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MURRAY–DARLING BASIN AUTHORITY

Drought Emergency Framework for Lakes Alexandrina and Albert

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Summary

Lakes Alexandrina and Albert are Ramsar listed wetlands that are located at the terminus of the Murray–Darling Basin. They are home to unique aquatic and terrestrial ecosystems that support a range of important flora and fauna and underpin social and economic activity in the region. The 2006-2010 extreme drought in the Murray–Darling Basin saw an unprecedented draw down of the water levels in the Lower Lakes; down to just below -1.0m AHD. Noting that lake levels historically are at +0.4m to +0.8m, this event led to a number of ecological, social and economic impacts relating to poor water quality, exposed lake beds and localised acidification events.

In response to the emerging threat of a potential lake-wide acidification event, Murray-Darling Basin Ministerial Council adopted the Real-time Management Strategy to Avoid Acidification in the Lower Lakes in November 2008 (original strategy). If critical triggers were reached, this original strategy aimed to avoid broad scale acidification of the Lower Lakes through the introduction of minimum quantities of seawater. This strategy was not implemented, but the original strategy included a requirement for a detailed review once new knowledge was gained from the acid sulfate soil research program, hydrodynamic modelling, water quality data and ecological consequence assessments.

This Drought Emergency Framework for Lakes Alexandrina and Albert (Emergency Framework) replaces the original strategy and includes new information and knowledge gained from this research and monitoring. The Emergency Framework's overall purpose, principles, objectives and response strategy have now changed from the original, and it now encompasses a series of management actions associated with a lake level drawdown. It is a stand-alone document which links in with other management instruments related to Lakes Alexandrina and Albert.

The purpose of this Emergency Framework 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 0.0m AHD. When this trigger is reached, a Murray–Darling Basin jurisdictional High Level Steering Committee will be formed to provide sufficient lead-time to enable a well-considered management approach.

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.

A decision support tool has been included to facilitate a timely response to a future drawdown event. This tool includes two phases: a planning phase (lake levels +0.4m to 0.0m) and an

emergency actions phase (lake levels 0.0m to -2.7m) which incorporates four levels delineating likely impacts and potential management actions.

There are no mandatory requirements for particular acidification management responses. The decision support tool simply provides decision-making steps and a range of potential management actions that correspond to applicable lake levels. Consideration of selected options will need to be made against a range of environmental, social and economic factors which would be applicable to the time.

The Emergency Framework requires that planning and management response activities be coordinated by the Murray–Darling Basin Authority (MDBA) and the Government of South Australia. Decisions concerning management responses, depending on their nature, will be guided by the Basin Officials Committee (BOC), the High Level Steering Committee and other groups in order to make collective and considered decisions.

In order to keep the Emergency Framework up to date, a review should be completed when new information or technology becomes available, or after implementation during a future lake drawdown event.

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1. Introduction

1.1 Site description

Lakes Alexandrina and Albert (Lower Lakes) are part of a complex ecosystem that encompasses riverine, lentic, wetland, terrestrial, littoral and freshwater habitats. They exist at the terminus of Australia's largest river system, the Murray–Darling, and were designated part of the Coorong and Lakes Alexandrina and Albert Ramsar Wetland Ramsar site in 1985. They also form part of an icon site under The Living Murray Program and are listed as a Key Ecological Asset under the Murray–Darling Basin Plan. A map of the site is provided in Attachment 1.

The River Murray flows into the northern end of Lake Alexandrina and water can pass into and out of Lake Albert, which lies to the South East of Lake Alexandrina, through a restriction known as the Narrung Narrows. In the 1930s a series of five barrages were constructed at the southern end of Lake Alexandrina to secure navigation below Lock 1, and to supply water for stock and domestic users during periods of low River Murray flows.

1.2 Environmental Conditions of the Lower Lakes

The site's 2006 Ecological Character Description, adopted by the Australian and South Australian governments to meet obligations under the Ramsar convention, lists six primary determinants of ecological character, i.e. those that are central to maintaining the ecological character of the site (Phillips and Muller, 2006):

1. salinity
2. turbidity and sedimentation
3. keystone aquatic plant species
4. water levels
5. habitat connectivity
6. water regime, particularly flow patterns.

Between 2006 and 2010, River Murray flows were at historically low levels due to the combined impacts of extreme drought and over-allocation across the Murray–Darling Basin. As a result, inflows into the Lower Lakes were not able to replenish evaporative losses and average lake levels dropped to unprecedented lows. In April 2009 average water levels were at their lowest in Lake Alexandrina, at just below -1.0m AHD (see Figure 1).

Evapoconcentration, the seepage of marine water through the barrages and low Murray inflows led to salinity in both Lakes increasing beyond values normally associated with freshwater environments (generally less than 1,000 EC [ANZECC 2000]). At the height of drought conditions in 2009, salinity in the Goolwa Channel region of Lake Alexandrina exceeded 25,000 EC, but was more typically in the order of 5,000 EC in the main body of the lake.

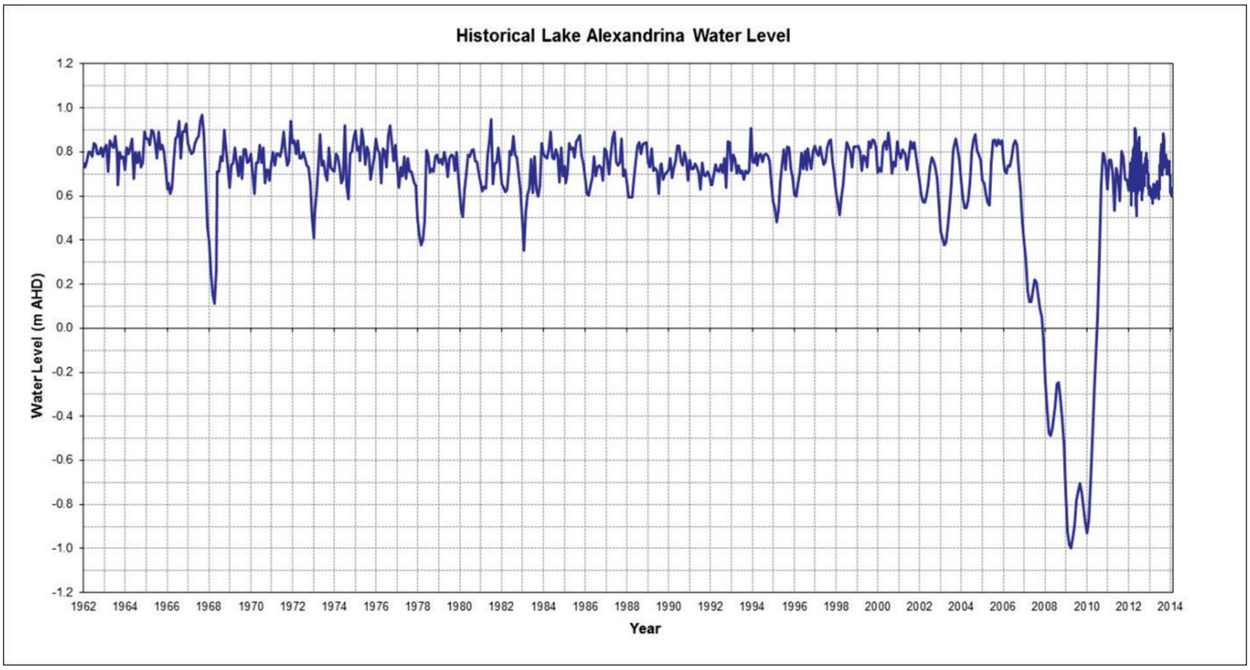

Figure 1. Lake Alexandrina water levels (1975-2011)

Low lake levels resulted in the exposure of previously submerged sulfidic sediments known as acid sulfate soils. CSIRO predicted that by March 2009 without management intervention, over 20,000 hectares of acid sulfate soil would have been exposed in Lakes Alexandrina and Albert posing substantial risks to the region's ecology and local communities (Fitzpatrick et al, 2008). With rewetting, acidic water of pH < 3 pooled in some acid sulfate soil hotspot areas, such as Currency Creek, Finniss River, Boggy Lake and Loveday Bay resulting in soil and water degradation (refer to Figure 2).

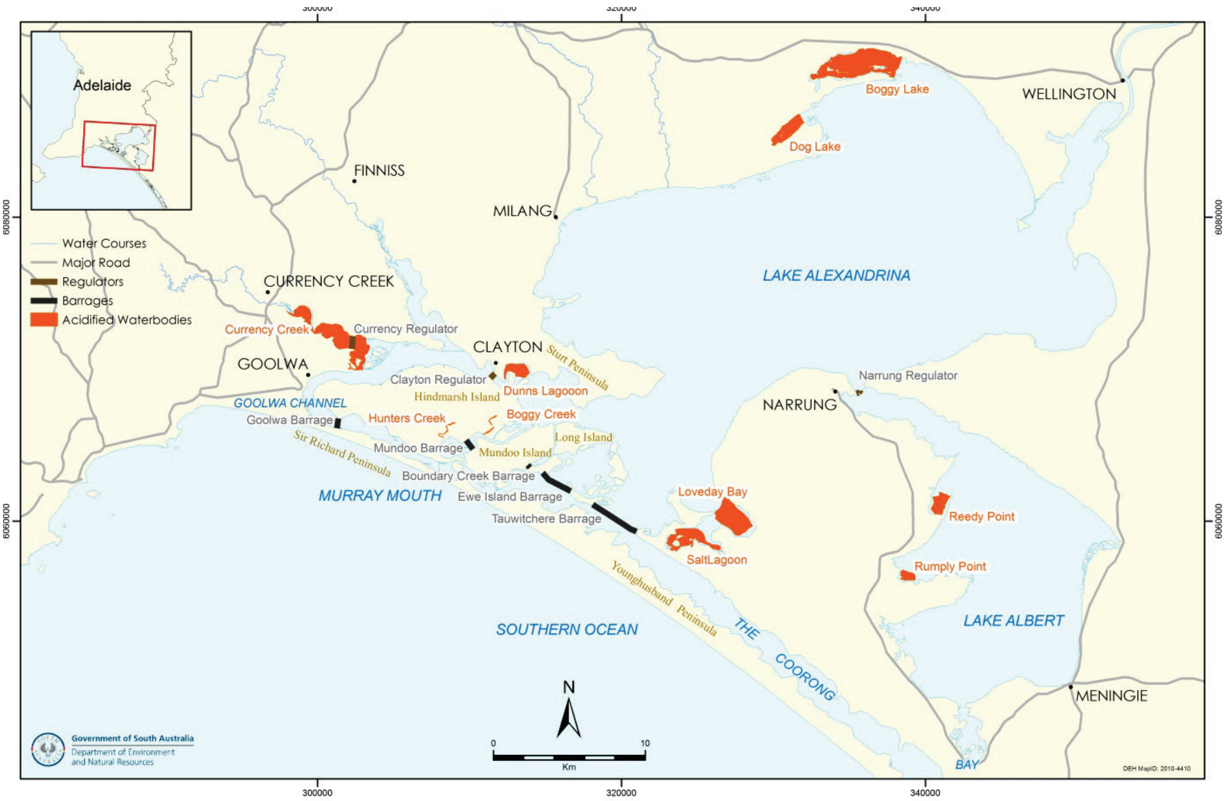

Figure 2. 2009/2010 known localised acidified water bodies in the Lower Lakes

Significant management actions were instigated to mitigate the impacts of exposed acid sulfate soils and to reduce further exposure. Such actions included:

- the temporary construction of the bunds at Narrung, Goolwa and Currency Creek and associated pumping to keep acid sulfate soils submerged
- the application of limestone to treat acidic water
- the vegetation of exposed lake bed habitat to facilitate sulfate reduction.

Further details of these management actions are provided in the Coorong, Lower Lakes and Murray Mouth Long Term Plan (DEH 2010a).

Because trigger levels for Lake-wide acidification (<25mg/L of carbonate which is the indicator of alkalinity) were not reached, widespread acidification did not occur. Please refer to Attachment 2 for detailed plots of carbonate levels during the drought.

However, the disconnection of wetlands caused by low lake levels, exposure of acid sulfate soils, and increasing salinity severely impacted the ecology of the Coorong, Lower Lakes and Murray Mouth site. Wetlands dried out and they, along with exposed lakebed areas, were colonised by terrestrial plants, many of which were introduced flora species. Much of the region's submerged aquatic habitat, particularly in local channels, was significantly reduced or eliminated. Diadromous fish species, the life-cycles of which require movement between freshwater, estuarine and marine habitats, were unable to pass through the barrages to complete their life cycle due to the low water levels in Lake Alexandrina. Further connectivity (both hydrological and ecological) was lost between Lake Alexandrina and both the Goolwa Channel and Lake Albert due to the temporary construction of the regulators and bund. Increasing salinity impacted freshwater fish, vegetation, macroinvertebrates and turtles. In addition, Lake Alexandrina was affected by the colonisation of an invasive estuarine/marine tubeworm, which grew on any solid structure, including turtle shells. The tubeworm's distribution expanded quickly as it was able to thrive in the higher salinities of southern Lake Alexandrina.

Significant rainfall and flooding in the Murray–Darling Basin throughout winter and spring 2010 greatly increased inflows and the Lower Lakes refilled quickly and caused re-wetting and mobilisation of acidity. Due to the volume of flows entering the region, habitats were hydrologically reconnected and in September 2010 water was released through the barrages for the first time since 2006. In total over 19,000 GL was estimated to have been released over the barrages in 2010-11 and 2011-12 reducing salinities significantly in Lake Alexandrina, but less so in Lake Albert. Environmental condition of the Lower Lakes has improved with the return of significant flows, but some acid sulfate soil hotspots still persist, groundwater is still acidic and some biota will take several years to fully respond to the change in conditions.

1.3 The Original Real Time Management Strategy

A concurrent strategy alongside the development of the long term plan for the region was 'The Real Time Management Strategy to Avoid Acidification in the Lower Lakes' (original strategy). This original strategy (see Attachment 3 for more information) aimed to avoid broad scale acidification of the Lower Lakes by, as a last resort, introducing minimum quantities of seawater through the barrages if either alkalinity or water level management triggers are reached. In November 2008, the Murray-Darling Basin Ministerial Council approved the original strategy, noting that it could not be implemented until *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) approval was gained.

