Amendment date: 16 Feb 2017

	Title of measure	**The Living Murray - Lindsay Island Stage 1**
	Proponent undertaking the measure	**Victoria, NSW and SA**
	Type of measure	**Supply**
1.	**Confirmation**	
	Date by which the measure entered into or will enter into operation *Must be before 30 June 2024*	The measure will be operational by 30 June 2024. The measure is operational. Commissioning of the works was completed in 2015.
	Confirmation that the measure is not an 'anticipated measure' *'Anticipated measure' is defined in section 7.02 of the Basin Plan to mean 'a measure that is part of the benchmark conditions of development'.*	Yes. It is a new project (not already included in the benchmark conditions).
	Confirmation that the proponent state(s) undertaking the measure agree(s) with the notification ***Basin Plan 7.12(3)(c)*** *Joint proposals will need the agreement of all proponents*	Yes.
2.	**Details of the measure**	
	Capacity of the measure to operate as a supply measure *'Supply measure' is defined in section 7.03 of the Basin Plan to mean 'a measure that operates to increase the quantity of water available to be taken in a set of surface water SDL resource units compared with the quantity available under the benchmark conditions of development'.*	Yes.
3.	**Description of the works or measure**	
	Lindsay Island is part of the Lindsay-Wallpolla Icon Site. The Stage 1 works were funded by the Living Murray program and aimed to maintain existing high quality habitat for native fish, increase the extent of flowing habitat on Lindsay Island by about 28 km, improve fish passage between the Lindsay Island anabranches and the River Murray and improve the condition of riparian vegetation. These works will contribute to achieving the ecological objectives that have been set for the site, focusing on in-stream habitat. The works include three new regulators: • Upper Lindsay River regulators (north and south inlets) • Mullaroo Creek regulator and fishway.	
4.	**Geographical location of the measure**	
	Lindsay Island is situated on the River Murray floodplain in north-western Victoria, near the SA border.	

5. Representation of the project in the MDBA modelling framework

The MDBA has represented the proposed infrastructure, operating strategies and water use in the MSM-BigMod model. **Attachment A** shows a schematic model representation at Lindsay Island. Spatial data (derived using a hydro-dynamic model) describes the areas inundated through the operating of the works. The areas inundated are combined with the timing of modelled operation by the Environmental Outcomes Scoring Tool to quantify the change in environmental outcomes, relative to the Benchmark environmental outcomes. No level-volume-area relationships are used in the MSM-BigMod model.

Lindsay Stage 1 operations is not modelled with a weir or lake, and hence there are no level-volume-area relationships. The storage and area in Mullaroo Creek are calculated based on flow routing and travel time shown below. As there is no regulating structure modelled, inflow to Lindsay River is routed to the downstream and returned to the river to simulate the return flow from the site to the river, again using the relationship shown in the table below.

Lindsay River		
Flow (ML/d)	**Travel time (day)**	**Area (ha)**
0	0.0	0
800	0.4	90
1300	0.4	90
1500	0.4	90
2000	0.4	90
2500	0.5	90
8082	0.6	90
19414	1.0	2840
36835	1.5	15100
54230	0.8	21600
95164	1.0	24500

The flow to Lindsay Island (Branch 81) is calculated as the sum of two separate inflows to Upper Lindsay and Mullaroo, if the inflow to Lock 7 is smaller than 15,000 ML/d. The flows are a function of the level in Lock 7 and are calculated using relationships shown in the tables below.

Level Lock 7 (mAHD)	Upper Lindsay Inflow (ML/d)
21.8	0
22.2	21
22.6	42
22.75	83
22.85	125
23	250
23.5	750
24	1600
24.5	2800
25	4300

Level Lock 7 (mAHD)	Inflow to Mullaroo (ML/d)
21.8	0
21.88	267
21.9	306
21.92	346
21.94	389
21.96	429
21.98	473
22	515
22.02	557
22.04	599
22.06	640
22.08	684
22.12	772
22.16	856
22.2	931
22.24	1006
22.28	1080
22.38	1270
22.48	1450
22.58	1640
22.68	1820
22.78	2000
22.88	2190
22.98	2370
23.08	2560
23.18	2740
23.38	3110
23.78	3950
24.58	5820

When the flow to Lock 7 is over 17,000 ML/d the flow to Lindsay is calculated as a combined anabranch and floodplain flow, which is based a relationship with the level in lock 7, shown below.

Level Lock 7 (mAHD)	Inflow Lindsay (ML/d)
21.8	0
22.1	950
22.39	1410
22.52	1753
22.78	2829
22.97	3899
23.16	5312
23.35	6753
23.44	7713
23.68	10232
24.16	15914
24.63	21596
25.16	42414
25.5	95164

A standard evaporation loss is applied by MSM–Bigmod with evaporation and rainfall calculated using monthly data from the Lake Victoria climate station and a pan evaporation factor of 0.830. Seepage is assumed to be zero.

6. Representation of each operating strategy in the MDBA modelling framework.

The operating strategy used in MSM-BigMod for Lindsay Stage 1 is shown below.

Operating strategy	Optimal frequency	Resilience period	Min river flow to operate	Equivalent natural flow
Lindsay Stage 1 (LIF)	1 in 2 yrs	4 yrs	1,000 ML/d at Lock 8 D/S	20,000 ML/d for 2 months at Lock 8 D/S

In relation to the current SDL adjustment process, the Mullaroo and Lock 7 raising is incorporated in the model.

The operating strategy, hydraulic and hydrologic models and outputs have been provided to the MDBA. Further details are available in the Lindsay-Wallpolla Islands Environmental Water Management Plan (**Attachment B**) and interim operating strategy for the icon site (**Attachment C**).

7.	Spatial data describing the inundation extent associated with the operation of the measure

The total area of inundation for Lindsay Fresh operation is 73 ha. For the purpose of calculating scaling factors for the Ecological Outcomes scoring method, the inundation areas associated with the works were combined with maps of SFI flow bands and maps representing the ecological elements used in the scoring method. The areas for the resulting hydrological assessment units (HAU) are provided in tables below.

Inundation area (ha) of HAU for LIF	SFI Flow Bands					
Ecological Element	**40,000**	**60,000**	**80,000**	**100,000**	**125,000**	**>125,000**
General health and abundance - all	59.0	13.0	1.0	0.0	0.0	0.0
Bitterns, crakes and rails	58.0	12.9	1.1	0.0	0.0	0.0
Breeding - Colonial-nesting waterbirds	59.0	13.0	1.0	0.0	0.0	0.0
Breeding - other waterbirds	58.0	12.9	1.1	0.0	0.0	0.0
Redgum Forest	2.0	0.5	0.1	0.0	0.0	0.0
Redgum Woodlands	1.9	0.5	0.1	0.0	0.0	0.0
Forests and Woodlands: Black Box	11.4	4.8	0.6	0.0	0.0	0.0
Lignum (Shrublands)	1.9	2.3	0.2	0.0	0.0	0.0
Tall Grasslands, Sedgelands and	58.0	12.9	1.1	0.0	0.0	0.0
Benthic Herblands	0.0	0.0	0.0	0.0	0.0	0.0
Short lived fish	58.0	12.9	1.1	0.0	0.0	0.0
Long lived fish	59.0	13.0	1.0	0.0	0.0	0.0

8.	Surface water SDL resource units affected by the measure

This measure identifies all surface water resource units in the Southern Basin region as affected units for the purposes of notifying supplying measures. The identification of affected units does not constitute an agreement between jurisdictions on apportioning the supply contribution, which will be required in coming months.

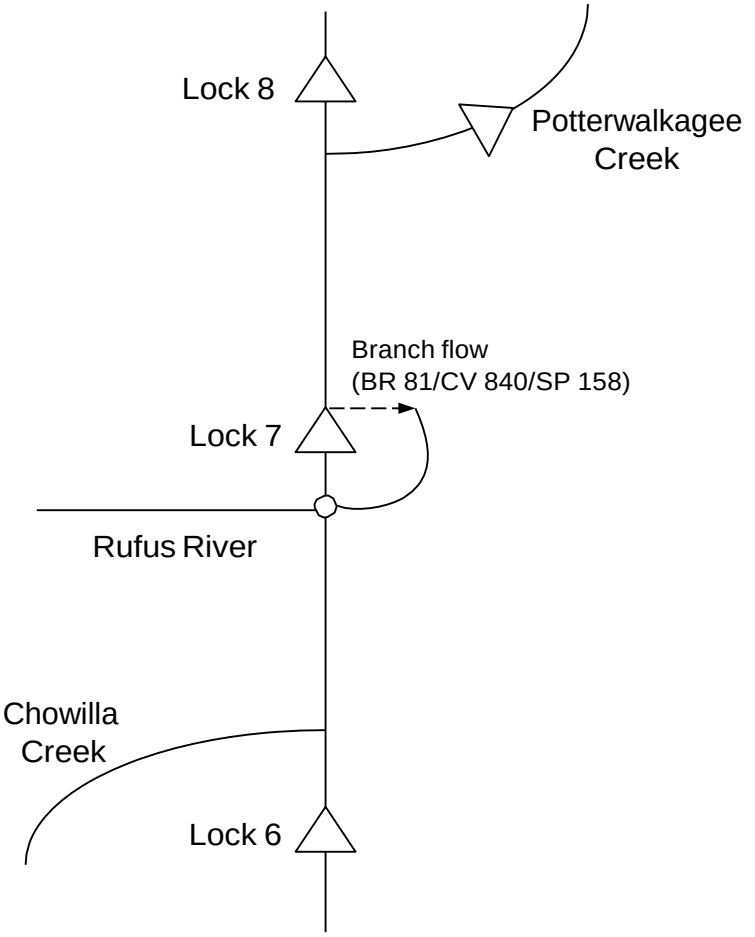
9.	Details of relevant constraint measures

Relevant constraint measures include the Hume to Yarrawonga, Yarrawonga to Wakool and Lower Murray proposals. Implementation of these constraint measures could have implications for the operating strategy at Lindsay Island.

Attachments:

A	MDBA, 2017	Lindsay Island (stage 1) representation in Murray model
B	MDBA, 2012	Lindsay-Wallpolla Islands Environmental Water Management Plan
C	Mallee CMA, 2015	Upper Lindsay Watercourse Enhancement Project Lindsay River Regulators Interim Operations Plan

Attachment A: Lindsay Island (stage 1) representation in Murray model (based on Bigmod Rev. 212)



Australian Government

MURRAY–DARLING BASIN AUTHORITY

MURRAY-DARLING BASIN AUTHORITY

Lindsay–Wallpolla Islands

Environmental Water Management Plan

February 2012

Lindsay–Wallpolla Islands

Environmental Water Management Plan

February 2012

Murray–Darling Basin Authority

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Cover image: Floodplain on Wallpolla Island

Photographer: Corey Brown © MDBA

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Contents

About this plan

This environmental water management plan consists of:

i. A long-term strategic plan, (per Clause 117 of the TLM Business Plan), which outlines the icon site's environmental water requirements and how to broadly achieve them with a combination of environmental water and works and measures.

ii. Schedules detailing operational information about the icon site such as Operating, Condition Monitoring, Risk Management and Communication Plans. These Schedules will be added to the environmental water management plan as they become available and updated to reflect learnings from the operation of works, the results of environmental waterings and the latest science.

The environmental water management plans provide context for an icon site's water planning, delivery, monitoring and consultation processes. While the environmental water management plans include proposed operating strategies, annual water planning and implementation will be responsive to changing water resource conditions, opportunities and environmental priorities throughout the season and from year to year.

This environmental water management plan and associated schedules have been prepared by TLM partner governments in consultation with the relevant stakeholders. The MDBA would like to acknowledge the significant contribution of all those involved in the development of the environmental water management plans.

Summary

The Living Murray Initiative is one of Australia's largest river restoration programs, established in 2002 following evidence of declining health in the River Murray system. The long-term goal of this program is to achieve a healthy working River Murray system for the benefit of all Australians. Since 2004, a total of $700 million has been committed to improve environmental outcomes at the six icon sites:

- Barmah–Millewa Forest
- Gunbower–Koondrook–Perricoota Forest
- Hattah Lakes
- Chowilla Floodplain and Lindsay–Wallpolla Islands
- Lower Lakes, Coorong and Murray Mouth
- River Murray Channel.

With the recovery of almost 500 gigalitres (GL) for environmental waterings, The Living Murray is in a phase of design, construction and operation of infrastructure works to facilitate environmental water delivery and maximise the associated environmental outcomes at the icon sites.

The Chowilla Floodplain and Lindsay–Wallpolla icon site spans South Australia, New South Wales and Victoria, with Chowilla in South Australia and New South Wales, and Lindsay–Wallpolla Islands in Victoria.

The icon site is important because it retains much of the area's natural character and attributes. It is typified by complex anabranch systems, including streams, billabongs and backwaters, and swamps (Victorian Department of Sustainability and Environment 2010). It has a high diversity of both terrestrial and aquatic habitats, supports populations of rare, endangered and nationally threatened species and contains heritage protected sites of cultural significance. The area is also important for its recreational and economic values.

The Lindsay–Wallpolla Islands include three separate anabranch systems within the Murray–Sunset National Park: Wallpolla Island, Mulcra Island and Lindsay Island. Wallpolla Island, Lindsay Island and Lake Wallawalla are listed in *A Directory of Important Wetlands in Australia* (Environment Australia 2001).

Environmental water management plans have been developed for each icon site with the aim of describing The Living Murray objectives and targets, water delivery arrangements and the watering regimes for each site. This document is the Lindsay–Wallpolla Environmental Water Management Plan and supersedes the Chowilla Floodplain (including Lindsay–Wallpolla Islands) Environmental Management Plan 2005–06. Although the South Australian—New South Wales (Chowilla) and Victorian components of the icon site are contiguous, separate environmental watering management plans have been prepared for each as they are managed by different jurisdictions and agencies, and have separate governance and management committee structures. Each component also has specific ecological objectives and environmental watering management options.

Altered flow regimes in the River Murray are the key threat to the values of the icon site. River regulation and water extraction have reduced the frequency and duration of natural flooding regimes across the islands, degrading flora, fauna and cultural values associated with waterways and wetlands.

A suite of works have been developed for the icon site that aims to achieve the ecological objectives set for Lindsay–Wallpolla Islands, such as increasing the diversity and abundance of wetland vegetation and maintaining the current condition and extent of river red gum (*Eucalyptus camaldulensis*) communities. These works include:

- Regulators and ancillary works on Mulcra Island that enable inundation of the floodplain when Lock 8 is raised at regulated flows. This will water 800 ha of floodplain and increase flows through 20 km of Potterwalkagee Creek.
- Regulators at Horseshoe Lagoon (Wallpolla Island) and Webster's Lagoon (Lindsay Island) that can be flooded by the weir pools of locks 9 and 6 respectively. Regulators allow annual drying phases to be introduced, as would have occurred under natural conditions. Wetlands can also be surcharged using temporary pumps to water the large fringing river red gums.
- Replacing pipe culverts on the inlet channels of Lake Wallawalla (Lindsay Island) with large regulators to allow water to be retained in the wetland when it fills from high flows in the Lindsay River. This will water fringing vegetation and provide more than 800 ha of wetland habitat. The regulators also facilitate pumping environmental water into the lake during long dry periods.

- Replacing stop banks with regulators on two Lindsay River inlets to increase flows into the upper Lindsay River. This will provide an additional 20 km of anabranch habitat when Lock 7 is raised at regulated flows. An existing fixed crest weir on the Mullaroo Creek will also be replaced with a regulator and fishway to maintain high quality habitat for Murray cod (*Maccullochella peelii*).

