What is our goal for the Coorong Lower Lakes and Murray Mouth?

The goods and services that drive the regional economy and support local social systems stem largely from a healthy and functioning environment. It is therefore critical that our primary focus is to conserve the species, ecological communities and ecosystem services of the site. In doing so, our actions will contribute significantly to regional social and economic wellbeing in the long term

Our goal therefore is to secure a future for the Coorong, Lower Lakes and Murray Mouth as a healthy, productive and resilient wetland system of international importance.

How this goal translates to outcomes at the site will depend on the future climate, how the extent of freshwater availability affects the ecological character of the site and what is realistic to achieve. A more precise goal for the site based on the predicted climatic scenarios will be developed through consultation with the community and scientists and form part of the long-term plan.

The table below provides a preliminary description of the possible implications to the Ecological Character of the Coorong, Lower Lakes and Murray Mouth for each of the three CSIRO modelled future climatic scenarios (wet – median – dry) and the extreme dry situation currently being experienced.

It should be noted that this table is based on the current water allocation arrangements and does not incorporate water recovery targets being achieved by the Living Murray initiative or arrangements being considered through the development of the Murray Darling Basin Plan. For example, it may be possible to improve outcomes in terms of Ecological Character by improving water allocation arrangements for the dry and/or median scenarios.

Climatic Scenario	Overview	Possible implications to Ecological Character of the Coorong, Lower Lakes and Murray Mouth	Implications for the Coorong, Lower Lakes and Murray mouth
Wet 2030 Model Scenario (CSIRO 2008)	mean total end of system flow = 5,550 GL/yr	• Water levels in Lake Alexandrina maintained between 0.3 and 0.85mAHD in most years. In some years water levels may be higher due to the sheer volume of water available. • Wetland systems (including Lakes Alexandrina and Albert, the Coorong, the Murray Mouth and Estuary, the Goolwa Channel and the Tributaries) connected, healthy, resilient and productive. • Ruppia species present in both the North Lagoon and South Lagoon of the Coorong. The salinity gradient present in the lagoons promotes the survival of the diversity of biota the Coorong is renowned for.	• 117.3% of mean flow under current development and historic climate at Murray mouth
Median 2030 Model Climate (CSIRO 2008)	mean total end of system flow = 3,482 GL/yr	• Water levels in Lake Alexandrina maintained between 0.3 and 0.85mAHD for more than 50% of the time. • Wetland systems (including Lakes Alexandrina and Albert, the Coorong, the Murray Mouth and Estuary, the Goolwa Channel and the Tributaries) connected during these periods. Outside of these times, the Coorong, Murray Mouth and Estuary could experience periods of disconnection. • Dredging required to maintain an open Murray Mouth sometimes. • Ruppia would start to disappear from the South Lagoon of the Coorong	• 73.6% of mean flow under current development and historic climate at Murray mouth • severe drought inflows to the lower lakes (i.e. < 1,500 GL) increase to 13% of years • slightly increased the average period between flood events that flush the Murray mouth • maximum period between flood events that flush the Murray mouth increased to nearly 1 in 8 years • average annual volumes of environmentally beneficial floods close to halved
Dry 2030 Model Scenario (CSIRO 2008)	mean total end of system flow = 1,417 GL/yr	• Water level in Lake Albert dropped to levels close to the acidification trigger of -0.5mAHD with water being pumped from Lake Alexandrina into Lake Albert to avert acidification of the latter i.e. these wetland systems would be artificially connected • Water levels in Lake Alexandrina dropping • Flows over the barrages would occur approximately every three years in ten. • Dredging would be required to maintain an open Murray Mouth most of the time. • The ecology of the Coorong would likely be significantly altered, with Ruppia species almost absent from the South Lagoon and contracting from the North Lagoon.	• 29.9% of mean flow under current development and historic climate at Murray mouth • increase in cease to flow frequency at Murray mouth to 70% of time. • severe drought inflows to the lower lakes (i.e. < 1,500 GL) increase to 33% of years • increased the average period between flood events that flush the Murray mouth to 1 in 3 years • maximum period between flood

Climatic Scenario	Overview	Possible implications to Ecological Character of the Coorong, Lower Lakes and Murray Mouth	Implications for the Coorong, Lower Lakes and Murray mouth
			events that flush the Murray mouth increased to over 1 in 16 years
CLLMM Extreme-Dry Scenario	mean total end of system flow = 336 GL/yr	• Lake Albert disconnected from Lake Alexandrina • Lake Alexandrina a shallow water body disconnected from Lake Albert, the Coorong, Murray Mouth and Estuary, the Goolwa Channel and the Tributaries • Large areas of exposed acid sulfate soils in Lakes Alexandrina and Albert, the Goolwa Channel and Tributaries • No flows over the barrages most of the time. • Coorong becomes hypermarine, and the salinity gradient that supports the diversity of species characteristic of the Coorong non-existent in the South Lagoon and parts of the North Lagoon.	• severe drought inflows to the lower lakes (i.e. < 1,500 GL) increase to 100% of years

Management response to a 'wet, 'median', 'dry' and 'extreme dry' future climatic scenario

Presented below is a table of draft management actions that have been developed based on the best currently available scientific information and with the advice of local community members. The actions presented here do not represent a final management response, nor do they represent a formal South Australian Government position, rather they are provided as a prompt for further discussion with the community, scientists, industry groups and other government agencies (i.e. local government and the Australian Government).