It needs to be noted that the original strategy was developed at the height of the 2006-2010 drought in response to the emerging acidification threat in the Lower Lakes. Since then, research, monitoring and management activities have led to an increased body of knowledge concerning acid sulfate soil management in the Lower Lakes. Fittingly, the knowledge has been incorporated into this Emergency Framework.

Please refer to Attachment 4 for more information regarding acid sulphate soils management and research.

2. The Drought Emergency Framework for Lakes Alexandrina and Albert

With the finalisation of the scientific studies, it became possible to revise the original strategy and include a decision support tool so critical triggers can be considered.

2.1 Context and Purpose

The original strategy has been updated to take into account:

- Information from the management and monitoring of research into acid sulfate soils.
- The South Australian government has incorporated the water quality triggers into the Acid Sulfate Soil Management Project (components of actions a and c of the original strategy – see Attachment 3). These triggers will alert managers if acidification events are likely to occur. If these triggers are met, conditional funding is available until 2015/16 under the Murray Futures Program to neutralise acid water by limestone dosing.
- Under the Murray Futures Program, a 170km pipeline network has been constructed to provide potable and irrigation water to households and farms around the Lower Lakes. This provides much improved security of supply if the lake levels recede.
- The Basin Plan aims to keep the Lower Lakes water levels above 0m AHD 100% of the time and above +0.4m AHD 95% of the time (Section 8.06 3e [i] [ii]) to help achieve a number of management objectives. As such, they are considered appropriate triggers for planning and implementation of emergency mitigation actions.
- There is a need for a defined planning period if lake water levels are forecast to approach 0m AHD to account for lead time to implement management actions and approvals.
- The option of introducing seawater (action *d* of the original strategy) has been investigated through the Acid Sulfate Soil Research Program and background studies to support the environmental impact assessment. This option hasn't been excluded, but the studies concluded that there would be many negative consequences from the introduction of seawater, resulting in a collapse of existing ecosystems. In addition, it is not currently known at what point (lake level) the use of seawater to prevent the exposure of acid sulfate soils would be appropriate. As a result, this action is not currently supported by the South Australian Government and further investigations would be required before it could be considered as a viable option to maintain water levels. Therefore, the use of seawater has not been assigned to any particular stage of the emergency actions phase (see Section 2.4 below). This framework is designed to allow enough planning and preparation time to avoid worst case scenarios of acidification or hyper-salinity. In accepting this, it is recognised that under Basin Plan conditions, the likelihood of such an event is very low (refer to Section 2.3 below).
- Introduction of seawater early before water levels drop below 0.0m AHD would compromise major urban, irrigation and riparian stock and domestic supplies below lock 1, through saltwater entering the off-takes.

The purpose of this Emergency Framework is to guide decision making processes for the management of the Lower Lakes during extreme drought, when lake water levels approach or drop below 0.0m AHD and it includes:

- management objectives and principles
- future likelihood of triggering 0m AHD
- a decision support tool
- governance and review requirements
- background supporting information.

These components are presented below.

2.2 Management Objectives and Principles

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.

2.3 Future likelihood of the Lower Lakes dropping below 0m AHD

With the inception of the Basin Plan, the risk of lake levels dropping below 0.0m AHD is significantly reduced due to the increased availability of environmental water (the Basin Plan has a target for the Lower Lakes to not drop below 0.0m AHD 100% of the time).

Under the Basin Plan, there will be a greater share of water remaining in the river system compared with the share during the 2006-10 drought. If in the unlikely event that the Lower Lakes were to be drawn down to the 2009-10 levels, it would take only minimal River Murray inflows to bring them up above 0.0m AHD.

Please refer to Attachment 5 for more information.

2.4 Decision Support Tool

2.4.1 Preliminary

Initiation of a governance and decision making process before water levels or water availability become limiting factors is critical to support the objectives and principles of this Emergency Framework. The operation of a decision support tool that is based on water levels/availability facilitates this process.

The following decision support tool reflects the current management aims for the Lower Lakes and the outputs from the Acid Sulfate Soils Research Program. The decision support tool consists of two phases – the planning phase (0.4m AHD to 0.0m AHD) and the emergency action phase (0.0m to -2.7m AHD[1]). Within the planning phase, advice is provided to the Basin Officials Committee (BOC) and to the Water Liaison Working Group if water levels are approaching 0.0m AHD. To enable sufficient lead in times for the planning processes, BOC establishes the High Level Steering Committee when there is confirmation that water levels will reach or drop below 0.0m AHD during the next water year.

The emergency actions phase is enacted by BOC when the Lower Lakes reach 0.0m AHD. Within the emergency action phase there are four levels where the emergency responses are implemented, subject to guidance by the High Level Steering Committee who are informed by multi-history outlooks and by advice from the Murray-Darling Basin Authority (MDBA) and South Australia.

Likewise if, during the emergency actions phase, River Murray inflows return and the Lower Lakes rise above 0.0m AHD, then BOC would need to agree to cease that phase and move back into the planning phase. If the inflows continued to raise levels above +0.4m AHD, then the higher level steering committee would need to decide if the operation of the Lower Lakes can return to a normal state – i.e. moving from under the direction of this Emergency Framework.

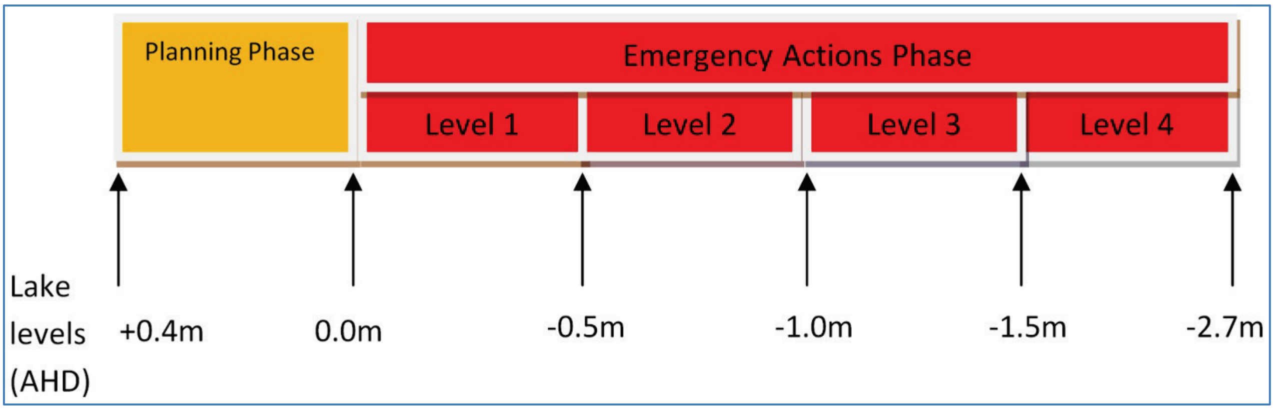

Figure 3. Phases and levels of the Emergency Framework in relation to lake levels

[1] Note -2.7m AHD represents an empty lake.

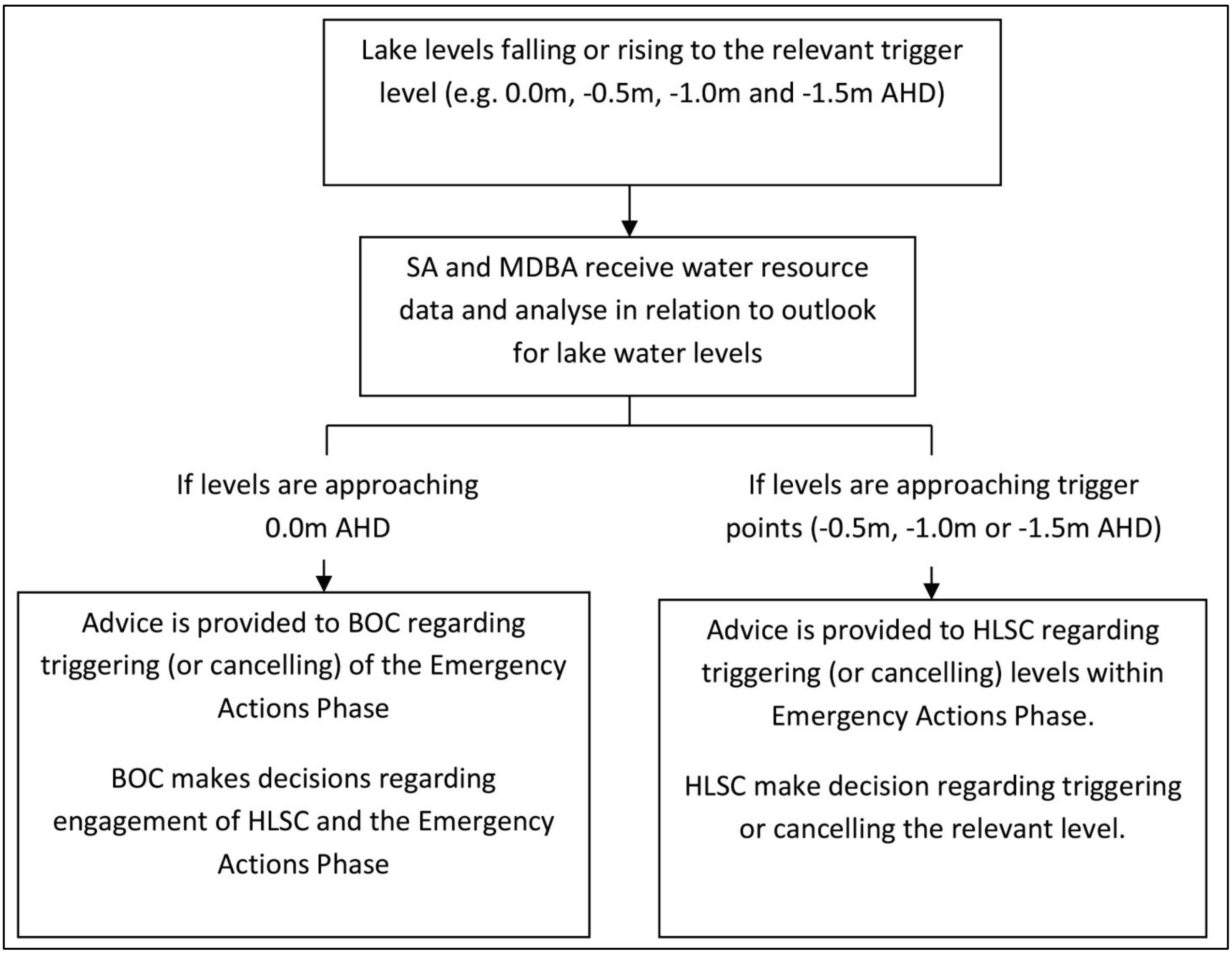

Figure 4. Emergency Framework trigger process

Predictions of lake water levels

Decisions to move between phases and levels (triggering) of this Emergency Framework will be informed by multi-history outlooks of lake levels and other water resource assessments. Multi-history outlooks utilise analysis involving the hydrologic model for the River Murray (MSM BigMOD_[2]). They are also a widely accepted and practiced method of predicting short (few weeks) or long term (years) River Murray flows and were used in the 2006-2010 drought to estimate likely Lake water levels.

Multi-history outlooks are probability-based determinations made by looking forward from the present day under a repeat of the recorded historical inflow and climate conditions. The data set in the model is based on 119 years (1891-2010) of historical flow records. Predictions can be made based using the full 119 year period or, if required, using terciles (e.g. groupings of wet, median or dry years). Using terciles allows consideration of the applicable water availability conditions.

Under an extreme drought scenario that was likely to trigger, or had triggered this Emergency Framework, then the dry tercile (driest years of the historical flow record) would be the appropriate choice to produce the range of conditions expected in the future. That said, if inflows

[2] The Hydrological model used by the MDBA to simulate the River Murray System operations under the Murray–Darling Basin Agreement.

and lake levels were rising after an extreme drought, other terciles or the full data set, could be a more appropriate choice.

Where multi-history outlooks are being used to inform decision making for acid sulfate soil management, they need to be interpreted in a way that ensures that hazards with a reasonable likelihood and consequence are addressed. Conversely, a costly management action should not be implemented if the decision makers are reasonably assured that the hazard will not eventuate.

For further detail regarding multi-history outlooks, refer to Attachment 6.

Risk management

This Emergency Framework does not set specific requirements (i.e. a formal risk matrix or weightings) to analyse the risks of acid sulfate soil hazards. This is because the likelihood and consequence of acid sulfate soil hazards, available avoidance/mitigation options and environmental conditions will all vary over time as will the rate of recovery of acid sulfate soils. Instead, risk management is reflected in this framework by establishing sufficient timeframes associated with water levels to allow for planning, analysis and consensus for action by the Murray–Darling Basin jurisdictions.

Interpretation of the requirements of the Planning and Emergency Actions phases

The following planning and emergency actions phases, set the logic and decision making processes that need to be followed in planning and implementing an emergency response to critical lake water levels.

There are high level summaries of potential acidification impacts that can be expected within each phase/level and a list of potential actions that could be undertaken to prevent or manage impacts. Note that these actions are suggestions only and the selection process for each action would need to consider a combination of social, economic, environmental and financial factors. The logic is that once an action is stated, for example in Level 1 of the emergency actions phase, it is then repeated for levels below as it is not assumed that the action may actually be implemented in Level 1.

Note that this Emergency Framework does not override any provisions of the Basin Plan and that all requirements of the Basin Plan need to be adhered to.

Please refer to Attachment 7 for a flow chart of the logic of the planning and emergency actions phases.

2.4.2 Planning Phase: +0.4m to 0.0m AHD (Planning Phase)

If water levels drop below +0.4m and there is a high likelihood that they cannot be maintained above +0.4m over the next water year, then the planning phase will be initiated by the MDBA and South Australia. The planning phase represents a water level scenario between +0.4m and 0.0m AHD. During this planning phase, the barrages won't be operational and they should be closed as early as possible and the lake levels held as high as possible.

This scenario would most likely involve the Tier 2 or 3[3] water sharing arrangements (insufficient water for conveyance needs or insufficient water for critical human needs) being implemented under the Basin Plan. Given the low water availability, it is unlikely that environmental water delivery can be delivered in this scenario. However, this will need to be verified, prior to considering other actions.