Together, the works will enable more natural water regimes to be reinstated across Lindsay–Wallpolla Islands, targeting over 1,800 ha of floodplain and wetlands. Operation will include maintaining base flows and providing spring freshes in anabranches on Mulcra and Lindsay islands (Potterwalkagee Creek and Lindsay River), broadscale floodplain inundation at Mulcra Island and managing the water regime of regulated wetlands (Wallpolla Horseshoe Lagoon, Mulcra Horseshoe Lagoon, Webster's Lagoon and Lake Wallawalla).

Annual ecological monitoring occurs across the icon site, through the Icon Site Condition Monitoring Program. Monitoring examines the condition of waterbird and fish populations, and vegetation communities, tracking the progress towards achieving the ecological objectives for the icon site. It is anticipated that additional monitoring will be undertaken during and following watering events, including activities such as groundwater monitoring, compliance monitoring and vegetation response (as part of the Native Vegetation Offset Management Plan).

The Environmental Water Management Plan promotes an adaptive management approach through 'learning by doing'. Ecological information collected during and after environmental watering events will be incorporated into the icon site operating strategy to ensure it remains relevant and effective.

The Environmental Water Management Plan recognises the importance of ongoing community consultation and communication in the delivery of the plan's components. Several committees have been established for Lindsay–Wallpolla Islands. These committees (together with The Living Murray Indigenous Facilitator, various project working groups, other established community groups and activities under communication plans and strategies) provide a mechanism for consulting with a range of community and agency stakeholders.

1. The Living Murray

The Living Murray (TLM) Initiative is one of Australia's most significant river restoration programs. Established in 2002, it is a partnership of the Australian Government and the governments of New South Wales, Victoria, South Australia and the Australian Capital Territory. The initiative is coordinated by the Murray–Darling Basin Authority (MDBA). The long-term goal of this program is to achieve a healthy working River Murray system for the benefit of all Australians.

The Living Murray aims to improve the environmental health of six icon sites chosen for their significant ecological, cultural, recreational, heritage and economic values:

- Barmah–Millewa Forest
- Gunbower–Koondrook–Perricoota Forest
- Hattah Lakes
- Chowilla Floodplain and Lindsay–Wallpolla Islands (including Mulcra Island)
- River Murray Channel
- Lower Lakes, Coorong and Murray Mouth.

Through its First Step water recovery initiative, TLM has acquired a water portfolio consisting of environmental water entitlements. As of May 2011, there was 478.97 gigalitres long-term Cap equivalent (LTCE), with another 7.1 GL to be recovered in 2011–12. The actual volume of water available against these entitlements depends on the allocations.

This portfolio will be used to achieve environmental objectives at the icon sites. Regulating structures, water delivery channels and fishways, known as works and measures, will deliver and manage the environmental water at the icon sites. On-ground works for each icon site were being progressively constructed from 2010 to 2012. The success of the environmental watering against the objectives is monitored using fish, birds and vegetation as an overall indicator of the icon site's health.

Once finalised, TLM will seek to align itself to the requirements of the Basin Plan Environmental Watering Plan.

Further information on TLM is available on the MDBA website at <**www.mdba.gov.au/programs/tlm**>.

Figure 1.1: Location of The Living Murray icon sites

The Living Murray icon site environmental water management plans

The Lindsay–Wallpolla Islands Environmental Water Management Plan establishes priorities for the use of TLM water within the icon site, and identifies environmental objectives and targets (where appropriate), water delivery options and regimes for the site that can use The Living Murray water portfolio.

Development of the environmental water management plans has been coordinated by MDBA in consultation with the Environmental Watering Group to ensure a consistent approach to planning and management across the icon sites.

This revision builds on previous iterations of the Lindsay–Wallpolla Islands Environmental Water Management Plan (previously known as 'environmental management plans') and incorporates consultation, research into icon site key species, learning from water behaviour modelling and outcomes from previous environmental watering.

The Lindsay–Wallpolla Islands Environmental Water Management Plan reflects the larger volume now held in The Living Murray water portfolio, and uses TLM works and measures (as construction is completed) and monitoring information gathered at the icon site.

This environmental water management plan deals specifically with the Victorian component of the Chowilla–Lindsay–Wallpolla icon site—Lindsay–Wallpolla Islands. A separate environmental water management plan for the Chowilla Floodplain has been prepared by South Australia and New South Wales.

Planning context and legislation framework

The Australian Government, Victoria, New South Wales and South Australia have comprehensive legislative frameworks addressing natural resource and environmental management. For activities associated with management of The Living Murray icon site, including construction of works under TLM, the principal pieces of legislation and planning strategies are detailed below.

Agreements

Ramsar Convention on Wetlands of International Importance

The Ramsar Convention on Wetlands of International Importance (the Ramsar Convention) is an international treaty with the broad aim of halting the worldwide loss of wetlands and to conserve, through wise use and management, those that remain. For wetlands to be listed as Ramsar wetlands, they need to be representative, rare or unique in terms of their ecological, botanical, zoological, limnological or hydrological importance. Ramsar-listed wetlands can be natural, artificial, permanent or temporary swamps, marshes, billabongs, lakes, salt marshes or mudflats classified as wetlands.

Signatories to the Ramsar Convention, including Australia, are required to formulate and implement their planning so as to promote the conservation of wetlands included in the Ramsar list, and as far as possible the wise use of all wetlands in their territory. Ramsar wetlands in Australia are protected under the *Environment Protection and Biodiversity Conservation Act 1999* as a matter of national environmental significance (Department of the Environment, Water, Heritage and the Arts 2009).

Bilateral migratory bird agreements

Over the past 30 years Australia has signed three bilateral migratory bird agreements in an effort to conserve migratory birds in the east Asian and Australian regions: China–Australia Migratory Bird Agreement (signed in 1986); Japan–Australia Migratory Bird Agreement (signed in 1974); and the Republic of Korea–Australia Migratory Bird Agreement (came into effect in 2007).

These agreements protect terrestrial, water and shorebird species that migrate from Australia to Japan or China. The Japan–Australia Migratory Bird Agreement also provides for cooperation on the conservation of threatened birds, while the Republic of Korea–Australia Migratory Bird Agreement ensures conservation of migratory birds and collaboration on the protection of migratory shorebirds and their habitat (Department of Sustainability, Environment, Water, Population and Communities, 2011a).

Murray–Darling Basin agreements

The Murray–Darling Basin Ministerial Council established The Living Murray in 2002. In 2004, the Australian Government and the governments of New South Wales, Victoria, South Australia and the Australian Capital Territory signed the Intergovernmental Agreement on Addressing Water Over-allocation and Achieving Environmental Objectives in the Murray–Darling Basin, which gave effect to a funding commitment (made in 2003) of $500 million over five years for TLM. The Living Murray program's First Step aimed to recover 500 GL of water for the River Murray and focused on improving the environment at the six icon sites. A supplementary Intergovernmental Agreement was signed in 2006 which provided increased funding of $200 million to The Living Murray.

The role of the Intergovernmental Agreement on Murray–Darling Basin Reform, signed by the Council of Australian Governments, is to:

- promote and co-ordinate effective planning and management for the equitable, efficient and sustainable use of the water and other natural resources of the Murray–Darling Basin (Council of Australian Governments 2008).

This Agreement was the foundation for the *Water Act 2007*, which established the MDBA whose role is to manage the Basin's water resources through the development of a Basin plan.

Commonwealth legislation

Water Act 2007

The Intergovernmental Agreement on Murray–Darling Basin Reform was the foundation for the *Water Act 2007*, which established the MDBA to manage the water resources of the Murray–Darling Basin in an integrated, consistent and sustainable manner. The Water Act requires MDBA to prepare and oversee a Basin Plan as a legally enforceable document that provides for the integrated and sustainable management of water resources in the Basin.

The Basin Plan's Environmental Watering Plan will provide a strategic framework for coordinated environmental water planning and environmental watering throughout the Murray–Darling Basin. In the future, TLM will align with the Environmental Watering Plan in the development of Basin states' long-term and annual environmental watering plans and through the annual environmental water prioritisation processes.

Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places (including natural, historic or Indigenous places) —defined in the EPBC Act as matters of national environmental significance. There are eight matters of national environmental significance to which the EPBC Act applies.

The EPBC Act aims to balance the protection of these crucial environmental and cultural values with our society's economic and social needs by creating a legal framework and decision-making process based on the guiding principles of ecologically sustainable development (Department of Sustainability, Environment, Water, Population and Communities, 2011b).

Native Title Act 1993

Section 24KA of the *Native Title Act 1993* requires that native title claimants are notified of any future act consisting of the grant of a lease, licence, permit or authority under legislation that relates to the management or regulation of surface or subterranean water.

Victorian legislation

The principal Acts listed in this section operate in conjunction with other state legislation that deals with the management and conservation of Victoria's natural resources, and outlines obligations relating to obtaining approvals for structural works within TLM icon sites.

Aboriginal Heritage Act 2006

The *Aboriginal Heritage Act 2006* provides for the protection of Indigenous Australian cultural heritage in Victoria. The Act also provides for the introduction and management of a system of Registered Aboriginal Parties that allows Indigenous groups with connection to country and others to be involved in decision-making processes around cultural heritage. Regulations enabled under this Act require a cultural heritage management plan to be prepared when undertaking high impact activities in culturally sensitive landscapes.

Figure 1.2: The white-bellied sea eagle is listed as threatened in Victoria under the Flora and Fauna Guarantee Act

Environmental Effects Act 1978

The *Environmental Effects Act 1978* aims to ensure that development occurs in an ecologically sustainable manner and provides for assessment of any project or development that could have significant effects on the environment. This Act enables the Victorian Minister for Planning to decide whether an environmental effects statement should be undertaken for proposed projects. Projects should be referred to the minister if they meet any referral criteria, as set out in ministerial guidelines (Victorian Department of Sustainability and Environment 2006). A project can be referred by the proponent, a statutory authority or any minister.

Flora and Fauna Guarantee Act 1988

The aim of the *Flora and Fauna Guarantee Act 1988* is to conserve threatened flora and fauna species and communities, and to manage potentially threatening processes. This Act provides for the establishment and maintenance of lists of threatened species, potentially threatening processes and excluded species, which are those not to be conserved because they constitute a serious threat to human welfare (i.e. human disease organisms).

The Act directs that action statements (brief management plans) are to be prepared for listed species to track the progress of management actions, and recovery plans are to be prepared for species also listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth).

Forests Act 1958

The *Forests Act 1958* governs forest management in Victoria. This Act and associated regulations are supported by Victoria's five regional forest agreements. Under the Act's provisions, detailed forest management plans are developed for each area following a complex assessment process that considers all forest values. These management plans provide for the control, maintenance, protection and taking of forest produce and fire management in state forests.

Planning and Environment Act 1987

The *Planning and Environment Act 1987* establishes a framework for planning the use, development and protection of land in Victoria in the present and long-term interests of all Victorians. Local planning schemes are enabled under this Act.

This Act enables the Gannawarra and Campaspe planning schemes. Under these schemes, planning permits are required for proposed works under The Living Murray initiative in these areas, with applications prepared and submitted to the relevant councils.

Murray–Darling Basin Act 1993

The *Murray–Darling Basin Act 1993* enables the Murray–Darling Basin Agreement 2008, which was entered into by the Australian Government and the governments of New South Wales, Victoria, Queensland, South Australia and the Australian Capital Territory with regard to the water, land and other environmental resources of the Murray–Darling Basin. This Act provides for the referral of selected powers under the Victorian Constitution that enable the Australian Government to manage specific aspects of water resource management within the Basin.

National Parks Act 1975 and Parks Victoria Act 1998

In Victoria, national parks are managed by Parks Victoria. Under the *Parks Victoria Act 1998*, Parks Victoria's responsibilities are to provide services to the state and its agencies for the management of parks, reserves and other public land. Under s. 27 of the *National Parks Act 1975*, works by a public authority within a park reserved and managed under the provisions of the Act are subject to consent by the minister. A condition of this consent is that the proposed works comply with the management objectives and strategies for the park.

Water Act 1989

The Victorian *Water Act 1989* governs the way water entitlements are issued and allocated in Victoria. The Act defines water entitlements and establishes the mechanisms for managing Victoria's water resources. Part 10 of the Water Act establishes waterway management and general river health management as the responsibility of catchment management authorities and Melbourne Water (where applicable). For TLM works, s. 67 of the Water Act identifies catchment management authorities as the responsible authorities for issuing licences for conducting works in a designated waterway.

New South Wales legislation

Crown Lands Act 1989

The *Crown Lands Act 1989* ensures that Crown land is managed for the benefit of the people of New South Wales and, in particular, provides for the management, proper development, conservation and regulation of the conditions under which Crown land is permitted to be used, or otherwise dealt with. The Land and Property Management Authority is responsible for the sustainable and commercial management of Crown land in New South Wales. A Crown land licence is a contractual agreement that grants the licensee a personal right to occupy and use Crown land for a particular purpose.

Environmental Planning and Assessment Act 1979

This Act forms the statutory framework for planning approval and environmental assessment in New South Wales. Implementation of the *Environmental Planning and Assessment Act 1979* is the responsibility of the Minister for Planning, statutory authorities and local councils. The need or otherwise for development consent is set out in environmental planning instruments — state environmental planning policies, regional environmental plans or local environmental plans.

Fisheries Management Act 1994

The *Fisheries Management Act 1994* lists threatened aquatic species, endangered populations and ecological communities, and key threatening processes. Potential impacts on species, populations and communities subject to this Act are assessed by Industry and Investment NSW.

Water Management Act 2000

The *Water Management Act 2000* provides for the sustainable and integrated management of the water sources of the state to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality. Any activity that affects the quantity or flow of water in a water source requires consent under this Act.

Planning frameworks and strategies

Management objectives outlined in the environmental watering management plan are complementary to objectives and outcomes in Victorian regional planning strategies.

Regional catchment strategies

The Victorian *Catchment and Land Protection Act 1994* established overarching strategic documents aimed at halting biodiversity decline through the implementation of priority programs, including those that protect and manage wetlands. The catchment management authorities are responsible for coordinating the implementation of the Regional Catchment Strategy and its sub-strategies and action plans under the Water Act (Vic.).

Victorian Northern Region Sustainable Water Strategy

Regional sustainable water strategies were legislated through 2005 amendments to the Water Act (Vic.) and fulfil Victoria's commitment to the National Water Initiative to carry out open, statutory-based water planning. Sustainable water strategies take a long-term view of water resource planning and, as such, they guide the development, integration and implementation of management plans prepared by water corporations and catchment management authorities operating within each region.

Victorian River Health Strategy

The Victorian River Health Strategy was released in 2002 with the statewide objective of achieving healthy rivers, streams and floodplains that meet the environmental, economic, recreational and cultural needs of current and future generations. The strategy provides the policy direction and planning framework for communities to work in partnership with government to manage and restore Victoria's rivers over the long term.

Regional river health strategies

These strategies were established as a part of the Victorian Government's response to the Victorian River Health Strategy. They provide regional frameworks for catchment management authorities, as regional caretakers, to achieve regional river health outcomes.

Victorian Native Vegetation Management: A Framework for Action

The *Native Vegetation Management: A Framework for Action* was released in 2002. The framework establishes the strategic direction for the protection, enhancement and revegetation of native vegetation across the Victorian landscape.

Improving the quality and amount of native vegetation in Victoria is critical to maintaining land and water health. The framework's main goal is to achieve a reversal across the entire landscape of the long-term decline in the extent and quality of native vegetation, leading to a net gain.

Mallee Parks Management Plan

The Mallee Parks Management Plan 1996 sets out the broad directions for future management of Mallee Parks and provides management objectives and strategies to achieve a high standard of conservation and recreation management. One of the major directions is to restore a more natural water regime.

Governance and planning arrangements

The Living Murray is a joint initiative and is managed collaboratively by partner governments. The Murray–Darling Basin Intergovernmental Agreement on Addressing Water Overallocation and Achieving Environmental Objectives in the Murray–Darling Basin (Council of Australian Governments 2004) outlines the governance arrangement for implementing The Living Murray program. The 2004 intergovernmental agreement is complemented by The Living Murray Business Plan, which provides operational policies to guide TLM implementation.