Guided by the ideas put forward by scientists, the community and government agencies, the *Directions for a healthy future* document proposed core elements which need to be in place to ensure that the Coorong, Lowe Lakes and Murray Mouth can deal with any future climatic scenario. These Core Elements also retain, to the maximum extent practicable, the ecological values which make this area a wetland of international importance, and promote the intention to manage this site as one interconnected system.

For ease of presentation only, the actions listed here have also been grouped according to the components of the site (Coorong and Murray Mouth, Lake Albert, Lake Alexandrina, Tributaries-Finniss River and Currency Creek). This is so that those with an interest in a particular location can see which actions are proposed for these locations.

As a result of feedback received during public consultation on the *Directions for a healthy future* document in May 2009, the six Core Elements have been refined. These are reflected in the headings used in the table below.

In the tables below, Y = Yes (the action would be undertaken under a particular scenario) and N = No (the action would not be undertaken under a particular scenario)

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A. Management Actions: Coorong & Murray Mouth

Core Element: Freshwater provided to the Lakes & Coorong and managing variable lake levels								
No.	**Management Action**	**Description**	**Rationale**	Assumption/Risk	**Climatic Scenario** (Wet, Median, Dry, Extreme Dry)			
					W	**M**	**D**	**ED**
A1	**Increase diversion of the water from the South East Drainage system**	Restoration of surface water flow path from wetlands of the Upper South East to the South Lagoon of the Coorong	Reduction of salinity in South Lagoon	Reduction in salinity dependent on volume, quality and timing of inflows Requires further investigation/consideration. Contribution of freshwater inflow may not be significant. Water quality issues & implications. Need to consider possible impacts on Upper South East wetlands. Feasibility assessment underway.	**N**	**Y**	**Y**	**Y**
A2	**Increased freshwater provided from upstream in the MDB (Basin Plan, Water for the future, buy backs etc)**	Secure freshwater from upstream of the Coorong, Lower Lakes and Murray Mouth –through buybacks, the Basin Plan, Water Allocation Planning processes (Links to B1, C1& D1)	Short-term – Reduces salinity within the wetland system, including the Coorong. submerges Acid Sulfate Soils Long-term - Delivery of freshwater to the site is the preferred option for establishing a healthy, productive and resilient wetland of international importance. Re-establishes salinity gradient within the Coorong that makes it a productive estuarine system, Secures the future of	Requires feasibility assessment	**W**	**M**	**D**	**ED**
					Y	**Y**	**Y**	**Y**

			communities and industries dependent on the wetland system.					
A3	**Connect Lake Albert to the North Lagoon of the Coorong**	Construct a channel linking Lake Albert to the North Lagoon of the Coorong and discharge water from Lake Albert to the North Lagoon. Return flows would be prevented by design.	High River Murray flows from Lake Alexandrina could be delivered directly to the North Lagoon via Lake Albert.	Would only be possible when sufficient flows were available. Impacts on ecological character of the Estuary, the Murray Mouth?	**W** **Y**	**M** **Y**	**D** **N**	**ED** **N**

Core Element: The Murray Mouth Open and connecting the Coorong, River and Lakes to the Sea								
No.	**Management Action**	**Description**	**Rationale**	**Assumption/Risk**	**Climatic Scenario** (Wet, Median, Dry, Extreme Dry)			
A4	**Dredging – existing strategy**	Dredge the Murray Mouth in accordance with existing procedures.	Murray Mouth needs to be kept open when insufficient river flows are available to flush the Murray Mouth. This is to maintain system connectivity, which is critical for a healthy, productive and resilient wetland.	** Needs to be in accordance with an existing agreement with the MDBA Feasibility assessment underway.	**W** **N**	**M** **Y**	**D** **Y**	**ED** **Y**
A5	**Dredging – increase channel dimensions**	Dredge the Murray Mouth to establish and maintain mouth channels that are larger in size, and to get greater penetration of tidal flows along the Coorong.	Murray Mouth needs to be kept open when insufficient river flows are available to flush the Murray Mouth. This is to maintain system connectivity, which is critical for a healthy, productive and resilient wetland.	Increased penetration of tidal flows along the Coorong may help to re-establish the salinity gradient critical to maintaining estuarine productivity. Feasibility assessment underway	**W** **N**	**M** **Y**	**D** **Y**	**ED** **Y**