The following decision points form the key steps in the planning phase:

Step 1 The MDBA and South Australia determine if the water levels can be maintained above 0.0m, without further intervention, over the next water year:

- if the likelihood is high, then continue actions to return levels to +0.4m and consider any relevant actions under Step 2.
- if the likelihood is moderate or low, then move to steps 2 and 3.

Step 2 Potential actions (by South Australia with support of MDBA) to be considered in this Phase:

- continue investigating sourcing of environmental water with the aim to keep the water levels as high as possible or at the very least above 0.0m AHD
- re-assessment of water level outlooks (especially if environmental water is delivered), as required, to maintain an up-to-date understanding of the situation
- development of plans to mitigate and manage acidification impacts during the emergency action phase
- consideration of referrals and approvals for future actions under relevant environmental and planning legislation (e.g. EPBC Act, etc)
- native fish translocations
- works to seal barrage gates (note that this should be done as early as possible to keep salinities as low as possible)
- increased water quality monitoring to appropriately track key triggers
- consider Murray Mouth closure implications and dredging requirements.

[3] Chapter 11, Parts 4 and 5 of the Basin Plan.

Step 3

- the MDBA and South Australia notify BOC of impending low water levels (approaching 0.0m AHD). Water Liaison Working Group will need to discuss and provide advice to the MDBA who will then advise BOC concerning water resource outlooks.
- the MDBA and South Australia request for BOC to engage the High Level Steering Committee if the lake levels are predicted to reach 0.0m during the next water year. The High Level Steering Committee, throughout the emergency actions phase, will be required to review current scientific understanding, water resource outlook and make recommendations to relevant decision makers, regarding management actions.

Several consequences of low water levels are summarised below; these are based on the scientific investigations of the Acid Sulfate Soils Research Program (see Attachment 4).

Ecological Impacts[4]

Freshwater wetland habitats surrounding Lakes Alexandrina and Albert, Finniss River and Currency Creek will start to become disconnected during this phase. High value wetlands on Hindmarsh Island will start becoming dry below +0.2m resulting in desiccation of aquatic plants and aquatic fauna such as EPBC Act listed small bodied native fish.

Salinity Issues

Seawater seepage is likely to occur through the barrages on high tides (overtopping of stop logs/gates by wave action and reverse flow across auxiliary spillways at Ewe Island and Tauwitchere Island barrages) which will impact locally on salinity levels in Lake Alexandrina.

Releases from barrages into the Coorong are not physically possible, and as such it is likely that the Coorong salinity levels will increase.

Pest impacts

Tube worms may start colonising the freshwater environments if salinity has increased. This could impact freshwater turtles, as tubeworms become attached to shells and limit respiration.

Acidification impacts

The remaining acidity that accumulated during the 2006-2010 lake drawdown event may start leaching into the waterbody and result in elevated metal levels and localised acid water events.

[4] Attachment 8 summaries ecological impacts/responses experienced under declining water levels.

2.4.3 Emergency Action Phase - (Commencement of emergency actions)

Level 1: 0.0m to -0.5m AHD

If water levels drop below 0.0m, then Level 1 is to be initiated by direction of BOC at the request of the MDBA, South Australia and the High Level Steering Committee. Level 1 represents a water level between 0.0m and -0.5m AHD. The default position for the barrages will be closed.

This scenario would most likely involve the Tier 3[5] water sharing arrangements (insufficient water for conveyance needs or insufficient water for critical human needs) under the Basin Plan being implemented. Given the low water availability, it is unlikely that environmental water delivery can be delivered in this scenario. However, this will need to be verified, prior to considering other actions.

The following decision points form the key steps in Level 1:

Step 1 MDBA and South Australia determine if the water levels can be maintained above -0.5m, without further intervention over the next water year:

- If the likelihood is high, then continue actions to return levels to 0.0m and consider any relevant actions under Step 2. When levels reach 0.0m, BOC is then requested to un-trigger the Emergency Action Phase, based on the advice of the High Level Steering Committee and Water Liaison Working Group.
- If the likelihood is moderate or low, then move to step 2.

Step 2 The higher level steering committee will review current scientific understanding and water resource outlook to make recommendations regarding the most appropriate management actions to avoid acidification of water bodies. Potential actions, but not limited to, to be considered at this level:

- continue investigating sourcing environmental water, aiming to keep the water levels above -0.5m AHD (note that this is an action that South Australia and the MDBA can pursue with environmental water holders without endorsement of the higher level steering committee). Note that this option will only be available if upstream flows are filling water allocations.
- re-assessing water level outlooks (especially if environmental water is delivered) as required, to maintain an up-to-date understanding of the situation
- consider if further scientific studies are required to inform decision making
- event-based water quality monitoring will be needed to support management actions and triggers. Refer to Attachment 9 for triggers
- limestone dosing

[5] Chapter 11, Part 5 of the Basin Plan.

- aerial seeding and planting around lake margins to promote sulfate reduction
- native fish translocations
- works to seal barrage gates
- regulator or blocking bank construction.

Water bodies at risk may include Currency Creek and Lake Albert. Several consequences of low water levels are summarised below.

Ecological Impacts[6]

Freshwater wetland habitats surrounding Lakes Alexandrina and Albert are likely to be dry and desiccated with associated ecological impacts. High value wetlands on Hindmarsh Island become desiccated with direct impacts to EPBC Act listed small bodied native fish. Acidity expressed in these wetlands may start having an ecological impact. Murray Mouth may become constricted reducing tidal flushing required to maintain Coorong salinity levels.

Salinity Issues

Seawater seepage will continue through the barrages on medium and high tides (overtopping of stop logs/gates by wave action and reverse flow across auxiliary spillways at Ewe Island and Tauwitchere Island barrages) which will impact locally on salinity levels in Lake Alexandrina. Extreme wind events are likely to move saline water into the River Murray channel. Coorong salinities are likely to be increasing beyond environmental targets.

Pest impacts

Tube worms will start colonising the freshwater environments where salinity has increased. This will impact upon freshwater turtles as tubeworms become attached to shells and limit respiration.

Acidification Impacts

Remaining acidity that accumulated during the 2006-2010 lake drawdown event may start leaching into the waterbody and result in elevated metal levels and localised acid water events. Water levels in Lake Albert will decline as connectivity between Lake Alexandrina is limited beyond -0.3m. Lake Albert’s exposed soils will express acidity and soils will oxidise when becoming exposed. Lake Albert’s waterbody will be susceptible to acidification.

[6] Attachment 8 summaries ecological impacts/responses experienced under declining water levels.

Level 2: -0.5m to -1.0m AHD

If water levels drop below -0.5m, then Level 2 will be initiated by the High Level Steering Committee. Level 2 represents a water level between -0.5m and -1.0m AHD. The default position for the barrages will be closed.

This scenario would most likely involve the Tier 3[7] water sharing arrangements (insufficient water for critical human needs) under the Basin Plan being implemented. Given the low water availability, it is unlikely that environmental water delivery can be delivered in this scenario. However, this will need to be verified, prior to considering other actions.

The following decision points form the key steps in Level 2:

Step 1 MDBA and South Australia determine if the water levels can be maintained above -1.0m, without further intervention over the next water year:

- if the likelihood is high, then continue actions to return levels to -0.5m and consider any relevant actions under Step 2. When levels reach -0.5m, High Level Steering Committee is then requested to un-trigger the Level 2, based on the advice of the MDBA and South Australia.
- if the likelihood is moderate or low, then move to step 2.

Step 2 The High Level Steering Committee will be required to review current scientific understanding, water resource outlook and make recommendations regarding the most appropriate management actions to avoid acidification of water bodies. Potential actions, but not limited to, to be considered at this level:

- investigation of sourcing environmental water is continued with the aim to keep the water levels above -1.0m AHD (note that this is an action that South Australia and the MDBA can pursue with environmental water holders without endorsement of the High Level Steering Committee). Note that this may only be possible if upstream flows were filling water allocations.
- re-assessment of water level outlooks (especially if environmental water is delivered), as required, to maintain an up-to-date understanding of the situation.
- event-based water quality monitoring will be needed to support management actions and triggers. Refer to Attachment 9 for triggers
    - limestone dosing
    - native fish translocations and captive maintenance
    - regulator or blocking bank construction and pumping water to maintain levels
    - works to seal barrage gates

[7] Chapter 11, Part 5 of the Basin Plan.

- extensive aerial seeding will continue to stabilise exposed lake beds and to provide carbon to facilitate acid consumption through sulfate reduction processes.

Water bodies at risk will include Currency Creek, Finniss River, Goolwa Channel, Dunn's Lagoon, Boggy Lake, Dog Lake, Loveday Lagoon and Lake Albert (critical acidification threshold for Lake Albert is -0.75m). Extensive soil acidification on the exposed lake bed is also expected, creating dust nuisances.

Several consequences of low water levels are summarised below.

Ecological Impacts[8]

Freshwater wetland habitats surrounding Lakes Alexandrina and Albert will be dry and desiccated with associated ecological impacts. High value wetlands on Hindmarsh Island are likely to be salinised and acidified with direct impacts to EPBC Act listed small bodied native fish. Lake bed impacts will be present with aquatic flora and fauna desiccated as a result of low water levels. The majority of ecological function will cease or become limited, and a move to another ecological state is highly likely.

Salinity Issues

Seawater seepage will continue through the barrages on Low, medium and high tides (overtopping of stop logs/gates by wave action and reverse flow across auxiliary spillways at Ewe Island and Tauwitchere Island barrages) which will impact on salinity levels in Lake Alexandrina. Wind events will move more saline water from Lake Alexandrina into the River Murray channel. Evapo-transpiration will result in increasing salinity levels in Lakes Alexandrina and Albert. Coorong salinities will be increasing.

Pest impacts

Tube worms will be colonising the freshwater environments where salinity has increased. This will impact upon freshwater turtles as tubeworms become attached to shells and limit respiration.

Acidification Impacts

Acidity from exposed soils will enter the waterbody upon re-wetting from rainfall events, this could result in elevated metal levels and localised acid water events. Lake Albert will naturally disconnect from Lake Alexandrina and will be at risk from Lake wide acidification. Currency Creek, Finnis River, Loveday Bay, Boggy Creek and Boggy Lake are likely to have minor acidity events.

[8] Attachment 8 summaries ecological impacts/responses experienced under declining water levels.

Level 3: -1.0m to -1.5m AHD

If water levels drop below -1.0m, then Level 3 will be initiated by the High Level Steering Committee. Level 3 represents a water level between -1.0m and -1.5m AHD. The default position for the barrages will be closed.

This scenario would most likely involve the Tier 3[9] water sharing arrangements (insufficient water for critical human needs) under the Basin Plan being implemented. Given the low water availability, it is unlikely that environmental water delivery can be delivered in this scenario. However, this will need to be verified, prior to considering other actions.

The following decision points form the key steps in Level 3:

Step 1 MDBA and South Australia determine if the water levels can be maintained above -1.5m, without further intervention over the next water year:

- if the likelihood is high, then continue actions to return levels to -1.0m and consider any relevant actions under Step 2. When levels reach -1.0m, the High Level Steering Committee is then requested to un-trigger the Level 3, based on the advice of the MDBA and South Australia.
- if the likelihood is moderate or low, then move to step 2.

Step 2 The High Level Steering Committee will be required to review current scientific understanding, water resource outlook and make recommendations regarding the most appropriate management actions to avoid acidification of water bodies. Considered recommendations are critical as the consequences of decisions may take decades to recover from. Potential actions, but not limited to, to be considered at this level:

- investigation of sourcing environmental water is continued with the aim to keep the water levels above -1.5m AHD (note that this is an action that South Australia and the MDBA can pursue with environmental water holders without endorsement of the High Level Steering Committee). Note that this may only be possible if upstream flows were filling water allocations.
- re-assessment of water level outlooks (especially if environmental water is delivered), as required, to maintain an up-to-date understanding of the situation.
- event-based water quality monitoring will be needed to support management actions and triggers. Refer to Attachment 9 for triggers.
- limestone dosing.
- native fish captive maintenance program.
- regulator or blocking bank construction and pumping water to maintain levels.

[9] Chapter 11, Part 5 of the Basin Plan.

- works to seal barrage gates.
- extensive aerial seeding will continue to stabilise exposed lake beds and to provide carbon to facilitate acid consumption through sulfate reduction processes.

Extensive environmental impacts will be present within the Lower Lakes and below Lock 1. Water bodies or localities at risk include Currency Creek, Finniss River, Goolwa Channel, Dunn's Lagoon, Boggy Lake, Dog Lake, Loveday Bay, Lake Albert, River Murray Channel below Lock 1 and fringing lake edges. Several consequences of low water levels are summarised below.

Ecological Impacts[10]

All freshwater wetland habitats surrounding Lakes Alexandrina and Albert will be dry and desiccated with associated ecological impacts. High value wetlands on Hindmarsh Island will be salinised and acidified with direct impacts to EPBC Act listed small bodied native fish. Lake bed impacts will be present with aquatic flora and fauna desiccated as a result of low water levels. The majority of ecological function will have become limited and a move to another ecological state is highly likely.

Salinity Issues

Seawater seepage will continue through the barrages on Low, medium and high tides (overtopping of stop logs/gates by wave action and reverse flow across auxiliary spillways at Ewe Island and Tauwitchere Island barrages) which will impact on salinity levels in Lake Alexandrina. Wind events will move more saline water from Lake Alexandrina into the River Murray channel threatening domestic water supplies.

Pest impacts

Tube worms will have colonised the previous freshwater environments, this will result in significant turtle deaths as tubeworms limit respiration.

Acidification Impacts

Without preventative measures, acidity from exposed soils over 49,000Ha will enter the waterbody from groundwater, re-wetting and lake water movement, this could result in elevated metal levels and localised acid water events. Lake Alexandrina's waterbody will be under threat from acidification. Lake Albert has experienced Lake wide acidification at this level.

[10] Attachment 8 summaries ecological impacts/responses experienced under declining water levels.

Level 4: -1.5m AHD and -2.7m AHD (effectively a dry lake)

If water levels drop below -1.5m, then Level 4 will be initiated by the High Level Steering Committee. Level 4 represents a water level between -1.5m and -2.7m AHD. The default position for the barrages will be closed.

This scenario would most likely involve the Tier 3[11] water sharing arrangements (insufficient water for critical human needs) under the Basin Plan being implemented. Given the low water availability, it is unlikely that environmental water delivery can be delivered in this scenario. However, this will need to be verified, prior to considering other actions.