Groups with a direct role in TLM governance are the Murray–Darling Basin Ministerial Council, MDBA, Basin Officials' Committee, The Living Murray Committee and the Environmental Watering Group (see **Figure 1.3** for The Living Murray governance structure).

While MDBA plays a key coordination role at a TLM-wide level, management and delivery of TLM activities at the icon sites are primarily undertaken by relevant agencies in the jurisdictions where the icon sites are located.

In Victoria, the Department of Sustainability and Environment coordinates TLM delivery across all Victorian icon sites. A statewide governance framework has been developed, with a state steering committee and state construction committee to ensure high-level engagement of stakeholder agencies.

The icon site manager for Lindsay–Wallpolla Islands is the chief executive officer of the Mallee Catchment Management Authority, as catchment management authorities are responsible for river health and environmental water management in Victoria. The Mallee Catchment Management Authority therefore coordinates delivery of The Living Murray program at icon site level, working in partnership with Parks Victoria (the land manager) and supported by a number of icon site-specific committees. These committees are composed of representatives from relevant agencies and communities. For more detail on the roles and responsibilities of individual committees and groups, please refer to **Appendix A**.

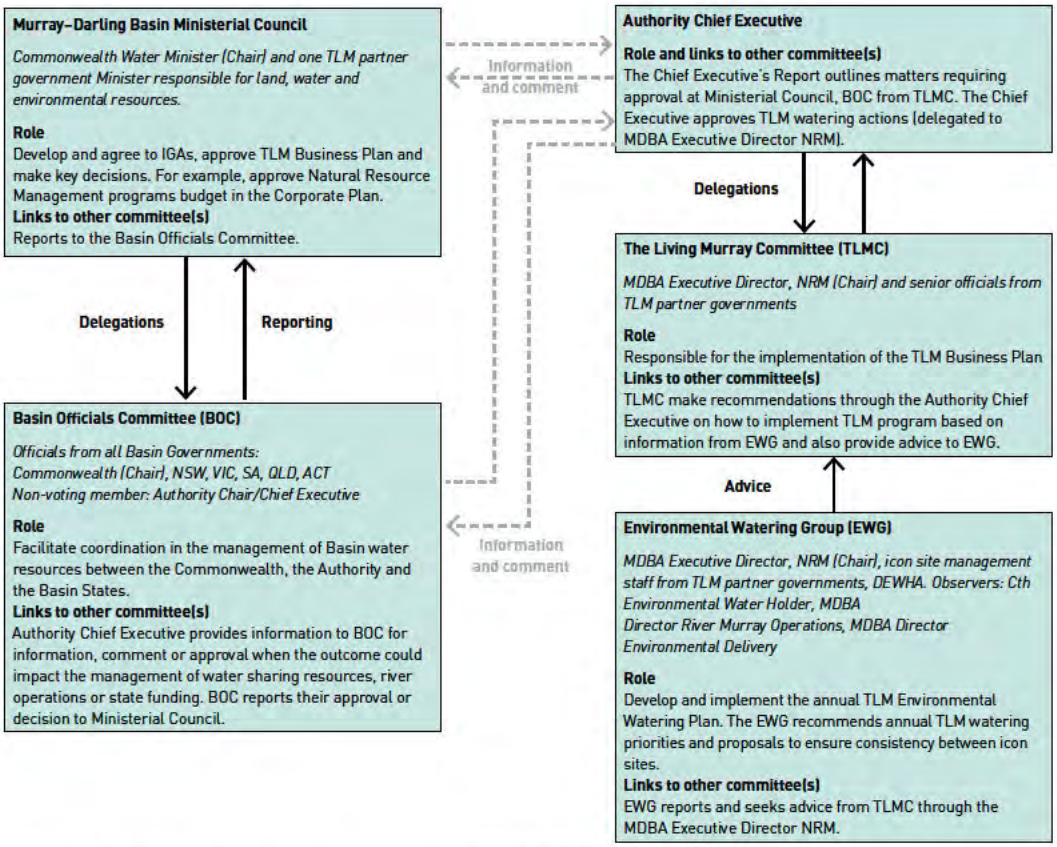

Figure 1.3: The Living Murray governance structure (MDBA)

2. Icon site description

The Chowilla–Lindsay–Wallpolla icon site is a cross-border icon site, having components in South Australia, New South Wales and Victoria (see **Figure 2.1**). The icon site covers 43,856 ha and has four main components — the Chowilla Floodplain (17,700 ha), which spans South Australia (74%) and New South Wales (26%), as well as the Lindsay, Mulcra and Wallpolla islands in north-west Victoria, which collectively cover 26,156 ha downstream of Mildura.

The Chowilla Floodplain and the Lindsay–Wallpolla Islands have specific physical differences and water delivery constraints that affect their management and the development of options for environmental watering. They lie within different states and are managed by different agencies, although consultation between icon site staff in New South Wales, South Australia and Victoria occurs regularly. While having similar values and hydrology, their geographical locations means that different water management infrastructure (e.g. River Murray weirs, small block-banks) influences the hydrology of each component. Accordingly, separate works options have been developed. However, there are clear opportunities to coordinate future operations, share technical knowledge and collaborate on monitoring and consultation activities.

Wallpolla Island is closest to Mildura and is bounded by Wallpolla Creek and the Lock 9 weir pool of the River Murray. It covers 9,000 ha and, together with Mulcra Island, was added to the Murray–Sunset National Park in June 2010. Mulcra Island covers 2,000 ha between Lindsay and Wallpolla Islands and is formed by the Potterwalkagee Creek and the weir pools at locks 7 and 8. Lindsay Island covers 15,000 ha and is bounded by the Lindsay River anabranch and both the locks 6 and 7 weir pools.

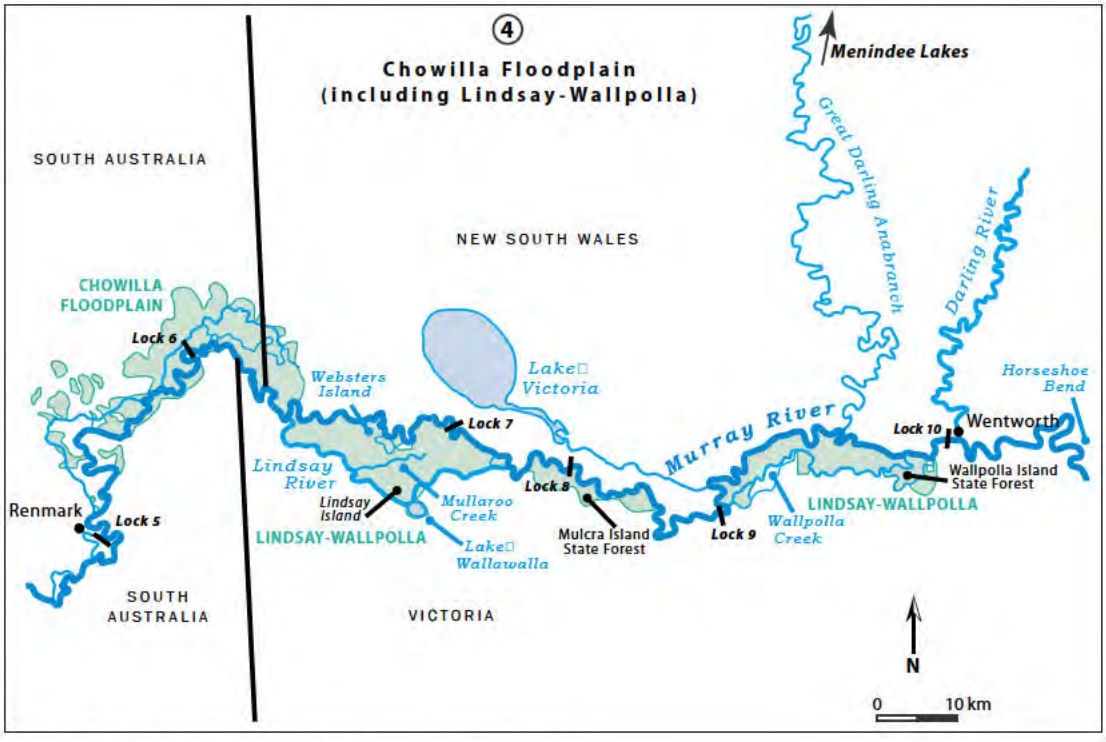

Figure 2.1: The Chowilla–Lindsay–Wallpolla icon site

The Lindsay–Wallpolla Islands lie within the Murray–Sunset National Park and are managed by Parks Victoria. Lindsay Island was included when the park was declared in 1991, with the Mulcra Island and Wallpolla Island state forests added in 2010. Ned's Corner lies to the south of Mulcra and Lindsay islands. Formerly a sheep and cattle station, this property was purchased by Trust for Nature in 2002 and is now managed for conservation.

Description of key ecological assets of the icon site

The Lindsay–Wallpolla floodplain lies within the Murray Scroll Belt bioregion, which is typified by the River Murray floodplain, oxbow lakes, ephemeral lakes, swamps and active meander belts (Victorian Department of Sustainability and Environment 2010). Here, red-brown earths, cracking clays and texture contrast soils support a range of vegetation types, including terrestrial, floodplain and aquatic ecosystems (Victorian Department of Sustainability and Environment 2010). The islands feature a number of waterways and wetlands.

This floodplain is relatively flat and is dissected by a network of anabranches, small creeks and permanent and ephemeral wetlands. Lindsay Island, Wallpolla Island and Lake Wallawalla are listed as nationally important wetlands (Environment Australia 2001).

Values of the icon site

The Lindsay–Wallpolla floodplain is an area of high ecological significance. When inundated, the waterways and wetlands of the floodplain provide refuges and resources for a range of flora and fauna, including threatened species; they also provide important waterbird breeding habitat.

Fauna

The floodplain supports diverse aquatic, wetland-dependent and terrestrial species. It provides important habitat for native fish, frogs, turtles and waterbirds, including many considered threatened at a national and state levels. Thirty-five species listed as threatened under the Victorian *Flora and Fauna Guarantee Act 1988* have been recorded there. The regent parrot (*Polytelis anthopeplus*), growling grass frog (*Litoria raniformis*)and the Murray cod are also listed as nationally threatened under the federal *Environment Protection and Biodiversity Conservation Act 1999* (Ecological Associates 2007).

Mullaroo Creek, a permanent Lindsay Island anabranch, supports one of the most significant populations of Murray cod (Figure 2.2) in the lower River Murray and Victoria, exhibiting significantly better age structure and population size than in any other Victorian system (Saddlier *et al*. 2008; Sharpe *et al*. 2009). It is the robustness of the Mullaroo Creek population that makes it of particular importance to the sustainability of broader regional populations (Sharpe *et al*. 2009). Key habitat features contributing to the viability of the population include the sustained moderate flows (e.g. >400 ML/d) and the hydraulic diversity, including sections of variable water velocity and high densities of submerged woody debris in the creek (Saddlier *et al*. 2008; Water Technology 2009).

The islands also provide resources for the growth and breeding of an additional four fish species listed under the Flora and Fauna Guarantee Act — freshwater catfish (*Tandanus tandanus*), silver perch (*Bidyanus bidyanus*), Murray–Darling rainbowfish (*Melanotaenia fluviatilis*) and unspecked hardyhead (*Craterocephalus stercusmuscarum fulvus*). Australian smelt (*Retropinna semoni*), bony bream (*Nematalosa erebi*), carp gudgeon (*Hypseleotris* spp.), dwarf flathead gudgeon (*Philypnodon macrostomus*) and flathead gudgeon (*Philypnodon grandiceps*) also occur (Mallen-Cooper *et al*. 2010).

During dry periods, floodplain wetlands (e.g. Lake Wallawalla) support terrestrial species such as small mammals and reptiles (Ecological Associates 2007). When flooded, these wetlands provide important habitat for a range of wetland-dependent species, including many waterbirds (MDBC 2006). When freshly inundated, these wetlands promote the growth of microbes, algae, macroinvertebrates, crustaceans and frogs, providing food for fish and birds such as dabbling ducks (*Anatidae* f.) and grazing waterfowl (Ecological Associates 2007).

Figure 2.2: The Murray–Darling rainbowfish was formerly widespread across the Basin but has declined in the Murray region. (Gunther Schmida © MDBA)

As the water level drops, the muddy lake bed becomes exposed, providing conditions for lakebed herbland to establish, and ideal grazing for wading birds such as the great egret (*Ardea alba*), greenshank (*Tringa nebularia*) and the red-necked stint (*Calidris ruficollis*), all of which are listed under the Japan–Australia, Republic of Korea–Australia and the China–Australia Migratory Bird agreements (Ecological Associates 2007; MDBC 2006; SKM 2003). Fish and carrion feeding birds such as the China–Australia Migratory Bird Agreement-listed white-bellied sea eagle (*Haliaeetus leucogaster*) (**Figure 1.2**) are also supported by the lake (Ecological Associates 2007).

Some 210 bird species, 49 of which are dependent upon water habitats, are known to use the Lindsay–Wallpolla floodplain for breeding, feeding and roosting. Of these bird species, 40 are considered threatened in Victoria; 24 are listed under the *Flora and Fauna Guarantee Act 1988* (Vic.) and three are listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (Ecological Associates 2007).

Flora

Together, the island floodplains support a number of plant species of national and state significance, including nine species listed as endangered under the Victorian Flora and Fauna Guarantee Act, and eight, such as bignonia emu-bush (*Eremophila bignoniiflora*), which are listed or nominated for listing (Ecological Associates 2007; MDBC 2006; SKM 2004). Plant communities on the floodplain have been mapped in detail and described by White and others (2003) as ecological vegetation classes (Ecological Associates 2007). Vegetation of the Lindsay, Mulcra and Wallpolla floodplain and wetlands consists of 21 individual ecological vegetation classes and one ecological vegetation class complex, the conservation significance of which range from 'least concern' to 'endangered' (Ecological Associates 2007; Victorian Department of Sustainability and Environment 2010).

Table 2.1: Ecological Vegetation Classes and their conservation significance: Lindsay–Wallpolla floodplain

Ecological Vegetation Class	Bioregional conservation significance
Floodplain vegetation	
Grassy riverine forest (106)	Depleted
Intermittent swampy woodland (813)	Depleted
Shrubby riverine woodland (818)	Least concern
Riverine grassy woodland (295)	Depleted
Lignum (*Muehlenbeckia florulenta*) swampy woodland (823)	Depleted
Riverine chenopod woodland (103)	Depleted
Lignum shrubland (808)	Least concern
Alluvial plains semi-arid grassland (806)	Vulnerable
Semi-arid chenopod woodland (98)	Depleted
Low chenopod shrubland (102)	Depleted
Sub-saline depression (820)	Vulnerable
Disused floodway shrubby herbland (807)	Endangered
Wetland vegetation	
Lignum swamp (104)	Vulnerable
Floodplain grassy wetland (809)	Endangered
Floodway pond herbland (810)	Depleted
Aquatic herbland	Depleted
Spike rush (*Eleocharis obicis*) wetland (819)	Vulnerable
Shallow freshwater marsh (200)	Vulnerable
Lake bed herbland (107)	Vulnerable
Ecological vegetation community complex	
Grassy riverine forest/floodway pond herbland (811)	Depleted

Source: Ecological Associates (2007); Victorian Department of Sustainability and Environment (2010).

River red gums (**Figure 2.4**) occur mainly in riparian and floodplain zones along the River Murray channel and on the edges of waterways and wetlands. These trees are an important source of habitat and a food resource for many fauna, including birds, reptiles and mammals, and are critical to the successful recruitment of many species.