A6	**Dredging with sand fluidisation**	As an adjunct to dredging, fluidise sand (by using pump and pipe infrastructure to inject water or air into the sand to cause re-suspension) to use the natural flow and enhance its capacity to move sand seawards.	Murray Mouth needs to be kept open when insufficient river flows are available to flush the Murray Mouth. This is to maintain system connectivity, which is critical for a healthy, productive and resilient wetland.	Feasibility assessment underway	**W**	**M**	**D**	**ED**
					N	**Y**	**Y**	**Y**
A7	**Channel dredging with River Mouth Training Walls**	Construct River mouth training walls to stabilise and maintain the entrance channel and improve navigability through the Murray Mouth. Dredge the Murray Mouth and inner channel to establish a good starting environment.	Murray Mouth needs to be kept open when insufficient river flows are available to flush the Murray Mouth. This is to maintain system connectivity, which is critical for a healthy, productive and resilient wetland.	Would need a comprehensive understanding of longshore sand transport over an extended period of time to determine the need to install an ancillary sand bypassing system. Benefits for the tidal regime of the Coorong would need assessing. Feasibility assessment underway	**W**	**M**	**D**	**ED**
					N	**Y**	**Y**	**Y**
A8	**Sand bypassing with River Mouth Training walls**	Construct River mouth training walls to stabilise and maintain the entrance channel and improve navigability through the Murray Mouth. As an adjunct, install infrastructure to bypass long term net sand transport.	Murray Mouth needs to be kept open when insufficient river flows are available to flush the Murray Mouth. This is to maintain system connectivity, which is critical for a healthy, productive and resilient wetland.	Would need a comprehensive understanding of longshore sand transport over an extended period of time to determine the need to install an ancillary sand bypassing system. Feasibility assessment underway	**W**	**M**	**D**	**ED**
					N	**Y**	**Y**	**Y**

Core Element: Maintaining system connectivity and ecological function					
No	**Management Action**	**Description**	**Rationale**	**Assumption/Risk**	**Climatic**

.					Scenario (Wet, Median, Dry, Extreme Dry)			
					W	M	D	ED
A9	**Fish passages through to the Coorong at Goolwa**	Fish passages (eg. vertical slots/rock ramps) will be installed in all structures (existing and proposed) to optimise fish passage between the lakes and the Coorong.	Fish passages are essential structures to enable fish to move between different parts of the Ramsar site that have been disconnected through barrages, regulators and other devices.	Can be provided either as a structural change to the Barrages, and/or through provision for freshwater flows through the Barrage (in the order of 5-10 GL/day) during wetter scenarios. Will be constructed to work at future water levels of the Lakes, Coorong and Sea.	Y	Y	Y	Y

Core Element: Managing localised threats, especially acidification								
No.	**Management Action**	**Description**	**Rationale**	**Assumption/Risk**	**Climatic Scenario** (Wet, Median, Dry, Extreme Dry)			
					W	M	D	ED
A10	**Pumping out of the South Lagoon**	Pumping out water from the South Lagoon at a set rate every day for one year. Requires completion of actions A4-A8 (as an open Murray Mouth is essential to the success of this action).	Will lead to a reduction of salinity in the South Coorong - salinities are currently above the threshold for keystone species, such as Ruppia. Complementary action to A11.	Assumes practical application options. Questions about pump locations, pumping rates, practicalities of disposal of hypersaline water (how to pump offshore), possible implications for North Lagoon are being investigated. Feasibility assessment underway	N	N	Y	Y
A11	**Clearing of sills near Parnka Point**	Channel through the Needles (North Parnka Point) to be widened and/or deepened through dredging.	Complementary action to A10 – essential to increase mixing between the North and South Lagoons and enhance the salinity gradient within the South Lagoon	**Geo-technical limitations Dredging impacts** **Feasibility assessment underway**	W	M	D	ED
					N	Y	Y	Y

			and to ensure the success of A10.					
A12	**Transplanting of Ruppia sp.**	Propagate and plant out *Ruppia megacarpa* into the North Lagoon and *Ruppia tuberosa* into the South Lagoon.	Ruppia spp. are keystone species for the ecology of the Coorong Lagoons and are in extremely poor condition. Existing populations are not self-sustaining. Revegetation will increase their cover and thereby improve overall ecological health of the Coorong lagoons.	Assumes that the system is operable within required ecological (salinity) limits and that we have a good knowledge of the Ruppia salinity tolerances (currently being investigated) and ability to transplant. Feasibility assessment required	**W**	**M**	**D**	**ED**
					Y	**Y**	**Y**	**N**

B. Management Actions: Lake Albert

No seawater, no connection to the Coorong, retain Narrung bund until sufficient freshwater flows

Core Element: Freshwater provided to the Lakes & Coorong and managing variable lake levels					
No.	**Management Action**	**Description**	**Rationale**	Assumption/Risk	**Climatic Scenario** (Wet, Median, Dry, Extreme Dry)