As a result, environmental water delivery would not be possible. The following decision points form the key steps in Level 4:

Step 1 MDBA and South Australia determine if the water levels can be maintained above a determined point (below -1.5m, but not below -2.7m as that is the floor of the lowest part of Lake Alexandrina), without further intervention over the next water year:

- if the likelihood is high, then continue actions to return levels to -1.5m and consider any relevant actions under Step 2. When levels reach -1.5m, the High Level Steering Committee is then requested to un-trigger Level 4, based on the advice of the MDBA and South Australia.
- if the likelihood is moderate or low, then move to step 2.

Step 2 The High Level Steering Committee will be required to review the current situation which will be close to widespread water body acidification of Lakes Alexandrina. Considered recommendations are critical as the consequences of decisions may take decades to recover from. Potential actions, but not limited to, to be considered at this level:

- investigation of sourcing environmental water is continued with the aim to keep the water levels above -1.5m AHD (note that this is an action that South Australia and the MDBA can pursue with environmental water holders without endorsement of the High Level Steering Committee). Note that this would only be possible if upstream flows were filling water allocations.
- re-assessment of water level outlooks (especially if environmental water is delivered), as required, to maintain an up-to-date understanding of the situation.
- event-based water quality monitoring will be needed to support management actions and triggers (refer to Attachment 9 for triggers).
- limestone dosing.
- native fish captive maintenance program.

[11] Chapter 11, Part 5 of the Basin Plan.

- regulator or blocking bank construction and pumping water to maintain levels.
- works to seal barrage gates.
- extensive aerial seeding will continue to stabilise exposed lake beds and to provide carbon to facilitate acid consumption through sulfate reduction processes.

Extensive environmental impacts will be present within the Lower Lakes and below Lock 1. Water bodies or localities at risk include Currency Creek, Finniss River, Goolwa Channel, Dunn's Lagoon, Boggy Lake, Dog Lake, Loveday Bay, Lake Albert, River Murray Channel below Lock 1 and fringing lake edges. Several consequences of low water levels are summarised below.

Ecological Impacts[12]

All freshwater wetland habitats surrounding Lakes Alexandrina and Albert will be dry and desiccated with associated ecological impacts. High value wetlands on Hindmarsh Island will be salinised and acidified with direct impacts to EPBC Act listed small bodied native fish. Lake bed impacts will be present with aquatic flora and fauna desiccated as a result of low water levels. The majority of ecological functions will have ceased and a move to another ecological state would occur.

Salinity Issues

Seawater seepage will continue through the barrages on low, medium and high tides (overtopping of stop logs/gates by wave action and reverse flow across auxiliary spillways at Ewe Island and Tauwitchere Island barrages) which will impact on salinity levels in Lake Alexandrina.

Salinity of the water will be beyond the tolerance range for freshwater biota, stock and domestic uses. Salinity spikes will be entering the River Murray channel and threatening South Australia water off takes.

Pest impacts

Tube worms will have colonised the previous freshwater environments, this will result in significant turtle deaths as tubeworms limit respiration. Tube worms will also colonise hard substrates such as irrigation pipes, boats, barrages and jetties.

Acidification Impacts

Acidity from exposed soils will enter the waterbody from groundwater, re-wetting and lake water movement. This could result in elevated metal levels and localised acid water events. The remaining water body in Lake Alexandrina will likely turn acid which will kill the remaining pH sensitive species in the water body. Infrastructure impacts are likely to occur under acid condition with concrete structures (barrages, weirs etc) sensitive to corroding.

[12] Attachment 8 summaries ecological impacts/responses experienced under declining water levels.

3. Governance of the Emergency Framework

The details of the governance arrangements surrounding the Emergency Framework are presented in Attachment 10, which discusses key managing agencies and their roles as well as discussion of how the Emergency Framework relates to the planning and management framework for the Lower Lakes. The key points are as follows:

- Murray-Darling Basin Ministerial Council is the approval body for the development and amendment of this Emergency Framework. Consistent with s26 (1) (b) and (c) of the Murray–Darling Basin Agreement, BOC will be delegated the responsibility to trigger the implementation of the emergency actions phase for when the Lower Lakes reach the level of 0.0m AHD (note this approval should be given in advance of the actual event rather than seeking it after the fact). BOC will be informed by the MDBA, South Australia and Water Liaison Working Group as necessary.
- BOC will direct the High Level Steering Committee to be engaged, when the Lower Lakes are predicted to reach 0.0m AHD during the next water year. The High Level Steering Committee will provide strategic direction from the joint governments to the response to avoid and manage acidification in the emergency actions phase.
- Key decision makers regarding acid sulfate soil management actions will vary, depending on the action implemented.
- The Emergency Framework will comprise the extreme dry scenario of the broader Lower Lakes Operating Strategy that is yet to be developed. Until the Lower Lakes Operating Strategy is developed, the Emergency Framework is a stand-alone document.

4. Requirement for review

The Emergency Framework has been developed with information gained from studies and assessments performed since the original strategy was approved in 2008. The next review of the Emergency Framework is not scheduled for a particular point in time. Instead, the next review should be made under the following circumstances:

- once new information from future studies is available; or
- after a review of a future implementation of this Emergency Framework; or
- if new management technologies become available.

5. References

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Attachment 1 - Map of the Lower Lakes Site

Figure 5. Map of the Lower Lakes Site

Attachment 2 - Alkalinity levels during the 2007-2010 drought

Figure 6 and Figure 7 show the recorded carbonate levels for each lake and acidic hot spots between 2007 and 2011.

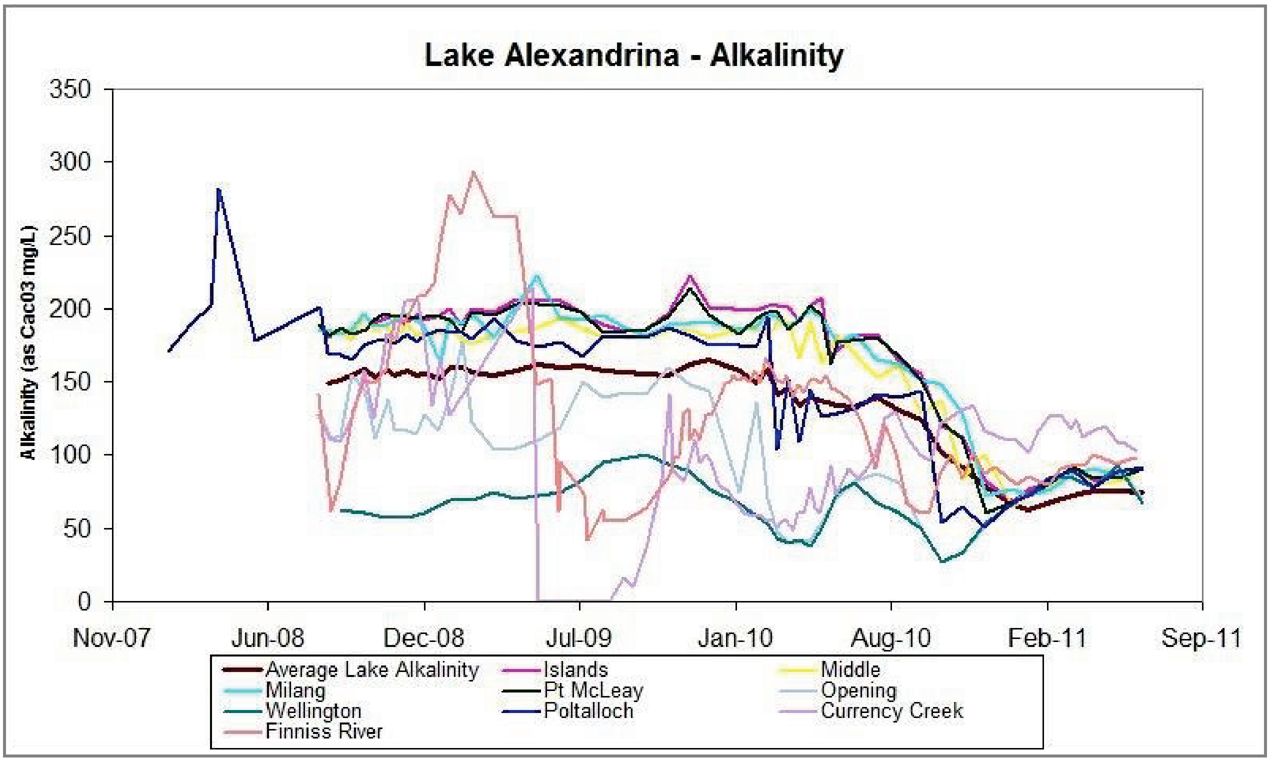

Figure 6: Lake Alexandrina Alkalinity (carbonate) plot for 2008-2011

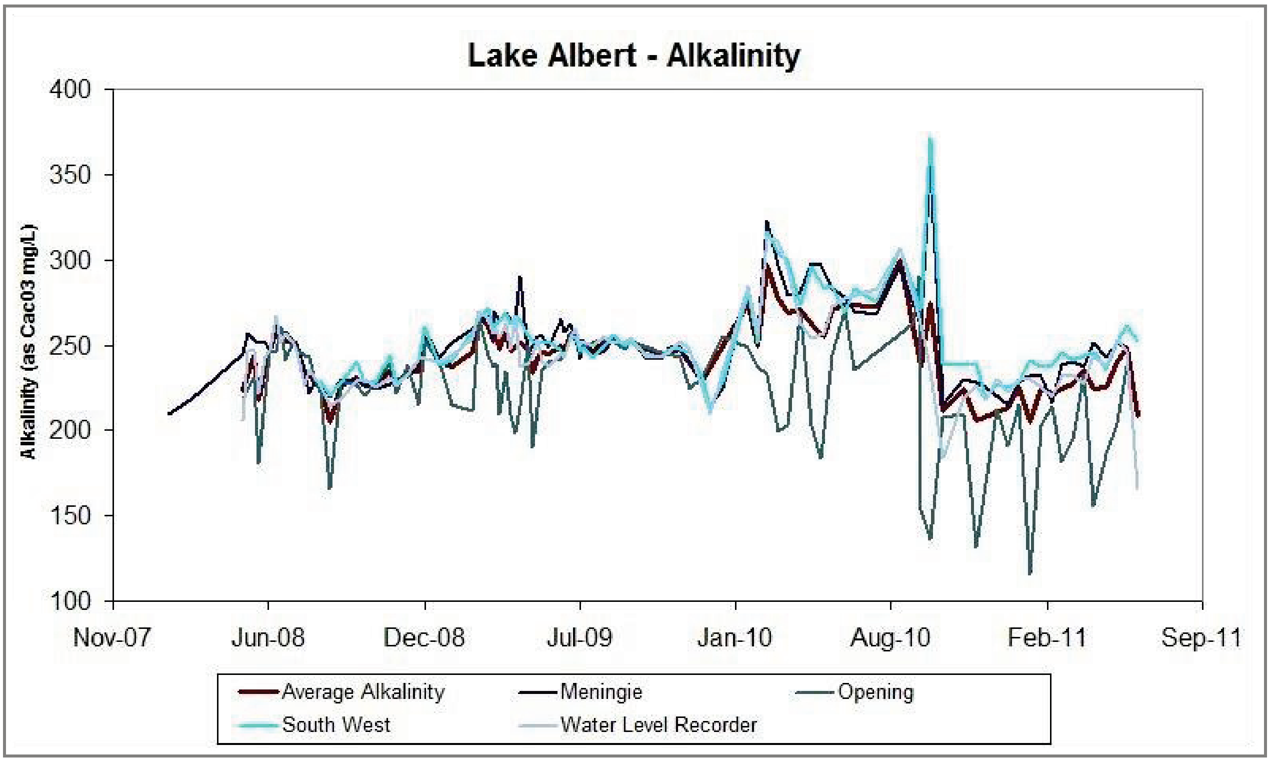

Figure 7: Lake Albert Alkalinity (carbonate) plot for 2008-2011

Attachment 3 – Objectives and actions of the Original Real-Time Management Strategy to Avoid Acidification in the Lower Lakes

The objectives of the original strategy were to:

1. avoid irreversible damage through acidification of the Lower Lakes system
2. avoid adverse impacts on the water quality of major water supply off takes
3. use treatments that as far as possible do not compromise mid to long term options.

The original strategy consists of the following actions:

a) continuous monitoring of water levels and pH in the Lower Lakes

b) pumping from Lake Alexandrina to Lake Albert to maintain water levels in Lake Albert above its management trigger level of -0.5 m AHD to avoid broad-scale acidification,

c) monitoring to provide at least four weeks advanced warning of reaching either of the following triggers:

  - A minimum 25mg/L of carbonate in either waterbody
  - Water levels of -1.5 m AHD in Lake Alexandrina and -0.5 m AHD in Lake Albert.

d) if either of these triggers are met and there is not sufficient freshwater, the minimum quantities of seawater necessary to maintain the Lower Lakes above these management triggers will need to be immediately introduced through the Lower Lakes Barrages. This action requires approval under the EPBC Act.

Several scientific studies have been completed to inform an environmental impact statement. However, the environmental impact statement was not completed and therefore the EPBC Act approval has not been given to introduce seawater into the Lower Lakes. The results of the environmental impact statement and Murray Futures Acid Sulfate Soil Research Program were presented to the High Level Steering Committee in September 2010. At this meeting it was agreed to update the strategy to reflect new scientific understanding and to develop a decision making framework.

Since the September 2010 High Level Steering Committee meeting, investigations of the ecological consequences of introducing seawater have been undertaken. The results show that salinity will be a key driver of ecological change in all scenarios, regardless of whether acidification occurs or not. The results also show that the introduction of seawater to Lake Alexandrina would lead to extreme increases in salinity and transition to highly simplified, hypersaline ecosystems. A healthy, estuarine/marine community would not establish (Muller, 2012). Please refer to Attachment 4 for more information regarding the study and acid sulfate soil management and research.

Attachment 4 - Further information on Acid Sulfate Soils management and research and the results of the investigations into the ecological consequences of seawater introduction

Management of Acid Sulfate Soils

Acid sulfate soil management involves firstly minimising its formation where possible, and, if not, then preventing extended periods of exposure where acid sulfate soils are present, followed by control and treatment activities to neutralise any acidity that forms.

