outcomes through eco-based tourism and commercial fisheries. Consideration of specific social and economic interests and objectives also needs to be undertaken when determining BMAs (eg preventing flooding of infrastructure and property etc). Boat navigation requires water levels to be maintained above a minimum level required for safe navigation, which is met comfortably when lakes water levels are above 0.4 m AHD and assuming calm wind conditions. Preventing flooding requires BMAs that limit water levels to below where infrastructure and property can potentially be damaged. Depending on the flow quantity and other constraints, it may not be possible to prevent water levels rising above these damaging levels.

Irrigation infrastructure surrounding the Lower Lakes, tributaries and Lower Murray Reclaimed Irrigation Areas (LMRIA) require local water levels to be maintained above +0.5m AHD to function. A survey of LMRIA critical operating limits indicates that a minimum of +0.4 m AHD in Lake Alexandrina is required to ensure upstream (ie River Murray Channel in LMRIA) levels remain above the critical +0.5m AHD (Mosely et al. 2017).

9.5 Barrage infrastructure

Opening and closing the barrages is the primary mechanism used to manage water levels in the Lower lakes. The efficacy of BMAs are dependent upon the duration, timing and periodicity of flow events from upstream, as well as the configuration and placement of barrage releases. Barrage management actions and release volume delivery splits between different barrages can be used to achieve one or more objectives such as influencing Coorong salinity levels, Murray Mouth scouring or ecological objectives. The capabilities and functionality of the barrages are dependent on their individual locations and design. For example, some barrages have a combination of automatic and manual gates/bays and/or have limited ability to pass water at low Lake water levels. Some constraints to operating the barrages exist, particularly when the Coorong water level exceeds the water level in Lake Alexandrina. Generally the majority of barrages are closed during reverse flow events, often with the exception of Tauwitchere barrage to enable ongoing connectivity between the Coorong and lakes to assist with the movement of fish.

9.5.1 Design

Goolwa Barrage features 128 bays of which 120 are operated by stop logs (**Figure 9-4**), three are fishways and five are navigable pass bays. It is the deepest of the five barrages at approximately 5.5 m deep. At the Goolwa Barrage, a crane mounted on steel rails is used to remove or add stop logs as necessary. This can limit the speed at which changes to the barrages configuration is made, as such its design should be considered when determining a BMA.

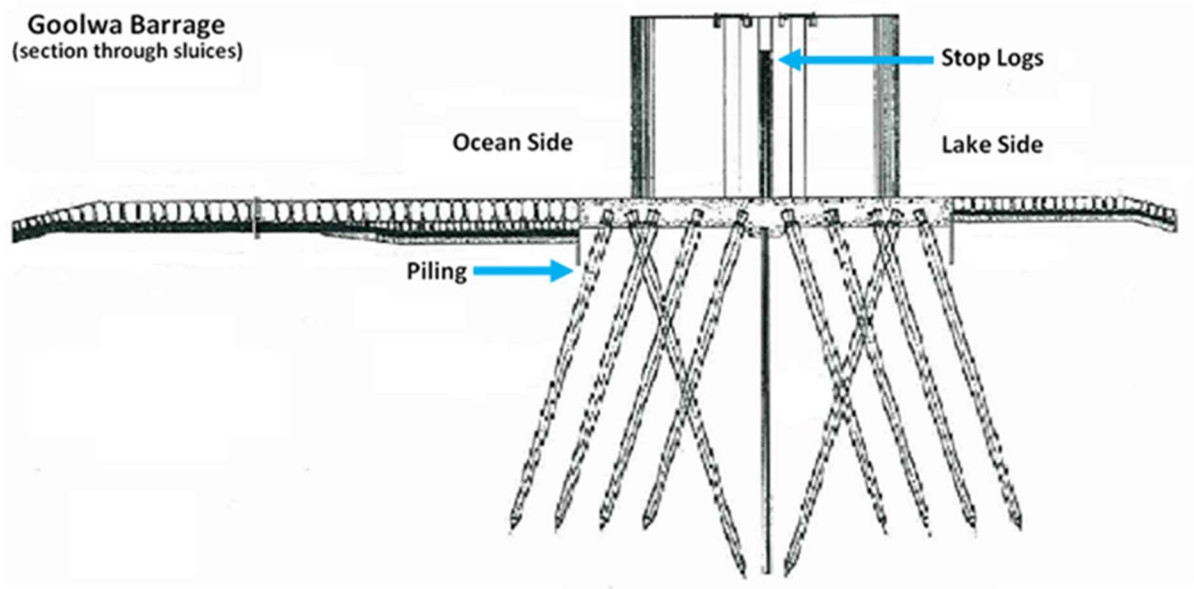

Figure 9-4. Cross section of Goolwa Barrage gates.

Tauwitchere Barrage consists of 329 bays comprising 168 manual radial taintor gates, 21 automated radial taintor gates, 130 bays with stop logs and three fishways (**Figure 9-5**). Each gate has rubber seals that have direct contact with the base and sides of the bay wall. A small hand operated lock chamber was constructed on the Tauwitchere Barrage.

Ewe Island has 49 manual radial taintor gates, 12 automated radial taintor gates and 49 bays with stop logs. Both the Tauwitchere and Ewe Island Barrages have a base sill height of around -0.5 m to 0.0 m AHD. The automated radial gates can allow for remote and rapid operations, which should be taken into consideration for BMAs.