B1	**Increase freshwater provided from upstream in the MDB (Basin Plan, Water for the future, buy backs etc)**	Secure freshwater from upstream of the Coorong, Lower Lakes and Murray Mouth – may be through buybacks, through the Basin Plan, through Water Allocation Planning processes (Linked to A2, C1 & D1)	Short-term – Reduces salinity within the wetland system, including Lake Albert. Submerges Acid Sulfate Soils Long-term - Delivery of freshwater to the site is the preferred option for establishing a healthy, productive and resilient wetland of international importance. Secures the future of communities and industries dependent on the wetland system.	Assumes we have a good understanding of existing ecological responses. The means of delivering water to Lake Albert will depend on the quantities available and may include removal of the bund at The Narrows, or recommencement of pumping from Lake Alexandrina.	**W**	**M**	**D**	**ED**
					Y	**Y**	**Y**	**Y**
B2	**Pumping from Lake Alexandrina**	Pump water into Lake Albert from Lake Alexandrina to avert acidification in Lake Albert.	The acidification trigger level for Lake Albert is -0.5mAHD. Pumping water from Lake Alexandrina to Lake Albert would avoid reaching this trigger point, thus avoiding acidification. However, pumping ceased on 30 June 2009: the continuing low inflows to the Lower Lakes was also bringing Lake Alexandrina closer to its trigger point. Further modelling will be undertaken to better define acidification trigger levels once results from acidity flux research investigations are obtained.	While pumping has ceased, their may be some potential to periodically pump some water from Lake Alexandrina to saturate high risk acid sulfate soil areas. Only possible when flows into Lake Alexandrina are at a level high enough to allow pumping into Lake Albert without impacting significantly on Lake Alexandrina also.	**W**	**M**	**D**	**ED**
					N	**N**	**Y**	**N**

					W	M	D	ED
B3	**Develop a framework to manage water most effectively within the site**	Develop and implement a framework to manage water most effectively within the site. Will incorporate a Lakes and Barrages Operating Strategy. (Linked to C2)	Water levels within the Lakes have traditionally been managed to provide for take by irrigators from the water bodies. Managing water levels primarily for ecological outcomes will allow for greater variation in lake levels and should lead to improved wetland health.	Operating Lake Albert at varying levels under a dry or extreme dry scenario is simply not possible. Variable water levels are more appropriately considered under wetter scenarios. Plan for developing a framework required	Y	Y	Y	Y
B4	**Reduce reliance upon Lakes for extractive uses – i.e. installation of pipeline and/or rainwater tanks etc (note that this action does NOT include the irrigation pipeline to Langhorne Creek, which is an existing action)**	Extend existing potable pipelines and the irrigation pipeline currently under construction to include all users of water extracted from the lakes. Undertake a regional water use and wastewater budget from Lock 1 to the Murray Mouth to identify 1) ways in which River Murray and tributary water use can be reduced or changed to benefit the wetland system and 2) opportunities for wastewater re-use to replace current River Murray and/or tributary water use. Options may include rainwater tanks and piping of treated wastewater to users. (Linked to C3)	Will remove reliance of all water users from the lakes and increase the reliability and quality of water supply to these users. Allows for greater flexibility in managing water levels in the lakes for wetland health.	Feasibility assessments required				

Core Element: The Murray Mouth open and connecting the Coorong, River and Lakes to the sea
The requirement to maintain an open Murray Mouth is addressed in the Coorong and Murray mouth section above.

The requirement to maintain the natural variable salinities in the Coorong in this future is addressed in the Coorong and Murray Mouth section above.

Core Element: Maintaining system connectivity and ecological function									
No.	**Management Action**	**Description**	**Rationale**	Assumption/Risk	**Climatic Scenario** (Wet, Median, Dry, Extreme Dry)			
B5	**Narrung Narrows remedial works (applies to wetter scenarios only) – remove bund, dredge narrows, undertake remedial works including modifications to ferry causeway to provide for natural flows through The Narrows**	Remove the bund between Lake Alexandrina and Lake Albert, dredge the Narrung Narrows and modify the ferry causeway to provide for natural flows through The Narrows	Improve connectivity between Lakes Alexandrina and Albert to improve the water quality and water regime in Lake Albert.	Need to consider costs of cartage and dumping of spoil etc. The ferry causeway built in 1966 reduces the funnel effect at this point, inhibits flow through The Narrows and limits the movement of water through this area.	**W**	**M**	**D**	**ED**
					Y	**Y**	**N**	**N**
B6	**Alternative to Narrung Narrows remedial works (applies to dry scenarios only) - Installation of permanent regulator at Narrung**	Construct a permanent regulator at the location of the bund between Lakes Alexandrina and Albert that can facilitate two-way wind-driven flow between the Lakes.	Allows for greater flexibility in varying water levels in the two Lakes. This has the potential to result in better water quality in one or both Lakes. May provide water savings Provides the opportunity to implement actions in one of the Lakes without impacting on the other Lake.	Assumes that this will help to be able to regulate water flows in/out of Lake Albert under dry scenarios. Regulator would be high and dry under an extreme dry scenario.	**W**	**M**	**D**	**ED**
					N	**N**	**Y**	**N**