In 2009 and 2010, water levels in the Lower Lakes fell to unprecedented levels (less than -1 m AHD in Lake Alexandrina and through pumping were held above -0.6 m AHD in Lake Albert), representing a very high risk of water body acidification with drying down and subsequent rewetting. Several prevention, control and treatment actions were implemented to manage this hazard.

Temporary regulators were constructed in the Narrung Narrows, Goolwa Channel and Currency Creek with water pumped across them to increase water levels and prevent continued exposure of acid sulfate soil. Complementary control and treatment actions involved:

- promoting bioremediation by aerial seeding and planting
- limestone addition to neutralise acid water.

Research by Southern Cross University confirmed the effectiveness of bioremediation which increased acidity consumption through the provision of additional carbon. Water quality monitoring has confirmed the effectiveness of limestone dosing as a method of neutralising pooled acid water.

The combination of management actions, depending on the acid sulfate soil hazard and the feasibility of each action, has been highly successful in avoiding and mitigating acidity until winter/spring 2010 when Darling and Murray River waters refilled the Lower Lakes.

Acid Sulfate Soils Research Program

The Acid Sulfate Soil Research Program comprised of acid sulfate soil experts from around Australia who formed a research cluster to provide scientific information to inform the management of the Lower Murray. All research reports have been through a peer review with oversight from an independent chair (Dr John Cugley). The program was implemented under the Coorong, Lower Lakes and Murray Mouth Long Term Plan with support from the MDBA. The results from this program have been previously endorsed by the MDBA and the High Level Steering Committee.

The data generated from the acid sulfate soil research program and other soil and water monitoring activities were combined to refine an existing hydrodynamic geochemical 3-D model used to determine acidification thresholds and water management levels for the Lower Lakes. Table 1 summarises the acidification modelling outputs for Lake Alexandrina and Lake Albert.

Table 1. Acidification and minimum water management levels

Model outputs	Lake Alexandrina (m AHD)	Lake Albert (m AHD)
2009 acidification triggers	-1.5*	-0.5
2010 revised acidification triggers	-1.75	-0.75
Lowest water management levels (recommended)	> -1.5 ± 0.25	> -0.5 ± 0.25

The Acid Sulfate Soil Program Research Cluster recommended water management levels of no lower than -1.5 and -0.5 ± 0.25 m AHD for Lake Alexandrina and Albert, respectively. This will allow for seasonal oscillations and potential ecological impacts resulting from declining water quality, especially salinity. These levels also take into account some of the inertia and build-up of acidity over time in the system.

The acid sulfate soils research program also highlighted that introducing the water would result in more-enhanced acidity fluxes around the already acidified lake margins, compared to using freshwater.

The research details can be found at: http://www.environment.sa.gov.au/Conservation/Rivers_Wetlands/Coorong_Lower_Lakes_Murray_Mouth/The_environment/Acid_sulfate_soils/Acid_Sulfate_Soils_Research_Program_reports.

Hydrodynamic modelling was conducted to look at a number of management scenarios to analyse the impacts of a continuation of the drought. These scenarios included: do nothing (allow lake to drawdown without intervention), maintain with seawater, and maintain with freshwater.

The results show that the use of seawater or freshwater to stabilise water levels at -1.5m AHD could avoid lake wide acidification. A significant issue with seawater input was the hypersaline conditions forecast for Lake Alexandrina within two to three years if it were used to maintain water levels to -1.5 m AHD. Even greater hypersalinity (>200 g/L) was predicted for Lake Albert, together with high levels of total nitrogen and phosphorus (TN and TP) creating a eutrophication risk in both lakes. Further considerations were also required regarding lake communities, Adelaide and country town water security. Hence, stabilising the Lower Lakes with freshwater creates better outcomes for water quality, economic, social and environmental objectives.

Ecological Consequences Assessment of Seawater Introduction

The hydrodynamic modelling outputs were used to assess the likely ecological consequences (both positive and negative) associated with each water management option. These options were: do nothing, maintain with seawater, and maintain with freshwater. The ecological consequences assessment process began with facilitated expert workshops that documented current knowledge of the Lower Lakes and Coorong ecosystem and identified a suite of ecological receptors (e.g. species, assemblages, functional groups) suitable for assessing both positive and negative consequences to the flora and fauna of the Coorong, Murray Mouth and Lakes Alexandrina and Albert. Sixteen local scientists familiar with the biota of the Coorong and Lakes Alexandrina and Albert were collectively trained in a common set of consequence assessment methods. Using these methods, each scientist determined the likely habitats, baseline conditions, thresholds and other considerations regarding tolerance and recovery strategies for their respective receptors. Each of the evaluations was based on three primary stressors: salinity, water level and pH.

The group identified a total of 55 receptors across six biotic groups that could collectively be used to assess the consequences to the flora and fauna of the site. They then independently completed the full suite of assessment templates using preliminary hydrological modelling outputs and attended a series of six two-day workshops in June 2010 covering six biotic groups: plankton, vegetation, lacustrine and estuarine macroinvertebrates, fish, frogs and birds. A combined workshop was then held to prepare guidelines for integration of individual receptor consequence scores and to review conceptual State and Transition models prepared in response to the information used in the workshops.

The outputs of these workshops were used to score consequences for each of the 55 receptors within these six biotic groups associated with three primary stressors: salinity, water level and pH, using outputs from the hydrological modelling. The consequence scores were then used to determine the most likely ecological outcomes (in terms of consequences to the different resident receptors and invasion of new taxa) under the six scenarios.

The start date for the ecological consequences assessment was October 2009. At that time, water levels in the Lower Lakes were very low (approximately -0.8 m AHD compared to full supply level of +0.75 m AHD) and it was not known whether future River Murray inflows would be sufficient to prevent further drawdown. Flow regulators were in place at Clayton and across the Narrung Narrows in October 2009. The Goolwa Channel regulator ponded water in Goolwa Channel to act as a freshwater refuge should the main lake bodies become more saline, acidic or both due to sustained low River Murray inflows.

The report “Ecological consequences of managing water levels to prevent acidification in Lakes Alexandrina and Albert” (Muller 2012) concludes that salinity will be a key driver of ecological change in all scenarios, regardless of whether acidification occurs or not. The introduction of seawater to Lake Alexandrina will lead to extreme increases in salinity and transition to highly simplified, hypersaline ecosystems. A healthy, estuarine/marine community will not establish.

In Lake Alexandrina under both the pumping and cease-pumping seawater scenarios, salinity will be the major driver of a series of ecological changes through brackish-estuarine, then marine and finally hypersaline salinity conditions. This will result in mixed and depauperate (poor) assemblages of biota in Lake Alexandrina over space and time rather than promote establishment of a healthy, resilient estuarine-marine ecosystem.

Importantly, the scenarios assessment predicted that despite the occurrence of salinity levels within the estuarine range across the majority of the lake between spring 2010 and spring 2012, very poor condition of the former estuary below the barrages at the beginning of the action period severely limited establishment of estuarine taxa in Lake Alexandrina. However, even if estuarine-marine organisms could colonise Lake Alexandrina during that period they would be lost to on-going salinisation. The only receptors likely to be abundant in Lake Alexandrina at the end of the action period are hypersaline plankton and insect larvae, with generalist shorebirds likely to remain to prey on the insect larvae. Very small populations of estuarine macroinvertebrates may persist if indeed they can establish and Small-mouthed Hardyhead may also persist although they would have experienced almost complete loss of habitat and food. Overall, the receptors typical of the Lake Alexandrina ecosystem would have perished under the seawater scenario regardless of whether pumping to Lake Albert ceases or not and a healthy replacement ecosystem would not have formed.

If pumping to Lake Albert continued, water levels would have been maintained and acidification would not have occurred. However, salinity levels would have rapidly increased and caused the progressive loss of all resident Lake Albert receptors by the end of the action period except for Small-mouthed hardyhead, insect larvae and some predatory birds. It is highly unlikely that other more salt-tolerant taxa would have established a new, complex ecosystem.

If pumping ceased, complete ecological collapse would have occurred from the catastrophic cascade of increasing salinity, acidification and then drying of Lake Albert.

In Figure 8 below, the scale used is grams per litre. Note that seawater is approximately 30 g/L. in the subsequent years of the assessment, salinity levels increased even further.

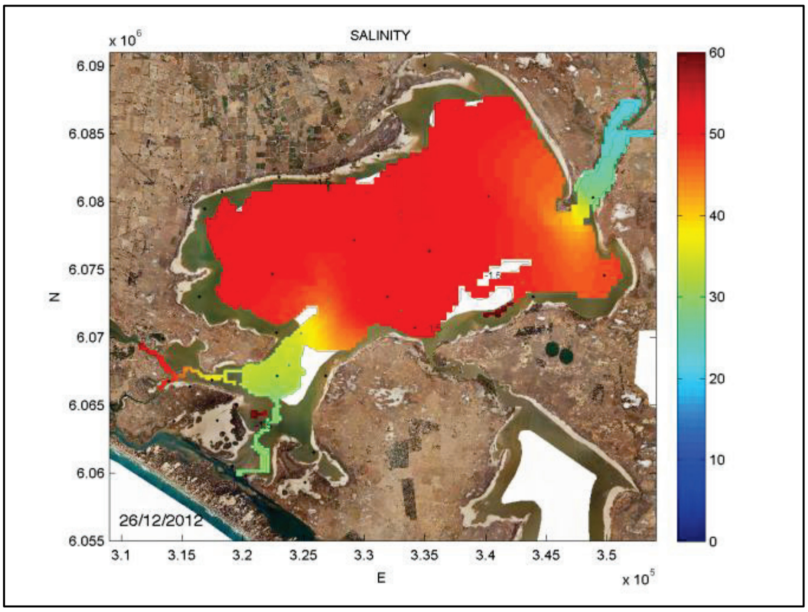

Figure 8: **Lake Alexandrina Salinity with Seawater at December 2012 showing the freshening effect of River Murray water in the north and seater in the south.**

Attachment 5 - Future likelihood of triggering 0m AHD

With the inception of the Basin Plan, the risk of lake levels dropping below 0.0m AHD is significantly reduced due to the increased availability of environmental water (the Basin Plan has a target for the Lower Lakes to not drop below 0.0m AHD) in the modelled period of record. Hydrological modelling (using latest data available) was conducted by the MDBA to assess the likelihood of triggering 0.0m AHD under a range of historical and future scenarios:

- Basin Plan baseline development conditions (Refer to MDBA 2012). This is the scenario that best represents the water sharing arrangements at the time of the 2006-2010 drought.
- Basin Plan 2800 GL with relaxed Murray–Darling Basin system channel constraints (i.e. increasing the channel capacity at Barmah Choke and Doctor's Point to 40,000 ML/day and Lower Darling to 18,000 ML/day [MDBA 2012]). This scenario best represents the future when the Basin Plan environmental water recovery measures have been achieved.
- 2030 median climate change (data from the CSIRO Sustainable Yields Project [CSIRO 2010]) with Basin Plan Baseline scenario levels of development. At the time of development, there was no modelling available to estimate the potential impacts of future climate change on the Basin Plan 2800 GL relaxed constraints scenario.

Results, presented in Figure 9 from this exercise indicate that:

- Under the Basin Plan baseline development scenario, the Lower Lakes drop below 0.0m AHD 2.8% (3.1 years out of 114 year simulation period) of the time.
- The likelihood of the Lower Lakes dropping below 0.0m AHD is considered very low under the Basin Plan 2800 GL relaxed constraints scenario because over the 114 year simulation period, the Lower Lakes do not drop below 0.0m (lowest level reached 0.15m). This is because there will be a greater proportion of water allocated to the environment and less extracted under this scenario.
- Under the '2030 median' climate change scenario, the Lower Lakes drop below 0.0m AHD 4% (4.5 years out of 114 year simulation period) of the time (to a minimum level of -1.0m). This is because there is reduced rainfall and higher evapotranspiration across the Murray–Darling Basin, resulting in lower inflows.

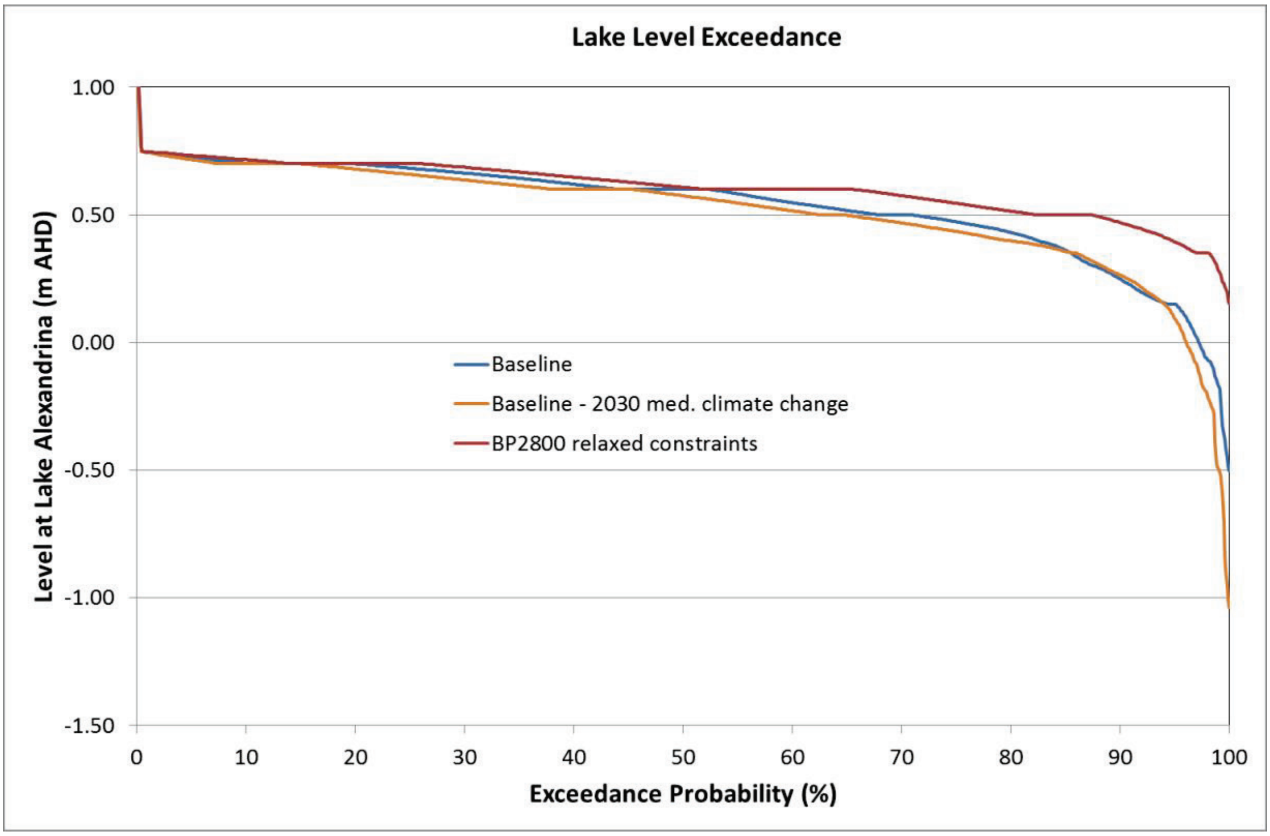

Figure 9: Lower Lakes level (m AHD at Milang) Exceedance Probability

The exceedance probability for the Lower Lakes' level at Milang for each scenario is presented in the plot above (modelled data over 114 years (1895-2009) on monthly time-step). It shows the likelihood of a specified level (y-axis) being exceeded on a given day (x-axis) over the 114 year simulation period.