Figure 2.3: River red gums occur mainly in riparian and floodplain zones along the Murray River (Corey Brown © MDBA)

River red gums also provide submerged woody habitat to anabranches through limb-drop or complete topples (Water Technology 2009; Ecological Associates 2007). Submerged woody habitat is a source of food and shelter for fish and aquatic macroinvertebrates. Similarly, limb-drop is a source of organic matter used to fuel primary productivity in the aquatic system.

In the vicinity of waterways, river red gums may be sustained by relatively fresh, shallow groundwater (Ecological Associates 2007). Over much of the floodplain, however, surface-water provided by floods is needed for these trees to survive. Under natural conditions, these areas would have been flooded for two to six years out of every 10, depending on their position on the floodplain.

Black box occurs commonly throughout the floodplain. It supports both arid and riverine bird species, and productivity and recruitment is strongly linked to flooding. Lignum is dispersed similarly to black box but is largely confined to floodplain depressions where water collects and persists after floods. When inundated, it provides habitat for both birds and fish.

Typically, arid zone floodplain wetlands are sites of high biodiversity and may support both aquatic and terrestrial plant communities, depending on inundation status (Henderson *et al*. 2009). When inundated, wetlands such as Lake Wallawalla and the Mulcra Horseshoe Lagoon host aquatic flora species grown from both dormant seeds and propagules present in the lakebed, as well as those washed in (Ecological Associates 2007). As the lake dries, aquatic vegetation will give way to wetland herb communities (Ecological Associates 2007). A total of 28 threatened wetland plant species have been reported on Lindsay Island (SKM 2003).

Anabranches dissecting the Lindsay–Wallpolla floodplain provide adverse aquatic habitats, including deep and shallow sections with varied flow velocities and both steep and sloping banks. Dense stands of aquatic macrophytes are supported and significant amounts of instream woody debris are present. The diversity of habitats within anabranches has significant potential to support fish, aquatic invertebrates, frogs and birds, including some that are threatened or uncommon.

Indigenous values

Indigenous Australian occupation across the Lindsay–Wallpolla floodplain dates back thousands of years, and was sustained by the rich productivity of the floodplain woodland and wetland systems. Historically, the islands would have been an abundant source of food and water for these communities. Today, many signs of Indigenous life still remain at the islands, including diverse archaeological site-types and complexes closely associated with floodplain features (SKM 2004). The floodplain contains many registered sites of cultural heritage, within each of which may be multiple items of significance such as burial sites, shell middens, hearths, stone artefact scatters and culturally scarred trees (Bell 2010; Kelton 1996). Under the *National Parks Act 1975* (Vic.) and the Mallee Parks Management Plan 1996, Lindsay Island is listed as a special protection zone for its many of archaeological sites.

Only a very small area of the icon site has been surveyed for areas of cultural significance, largely because of its isolation. Surveys show the area was once densely populated by Indigenous peoples, who maintained spiritual, cultural and emotional links with its land, waters and traditional resources such as native species used for food and medicine (K.Stewart, pers. comm., 2010) The land and waterways are associated with cultural learning, which is still being passed on to new generations today (NSW Department of Environment, Climate Change and Water 2010).

Culturally scarred trees are often a living remnant of traditional Indigenous life and frequently occur along the edges of waterways and wetlands. Many of these trees occur on the islands, but are often stressed because of lack of flooding and likely to die without intervention.

Social and economic values

Tourism in the Mildura region generates more than $210 million annually, and is the third-largest industry in the region (Mildura Development Corporation 2009), with tourist numbers in the tens of thousands every year (B. Rogers, pers. comm., 2010). Sites such as the Murray–Sunset National Park are major attractions contributing to the tourism industry and local economy. The island floodplains are also popular recreation sites for the local communities of Millewa and Sunraysia, Victoria and the Riverland in South Australia. Camping, canoeing, bird- and wildlife-watching, photography, fishing and four-wheel driving are all popular pursuits.

3. Ecological objectives and water requirements

Based on an understanding of the Chowilla–Lindsay–Wallpolla icon site's characteristics and ecological requirements, First Step Decision interim ecological objectives were developed and approved by Murray–Darling Basin Ministerial Council in 2003. Objectives include:

- high value wetlands maintained
- current area of river red gum maintained
- at least 20% of the original area of black box vegetation maintained.

Since these objectives were approved by Ministerial Council in 2003, jurisdictional agencies have continued to review and refine the First Step interim objectives to develop refined ecological objectives for icon sites. These refined ecological objectives reflect eight years of learning's from the delivery of environmental water, monitoring, modelling and consultation activities and scientific research, and enable a clearer, more effective, evaluation of environmental responses to environmental water delivery.

In consultation with communities, the First Step Decision objectives that relate to Victorian environmental water management plans have been extended to develop overarching objectives. These overarching objectives better reflect the specific icon site values that the environmental waterings aim to protect, as well as relevant jurisdictional management plans and obligations.

The objectives for the Lindsay–Wallpolla environmental water management plan are outlined in **Table 3.1**. In addition to the overarching objectives, more detailed objectives have been developed to guide icon site management. Targets to measure progress towards these objectives are under development for this icon site.

Table 3.1: Revised ecological objectives for the Lindsay–Wallpolla icon site

Vision: *To maintain and restore a mosaic of healthy floodplain communities across Lindsay, Mulcra and Wallpolla Islands which will ensure that indigenous plant and animal species and communities survive and flourish throughout the site*		
Icon site ecological objectives		Targets
Overarching objectives	Specific objectives	
Vegetation Increase the diversity, extent and abundance of wetland vegetation	Provide a diversity of structural aquatic habitats Increase diversity and abundance of wetland aquatic vegetation Maintain and improve the populations of threatened flora and fauna that are flow-dependent Restore productivity linkages between the river and floodplain habitats.	Targets under development
Fish Increase abundance, diversity and extent of distribution of native fish	Increase abundance, diversity and extent of distribution of native fish	Targets under development
Waterbirds Provide habitat for a range of waterbirds, including migratory species and colonial nesters	Provide occasional breeding and roosting habitat for colonial waterbirds Provide habitat suitable for migratory birds, especially species listed under the JAMBA, CAMBA and RoKAMBA	Targets under development

Recognising their different values and variable water requirements, specific objectives based on water regime classes were then developed for different wetland types and vegetation communities across the island (Ecological Vegetation Classes). These are:

- semipermanent wetlands — restore habitat and community diversity
- ephemeral wetlands — restore habitat and community diversity; reinstate the communities typical of ephemeral wetlands
- lignum — improve condition and increase extent to sustain species assemblages and processes typical of lignum communities
- open grassland — maintain habitat values and flora and fauna communities
- river red gum — maintain current condition and extent of river red gum communities to sustain species assemblages and processes typical of such woodland
- black box — improve condition to sustain species assemblages and processes typical of black box woodland.

In 2006 the Murray–Darling Basin Commission noted that the specific objectives for the Lindsay–Wallpolla component of the icon site were to be further developed (MDBC 2006). Following the completion of the *Floodplain Options Investigation: Lindsay, Mulcra and Wallpolla Islands* (Ecological Associates 2007), the objective for permanent wetlands (to restore habitat and community diversity) was removed because these do not occur naturally on the islands.

Water requirements

Ecology and hydrology

Duration, depth, frequency and timing of flooding influence plant species assemblages, their relative abundance and growth habit and the fauna communities they support. As such, plant community classifications are a useful way to directly relate water regime to flora habitat, and indirectly to fauna habitat.

Water regime classes are a spatial classification of the floodplain into areas with common water regimes and ecological characteristics. Each water regime class has its own distinct ecology and hydrologic requirements, as described in Ecological Associates (2007).

Water regime classes provide a basis to establish objectives for the location, extent and condition of components of the floodplain ecosystem and therefore to set hydrologic objectives. Water regime classes were defined using existing information that describes the vegetation and aquatic habitat values of the floodplain (Ecological Associates 2007).

The hydrological environments of Lindsay–Wallpolla Islands have been classified into water regime classes according to the vegetation communities and aquatic habitat present, their water regimes prior to river regulation and by their interpreted ecological roles (Ecological Associates 2007; see also **Table** and **figures 3.1–3.3**).

All wetland ecological vegetation classes have been classified into two water regime classes, according to water regimes, plant communities and dependent fauna (Ecological Associates 2007). All anabranch ecological vegetation classes have been grouped into water regime classes with specific water requirements based on the biota they support (Ecological Associates 2007).

The relationship between water regime classes and fauna species guilds and breeding waterbirds is outlined in Appendix B.

Table 3.2: Water regime classes and component ecological vegetation classes

Water regime class	Ecological vegetation classes
Red gum forest	Grassy riverine forest (106)
	Grassy riverine forest/floodway pond herbland complex (811)
Red gum woodland	Intermittent swampy woodland (813)
	Shrubby riverine woodland (818)
	Riverine grassy woodland (295)
	Riverine swampy woodland
Black box woodland	Lignum swampy woodland (823)
	Riverine chenopod woodland (103)
Lignum shrubland	Lignum shrubland (808)
	Lignum swamp (104)
Alluvial plains	Alluvial plains semi-arid grassland (806)
	Semi-arid chenopod shrubland (98)
	Low chenopod shrubland (102)
	Sub-saline depression (820)
	Disused floodway shrubby herbland (807)
Semipermanent wetlands	Floodplain grassy wetland (809)
	Water body—fresh
Temporary wetlands	Floodway pond herbland (810)
	Spike rush wetland (819)
	Shallow freshwater marsh (200)
	Lake bed herbland (107)
Anabranches	Ecological vegetation class mapping does not cover waterways