Core Element: Managing localised threats					
No.	**Management Action**	**Description**	**Rationale**	Assumption/Risk	**Climatic Scenario** (Wet, Median,

					Dry, Extreme Dry)			
B7	**Prevention of acidification**	Install low permeability sub-surface barriers in strategic locations parallel to the shoreline to permit groundwater mounding and partial submergence of acid sulfate soils. Mound water behind shallow terraces along contour lines and distribute over sediments via perforated pipes.	Prevention is preferable to treatment.	Best means of installing barriers needs to be investigated. Permanent impacts on groundwater flow within the sediment banks may be undesirable. Some of the exposed sediment banks are of permeable sandy sediments that may not permit sustainable surface water mounding behind terraces. Need to avoid breakdown of terraces by wind or wave action.	**W**	**M**	**D**	**ED**
					N	**N**	**Y**	**Y**
B8	**Hot spot Acid Sulfate Soil mitigation (e.g. cracking clays, sands, Mono-sulfidic Black Oozes)**	Apply finely ground limestone to exposed lakebeds. This may be surface application or subsurface application. (Linked to C8)	Application of finely ground limestone will neutralise acid that has been generated.	Assumes practical application options are sufficiently effective. Questions about off site impacts, source materials. Positive and negative socio-economic impacts will need to be considered. Feasibility assessment underway	**W**	**M**	**D**	**ED**
					N	**N**	**Y**	**Y**

B9	**"Bioremediation basin"**	Allow Lake Albert to drawdown to a level that will be sustained with groundwater or surface water inflows, noting that the groundwater may be highly saline. Remediate the lake by, applying organic matter, carbonate and iron, as required for sulfate reduction to pyrite. (Linked to C7)	Application of finely ground limestone will neutralise acid that has been generated. Bioremediation will help to manage the effects of acidification. Provides approximately 170GL per year of water savings, through ceasing to pump water from Lake	Assumes practical application options are sufficiently effective. Questions about off site impacts, source materials. Positive and negative socio-economic impacts will need to be considered. Feasibility assessment underway	**W**	**M**	**D**	**ED**
					N	**N**	**Y**	**Y**

			Alexandrina. Lake Albert converted to an ephemeral wetland, which can facilitate bioremediation.					
B10	**Revegetation for Acid Sulfate Soil remediation around Lake edges**	Exposed acid sulfate soils will be direct seeded with crops or native vegetation. (Linked to C4)	Revegetation using crops and native plants will help to promote conditions that do not encourage the formation of acid and will reduce mobilisation of heavy metals. This will prepare the Lake for other management options such as saturation of exposed soils with freshwater, native revegetation (reeds, rushes, trees).	Assumes practical application options. Questions about what species to plant where for best outcomes. Need to ensure no introduction of weeds or other future issues. Positive and negative socio-economic impacts will need to be considered. Feasibility assessment underway	**W** **N**	**M** **N**	**D** **Y**	**ED** **Y**
B11	**Planting of annual crop type species on exposed areas to contain wind erosion**	Areas exposed to wind erosion will be planted with annual crop species, initially to stabilise soils. This will be followed by the planting of natives such, as sedges, to increase biodiversity. (Linked to C5)	Promotes resilience within the wetland system as it minimises the exposure of new acid sulfate soils to air.	Assumes practical application options. Questions about what species to plant where for best outcomes. Need to ensure no introduction of weeds or other future issues. Positive and negative socio-economic impacts will need to be considered. Feasibility assessment underway	**W** **N**	**M** **N**	**D** **Y**	**ED** **Y**
B12	**"NRM" activities (weed control, fencing, rabbit control to ensure success of revegetation and cropping)**	Implement integrated pest plant and animal control programs across the whole site, including both aquatic and terrestrial habitats. Develop and implement a Code of Practice for lakeshore graziers that provides for best practice for managing stock	Pest plants and animals have the potential to significantly alter the Ecological Character of the site if not controlled. Uncontrolled stock access to the Lakes	Weed control, fencing, rabbit control necessary to ensure success of revegetation and cropping Feasibility assessment underway	**W** **Y**	**M** **Y**	**D** **Y**	**ED** **Y**

		around the Lakes – would cover issues such as fencing, alternative water points, erosion control and rotational grazing. (Linked to C7)	threatens some components of Ecological Character through processes such as disturbance of acid sulfate soils, trampling, grazing and pugging.					