If, once all of the environmental water has been recovered for the Basin Plan, the Lower Lakes were to be drawn down to the levels that were seen in 2009-10 (just below -1.0m AHD), the runoff across the basin would need to be much lower than that associated with the 2006-10 drought. This is because, under the Basin Plan, there will be a greater share of water remaining in the river system compared with the share during the 2006-10 drought.

If in the unlikely event that the Lower Lakes were to be drawn down to those 2009-10 levels it would take only minimal River Murray inflows to bring them up above 0.0m AHD. This is demonstrated through Figure 10 and Figure 11 whereby (conservatively) it takes around 1500 GL of water to fill the Lower Lakes from just below -1.0m to 0.0m (including evaporative losses) and that the probability of this volume flowing into the Lower Lakes in any given year is 99% under the Basin Plan conditions.

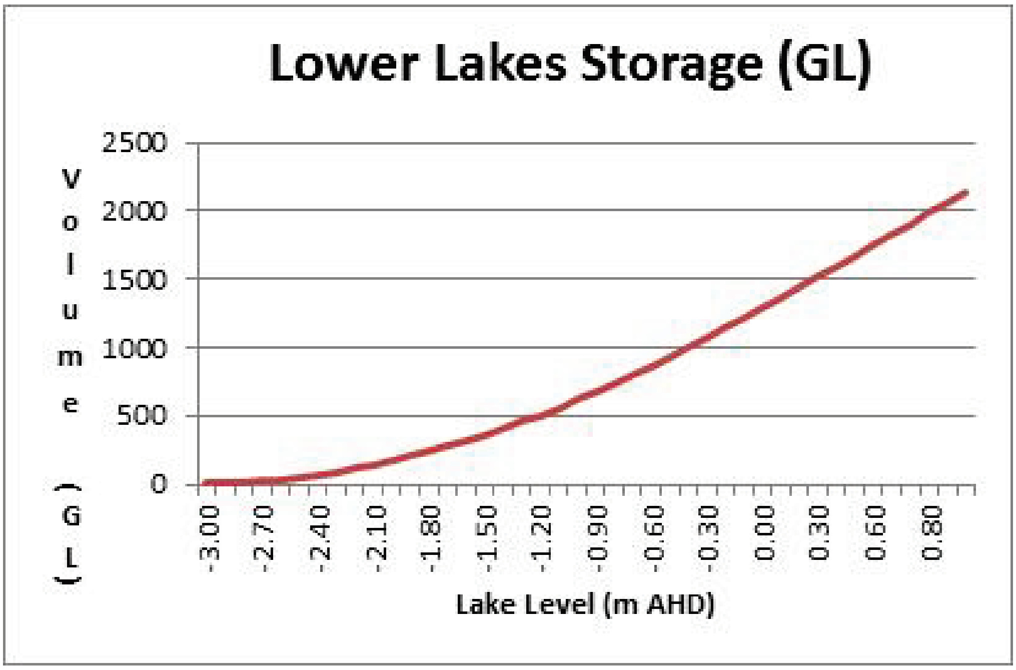

Figure 10: Lower Lakes Storage curve

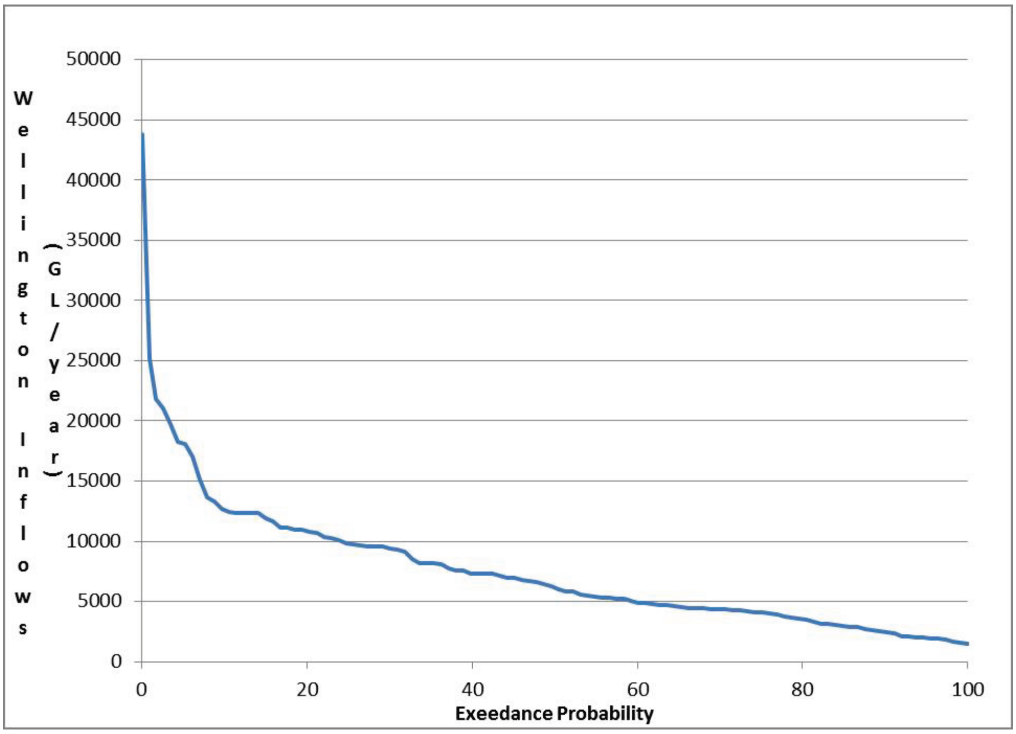

Figure 11: Lower Lakes Inflow Exceedance Probability under the Basin Plan 2800 GL relaxed constraints scenario

Attachment 6 - MDBA Multi-history Outlooks

The following is a snapshot of multi-history water resource outlooks:

1. Multi-history outlooks are generated looking forward from today under a repeat of "historical" inflow and climate conditions.

2. In running the multi-history, a scenario is created for each year in the historical record.

3. Probabilities of a particular event occurring can then be calculated based on how many times the event is seen to occur in the scenarios generated. This is referred to as the "all years probability", which assumes that each year in the historic record is equally likely to occur in the immediate future.

4. This assumption that all years in the historic record are equally likely to be repeated in the future can be improved in some circumstances. Where it can be shown that differences exist within the data, the runs can be separated into three populations or terciles. Statistics are then generated using only the (~40) years in the relevant tercile.

5. The tercile approach discussed in section 2.4.1 can be statistically justified where aggregated inflows over the previous 3 months are significantly different from the average (in the top or bottom 1/6 of the historical record). If the tercile approach is shown to be appropriate then only those years in the top or bottom 1/3 of inflows for that 3 month period are considered in generating the probability-based outlooks.

   Note: Where previous inflows are closer to the mean there is an argument for employing a "moving tercile" looking at the 1/3 of years centred around the observed value.

6. Probabilities reflecting the Bureau of Meteorology inflow outlooks can also been produced, considering only those years in top or bottom 1/3 of future (3 month) inflows.

Limitations of the Method

7. The tributary inflows assumed in the method are taken from a modelled current conditions run. The tributary storage levels influencing the inflows are driven by previous years in the long term model run; they are not associated with observed storage levels

8. Similarly the assumed tributary inflows will generally not be adjusted for flows in transit.

9. System behaviour, including operational practices and irrigation diversions will generally be based on long-term historical behaviour, which may not always be appropriate.

10. The range of possible outcomes is limited to those that would have been observed under a repeat of any of the historical record (to the 1890s). Recent years have seen record droughts and record summer floods and they could not have been predicted by applying this method before they occurred.

11. Some outputs are presented as time series where they are independent distributions of observations for consecutive time periods.

Attachment 7 - Flow chart Logic for the Planning and Emergency Actions phases

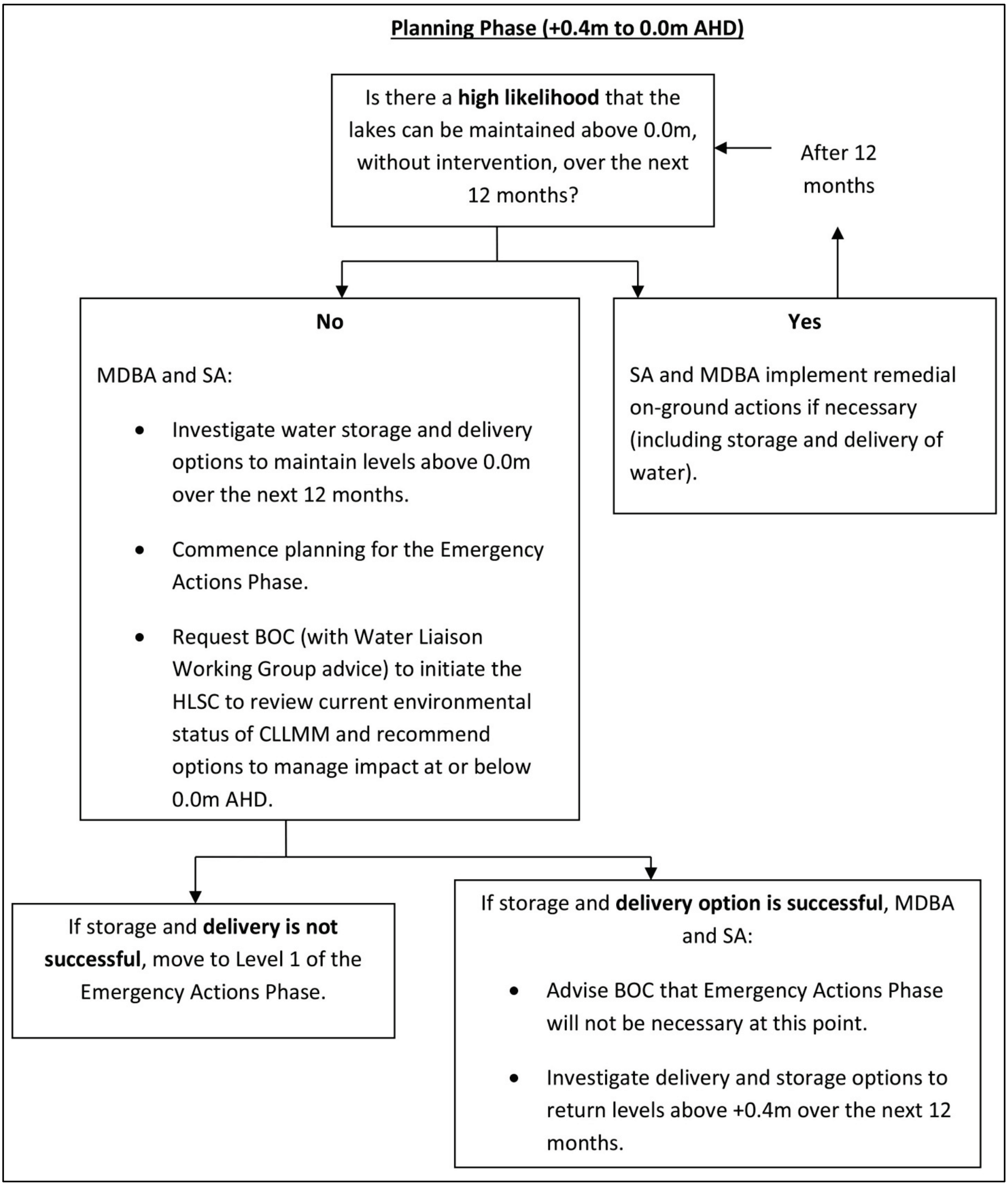

Figure 12: Flow chart logic for the Planning and Emergency Action Phase (+0.4m to 0.0m AHD)