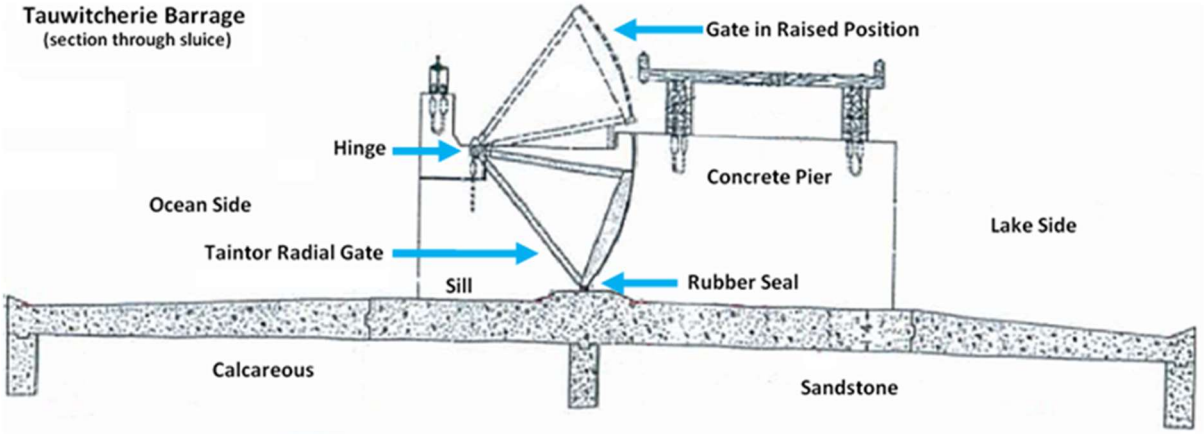

Figure 9-5. Cross section of Tauwitchere Barrage's radial gate system.

Mundoo and Boundary Creek Barrages are the shortest of the five barrages. Currently there are a total of 26 bays at the Mundoo Barrage consisting of six remotely operated vertical spindle gates, 19 stop log bays and one fishway. Boundary Creek has four bays containing stop logs, one fishway and one used for attractant flow for the fishway. These barrages have a base sill level of approximately -0.5 m to 0.0 m AHD.

9.6 South East Flows Restoration Project

The South East Flows Restoration Project (SEFRP) was implemented to provide the capability to deliver a median 26.5 GL of annual flow into the Coorong South Lagoon. This will be achieved by connecting additional parts of the existing South East Drainage Network to the Coorong via Salt Creek (**Figure 9-6**). The principle aim of the SEFRP is to deliver water to the Coorong South Lagoon for salinity management to support the ecological health of the Coorong (eg support the life-cycle of *Ruppia tuberosa,* native fish habitat and waterbird feeding and breeding). SEFRP Flows will be used to complement barrage releases.

The construction phase for the SEFRP is complete with an additional 13km of new channel created and an upgrade of 60km of existing drains. The SEFRP Channel is designed to divert water from the Blackford Drain and existing drainage network to the Morella Basin and Tilley Swamp to supply the Coorong South Lagoon at its time of greatest need. The SEFRP now has the capability to deliver winter flows directly to the Coorong South Lagoon when required, and the flexibility to store water in the Tilley Swamp Watercourse for delayed release through Salt Creek in the months following winter to protect from summer increases in salinity.

An operations manual for the SEFRP is in preparation and will enable operators to manage flows according to the immediate or forecast salinity and ecological requirements of the Coorong South Lagoon, such that volumes, timing and duration are considered under a number of operational scenarios.

The SEFRP Operations Manual will assist with integrating SEFR operations with the BOS and will be reviewed as new knowledge emerges.

Figure 9-6. South East Flows Restoration Project Alignment map.

9.7 Digital solutions

Barrage management actions are undertaken after considering a range of complex and often competing interests and factors. These considerations are described by the DMF (Section 6), a management tool that facilitates transparent, efficient and adaptive decision making for all BMAs. Critical to the success of the DMF is the provision of a digital solution that enables BMAs to be documented and a connection between them and their outcomes i.e. 'lessons learnt', to be established. The digital solution should follow, where practicable, the process outlined by the DMF. This will improve the transparency, accountability and public value of BMAs, which is necessary given the significant investment in water recovery and associated projects across the Murray-Darling Basin. It is also imperative to be able to show that environmental water delivery is achieving optimal outcomes in this region given the condition of the Coorong and also the level of public scrutiny in relation to environmental water recovery and delivery.

10 BOS Review

The BOS is intended to be a 'living' document that will be regularly updated as new information and science becomes available, that is relevant to optimising BMAs. It is important to differentiate between an operational versus a strategic review of the BOS. Operational reviews will focus on assessment of short term effectiveness and efficiencies within the BOS. For example, improvements to the DMF will be incorporated following an operational review. Conversely, the objective of a strategic review of the BOS is to evaluate the overall performance of the BOS in meeting the BWLMP. Changes to the BOS based on this assessment are a basis for considering changes to the BWLMP during its review. Subject to funding, a Management Action Database will be developed and utilised to capture information, which will greatly assist with future operations and management.

Operating reviews are to be undertaken on an annual basis whereas strategic reviews of the BOS are to be undertaken every 3 years, unless otherwise required earlier.

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