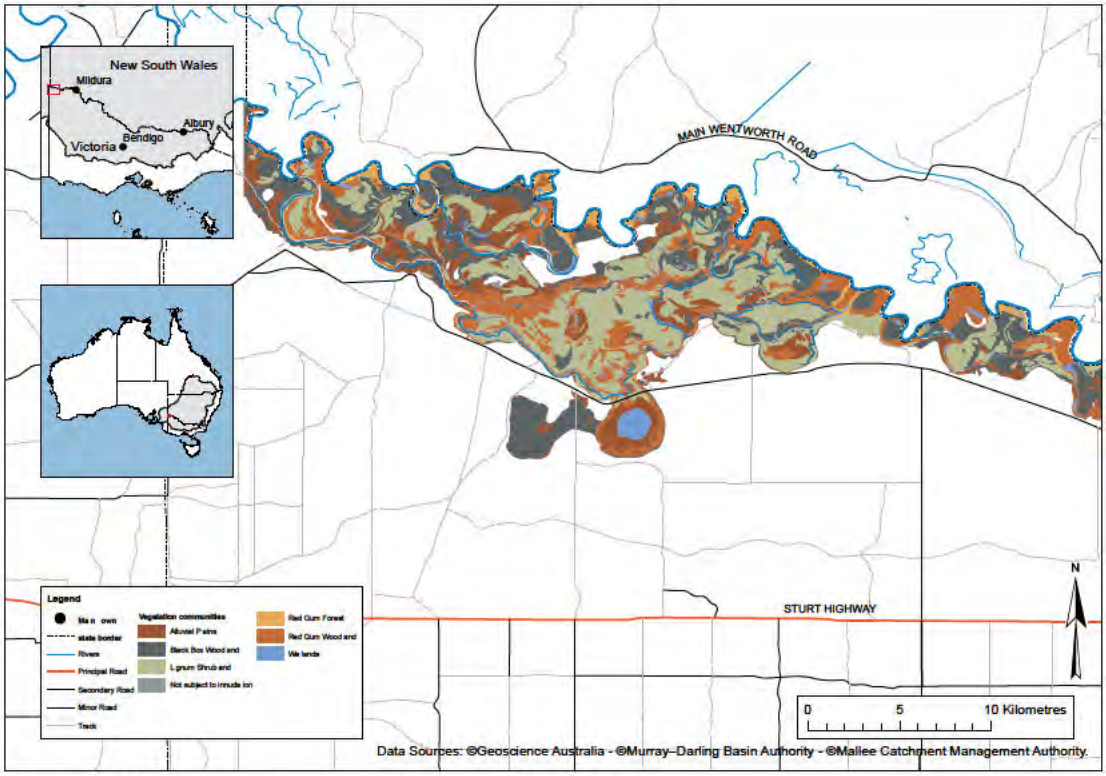

Figure 3.1: Water regime class distribution on Lindsay Island

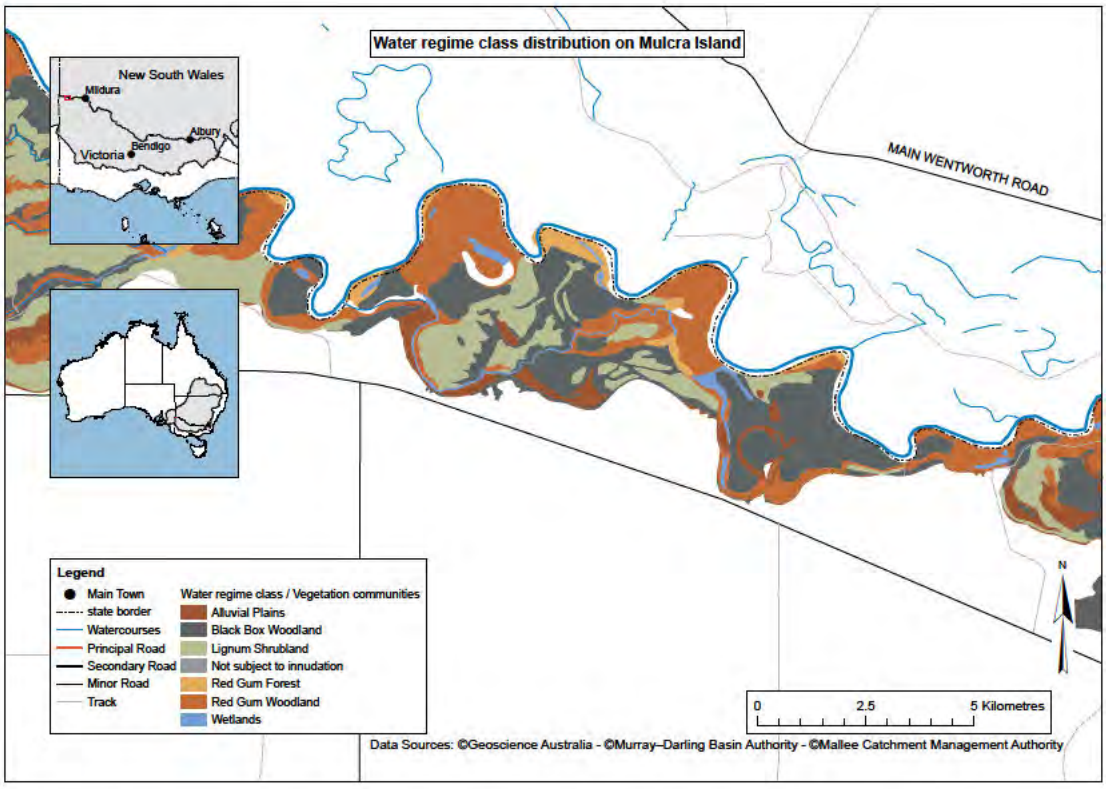

Figure 3.2: Water regime class distribution on Mulcra Island

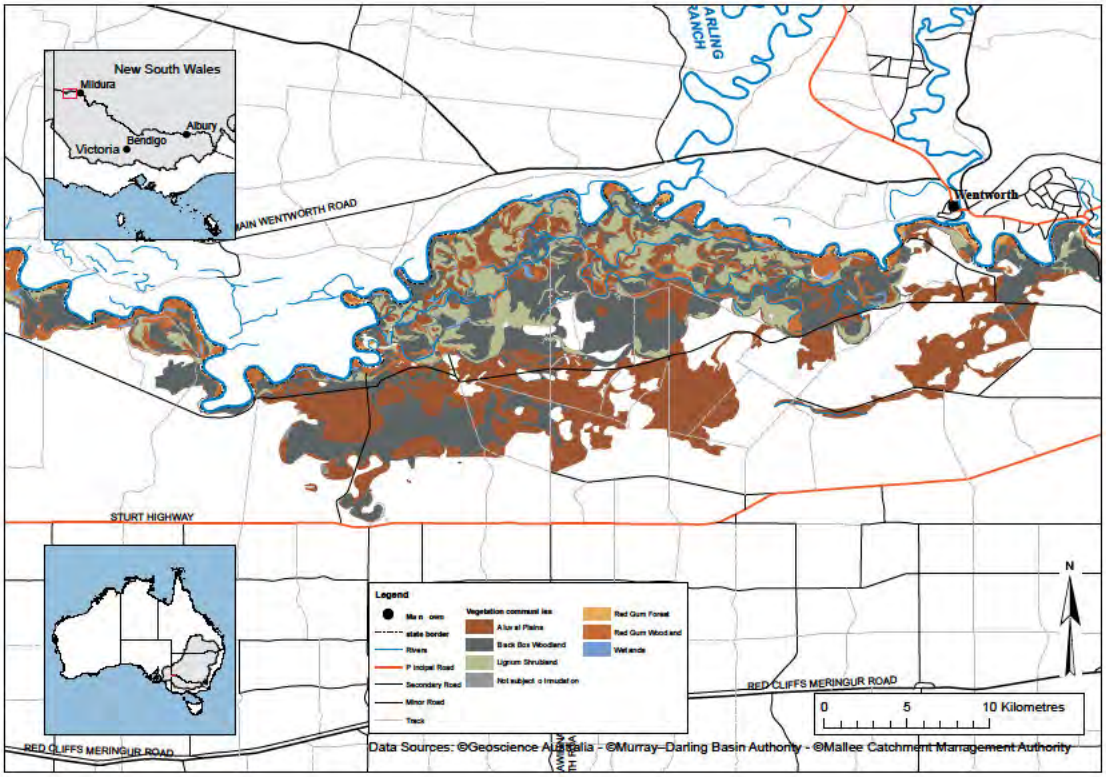

Figure 3.3: Water regime class distribution on Wallpolla Island

Table 3.3: Water requirements for the icon site environmental objectives

First Step Decision objective	Refined objectives	Vegetation community (water regime class)	River flow rate (ML/day)	Duration	Timing	Frequency (years in 10)	Maximum time between events	Works or other mechanisms to assist meeting objectives	Area flooded by works (ha)
			Required water regime						
High value wetlands maintained	Provide a diversity of structural aquatic habitats	Temporary wetlands	>30,000 ML/d	2 months	Spring	2–8	4 years	Mulcra Island works	1,286 ha across the entire icon site[b]
		Semipermanent wetlands	>60,000 ML/d	1 month				Lindsay Stage 1 works	
	Increase diversity and extent of distribution of native fish							Wetland regulators[a]	
	Increase diversity and abundance of wetland aquatic vegetation								
	Provide occasional breeding and roosting habitat for colonial water birds	Lignum shrubland	>50,000 ML/d	2 months	Spring	5	5 years	Mulcra Island works	161 ha on Mulcra Island[b]
	Maintain and improve the populations of threatened flora and fauna that are flow-dependent							Lake Wallawalla regulators	~70 ha at Lake Wallawalla
	Restore productivity linkages between the river and floodplain habitats	Anabranches	15,000 ML/d	14 days (3–4 freshes/y)	August–December	8	2 years	Mulcra Island works Lindsay stage 1 works	Flows improved over 20 km on Mulcra Island and 20 km on Lindsay Island
Current area of river red gum maintained	Provide occasional breeding and roosting habitat for colonial water birds	Red gum forest	>60,000 ML/day	4 months	Spring	7	4 years	Mulcra Island works	29 ha on Mulcra Island[b]
	Provide habitat suitable for migratory birds, especially species listed under the Japan–Australia and the China–Australia migratory bird agreements								
	Restore productivity linkages between the river and floodplain habitats	Red gum woodland	>80,000 ML/d	2 months	Spring	6	7 years	Mulcra Island works Wetland regulators Lake Wallawalla regulators	263 ha on Mulcra Island[b] Minor areas around wetlands ~250 ha at Lake Wallawalla
At least 20% of the original area of black box vegetation maintained	Provide habitat suitable for migratory birds, especially JAMBA- and CAMBA- listed species	Black box woodland	n/a	1 month	August–December	1–2	8 years	Mulcra Island works Lake Wallawalla regulators	45 ha on Mulcra Island[b] ~200 ha at Lake Wallawalla
	Restore productivity linkages between the river and floodplain habitats								

Notes
a Wetland regulators include those at Horseshoe Lagoon on Wallpolla Island, and Webster's Lagoon and Lake Wallawalla on Lindsay Island.
b Area flooded includes any areas in New South Wales inundated by raising Lock 8.

Climate and rainfall in the Murray–Darling Basin

Historically, the climate of the Murray–Darling Basin has been variable. Climate change science indicates a likely increase in this variability, resulting in more frequent and extreme floods and droughts (MDBA 2010a). Consequently, river storages and the use of environmental water will be managed according to these varying river flows.

Between 1996 and 2010, the Murray–Darling Basin was in a drought characterised by below-average rainfall in autumn and winter and few wet periods. This drought was significantly drier than the Federation Drought (mid-1890s to early 1900s) and the droughts of the World War II era (1937–1945).

Beginning in spring 2010, and continuing through the summer of 2010–11, widespread, above average rainfall across the Murray–Darling Basin broke the long standing drought. This rainfall was associated with the development, beginning in 2010, of a moderate to strong La Nina event making 2010 the wettest year on record for the Murray–Darling Basin.

Antecedent hydrologic conditions

Lindsay–Wallpolla Islands are located within the semi-arid Mallee region of Victoria. The climate is the hottest and driest in Victoria, with an average annual rainfall of 270 mm in Mildura. Average maximum temperatures are around 32°C in summer and 16°C in winter, with high evaporation rates throughout the year. As such, the River Murray represents an important source of water for the floodplain ecosystem.

The past 100 years has seen a vast increase in regulation and water extraction within the River Murray, resulting in reductions in the occurrence of high flows and extended periods of low flows, delays to the onset of floods and reduced frequencies and durations of floods (**Figure 3.4**)(Ecological Associates, 2007; SKM 2004). Flows are now captured in upstream storages and gradually released, resulting in relatively even flows all year round, transforming the River Murray into a deep habitat with low water velocities and stable water levels at low to moderate flows (Walker & Thoms 1993).

These changes to the flooding regime have affected the condition of the Lindsay–Wallpolla floodplain ecosystem. In recent years, the reduction in flooding caused by river regulation has been compounded by extended drought. These impacts are likely to increase under the predicted influence of climate change, however recent flooding in late 2010 and early 2011 will provide significant environmental benefits.

The widespread rainfall in spring 2010 has generated high flows throughout the Murray system. Flows downstream of Lock 9 began to rise in late August 2010, reaching 30,000 ML/d in October 2010. This inundated low lying wetlands along the river channel and generated flow through a number of anabranches across the islands. Flows have risen steadily since early November and exceeded 60,000 ML/d in mid-January 2011. This has generated flow into Lake Wallawalla and flooded most wetlands across the floodplain.

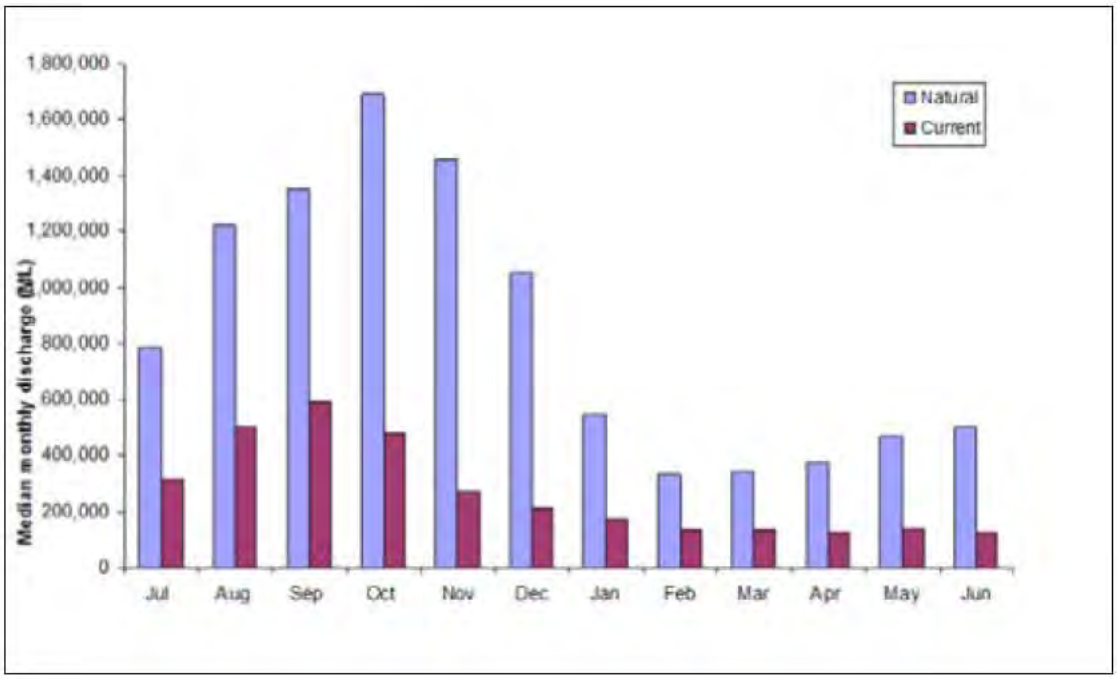

Figure 3.4: Monthly discharge at Lock 8, for modelled natural flows and modelled current system; based on 115 years of data (1894–2009) provided by MDBA

Past management actions and activities

As discussed in **Chapter 2**, Lindsay Island was made part of the Murray–Sunset National Park in 1991, with Mulcra and Wallpolla islands added in June 2010. The islands have traditionally been used for grazing, apiary, timber harvesting and water extraction, as well as broadacre and irrigated cropping.

The anabranches of Lindsay River and Wallpolla Creek are used for irrigation, stock and domestic extraction. At present, there is about 1,457 ha of irrigated horticulture at Lindsay Point, a small amount of stock and domestic extraction from Wallpolla Creek as part of Kulnine Station operations, and irrigation as part of Keera Station. Water extraction from Potterwalkagee Creek ceased when Trust for Nature purchased the adjacent property, Ned's Corner, and decommissioned the dam and channels.

4. Water delivery

Prioritisation of water requirements

The Living Murray Annual Environmental Watering Plan, developed by the Environmental Watering Group, includes a flexible decision framework to guide prioritisation of environmental watering actions. It also contains icon site environmental watering proposals, water availability forecasts and management objectives for water resource scenarios (see **Table 4.1**).

Throughout the year the Environmental Watering Group recommends environmental watering actions to the Murray–Darling Basin Authority (MDBA) for approval. These recommendations are based on the Annual Environmental Watering Plan and the volume of water available in The Living Murray's environmental water portfolio.

Local watering actions are prioritised under different water availability scenarios (see **Table 4.1**), according to the Mallee River Health Strategy (Mallee Catchment Management Authority 2006) and the Victorian Government's Northern Region Sustainable Water Strategy (Victorian Department of Sustainability and Environment 2009). Sites are chosen according to water availability and the environmental outcome achievable, as well as the ability of managers to deliver water to the site and the practicality of retaining water within the site.

Table 4.1: Objectives under different water availability scenarios

	Extreme dry	Dry	Median	Wet
Ecological watering objectives	Avoid irretrievable loss of key environmental assets	Ensure priority river reaches and wetlands have maintained their basic functions	Ecological health of priority river reaches and wetlands have been protected or improved	Improve the health and resilience of aquatic ecosystems
Management objectives	Avoid critical loss of species, communities and ecosystems Maintain key refuges Avoid irretrievable damage or catastrophic events	Maintain river functioning with reduced reproductive capacity Maintain key functions of high priority wetlands Manage within dry spell tolerances Support connectivity between sites	Enable growth, reproduction and small-scale recruitment for a diverse range of flora and fauna Promote low-lying floodplain-river connectivity Support medium flow river and floodplain functional processes	Enable growth, reproduction and large-scale recruitment for a diverse range of flora and fauna Promote higher floodplain-river connectivity Support high flow river and floodplain functional processes
Example priority locations for Lindsay–Wallpolla floodplain icon site	Base flows in Mullaroo Creek to preserve Murray cod populations	Base flows in Mullaroo Creek Base flows in Potterwalkagee Creek, Lindsay River and Wallpolla Creek Maintain priority wetlands (e.g. Webster's Lagoon)	As for Dry and: Spring pulse events in Potterwalkagee Creek and Lindsay River Inundate Mulcra floodplain Inundate Lake Wallawalla	As for Median and: Using natural flood events to inundate the broader floodplain

The Living Murray works and water modelling

Modelling

Modelling completed in 2008 found that the environmental water requirements of the floodplain icon sites (with the exception of Barmah–Millewa and the Lower Lakes, Coorong and Murray Mouth and River Murray Channel icon sites) could largely be met by a combination of the proposed TLM works, the 500 GL of recovered TLM water and 70 GL long-term Cap equivalent (LTCE) of River Murray Increased Flows.

This modelling was based on a number of assumptions including the use of unregulated flow events for environmental watering actions. It was also agreed as a modelling principle that return flows could be used to water at multiple environmental sites. There are a number of constraints to the implementation of this principle which TLM are currently working to resolve.

Further modelling is also planned to allow greater optimisation of works and measures to achieve icon site ecological objectives as we gain a greater understanding of operating scenarios.

Works

A range of water management options for Lindsay–Wallpolla Islands have been investigated under TLM. Many have been progressed to the detailed design or construction phases. Concept designs have been developed for the remaining options for further development if funding becomes available.

A brief description of priority options across Lindsay–Wallpolla Islands is provided in **Table 4.2**; see **Figure 4.1** for works locations.