C. Management Actions: Lake Alexandrina

Management and mitigation of acid sulfate soils (includes treatment of eastern end of Hindmarsh Island), no seawater

Core Element: Freshwater provided to the Lakes & Coorong and managing variable lake levels								
No.	**Management Action**	**Description**	**Rationale**	Assumption/Risk	**Climatic Scenario** (Wet, Median, Dry, Extreme Dry)			
					W	**M**	**D**	**ED**
C1	**Increased freshwater provided from upstream in**	Secure freshwater from upstream of the Coorong, Lower Lakes and Murray Mouth –through buybacks,	Short-term – Reduces salinity within the wetland system, including Lake	Approach and feasibility to be scoped	**Y**	**Y**	**Y**	**Y**

	the MDB (Basin Plan, Water for the future, buy backs etc)	the Basin Plan, Water Allocation Planning processes	Alexandrina. Submerges Acid Sulfate Soils Long-term - Delivery of freshwater to the site is the preferred option for establishing a healthy, productive and resilient wetland of international importance. Secures the future of communities and industries dependent on the wetland system.					
C2	**Develop a framework to manage water most effectively within the site**	Develop and implement a framework to manage water most effectively within the site. Will incorporate a Lakes and Barrages Operating Strategy.	Water levels within the Lakes have traditionally been managed to provide for take by irrigators from the water bodies. Managing water levels primarily for ecological outcomes will allow for greater variation in lake levels and should lead to improved wetland health.	Plan for developing a framework required	**W** **Y**	**M** **Y**	**D** **Y**	**ED** **Y**
C3	**Reduce reliance upon Lakes for extractive uses – i.e. installation of pipeline and/or rainwater tanks etc**	Extend existing potable pipelines and the irrigation pipeline currently under construction to include all users of water extracted from the lakes. Undertake a regional water use and wastewater budget from Lock 1 to the Murray Mouth to identify 1) ways in which River Murray and tributary water use can be reduced or changed to benefit the wetland system and 2) opportunities for wastewater re-	Will remove reliance of all water users from the lakes and increase the reliability and quality of water supply to these users. Allows for greater flexibility in managing water levels in the lakes for wetland health.	Feasibility assessment required	**W** **Y**	**M** **Y**	**D** **Y**	**ED** **Y**

		use to replace current River Murray and/or tributary water use. Options may include rainwater tanks and piping of treated wastewater to users.						

Core Element: The Murray Mouth open and connecting the Coorong, River and Lakes to the sea
The requirement to maintain an open Murray Mouth is addressed in the Coorong and Murray mouth section above.
The requirement to maintain the natural variably salinities in the Coorong is addressed in the Coorong and Murray Mouth section above.

Core Element: Accepting variable water levels, yet maintaining system connectivity
The requirement to maintain ecological connectivity in this future is addressed in the Coorong and Murray Mouth and Lake Albert sections above.

Core Element: Managing localised threats, especially acidification								
No.	**Management Action**	**Description**	**Rationale**	Assumption/Risk	**Climatic Scenario** (Wet, Median, Dry, Extreme Dry)			
					W	**M**	**D**	**ED**
C4	**Revegetation (native) for ecosystem rehabilitation around Lake edges**	Revegetate the adjacent high elevation areas of the lake above +0. 75m AHD with native species.	Planting these areas will increase the connection between habitats within the Lake, including between aquatic and terrestrial habitats. Additional benefit of providing additional carbon and iron to the Lake system.	Assumes practical application options. Questions about what species where for best outcomes. Need to ensure no introduction of weeds or other future issues. Positive and negative socio-economic impacts will need to be considered. Feasibility assessment underway	**Y**	**Y**	**Y**	**Y**
C5	**Cropping of annual species in exposed areas**	Areas exposed to wind erosion will be planted with annual crop species, to be followed by	Promotes resilience within the wetland system as it minimises the exposure of	Assumes practical application options. Questions about what	**W**	**M**	**D**	**ED**
					N	**N**	**Y**	**Y**