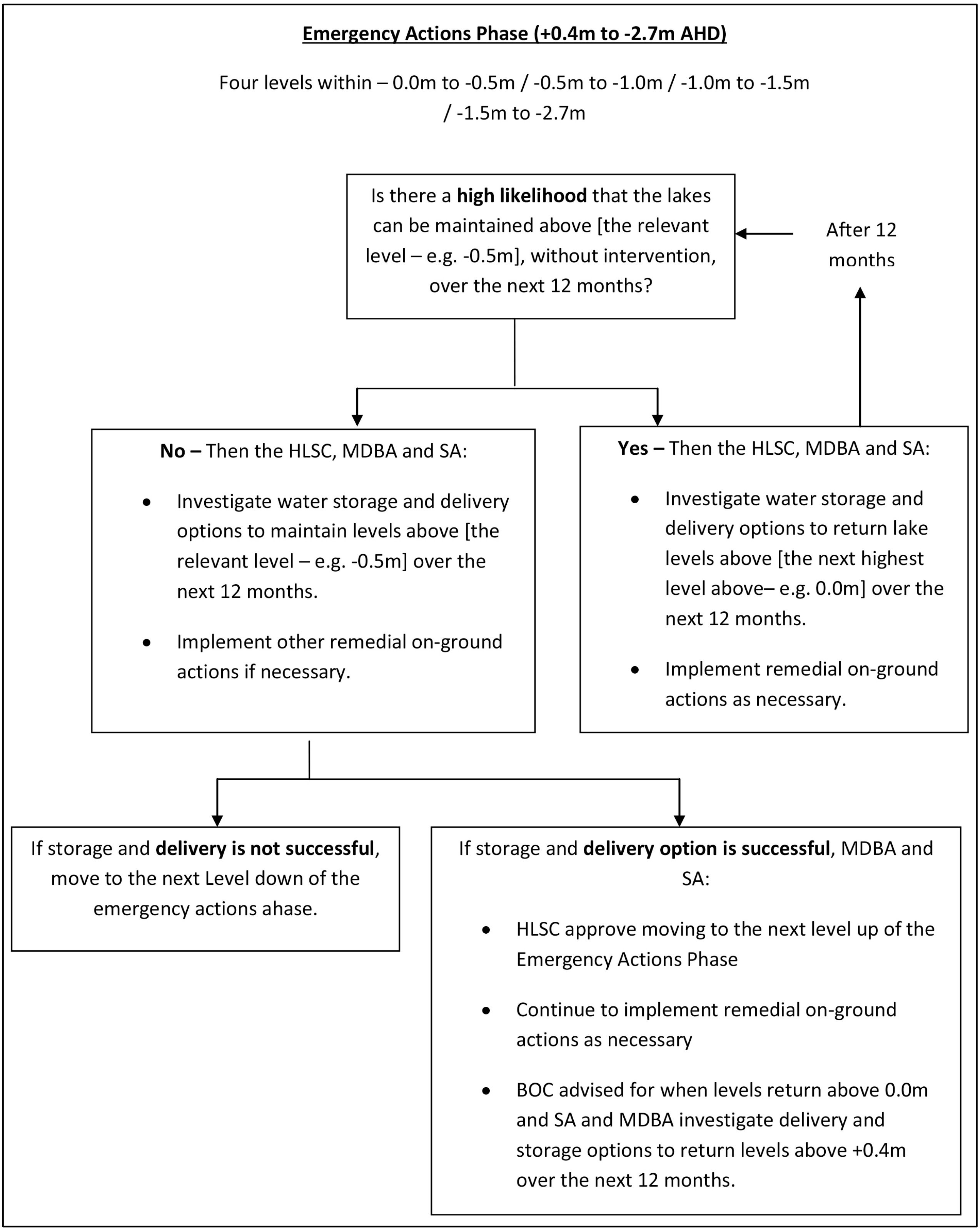

Figure 13: Flow chart logic for the Planning and Emergency Action Phase (+0.4m to -2.7m AHD)

Attachment 8 - Indicative ecological response to declining water levels and quality

Table 2. Indicative ecological response to declining water levels and quality.

Lake level (metres ADH)	Total volume (GL) (Lakes Alexandrina and Albert combined)	Total surface area (hectares)	Average annual net loss (GL)	Measured / modelled Lake Alexandrina salinity (EC)	Ecological and management implications
0.8	1 924	82 171	802	400 – 2 300	Lower Lakes surcharge level under pre-drought conditions.
0.75	1 883	82 014	800	400 – 2 300	Lower Lakes full supply level.
0.7	1 842	81 857	799	400 – 2 300	
0.6	1 761	81 669	797	400 – 2 300	
0.5	1 679	80 976	790	400 – 2 300	Lower Lakes preferred minimum level under pre-drought conditions. Barrage opening not possible below this level under current operational arrangements. Therefore: • fish that require both marine and freshwater habitats are unable to migrate between sea and Lower Lakes and are therefore unable to complete their life cycles (fish ways allow flows and fish passage through at lower water levels) • water level and salinity targets for the Coorong are not met due to inadequate freshwater flows. Therefore all Coorong biota (aquatic plants, mudflat invertebrates, fish, shorebirds, fish-eating birds, waterfowl) are impacted • dredging required to maintain an open mouth. Murray Mouth closure leads to: • salinisation of estuary and exacerbation of inappropriate salinity and water levels in Coorong • all Murray estuary biota threatened.

Lake level (metres ADH)	Total volume (GL) (Lakes Alexandrina and Albert combined)	Total surface area (hectares)	Average annual net loss (GL)	Measured / modelled Lake Alexandrina salinity (EC)	Ecological and management implications
0.4	1 599	79 899	779	400 – 3 000	
0.3	1 519	78 820	769	400 – 3 000	Likely exposure of all fringing submerged and emergent aquatic vegetation around the shoreline of the Lower Lakes and tributary wetlands. Therefore: • loss of fringing vegetation, unless exposure is temporary • likely loss of many freshwater fish and waterbird species.
0.2	1 441	77 754	759	400 – 3 000	fish communities in certain areas becoming isolated
0.1	1 364	76 664	748	400 – 3 000	Hindmarsh island wetlands drying and acidification likely.
0	1 288	75 349	735	400 – 3 000	Exposure of Lake beds and acidity entering waterbody
-0.1	1 213	73 919	721	3 000	Salinity levels within Lakes and Coorong rise, barrages leaking due to marine water head pressures.
-0.2	1 140	72 414	706		Currency Creek, Finniss River and Goolwa Channel likely to express acidity
-0.3	1 068	70 972	692	3 250	Lakes Alexandrina and Albert become disconnected at this level. Therefore: • fish communities in each lake become isolated. • increased salinity.
-0.4	998	69 405	677	3 500	Pest species such as tube worm likely to increase, impacts on turtle populations likely.
-0.5	930	67 787	661	4 000	Further exposure of lake bed and acidification of soils and acidity entering waterbody
-0.6	863	66 106	645		
-0.7	797	64 278	627	4 500	Acidification of Lake Albert is predicted to occur at this level (-0.75 m AHD) and lower. Therefore: • all biota in Lake Albert threatened • salinity in Lake Alexandrina exceeds threshold for most freshwater fish • likely loss of freshwater fish from Lake Alexandrina and tributary wetlands.

Lake level (metres ADH)	Total volume (GL) (Lakes Alexandrina and Albert combined)	Total surface area (hectares)	Average annual net loss (GL)	Measured / modelled Lake Alexandrina salinity (EC)	Ecological and management implications
-0.8	734	62 456	610	5 000	
-0.9	673	60 614	592	5 500	
-1	613	58 471	571	5 750	High salinity levels and acidity levels within Lakes
-1.1	556	55 356	541	6 250	Up to 20,000HA of acid soils exposed
-1.2	502	52 858	514	6 700	Disconnection between Lake Alexandrina and Goolwa Channel occurs
-1.3	451	49 771	486	7 000	
-1.4	403	45 715	447	7 500	
-1.5	359	42 391	414	7 800	
-1.6	318	40 347	395	8 000	
-1.7	278	38 598	377	8 300	Acidification of Lake Alexandrina is predicted to occur at this level (-1.75 m AHD) and lower. Therefore: • all biota in Lake Alexandrina and tributary wetlands (estuarine fish, waterfowl, fish-eating birds) threatened. • Salinities beyond tolerance range for freshwater biota

Attachment 9 - Water Quality Triggers

Table 3. Commencement triggers for aerial limestone dosing (over a minimum of two locations for two consecutive days; pH < 7.5)

Trigger Value	Proposed Action
Alkalinity >100 mg/L but >20% fall in alkalinity compared to lake concentrations	Increase monitoring rate of alkalinity change (ambient and event-based monitoring)
Alkalinity <100 mg/L and >20% fall in alkalinity compared to lake concentrations	Monitor alkalinity weekly Get dosing equipment ready
Alkalinity <25 mg/L and acidity present in the waterbody	Commence aerial limestone dosing Monitor application rate Monitor upstream and downstream water quality daily
Acidity >100 mg/L	Continue larger scale aerial limestone dosing to counter acidity Monitor application rate Monitor upstream and downstream water quality daily
Acidity >1000 mg/L	Increase rate of limestone application Monitor application rate Monitor upstream and downstream water quality daily Commence additional application of limestone at effected areas

Table 4. Proposed termination triggers for aerial limestone dosing (over all sites for a minimum of five days (5 monitoring events; pH > 7.8)

Trigger Value	Proposed Action
Acidity >100 mg/L	Continue limestone dosing Monitor limestone application rate Monitor water quality
Alkalinity <100 mg/L	Re-assess dosing rate Periodic dosing Monitor water quality
Alkalinity >100 g/L	Stop dosing Monitor water quality weekly Dosing equipment on standby
Alkalinity stable <20% difference in alkalinity from lake concentrations	Decrease monitoring rate of alkalinity change Equipment decommissioning

Attachment 10 - Governance Arrangements of the Emergency Framework

This Attachment is included to provide an overview of the complex governance arrangements involving the Lower Lakes and how the different groups/planning frameworks will relate to the Emergency Framework.

10.1 Managing Agencies and their roles

The key groups involved in the development and implementation of the Emergency Framework are discussed in this section. A schematic diagram is presented in Figure 14 showing the relationships of some of these key groups to the Emergency Framework.

10.1.1 Murray–Darling Basin Authority

The Murray–Darling Basin Authority (the MDBA) is a Commonwealth Statutory Authority that reports to the Commonwealth Minister for Water. The principal aim of the MDBA is to manage the Basin's water resources in the national interest through the development and implementation of the Basin Plan and management of River Murray Operations (including barrage operation at the Lower Lakes. For more information about the MDBA, go to www.mdba.gov.au.

The MDBA also directs the operations of the Lower Lakes' barrages.

The MDBA is the lead agency on the coordination of the development and implementation of the Emergency Framework. For example, the MDBA chairs and organises the meeting of the Coorong Lower Lakes Murray Mouth High Level Steering Committee (see below) at times required by the Emergency Framework. It also provides a coordination role in the implementation of the Living Murray Program which is a major potential source of environmental water for the Lower Lakes.

As the lead agency, the MDBA will lead the inclusion of the requirements of the Emergency Framework into the existing River Murray management framework.

In addition, the MDBA provides funding for South Australia to maintain certain telemetered water level and water quality monitoring stations. The data gained from these monitoring stations is analysed by the MDBA to determine current lake levels and water quality levels. Outlooks on future lake levels are then made by the Authority according to a number of water availability scenarios. Such information would be provided to the Coorong Lower Lakes Murray Mouth High Level Steering Committee to inform decision making if the Emergency Framework were to be triggered.

10.1.2 The Commonwealth

The Commonwealth, represented by the Department of the Environment, has a number of distinct roles in the Emergency Framework. The first role is as a member of the Coorong Lower Lakes Murray Mouth High Level Steering Committee where its representative partakes in the endorsement of matters under the Emergency Framework alongside the state governments and the MDBA.

The second role is as the administrator of the *Environment Protection and Biodiversity Conservation Act 1999*, whereby the Department recommends matters to the Minister about whether or not a proposed action should proceed. This role will be triggered if a proposed management action has the potential to impact on matters of national environmental significance.

A third role, involves the management of the Commonwealth Environmental Water holdings, which are administered by the Commonwealth Environmental Water Office. This is an important role in that these holdings generally comprise the majority of annual environmental water allocation available for the Lower Lakes.

The fourth role is as the administrators of the Coorong, Lower Lakes, Murray Mouth (CLLMM) Recovery Project, which makes funding available for scientific assessments, management actions as well as monitoring in the Lower Lakes.

10.1.3 Government of South Australia

The Environment Protection Authority (EPA) and the Department for Environment, Water and Natural Resources (DEWNR) will also have regulatory roles to ensure that any implemented management actions under the Emergency Framework meet legislative requirements. For example, the EPA will be required to impose water quality monitoring requirements if actions such as the construction of regulators are required, as occurred in the last drought.

The South Australian Government is manually monitoring water levels and water quality as part of the CLLMM Recovery Project until 2016.

10.1.4 SA Water Corporation

As agent of the SA Minister for the River Murray, SA Water Corporation designs, constructs, operates and maintains the Lower Lakes Barrages and under the direction of the MDBA.

10.1.5 Murray-Darling Basin Ministerial Council and Basin Officials Committee

The Murray–Darling Basin Ministerial Council comprises ministers from the states and Commonwealth. Its key role is to consider and determine outcomes and objectives on major water and natural resource management policy issues of common interest to the Basin States.

The Basin Officials Committee (BOC) is a group made up of senior members of the different state governments and the Australian Government in the MDB. Its principle role is to advise Ministerial Council in relation to water and other natural resource management issues of common interest to the Basin States.

Both Ministerial Council and BOC are involved in the approval of the Emergency Framework and will be involved in any future revisions. In particular, BOC will be the decision making body with regard to the triggering of the Emergency Framework when the Lower Lakes reach emergency water levels (i.e. 0.0m AHD). It will be upon BOC's direction that the Coorong Lower Lakes Murray Mouth High Level Steering Committee (see below) will be engaged to provide direction to the emergency response to avoid and manage acidification.

Under the Emergency Framework, the Authority may need to give appropriate direction to provide for the operation of the barrages or delivery of water in order to implement HLSC-endorsed management actions. If current agreed barrage operation rules or water sharing arrangements do not permit such actions, then changes to rules may need to be approved by the BOC or Ministerial Council.

10.1.6 Coorong Lower Lakes Murray Mouth High Level Steering Committee

The Coorong Lower Lakes Murray Mouth High Level Steering Committee will provide oversight and advice with regard to the review of monitoring information, assessment of the timeframes and proposed management actions when directed by BOC. Endorsement of management actions for the Emergency Framework would be made on a consensus-basis with advice provided to the relevant decision makers. For example, the High Level Steering Committee previously met on a regular basis during 2008-2010 to discuss current and forecast lake conditions and to provide advice regarding management decisions under the original strategy (see Attachment 2). Upon conclusion of the drought the focus of the High Level Steering Committee has been to provide advice regarding the development of the Emergency Framework. The High Level Steering Committee consists of high level officials from the Authority, the Commonwealth and the state governments of South Australia, Victoria and New South Wales.

10.1.7 Water Liaison Working Group

The Water Liaison Working Group is established to advise BOC, through the Authority on its functions in relation to river operations for the River Murray System, including:

- water accounts (including at the State and intervalley scales)
- assessments of water resources availability to States under agreed inflow scenarios
- hydrometric data collection and management
- operational plans, guidelines or policies concerning any aspect of the distribution of waters or River Murray System operations
- extra-ordinary river operations, water sharing or water accounting issues that may be referred to it from time to time
- any other functions or matters agreed and referred to it by the Basin Officials Committee.