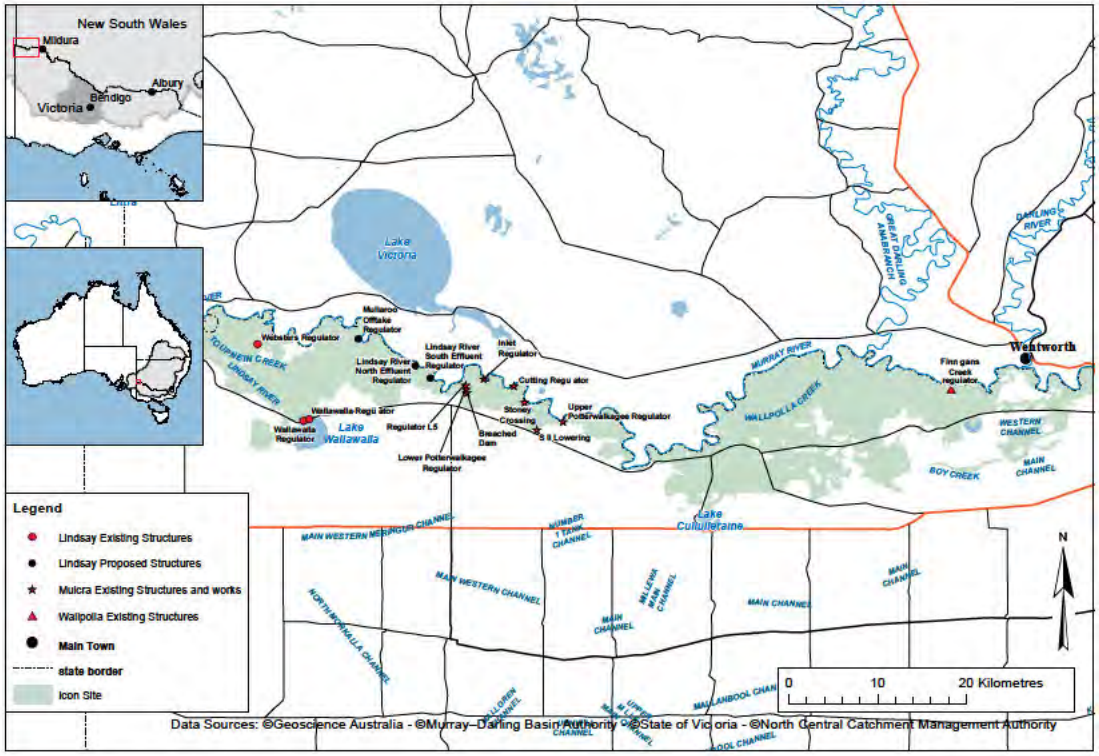

Figure 4.1: Map of existing and proposed works on Lindsay-Wallpolla Islands

Table 4.2: Completed and proposed works and their functions

Works package	Component	Function	Status
Mulcra Island	Lower Potterwalkagee regulator	Enable inundation of the Mulcra Island floodplain	Completed (2010–11)
	Lock 8 track upgrade (in Victoria and NSW)	Maintain access to Lock 8 during inundation events	
	Breached dam rehabilitation	Reinstate the natural creek alignment Remove willows and cumbungi (*Typha* species) Improve connectivity	
	'The Cutting' block bank	Prevent water draining back to the River Murray when the floodplain is inundated (maximising inundation)	
	Stoney Crossing regulator	Maximise flow capacity during inundation events and improve fish passage Enable flow management, including periodic drying of Potterwalkagee Creek	
	Upper Potterwalkagee sill lowering and regulator	Enable flow management Increase flowing habitat Improve connectivity and fish passage Inundate Snake Lagoon	
	Mulcra Horseshoe inlet regulator (L1) and L5 regulator	Enable water to be retained to desired depth and area	
	Mulcra Horseshoe pipe and channel	Deliver water from the lower Potterwalkagee Creek to the Mulcra Horseshoe wetland	
	Lock 8 track regulator (in New South Wales)	Improve connectivity between river and floodplain	
Webster's Lagoon (Lindsay Island)	Inlet regulator	Disconnect wetland from weir pool to allow for drying phase and re-instate variable water regime	Completed (2005–06)
Lake Wallawalla Regulator (Lindsay Island)	Inlet regulators (2)	Reinstate connectivity with the Lindsay River Retain inflows for desired duration Allow wetland to fully drain upon flood recession	Completed (2005–06)
	Raise Mail Road by 1 m		
Lindsay Island stage 1	Upper Lindsay River regulators (north and south inlets)	Improve flow capacity Provision of base flow to the upper Lindsay River Improve connectivity and fish passage Enable within channel spring pulse event	Detailed design (construction anticipated 2010–11)
	Mullaroo Creek regulator and fishway	Maintain fast flowing habitat for Murray cod Improve fish passage between Mullaroo Creek and River Murray	Detailed design (construction anticipated 2011–12)
Lindsay Island Stage 2	Lindsay River Weir and ancillary regulators	Enable inundation of approximately 5000 ha on Lindsay Island	Concept design
Horseshoe Lagoon (Wallpolla Island)	Inlet regulator	Disconnect wetland from weir pool to allow for drying phase and re-instate variable water regime	Completed (2005–06)
Lock 9 bypass	Bypass channel around Lock 9 and ancillary regulators	Extend and improve flowing fish habitat and connectivity Enable floodplain inundation	Concept design

Operating regimes for environmental watering actions

This section of the environmental water management plan provides a broad description of the proposed operating regimes to maximise ecological outcomes from the use of The Living Murray Water portfolio and works. To meet the proposed operating regimes a combination of unregulated and regulated environmental water may be used. While this environmental water management plan focuses on the use of environmental water from The Living Murray's Water Portfolio, there may also be other sources of environmental water available to meet the proposed regimes.

The overall aim of environmental water management across Lindsay–Wallpolla Islands is to provide a watering regime that meets the environmental water requirements of floodplain vegetation and the associated biota over the greatest area possible, taking into account recent watering events.

While the River Murray weirs (7, 8 and 9) have contributed to the changed hydrology of the islands, these structures also provide opportunities to maximise the benefits of environmental water delivery. Raising and lowering weirs can, to some extent, mimic the variable flows that would have occurred under unregulated conditions. Raising weirs under higher flows can increase the inundation of floodplain immediately upstream and also generate higher flows through upstream effluents, mimicking freshes.

The operating regimes for completed works and those in the detailed design phase (**Figure 4.2**) are outlined below, with detailed operating strategies provided in **Schedule A** (when completed). Operating strategies have not been developed for those options at concept design phase (Lindsay Island Stage 2 and Lock 9 bypass).

Opportunities exist for the coordination of operation across the Chowilla–Lindsay–Wallpolla icon site. The raising of the Lock 6 weir pool for operation of the Chowilla Floodplain TLM works potentially will require raising Lock 7, to maintain flow velocities through the Mullaroo system. This will allow operation of the Lindsay River spring pulse scenarios in conjunction with environmental watering on the Chowilla floodplain. This concept can be extended to include filling of Lake Wallawalla by pumping. Operating infrastructure to inundate Mulcra Island and Chowilla at the same time is likely to improve the ecological outcomes at both sites.

Mulcra Island

The proposed operating regime for Mulcra Island aims to maintain base flows through the system year-round, with a partial drying phase once every six to eight years to mimic natural low flow periods. Base flows are supplied under normal regulated conditions, with Lock 8 maintained at full supply level (FSL, 24.6 m Australian height datum [AHD]). This provides a permanent flow of between 50 and 100 ML/d through the new Stoney Crossing Regulator to the 10 km section of Potterwalkagee Creek downstream.

Spring freshes will be provided once every one to two years by a moderate raising of the Lock 8 weir pool (by 20 to 60 cm). Broader floodplain inundation will occur every two to three years through raising the weir pool to the top of piers (25.7 m AHD) and raising the Lower Potterwalkagee Creek regulator to pond water behind the regulator. This would mimic a 50,000 ML/d flood event and inundate about 822 ha (including 250 ha in New South Wales).

Lindsay Island — stage 1

The proposed operating strategy of the Lindsay Island stage 1 works aims to maintain existing high quality habitat for native fish, increase the extent of flowing habitat, improve fish passage and the condition of riparian vegetation. With these aims in mind, the operating regime involves provision of two key elements — low base flows and spring freshes.

Low base flows will be the normal mode of operation at the normal Lock 7 weir pool level (22.1 m AHD). At this level, the northern Lindsay regulator will be opened to allow inflows of 35 to 40 ML/d, while no flows will pass through the southern Lindsay regulator. The Mullaroo Creek regulator will be operated to pass ~700 ML/d.

Spring freshes will be provided by raising the Lock 7 weir pool to 22.6 m AHD for nine weeks, once or twice each year in years where River Murray flows of at least 17,000 ML/d have not been recorded in the previous nine months. When providing a spring fresh, both the northern and southern Lindsay regulators will be open and the Mullaroo Creek regulator will be operated to pass ~700 ML/day.

Providing spring freshes in the Lindsay River will also increase opportunities to inundate Lake Wallawalla using temporary pumps. This large wetland would normally fill via two small effluents from the middle reaches of the Lindsay River, when River Murray flows exceed 50,000 ML/d. During extended low-flow periods, as have occurred over recent years, water can be pumped from the Lindsay River into the wetland, provided that flows are high enough.

Wetland regulators

In the absence of moderate-to-high River Murray flows, regulated wetlands within the floodplain are currently prioritised and filled in accordance with the Environmental Water Group's watering criteria. These wetlands include Horseshoe Lagoon on Wallpolla Island, Lake Wallawalla and Webster's Lagoon on Lindsay Island. The specific objectives and operation of these works are outlined in **Table 4.3**.

Table 4.3: Operating regime of the regulated wetlands

Wetland (connection to River Murray)	Ecological objectives	Operation to achieve objectives
Horseshoe Lagoon–Wallpolla Island (Finnigan's Creek) Webster's Lagoon–Lindsay Island (Toupnein Creek)	Increase the area and extent vegetation in the littoral zone Provide breeding habitat for waterfowl, particularly ducks and grebes Provide habitat and promote breeding events of small fish, frogs and turtles Limit river red gum regeneration in the wet-dry littoral zone Limit cumbungi growth in the permanent pool and promote greater macrophyte diversity Reduce carp abundance	Wet the wet-dry littoral zone for 3–6 months winter/spring Filling: wetland inundated at normal weir pool levels Surcharging: regulator closed and temporary pumps used to surcharge wetland Dry the wet-dry littoral zone for 6 months summer/autumn Completely dry the permanent zone annually for 6 to 7 months Drying: regulator closed to disconnect wetland and allow drying Carp screens in operation when regulators open to allow natural inflows
Lake Wallawalla–Lindsay Island (floodrunner from Lindsay River)	Maintain lakebed herbland (supports several threatened species) Improve condition and regeneration of river red gums Provide successful waterbird breeding events Maintain populations and breeding events of small native fish Provide breeding events for golden perch (*Macquaria ambigua*) and other large floodplain fish Reduce carp abundance	Allow higher water levels to be retained in the lake and provide the opportunity to increase duration of inundation Filling: wetland filled by natural floodwaters or pumped environmental water; both regulators closed to retain water in the lake Allow complete drainage of the lake Drying: regulators fully opened Operate the structures to reduce carp access and promote movement of native fish Carp screens in operation when regulators open

Water accounting and measurement

Water accounting methodology will be developed and agreed in advance by The Living Murray Committee and the Basin Officials Committee. Consistency of water accounting methodology will be sought wherever possible. Where relevant, water accounting will be consistent with the Water Accounting Conceptual Framework and Australian Water Accounting Standards.

The best available, most appropriate and cost-effective measurement technique will be used to determine environmental water use. The appropriateness of the measurement technique is likely to differ depending on icon site and event. For example, under dry conditions, environmental water pumped into Hattah Lakes is likely to be measured using a meter while return flows are measured via a gauging station; under wet conditions, environmental water returning from Barmah–Millewa Forest will need to be modelled.

Accurate measurement of water use at Mulcra and Lindsay islands will be difficult because operating strategies involve raising locks 7 and 8. As such, modelling of the losses incurred when surcharging weir pools will be required at these sites.

Evaluation and management of risks

A number of risks are associated with using infrastructure to deliver environmental water. A risk assessment has been undertaken for the operation of the Lindsay–Wallpolla floodplain works (**Table 4.5**). Monitoring and mitigation will be carried out where possible, the results of which will be taken into consideration when implementing adaptive management principles. These risks and mitigating measures are further detailed in a detailed Risk Monitoring Plan, included at Schedule 2.

Table 4.4: Operating regimes contributing to ecological objectives

First Step Decision objectives	Vegetation community area inundated (ha)	Operating strategy	Frequency (years in 10)	Duration	Water availability scenario (range if appropriate)	Estimated volume of water required (GL)	Estimated volume of water used (GL)
Mulcra Island works							
Preferred operating scenario							
High value wetlands maintained Current area of river red gum maintained At least 20% of the original area of black box vegetation maintained	324 ha wetlands 161 ha lignum shrubland 292 ha river red gum communities 45 ha black box woodland	Maximum floodplain inundation (including Mulcra Horseshoe)	5	4 months (full operation)	Median-wet	40	5.3
		Spring fresh	5 (3–4 per year)	14 days, 7 days between pulses	All	5.5	0.5
Minimum operating scenario							
High value wetlands maintained Current area of river red gum maintained At least 20% of the original area of black box vegetation maintained	324 ha wetlands 161 ha lignum shrubland 292 ha river red gum communities 45 ha black box woodland	Maximum floodplain inundation (including Mulcra Horseshoe)	3	4 months (full operation)	Median-wet	40	5.3
		Spring fresh	8	14 days, 7 days between pulses	All	5.5	0.5
Regulated wetlands — Horseshoe Lagoon–Wallpolla Island; Webster's Lagoon–Lindsay Island							
Preferred operating scenario							
High value wetlands maintained Current area of river red gum maintained	120 ha wetlands Surrounding large old river red gum	Fill wetlands at regulated flows	9	3–6 months	All	2.7	2.7
		Surcharge wetlands using temporary pumps	5	3–4 weeks			
		Close regulators to dry	10	6 months			
Minimum operating scenario							
High value wetlands maintained Current area of river red gum maintained	120 ha wetlands Surrounding large old river red gum	Fill wetlands at regulated flows	5	3–6 months	All	2.7	2.7
		Surcharge wetlands using temporary pumps	3	3–4 weeks			
		Close regulators to dry	10	6 months			
Lindsay Stage 1 and Lake Wallawalla regulators[a]							
Preferred operating strategy							
High value wetlands maintained Current area of river red gum maintained At least 20% of the original area of black box vegetation maintained	800 ha wetlands[b] 20 km of riparian vegetation watered along watercourses	Base flows (Lindsay South)	10	Year round	All	0	0
		Spring fresh	8	14 days, 7 days between pulses	All	Minor[c]	Minor[c]
		Pumping to inundate Lake Wallawalla	(3–4 per year)	4 months (full operation)	All	12	12
Minimum operating scenario							
High value wetlands maintained Current area of river red gum maintained At least 20% of the original area of black box vegetation maintained	800 ha wetlands	Base flows (Lindsay South)	10	Year round	All	0	
		Spring fresh	5 (3–4 per year)	14 days, 7 days between pulses	All	Minor[c]	Minor[c]
		Pumping to inundate Lake Wallawalla	1	4 months (full operation)	All	12	12

Notes

a Lindsay Stage 1 works and Lake Wallawalla regulators would be operated together.

b The area of 800 ha covers fringing vegetation around Lake Wallawalla–includes river red gum woodland, black box woodland and small areas of lignum. Actual areas watered have yet to be calculated.

c Water use is yet to be calculated but is expected to be minor.

Table 4.5: Potential risks associated with TLM works on Lindsay–Wallpolla Islands

Risk	Description	Mitigation
Salinity	With any extended floodplain inundation there is a risk of mobilising salt stored within the floodplain. If operation of TLM works results in an accountable impact under the Basin Salinity Management Strategy, an entry must be made on Schedule B of the Basin Salinity Management Strategy (BSMS) Salinity Register. Victoria has conducted preliminary assessments of the impacts of proposed TLM operating strategies in line with BSMS requirements and submitted these to MDBA. These assessments suggest that salinity impacts are likely to be insignificant to minor; where accountable, provisional entries will be made on the BSMS register.	Salinity investigations and assessments guiding initial operations. Ongoing salinity monitoring. Adaptive management if necessary.
Sediment transport and erosion	Flows through waterways and into wetlands may cause erosion and contribute to sedimentation. Mobile sediment may detrimentally effect water quality and change the bed planform.	Geomorphologic investigations and assessments guiding initial operations. Ongoing geomorphologic monitoring. Adaptive management if necessary.
Water quality	Changes to water regimes risks releasing salt and nutrients from the waterway, wetland and/or groundwater, resulting in decreased water quality in the water body. They may also cause saline and black water, resulting in fish or vegetation kills. Other parameters that may affect water quality include suspended sediment loads and temperature	Water quality investigations and assessments guiding initial operations. Ongoing water quality monitoring. Adaptive management if necessary.
Pest vertebrate species	Water management actions may benefit undesirable aquatic and terrestrial pest species through provision of habitat and food resources.	Pest animal investigations and assessments guiding initial operations. Ongoing pest monitoring. Adaptive management if necessary.
Fish passage	Passing more water through anabranches and less through the main channel may reduce stimulus for fish to use the main-stem as a major migratory route.	Fish investigations and assessments guiding initial operations. Ongoing fish monitoring. Adaptive management if necessary.
Pest flora species	Increased water on the floodplains may increase the occurrence of pest plant dispersal and colonisation.	Pest plant investigations and assessments guiding initial operations. Ongoing pest plant monitoring. Adaptive management if necessary.
Cultural heritage	On-ground works may potentially disturb or damage features of cultural significance during the construction phase.	Cultural heritage investigations and assessments guiding initial operations. Ongoing cultural heritage monitoring. Adaptive management if necessary.
Further risk assessment and monitoring	Refer to Risk Management Plan (Schedule B).	–

5. Environmental monitoring

Different monitoring methods are used to assess progress toward the icon site ecological objectives. These include River Murray system-scale, icon site condition and intervention monitoring. The Living Murray (TLM) Outcomes Evaluation Framework (Murray–Darling Basin Commission 2007) outlines the rationale for these monitoring methods, which are summarised below.