	to contain wind erosion, to be followed by planting natives and increasing biodiversity	plantings of native. Species.	acid sulfate soils to air.	species where for best outcomes. Need to ensure no introduction of weeds or other future issues. Positive and negative socio-economic impacts will need to be considered. Feasibility assessment underway				
C6	**"NRM" activities (weed control, fencing, rabbit control to ensure success of revegetation and cropping)**	Implement integrated pest plant and animal control programs across the whole site, including both aquatic and terrestrial habitats. Develop and implement a Code of Practice for lakeshore graziers that provides for best practice for managing stock around the Lakes – would cover issues such as fencing, alternative water points, erosion control and rotational grazing.	Pest plants and animals have the potential to significantly alter the Ecological Character of the site if not controlled. Uncontrolled stock access to the Lakes threatens some components of Ecological Character through processes such as disturbance of acid sulfate soils, trampling, grazing and pugging.	Weed control, fencing, rabbit control necessary to ensure success of revegetation and cropping Feasibility assessment required	**W** **Y**	**M** **Y**	**D** **Y**	**ED** **Y**
C7	**Bioremediation wetlands for areas that disconnect from main water body of Lake Alexandrina**	Manage Lake Alexandrina water levels to a level that will sustain wetland function. Manage acid sulfate soils in the lake by applying limestone and cover crops, and saturation.	Application of finely ground limestone will neutralise acid that has been generated. Bioremediation will manage acidification risks and acid sulfate soils. Parts of Lake Alexandrina converted to ephemeral wetlands/swamp, which can function as Bioremediation Basins.	Assumes practical application options are sufficiently effective. Questions about off site impacts, source materials. Positive and negative socio-economic impacts will need to be considered. Feasibility assessment underway Alternative arrangements would need to be made to provide water to Lake Albert, if it were to retain water.	**W** **N**	**M** **N**	**D** **Y**	**ED** **Y**

C8	**Prevention of acidification**	Install low permeability sub-surface barriers in strategic locations parallel to the shoreline to permit groundwater mounding and partial submergence of acid sulfate soils. Mound water behind shallow terraces along contour lines and distribute over sediments via perforated pipes.	Prevention is preferable to treatment	Best means of installing barriers needs to be investigated. Permanent impacts on groundwater flow within the sediment banks may be undesirable. Some of the exposed sediment banks are of permeable sandy sediments that may not permit sustainable surface water mounding behind terraces. Need to avoid breakdown of terraces by wind or wave action.	**W**	**M**	**D**	**ED**
					N	**N**	**Y**	**Y**
C9	**Hot spot Acid Sulfate Soil mitigation (e.g. cracking clays, sand, Mono-sulfidic Black Oozes)**	Apply finely ground limestone or water to exposed lakebeds	Application of finely ground limestone will neutralise acid that has been generated. It will also help to promote conditions that do not encourage the formation of acid.	Assumes practical application options are sufficiently effective. Questions about off site impacts, source materials. Positive and negative socio-economic impacts will need to be considered. Feasibility assessment underway	**W**	**M**	**D**	**ED**
					N	**N**	**Y**	**Y**
C10	**Introduction of minimal amounts of seawater to avert acidification of Lake Alexandrina**	The minimum amount of seawater necessary will be introduced to avert acidification of Lake Alexandrina.	May avoid acidification (although could make it worse)	Further research is occurring through the seawater EIS required as part of Environment Protection and Biodiversity Conservation Act approvals. It is possible that this action could result in changes to ecological character and further planning would be required to identify recovery strategies to return the site to a functional freshwater system.	**W**	**M**	**D**	**ED**
					N	**N**	**N**	**Y**

D. Management Actions: Tributaries - Finniss River and Currency Creek

Management and mitigation of Acid Sulfate Soils, no seawater

Core Element: Freshwater provided to the Lakes & Coorong and managing variable lake levels								
No.	**Management Action**	**Description**	**Rationale**	Assumption/Risk	**Climatic Scenario** (Wet, Median, Dry, Extreme Dry)			
					W	**M**	**D**	**ED**
D1	**Increased freshwater provided from upstream in the MDB (Basin Plan, Water for the future, buy backs etc)**	Secure freshwater from upstream of the Coorong, Lower Lakes and Murray Mouth –through buybacks, the Basin Plan, Water Allocation Planning processes	Short-term – Reduces salinity within the wetland system. Submerges Acid Sulfate Soils. Long-term - Delivery of freshwater to the site is the preferred option for establishing a healthy, productive and resilient wetland of international importance. Secures the future of communities and industries dependent on the wetland system.	Approach and feasibility to be scoped	**Y**	**Y**	**Y**	**Y**

D2	**Reduce reliance upon Lakes for extractive uses – ie installation of pipeline and/or rainwater tanks etc**	Extend existing potable pipelines and the irrigation pipeline currently under construction to include all users of water extracted from the lakes. Undertake a regional water use and wastewater budget from Lock 1 to the Murray Mouth to identify 1) ways in which River Murray and tributary water use can be reduced or changed to benefit the wetland system and 2) opportunities for wastewater re-use to replace current River Murray and/or tributary water use. Options may include rainwater tanks and piping of treated wastewater to users.	Will remove reliance of all water users from the lakes and increase the reliability and quality of water supply to these users. Allows for greater flexibility in managing water levels in the lakes for wetland health.	Feasibility assessment required	

Core Element: The Murray Mouth open connecting the Coorong, Lakes and the sea
The requirement to maintain an open Murray Mouth in this future is addressed in the Coorong and Murray mouth section above.
The requirement to maintain the natural variable salinities in the Coorong in this future is addressed in the Coorong and Murray Mouth section above.