It is comprised of river operations representatives from the state governments and state Authorities such as SA Water Corporation.

Under the Emergency Framework, the Water Liaison Working Group could be requested by the MDBA to provide advice regarding the triggering of the Emergency Framework. In addition, it could help investigate water accounting arrangements for a proposed environmental watering if it was deemed out of the ordinary.

10.1.8 Murray Darling Basin Coordinating Committee (MDBCC)

The role of the MDBCC is to provide strategic leadership and coordination with respect to the South Australian Department of Environment, Water and Natural Resources (DEWNR) Murray Darling Basin policy, planning, services and initiatives. The committee ensures strong science, monitoring and information sharing across the Department and a forum for the collaborative development and endorsement of high level strategies.

It also provides advice and information to the South Australian BOC member, the Chief Executive, Executive, and South Australia Murray-Darling Basin Natural Resource Management Board about relevant issues, risks and opportunities that will impact on DEWNR. Membership comprises of senior managers within DEWNR.

10.1.9 South Australian River Murray Operations Working Group

The South Australian River Murray Operations Working group (chaired by DEWNR), consists of managers, policy officers, operations officers, coordinators and senior scientists from DEWNR, SA Water, Primary Industries and Resources, South Australian Murray Darling Basin and the South Australian Research and Development Institute.

The key role for this group is to develop and provide input on routine and day-to-day decisions relating to river operations in South Australia. This working group is also responsible for the development of the South Australian Annual River Murray Operating Plan (see below).

10.1.10 CLLMM Steering Committee

A CLLMM Steering Committee has been established with South Australian membership at the senior executive level to assist in the ongoing monitoring of the CLLMM Recovery Project. The CLLMM Steering Committee has a representative that is also part of the Coorong Lower Lakes Murray Mouth High Level Steering Committee to ensure effective transition of information back to the South Australian CLLMM Steering Committee. This Committee provides advice and endorsement on planning, operational delivery, integration, and general project matters. This Committee can also provide advice and make recommendations to the Chief Executive’s NRM Group on matters related to the implementation of the NRM Projects and matters of relevance to the site, for example, the initiation of the Real Time Management Strategy.

Lower level governance arrangements ensure there is engagement with and feedback to community organisations and advisory groups who provide advice, endorsement of proposed decisions or input into decision-making.

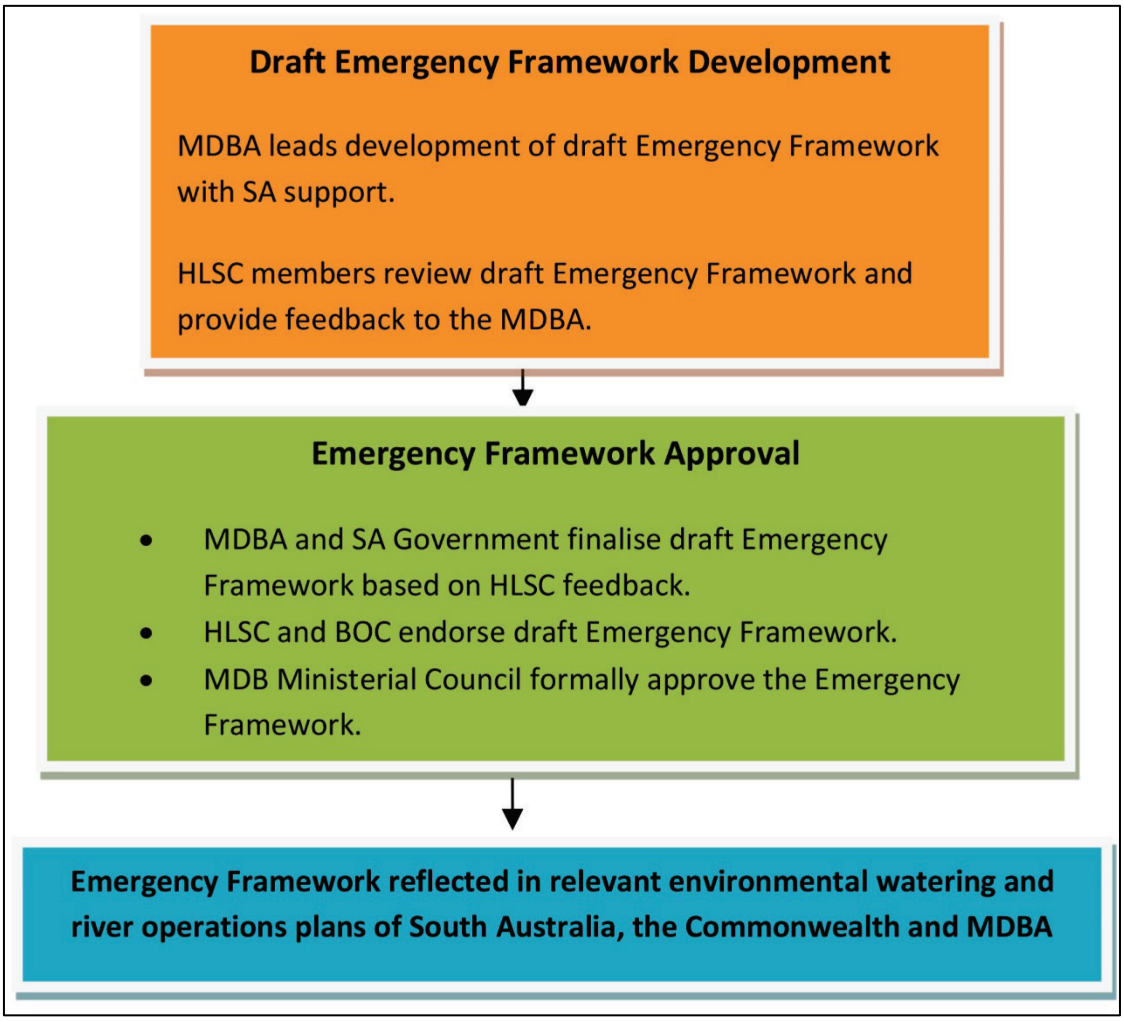

Figure 14: The Emergency Framework development and approval process

10.2 The Lower Lakes Planning and Management Framework

This section outlines how the Emergency Framework relates to the planning and management framework surrounding the CLLMM site. It discusses the legislative context and the long-term planning framework as well as the annual planning activities which will have relationships with the development and implementation of the Emergency Framework. Figure 15 provides a visual representation of these relationships.

The Murray–Darling Basin Ministerial Council originally requested the Murray–Darling Basin Commission (now MDBA) to develop risk management strategies and future management options for the CLLMM Site. In November 2008, Ministerial Council approved the Real Time Management Strategy to avoid acidification in the Lower Lakes. In doing so they also requested that the strategy be reviewed and updated. This new version, the Emergency Framework, is a result of that request.

10.2.1 Legislative requirements

Water Act 2007

The *Water Act 2007* implements a number of major reforms including the preparation of the Basin Plan, the establishment of the MDBA and the Commonwealth Environmental Water Office (CEWO) as well as a number of other key initiatives. The Water Act includes a number of objects; one of which is to give effect to international agreements. Given the Lower Lakes are part of a Ramsar listed wetland, the Emergency Framework helps to achieve this object by providing a mechanism with which to protect the Lower Lakes during times of severe drought.

Environment Protection and Biodiversity Conservation Act 1999

Consideration may need to be given to obtaining necessary approvals for particular management actions under the Emergency Framework. Central to this, are the requirements of the *Environment Protection and Biodiversity Conservation Act 1999 (the EPBC Act)* given that the area is a site of National Environmental Significance. Any management action proposed under this Emergency Framework that is considered to potentially have a significant impact on the Lower Lakes' ecological character will need consideration under the EPBC Act. This will require the proponent to refer the proposal for consideration and undertake the preparation of an environmental impact statement. For example, during the drought of 2006-2010, the Government of South Australia obtained approvals for the construction of regulators in the Goolwa Channel and Narrung Narrows in order to maintain water levels and prevent the exposure of potentially acidic sediments.

State legislation

Other approvals may also be required by the Environment Protection Authority or other relevant bodies in South Australia; and all approvals will be the responsibility of the relevant proponent. The nature of the proposed action will be the determining factor in the identification of the proponent and the type of approval needed.

10.2.2 Management Plans

Basin Plan

The Basin Plan has been developed in response to a need to reduce the over-allocation of water resources and make sufficient water available to water-dependent ecosystems in the Murray–Darling Basin. In determining how recovered water will be made available to the ecosystems of the Basin, the Basin Plan (chapter 7) requires the development of:

- a Basin-wide Environmental Watering Strategy developed by the MDBA
- Long Term Watering Plans for water resource plan areas, developed by the States
- Annual Environmental Watering Priorities for water resource plan areas, developed by the States
- Annual Environmental Watering Priorities for the entire Basin, developed by the MDBA.

The above requirements of the Basin Plan that are applicable to the South Australian component of the River Murray will complement the Emergency Framework in that there will need to be identification of water requirements, ecological objectives and targets that aim to prevent exposure of acid producing sediments.

Through the recovery of water for the environment, MDBA modelling shows that the Lower Lakes will receive more water in the future, than compared with the recent past. Such water is expected to dramatically reduce the potential for Lake Alexandrina to drop below 0.0m AHD under a 2750 GL recovery scenario.

The Coorong, Lower Lakes and Murray Mouth Long Term Plan

The Coorong, Lower Lakes and Murray Mouth Long Term Plan was developed to provide a clear direction for the future management of the region as a healthy, productive and resilient wetland of international importance (DEH 2010a).

This plan has enabled the development of knowledge about the management of the Lower Lakes and also informed the formulation of management practices to avoid acidification such as acidification thresholds and remediation methods.

CEWO Environmental Water Delivery Documents

The CEWO has prepared documents for the use of their environmental water entitlements at specific locations to ensure the efficient use of the water for targeted ecological objectives according to different water availability scenarios.

It should be noted that these documents are aspirational and identify the volumes of water that ideally should be provided to a site. The main factors influencing whether or not a particular site will receive water include availability of water allocation, delivery constraints and resilience/condition of the ecosystems at that site and at the other sites.

For more information on the CEWO Environmental water delivery: River Murray – Coorong, Lower Lakes and main channel below Lock 1, see: http://www.environment.gov.au/ewater/publications/ewater-delivery-river-murray.html.

TLM Environmental Water Management Plans

The Living Murray partners have prepared plans for the use of TLM environmental water entitlements for the six Icon Sites (of which the CLLMM is one) to ensure the efficient use of the water for targeted ecological objectives according to different water availability scenarios.

Like the CEWO Delivery Documents, these plans are aspirational and identify the volumes of water that ideally should be provided to a site. The main factors influencing whether or not a particular site will receive water include availability of water allocation, delivery constraints and resilience/condition of the ecosystems at that site and at the other sites.

For more information on the TLM Lower Lakes, Coorong and Murray Mouth Environmental Water Management Plan see: http://www.mdba.gov.au/about-basin/environmental-sites/lower-lakes-coorong-and-murray-mouth.

South Australia's River Murray Operating Strategy

South Australia's River Murray Operating Strategy provides an overarching strategic framework for transparent and coordinated operations of the River Murray system from the South Australian border to the Murray Mouth, taking into account a range of potential flow scenarios and the competing needs of all water users.

It is developed for each three year period (currently 2012-15) and underpins South Australia's River Murray Annual Operating Plan (see below) and is current until 2015 but may be updated as required. The River Murray Operating Strategy will incorporate a link to the Revised Real-time Management Strategy to Avoid Acidification in the Lower Lakes for very/extreme dry periods.

There is no legislation that requires South Australia to develop this River Murray Operating Strategy. It will also help inform the South Australian components of the MDBA's River Murray System Annual Operating Plan (see below).

10.2.3 Implementation Plans

Lower Lakes Operating Strategy

The Lower Lakes Operating Strategy, although not yet developed, is envisaged to document best-practice operating actions in order to improve the achievement of ecological outcomes at the Lower Lakes. It is to be developed by South Australia, the MDBA and the Commonwealth, in consultation with the states of NSW and Victoria. It will incorporate modelled ecological objectives consistent with the Environmental Water Management/Delivery plans described above; but will be concerned with the implementation of actions to achieve those objectives.

As an example, it will include details of the modelling and operational procedures for initiatives such as variable lake level operating (conceived under the CLLMM Long Term Plan); fishway operation; salinity management and acid sulfate soils management. It will also include likely management actions for those above mentioned initiatives applicable to a range of water availability scenarios. It is planned that this Emergency Framework will be a section of the Lower Lakes Operating Strategy and document the management actions in the extreme dry water availability scenario.

This information can be used to inform the development of detailed annual proposals for environmental water as well as include the step by step procedures for river operators to implement the management actions that involve water infrastructure.

Annual environmental water planning

Each year, the South Australian Government prepares proposals to environmental water holders for a share of the allocations held by TLM and the CEWO. These proposals are considered against a number of prioritisation criteria and it is key to note that the water holders also provide water to other sites upstream (for example, Chowilla floodplain, Koondrook-Perricoota-Gunbower Forest, etc) that are involved in the annual proposals process.

When triggered, the Emergency Framework will prompt the South Australian Government to highlight that environmental water will be required to maintain critical lake levels and avoid acidification. However, it cannot be construed that if the Emergency Framework is triggered then the Lower Lakes will receive the desired amount because water availability is finite, delivery constraints may apply and other upstream sites require water also.

MDBA River Murray System Annual Operating Plan

Prior to each water year, the MDBA releases the River Murray System Annual Operating Plan (1 June to 31 May) and this plan describes how the entire River Murray System may be operated under a number of assumed water availability scenarios in the coming year, based on the conditions leading up to the beginning of the water year.

If the Emergency Framework is, or is likely to be triggered in the coming year, this river operations plan will discuss the possible actions that might be implemented to prevent or manage the effects of acidification in the Lower Lakes.

South Australia's River Murray Annual Operating Plan

The South Australian Government prepares a similar annual operations plan to the MDBA, but with more detail relating to likely South Australian River Murray operations in a water year. In particular, this annual operating plan, describes the range of actions that may be undertaken under certain high and low flow situations to achieve desired outcomes.

Figure 15: Relationship of Real time management strategy with the existing planning and management framework