River Murray system-scale monitoring

Conducted annually, River Murray system-scale monitoring and evaluation focuses on the system's ecological health, measuring improvements relating to fish, waterbirds and vegetation.

Icon site condition monitoring

Condition monitoring assesses each icon site's condition in relation to its ecological objectives. Condition monitoring is typically conducted on a medium-frequency basis (months to years), depending on the rate of change. Condition monitoring includes standard methodologies for monitoring fish, birds and vegetation, as well as icon site-specific methods for monitoring other ecological objectives (see **Schedule 3**). These monitoring activities have been classified into three categories — A, B and O.

'A' category monitoring activities are undertaken at all icon sites using agreed standardised methodologies:

- fish condition monitoring using MDBA Sustainable Rivers Audit methodology
- waterbird condition monitoring using a standard on-ground method to link with the annual aerial waterbird survey
- tree condition monitoring for river red gum and black box using on-ground assessments linked to remote-sensing data.

'B' category contains icon site-specific monitoring using locally appropriate methods. This monitoring responds to unique icon site characteristics and is less easily standardised:

- tree community distribution
- tree population structure/recruitment and relative abundance
- understorey plant assemblages, including wetland and floodplain species, and targeted surveys to assess lignum (*Muehlenbeckia florulenta*) and cumbungi (*Typha* species) condition
- additional surveys for small-bodied fish
- bush birds.

'O' category uses icon site monitoring related to objectives and is less easily linked to TLM ecological objectives.

At Chowilla–Lindsay–Wallpolla, these include threatened bird species, including regent parrot and bush stone-curlew (*Burhinus grallarius*) and frogs.

The Mallee Catchment Management Authority is responsible for all ecological monitoring under The Living Murray program at the Lindsay–Wallpolla icon site.

At present, the site specific ecological objectives for Lindsay–Wallpolla do not provide SMART (specific, measurable, achievable, realistic and time bound) targets and, as such, reporting in relation to ecological targets is generally not possible (Wallace 2009). In the interim, while site-specific ecological targets are being developed, reporting will focus on the specified ecological objectives by reporting against the variables identified in the Outcomes Evaluation Framework, e.g. species diversity; spatial distribution; relative abundance; and age structure (Wallace 2009).

More detailed monitoring may be required during the first few managed watering events following completion of the proposed works. The existing condition monitoring program should provide sufficient information about the resulting ecological outcomes, but there will also be a need for real-time monitoring of a range of parameters to identify and manage risks.

In addition, under Victoria's Native Vegetation Framework, which aims to achieve a net gain in the extent and condition of native vegetation across the state, it has been agreed that any native vegetation clearing associated with The Living Murray can be offset using the measured improvement in condition of the areas watered by the works. This policy recognises that significant biodiversity gain will occur through large-scale environmental watering, but does require implementation of a monitoring program across proposed offset sites to demonstrate the maintenance or improvement of vegetation condition.

Intervention monitoring

To improve icon site management and enhance ecological outcomes intervention monitoring investigates the links between environmental watering, infrastructure and ecological outcomes. Intervention monitoring targets environmental watering events that will inform key knowledge gaps and ecological questions. These results can be applied to other icon sites with similar ecological communities, hydrology and processes.

Groundwater monitoring

In addition to monitoring ecological outcomes and risks, groundwater and salinity monitoring will need to be undertaken, to provide information for Schedule B of the Basin Salinity Management Strategy Salinity Register. Monitoring will be undertaken according to recommendations in SKM (2009; 2010).

Risk monitoring

Risk monitoring plans have been developed (Schedule B) based on risk investigations conducted during the detail design phase of the works. These plans target monitoring efforts specifically around identified risks of the works or operations. The results from this monitoring can be used to gauge the success of the works as well as guide future management decisions.

6. Community consultation and communication

Community support for activities delivered under The Living Murray (TLM) at the Lindsay–Wallpolla icon site depends on effective engagement with a range of stakeholders.

Engagement strategies have been developed for TLM projects at Mulcra and Lindsay islands (Schedule 4), in consultation with the Icon Site Community Reference Group, the Trust for Nature and four New South Wales landholders. These groups have also provided input into the development of the Lindsay–Wallpolla Environmental Water Management Plan.

The engagement strategies focus on ensuring that the community is informed of the context, history, proposed processes, constraints and opportunities for environmental water management at the Lindsay, Mulcra and Wallpolla islands. This in turn will better enable environmental water managers to consider community values and knowledge in decision-making where possible. The Community Reference Group (see **chapter 1**), the Trust for Nature and New South Wales landholders play a key role in this process by providing advice on the most appropriate methods of engagement.

Communication and engagement activities to date have included field trips, site visits, briefings, media releases as well as events and publications for key stakeholder groups such as the Community Reference Group, local government, adjoining landholders and the local community.

Despite extended drought and low irrigation allocations, the local and wider community has been generally supportive of emergency environmental watering events at Lindsay, Mulcra and Wallpolla islands. It is understood that community opinion may shift with continued drought and that a proactive program of communication and consultation will be imperative for program success.

7. Indigenous engagement

Indigenous people have many social, cultural, customary and economic interests in the water resources of the River Murray.

The Living Murray aims to maximise ecological outcomes through the delivery of environmental water and therefore cannot provide for the commercial economic interests of any of its stakeholders. However, The Living Murray is committed to taking into account Indigenous values and objectives in its environmental water planning and management. As Indigenous communities identify objectives and strategies for achieving these Indigenous objectives they will be incorporated into environmental water management plans in the future. Indigenous consultation will be reported on in The Living Murray Annual Environmental Watering Report and The Living Murray Annual Implementation Report.

Indigenous engagement is an important aspect of managing the Lindsay–Wallpolla Islands. The Mallee Catchment Management Authority The Living Murray Indigenous Facilitator assists the project team in ensuring the local Indigenous community is fully engaged, informed and involved in the project. Involvement of the Indigenous community is critical to ensuring the success for the project, particularly as there are a number of groups involved. The Living Murray Indigenous Facilitator assists the project team in ensuring the local Indigenous community is fully informed through face-to-face and community meetings, a quarterly newsletter, fact sheets and Mallee Catchment Management Authority website updates.

The Living Murray Indigenous Partnerships Project

Murray Lower Darling River Indigenous Nations successfully negotiated the Indigenous Partnerships Project under The Living Murray Initiative. The project employs an Indigenous facilitator and establishes an Indigenous working party at each of the icon sites.

This will enable the drafting of cultural maps that will be owned by the Indigenous nations and used in the asset management plans and significant ecological asset environmental watering plans. These maps will ensure that any proposed works will not negatively impact on Indigenous sites—such as hunting sites, native fauna grazing and breeding areas, native food and medicinal plant colonies, burial sites and Dreaming or spiritual sites.

Murray Lower Darling River Indigenous Nations is a partner in this project and will assist in the establishment and support of working groups where appropriate.

8. Adaptive management and reporting

An adaptive approach is critical in managing water-dependent ecosystems because it enables land managers and policy-makers to update strategies based on the outcomes of research and watering actions. This is known as 'learning by doing' and involves designing, implementing, monitoring, reporting and evaluating our work.

Environmental water management plans are constantly refined by adaptive management, which incorporates outcomes from environmental delivery, ecological monitoring, works, modelling and community consultation.

The Living Murray Annual Environmental Watering Plan is developed at the beginning of each watering season and complements the environmental water management plan. As the season progresses, the annual water planning process responds to water availability, opportunities and environmental priorities. A flexible decision-making framework is included in the annual plan so the Environmental Watering Group can assess water priorities throughout the year according to the water resource condition.

To highlight and analyse previous activities and outcomes, the Murray–Darling Basin Authority works with icon site managers to produce an annual TLM implementation report (as required under clause 199 of The Living Murray Business Plan), which is used by the Independent Audit Group. An annual external audit is conducted to ensure TLM is implemented at an appropriate level of transparency and accountability, and to promote public confidence in the program's efforts and outcomes. The implementation report and external audit are presented to the Murray–Darling Basin Ministerial Council.

To capture key learning and changing icon site management practices, schedules appended to the environmental watering management plan are updated as required.

Adaptive management

A close relationship is required between water management and monitoring to ensure that the system is operated to optimise ecological outcomes and minimise environmental risks.

Management of environmental water will occur adaptively in line with the following process (see **Figure 8.1**).

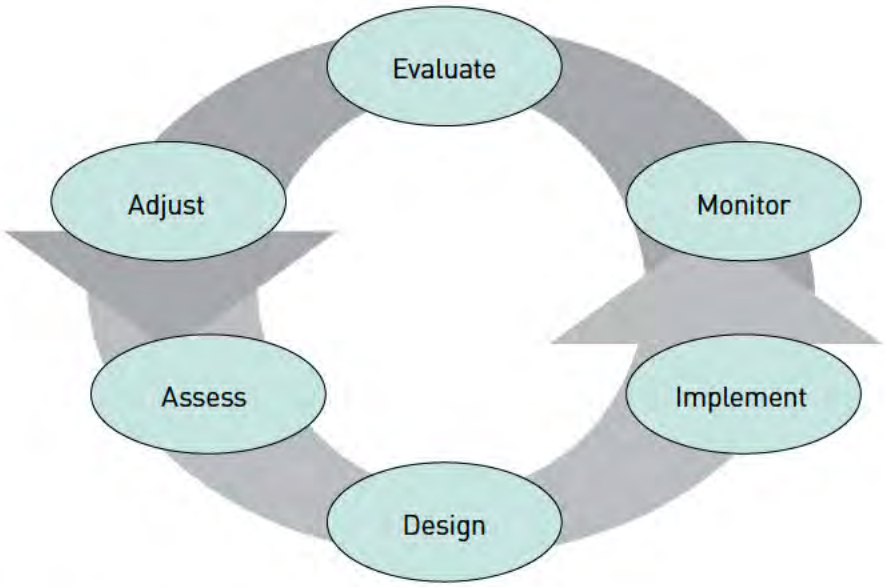

Figure 8.1: Adaptive management cycle

Assessment

The ecological issues, objectives, water requirement, priority areas and actions, and associated risks for restoring the floodplain are assessed. This stage requires community and expert input.

Design

Knowledge of the floodplain condition and its ecology are used to develop hypotheses in terms of expected responses and set objectives and targets. Interventions are designed, including a proposed package of works and operating rules.

Implementation

The recommended interventions are implemented.

Monitoring

The monitoring program will be coordinated by the Mallee Catchment Management Authority in conjunction with land managers. The different types of monitoring are discussed in **chapter 5**.

Evaluation

The monitoring results will be evaluated in light of the expected outcomes— ecological response. Triggers will be identified to inform if/how management needs to adjust (e.g. the size of flood event adopted, depending on water availability). Both short- and long-term triggers will be used. Short-term triggers include water movement into or out of structures, and whether specific biota (flora and fauna) begin to appear. Long-term triggers will include more detailed targets for ecological response.

Adjustment

The Icon Site Management Committee will consider the monitoring outcomes (and any new knowledge on the issues) to determine whether changes are required to the operating strategy and to redefine the expected outcomes from the operation (i.e. the objectives).

Assessment

Proposed changes will be assessed by the Icon Site Management Committee to consider if such changes still meet their expectations. Additional information provided through this step will be reviewed and considered.

Design

The program then moves back to the design stage where agreed changes are converted into changes to structural, operation or procedural plans.

Reporting

Improvements to actions and practices at the icon site (identified through the adaptive management process) will be reported to stakeholders through the existing governance arrangements described in **chapter 1**. This environmental water management plan will be reviewed periodically to capture the key lessons and changes in icon site management practices.

The outcomes achieved against the environmental water management plans will provide evidence of TLM progress. This information will be incorporated into the annual TLM implementation report and presented to the Murray–Darling Basin Ministerial Council. This meets the obligation to report on the annual progress of The Living Murray Initiative under clause 199 of The Living Murray Business Plan.

List of figures and tables

Figures

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Appendix A: Victorian icon site governance arrangements

In Victoria, The Living Murray (TLM) Initiative is delivered by the Department of Sustainability and Environment, which provides high-level policy input and coordinates TLM delivery across all Victorian icon sites.

With the exception of the Hattah Lakes, all TLM icon sites in Victoria are multi-jurisdictional. Interstate coordination for these cross-border sites occurs through the integrated coordinating committees and icon site management committees.

Victoria has set up a TLM steering committee to oversee TLM delivery in that state (see **Figure A.1**). This high-level committee, which is chaired by the Department of Sustainability and Environment, comprises representatives from key agencies responsible for implementing TLM. Goulburn–Murray Water has also convened a state construction committee to oversee the detailed design and construction phases.

The chief executive officers of the Mallee and North Central management authorities act as regional icon site coordinators for relevant icon sites. Icon site coordinators are responsible for delivering TLM at each icon site. Accordingly, the Department for Sustainability and Environment has entered into a memorandum of understanding with the Mallee and North Central catchment management authorities that:

- establishes a collaborative working relationship between the organisations
- sets out a common understanding of intent
- commits the organisations to sub-jurisdictional arrangements for delivery of The Living Murray Business Plan.

State water authorities (Goulburn–Murray Water and SA Water) are Murray–Darling Basin Authority-delegated constructing authorities for the icon sites. As such, they are responsible for detailed design and construction under the environmental water management plan once investment proposals have been approved by the MDBA.

Specific icon site arrangements and committees for Lindsay–Wallpolla Island are set out below.

Icon Site Management Committee

The Icon Site Management Committee is composed of representatives from the Mallee Catchment Management Authority, South Australia Water, the Murray–Darling Basin Authority, the Victorian Department of Sustainability and Environment (Office of Water and State-Wide Services), Parks Victoria and NSW Office of Water.

The purpose of the committee is to:

- oversee implementation of Victoria's obligations for TLM and the Environmental Delivery program at the Lindsay–Wallpolla Islands
- provide a forum for the cooperative delivery of TLM and the Environmental Delivery program for the Lindsay–Wallpolla Islands
- advise the Icon Site Coordinator (Mallee Catchment Management Authority Chief Executive Officer) on TLM matters and the Environmental Delivery program for the Lindsay–Wallpolla Islands
- facilitate and monitor progress of TLM program delivery.

The role of the committee is to facilitate TLM implementation through their respective agencies by:

- generating support for TLM environmental works and measures and environmental delivery projects planned for the Lindsay–Wallpolla Islands within their own agencies and facilitating resolution of issues relevant to their agency
- ensuring agency commitments for TLM environmental works and measures and environmental delivery projects are fulfilled
- attending meetings with the Icon Site Management Committee and Icon Site Coordinator, as required
- disseminating information regarding long-term obligations and annual deliverables to relevant agency officers, including engaging broader staff within their organisations
- providing advice to the Icon Site Coordinator regarding implementation, policy or legislative issues, as relevant to their respective agencies, which may affect program delivery

- providing advice regarding the progress of program implementation, as required
- nominating appropriate representatives from their respective agencies to participate on project working groups, as requested
- ensuring active and timely participation of the nominated representative
- ensuring that the nominated working group representative undertakes broader engagement within their organisation, including updates to the relevant committee member.