Core Element: Maintaining system connectivity and ecological function					
No.	**Management Action**	**Description**	**Rationale**	Assumption/Risk	**Climatic Scenario** (Wet, Median, Dry, Extreme Dry)

D3	**Installation of fish passage into regulators**	Fish passages (eg. vertical slots/rock ramps) will be installed in regulators to optimise fish passage between the tributaries, the lakes and the Coorong.	Fish passages are essential structures to enable fish to move between different parts of the Ramsar site that have been disconnected through barrages, regulators and other devices.		

Core Element: Managing localised threats, especially acidification								
No.	**Management Action**	**Description**	**Rationale**	Assumption/Risk	**Climatic Scenario** (Wet, Median, Dry, Extreme Dry)			
					W	**M**	**D**	**ED**
D4	**Installation of regulators to achieve soil saturation in creeks to address Acid Sulfate Soils (& removal in Year 5)**	Construct a temporary regulator from the mainland near Clayton to Hindmarsh Island, and additional low level temporary regulators at the terminal ends of Finniss River and Currency Creek to impound the first flushes from the tributaries. In a one off event, 27.5 GL of water will be pumped from Lake Alexandrina into the ponded area in July 2009 following completion of the regulators. Water in the Channel to be discharged when the water level reaches 0.70mAHD. Discharge location could be to Lake Alexandrina (via the regulator at Clayton) (as currently advised by the Commonwealth Government) or to the Murray Mouth and Coorong via the Goolwa barrage (would need to be negotiated with the Commonwealth Government).	Installation of the regulators will mitigate the acidification risks within the tributaries by inundating acid sulfate soils and minimising formation/ mobilisation of acid and heavy metal salts. Creation of a freshwater refuge area subject to operation of the regulators, and a reduction in salinity.	Assumes structures are required to address Acid Sulfate Soils. Questions about required height, construction, decommissioning and hydrodynamic implications. Positive and negative socio-economic impacts will need to be considered. An equivalent amount of water has been bought to compensate for the amount pumped from Lake Alexandrina.	**N**	**N**	**N**	**Y**

D5	**Revegetation (native) for Ecosystem rehabilitation around the tributaries**	Revegetate along the edges of the tributaries with native species	Provides an opportunity to increase the connection between habitats within the wetland system, including between aquatic and terrestrial habitats.	Assumes practical application options. Questions about what species where for best outcomes. Need to ensure no introduction of weeds or other future issues. Positive and negative socio-economic impacts will need to be considered. Feasibility assessment required	**W**	**M**	**D**	**ED**
					N	**N**	**Y**	**Y**
D6	**Cropping of annual species to contain wind erosion**	Areas exposed to wind erosion will be planted with annual crop species.	Promotes resilience within the wetland system as it minimises the exposure of acid sulfate soils to air.	Assumes practical application options. Questions about what species where for best outcomes. Need to ensure no introduction of weeds or other future issues. Positive and negative socio-economic impacts will need to be considered. Feasibility assessment required	**W**	**M**	**D**	**ED**
					N	**N**	**Y**	**Y**
D7	**"NRM" activities (weed control, fencing, rabbit control to ensure success of revegetation and cropping)**	Implement integrated pest plant and animal control programs across the whole site, including both aquatic and terrestrial habitats.	Pest plants and animals have the potential to significantly alter the Ecological Character of the site if not controlled.	Weed control, fencing, rabbit control necessary to ensure success of revegetation and cropping Feasibility assessment required	**W**	**M**	**D**	**ED**
					Y	**Y**	**Y**	**Y**
D8	**Hot spot Acid Sulfate Soil mitigation (e.g. cracking clays, sand, Mono-sulfidic Black Oozes)**	Apply finely ground limestone to exposed creek beds	Application of finely ground limestone will neutralise acid that has been generated. It will also help to promote conditions that do not encourage the formation of acid, and assist the re-establishment of key plant and animal species.	Assumes practical application options are sufficiently effective. Questions about off site impacts, source materials. Positive and negative socio-economic impacts will need to be considered. Feasibility assessment required	**W**	**M**	**D**	**ED**
					N	**N**	**Y**	**Y**

A Responsive Management Approach Based on Robust Research, Adequate Monitoring and Extensive Community Involvement

No.	Management Action	Description	Rationale	Assumption/Risk	Climatic Scenario (Wet, Median, Dry, Extreme Dry)			
					W	M	D	ED
	An adaptive management framework is under development. Community involvement aspects will be determined through consultation with			Undertake a review of the current status of Ecological Character and then monitor the recovery of Ecological Character (birds, fish, vegetation, water quality) as	Y	Y	Y	Y

	communities			a result of actions being undertaken. People and software requirements etc. Research example includes Coorong, Lakes And Murray Mouth Ecology under the direction of the Scientific Advisory Group. Research and monitoring will need to be in the order of 10% of the total budget. Community engagement, project managers, finance, procurement, policy, governance. This is to include policy work such as water allocation planning and other mechanisms.				