Icon Site Construction Committee

The Icon Site Construction Committee consists of representatives from the Mallee Catchment Management Authority, South Australia Water (chair), the Victorian Department of Sustainability and Environment (Office of Water and State-Wide Services), Parks Victoria, NSW Office of Water and the MDBA.

The objective of the committee is to:

- oversee the development of detailed designs and construction of works funded under TLM at the Lindsay–Wallpolla Islands, ensuring works are consistent with the approved investment proposal and construction proposal and address any issues identified in the assessment of these documents
- foster a sharing of expertise to ensure that environmental works are designed, constructed, operated, and commissioned efficiently, and effectively to deliver the agreed environmental functionality.

The specific tasks of the committee include providing technical oversight, identifying and addressing all land management issues associated with the works, regularly reviewing project costs and timelines, reviewing risks and mitigating measures and seeking endorsement from the State Construction Committee for any project changes.

While the committee sits under the State Construction Committee, information regarding project progress is also provided to the Icon Site Management Committee.

Icon Site Community Reference Group

The Lindsay–Wallpolla Islands Community Reference Group was established in 2008 as a requirement of The Living Murray Business Plan. The Lindsay–Wallpolla Community Reference Group and Hattah Lakes Community Reference Group have merged and meet as one group. The Community Reference Group provides a platform to seek advice and a community perspective on the communication and engagement activities proposed for the project. The Community Reference Group will continue to be engaged as an advisory body for the implementation of communication tools and actions. Membership of the group includes six representatives of the local community plus the Mallee Catchment Management Authority Board chairman. The Community Reference Group reports to the Icon Site Coordinator.

Icon Site Indigenous Reference Group

An Indigenous Reference Group was planned to be established for the icon site as a mechanism for consulting with Traditional Owner groups and obtaining advice on broader Indigenous engagement.

This group has yet to be established and in the interim representatives from the Ngintait people, Wergaia/Nyeri Nyeri people and the Mildura Aboriginal Co-operative are members of the Icon Site Management Committee.

Appendix B: Fauna guilds and breeding waterbirds — water regime class relationships

Table B.1: Water regime class use by fauna guilds

Water regime classes are abbreviated as SPW Semi-permanent wetland, TW Temporary wetland, LS Lignum shrubland, RGF River gum forest, RGW River gum woodland, BBX Black box woodland, ANB Anabranches and AP Alluvial plain.

Fauna group	Guild	Number of species and species of conservation significance	Primary water regime classes	Supplementary water regime classes	Rarely used water regime classes
Waterbirds	Dabbling ducks	6 species and 2 significant	SPW and TW	LS	LS
	Deep water divers	3 species and 3 significant	SPW and TW		LS
	Grazing Water fowl	3 species and 0 significant	SPW and TW		LS
	Large waders	4 species and 1 significant	SPW and TW		LS
	Shoreline forages	7 species and 0 significant	SPW and TW		
	Piscivores	16 species and 6 significant	SPW and TW		LS
Birds of prey	Large carnivores	2 species and 1 significant	ANB and SPW		LS
	Small carnivores	18 species and 4 significant	RGF, RGW, BBX and AP		LS
Bushbirds	Insectivores	88 species and 14 significant	RGF, RGW, BBX and AP		
	Arboreal granivores	22 species and 4 significant	RGF, RGW, BBX and AP		
	Nectivores/ Omnivores	20 species and 0 significant	RGF, RGW and BBX		
	Frugivores	3 species and 1 significant	RGF, RGW, BBX and AP		
Frogs	Terrestrial frogs	5 species and 2 significant	SPW and ANB	RGF and TW	LS
	Burrowing frogs	2 species and 0 significant	RGF and RGW		
Mammals	Aquatic mammals	1 species and 0 significant	RGF and RGW		
	Arboreal herbivores	1 species and 0 significant	RGF	RGW and BBX	
	Piscivores	1 species and 0 significant	ANB and SPW	TW	LS
	Large grazers	3 species and 1 significant	RGF, RGW and BBX	AP	
Reptiles	Aquatic reptiles	4 species and 2 significant	SPW and ANB	TW	LS
	Large carnivores	7 species and 4 significant	RGF RGW and BBX		
	Small carnivores	22 species and 3 significant	RGF, RGW, BBX LS and AP		
	Omnivores	2 species and 0 significant	RGF, RGW, BBX, LS and AP		

Fauna group	Guild	Number of species and species of conservation significance	Primary water regime classes	Supplementary water regime classes	Rarely used water regime classes
Fish	Flow-dependent	2 species and 1 significant	ANB	SPW, TW and RGF	
	Large fish	3 species and 2 significant	ANB	SPW and TW	
	Small fish	2 species and 1 significant	SPW and TW	ANB	LS
	Floodplain	1 species and 0 significant	RGF and RGW	SPW and TW	BBX and LS
	Flow-dependent	1 species and 1 significant	ANB		
Aquatic invertebrates	Wetland	1 species and 0 significant	SPW and ANB	TW	

Table B.2: Water regime class use by breeding waterbirds

Water regime classes are abbreviated as SPW Semi-permanent wetland, TW Temporary wetland, LS Lignum Shrubland, RGF Red gum forest, RGW Red gum woodland, BBX Black box woodland and AP Alluvial plain.

Common name	Breeding stimulus	Nest type	Principle breeding water regime class	Supplementary breeding water regime class	Rarely used water regime classes
Red-necked avocet	Flooding, seasonal	Ground scrape in flooded reeds	SPW	TW	LS
Black-fronted dotterel	flooding	Ground scrape in flooded reeds	SPW	TW	LS
Masked lapwing	Flooding	Ground scrape in flooded reeds	SPW	TW	LS
Red-capped plover	Flooding	Ground scrape in flooded reeds	SPW	TW	LS
Black-winged stilt	Flooding	Ground scrape in flooded reeds	SPW	TW	LS
Freckled duck	Flooding, seasonal	Platform in reeds or shrubs 1m above water	SPW	TW	LS
Black swan	Flooding	Mattress of vegetation near reeds	SPW	TW	LS
Musk duck	Seasonal	Mattress of vegetation over reeds	SPW	TW	LS
Australasian grebe	Flooding	Raft of reedy vegetation over deep water	SPW	TW	LS
Buff-banded rail	Flooding, seasonal	Platform in or on flooded reeds	SPW	TW	LS
Dusky moorhen	Flooding	Platform in or on flooded reeds	SPW	TW	LS
Purple swamphen	Flooding	Platform in or flooded reeds	SPW	TW	LS
Darter	Flooding	Stick nest in flooded trees	RGF and RGW		BBX
Little egret	Flooding, seasonal	Stick nest in flooded trees	RGF and RGW		BBX
White-necked heron	Flooding, seasonal	Stick nest in flooded trees	RGF and RGW		BBX
White-faced heron	Flooding	Stick nest in flooded trees	RGF and RGW		BBX
Great cormorant	Flooding	Stick nest in flooded trees	RGF and RGW		BBX
Little black cormorant	Flooding	Stick nest in flooded trees	RGF and RGW		BBX
Pied cormorant	Flooding	Stick nest in flooded trees	RGF and RGW		BBX

Common name	Breeding stimulus	Nest type	Principle breeding water regime class	Supplementary breeding water regime class	Rarely used water regime classes
Little pied cormorant	Flooding	Stick nest in flooded trees	RGF and RGW		BBX
Yellow-billed spoonbill	Flooding, seasonal	Stick nest in flooded trees	RGF and RGW		BBX
Australian wood duck	Flooding	Tree hollows near water	RGF and RGW		BBX
Pink-eared duck	Flooding	Tree hollows or reedy platform	RGF and RGW		BBX
Blue-billed duck	Flooding	Tree hollows or reedy platform	RGF and RGW	TW	LS
Chestnut teal	Flooding	Tree hollow or reedy platform	RGF, RGW and SPW	TW	LS
Grey teal	Flooding	Tree hollow or reedy platform	RGF, RGW and SPW	TW	LS
Australian shelduck	Flooding, seasonal	Tree hollow or reedy platform	RGF, RGW and SPW	TW	LS
Pacific black duck	Flooding	Tree hollow or reedy platform	RGF, RGW and SPW	TW	LS

Schedules

For all schedules see ←www.mdba.gov.au/programs/tlm/icon_sites/emp.→.

Schedule 1: Operating plan for Mulcra Island and Lindsay Stage 1

Schedule 2: Risk management plan for Mulcra Island and Lindsay Stage 1

Schedule 3: Condition monitoring plan for the Chowilla–Lindsay–Wallpolla icon site

Schedule 4: Communication plan

Abbreviations and acronyms

AHD	Australian height datum
CAMBA	China–Australia Migratory Bird Agreement
GL	gigalitres
JAMBA	Japan–Australia Migratory Bird Agreement
LTCE	long-term Cap equivalent
MDBA	Murray–Darling Basin Authority
MDBC	Murray–Darling Basin Commission
ML/d	megalitres a day
RoKAMBA	Republic of Korea–Australia Migratory Bird Agreement
TLM	The Living Murray

Glossary

Aquatic ecosystem	A water environment from small to large, from pond to ocean, in which plants and animals interact with the chemical and physical features of the environment.
Ecological objectives	An objective is a statement of the desired condition. It is not necessary to quantify an objective.
Ecological targets	A target is generated from the ecological objective and will ideally be quantitative.
Environmental water	Water that is available for the environment.
Environmental Watering Group	A jurisdictional committee that develops and implements the annual The Living Murray Environmental Watering Plan. The Environmental Watering Group recommends annual TLM watering priorities and proposals to ensure consistency between icon sites.
Environmental Water Management Plan	A plan that details the aims, objectives and management actions at an icon site that are in accord with The Living Murray. The plan complements state-based plans and processes.
Murray–Darling Basin Ministerial Council (Ministerial Council)	A ministerial council that develops and agrees to intergovernmental agreements, approves The Living Murray Business Plan and makes key decisions — for example, approval of the Murray–Darling Basin Authority's Natural Resource Management program's budget in the Corporate Plan.
Objective	Refer Ecological objectives.
Parameter	A measurable or quantifiable characteristic or feature.
Preferred operating strategy	Optimum operation of a structure to achieve a TLM ecological objective.
Ramsar Convention	A global treaty adopted in the Iranian city of Ramsar in 1971 that focuses on the conservation of internationally important wetlands.
River Management Division	A business unit of the Murray–Darling Basin Authority responsible for operating the River Murray system in accordance with the Murray–Darling Basin Intergovernmental Agreement. River Management Division manages the River Murray system to ensure that the available water is continuously accounted for and distributed to New South Wales, Victoria and South Australia in accordance with the Murray–Darling Basin Agreement.
River Murray Increased Flows (RMIF)	The component of the water recovered under the Snowy Water Inquiry Outcomes Implementation Deed (SWOID) that is returned to the River Murray system as an environmental flow.
Target	Refer Ecological target.
The Living Murray Committee	A jurisdictional committee responsible for implementing The Living Murray Business Plan.
Unregulated Flow	The volume of water surplus to regulated requirements and determined by the volume of flow in the River Murray exceeding (or predicted to exceed) the inlet channel capacity for Lake Victoria and entitlement flow for South Australia
Water requirements	Includes the flow, volume, timing, duration, velocity, depth, quality or any other attribute that is required to meet the ecological target.

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Australian Government

MURRAY-DARLING BASIN AUTHORITY

The Living Murray Program

INTERIM OPERATING PLAN 2015-16

Lindsay Island Environmental Works and Measures Program

Australian Government

MURRAY–DARLING BASIN AUTHORITY

Important notes regarding the nature of this document and proposed future works

The Interim Lindsay Island Operating Plan should be viewed as a living document, which will evolve in response to changing site conditions and ongoing knowledge development. The plan is a schedule to the Icon Site Environmental Management plan; it also includes sufficient detail to be a stand-alone document.

It is intended that this plan will be combined with the Mulcra interim Operating Plan and a new Wallpolla Operating Plan over the next financial year. In combining these Operating Plans, it is expected that there will be considerable review and revision of the content including a post commissioning review of risk assessments.

It is important to note that whilst some operations of the Mullaroo and Lindsay structures require manipulation of the Lock 7 weir pool, the detailed assessment of these weir pool manipulations is not covered within this document. The management of weir pool manipulation trials is coordinated by NSW Office of Water in consultation with MDBA, SA Water and Mallee CMA.

This plan will not prescribe particular watering events or if a watering event is to occur; the principal purpose of this document in the short-term is to provide guidance to assist with the commissioning of the Mullaroo Regulator and Fishway during the 2015/2016 water year.

In future this document will also provide a record of previous events and any considerations to improve subsequent operations in supporting the ecological objectives and in response to any impacts of operations to third parties. This document will also be updated as required in light of new information, changing site conditions and/or the performance of water management infrastructure.

Version control

Version	Date	Prepared	Reviewed	Approved
1 - 8	April 2013	Mallee CMA MDBA		
Post Mullaroo construction revision Version 1	May 2015	Mallee CMA	MDBA DELWP VEWH SA Water NOW GMW	
Post Mullaroo construction revision Version 2	June 2015	Mallee CMA	MDBA DELWP VEWH SA Water NOW GMW	Conditionally approved by Lindsay, Mulcra and Wallpolla Operating Group (LMWOG)
Post Mullaroo construction revision Version 3	June 2015	Mallee CMA	Victorian State Construction Committee	

Key Contacts

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Dept. Environment, Land, Water and Planning	[redacted] Sustainable Water Environments, Water Group [redacted]
NSW Office of Water	[redacted] Project Officer [redacted]
Goulburn-Murray Water - Accounting	[redacted] Manager Water Resources [redacted]
Murray-Darling Basin Authority – Commissioning	[redacted] Environmental Works and Measures Program Assets, River Management [redacted]
Murray-Darling Basin Authority – Water Delivery	[redacted] TLM Planning, Delivery and Monitoring Environmental Management [redacted]
Murray-Darling Basin Authority – Operations	[redacted] River Operator Operations, River Management [redacted]

Table of Contents

1 BACKGROUND

The Living Murray (TLM) is one of Australia's most significant river restoration programs. Established in 2002, TLM is a partnership of the NSW South Wales, Victorian, South Australian, Australian Capital Territory and the Commonwealth governments, coordinated by the Murray-Darling Basin Authority (MDBA). The long-term goal of this program is to achieve a healthy working River Murray system for the benefit of all Australians.

The Living Murray (TLM) Initiative was established in response to concerns about the environmental health of the River Murray. The initiative has recovered 500 GL of environmental water and has constructed works and associated measures to enable the efficient and effective use of environmental water. Following on from the construction of the infrastructure, the TLM program has begun to implement environmental watering activities, which have been monitored and reviewed to ensure the greatest ecological outcomes were achieved for the prevailing environmental and river system conditions.

The Living Murray program aims to improve the environmental health of six icon sites that were chosen for their significant ecological, cultural, recreational, heritage and economic values.

Lindsay Island is part of the Chowilla-Lindsay-Wallpolla Icon Site. Lindsay Island covers 15,000 ha of floodplain to the south of the River Murray, between Lock 8 and Lock 6 (Figure 1-1). The island is enclosed by the Lindsay River and extends for approximately 28 km from east to west. It incorporates a complex range of landforms including creeks, temporary anabranches, wetlands, floodplain woodlands and grasslands. Lindsay Island is part of the Murray-Sunset National Park and is managed by Parks Victoria. The island is a refuge for many species of state, national and international importance and is also recognised for its many sites of Aboriginal cultural heritage.

Changes to the flow regime in the River Murray have significantly reduced the ecological health of Lindsay Island. This is primarily due to a reduction in the frequency and magnitude of flooding as a consequence of the long-term effects of river regulation; further compounded by the recent 10 year drought.

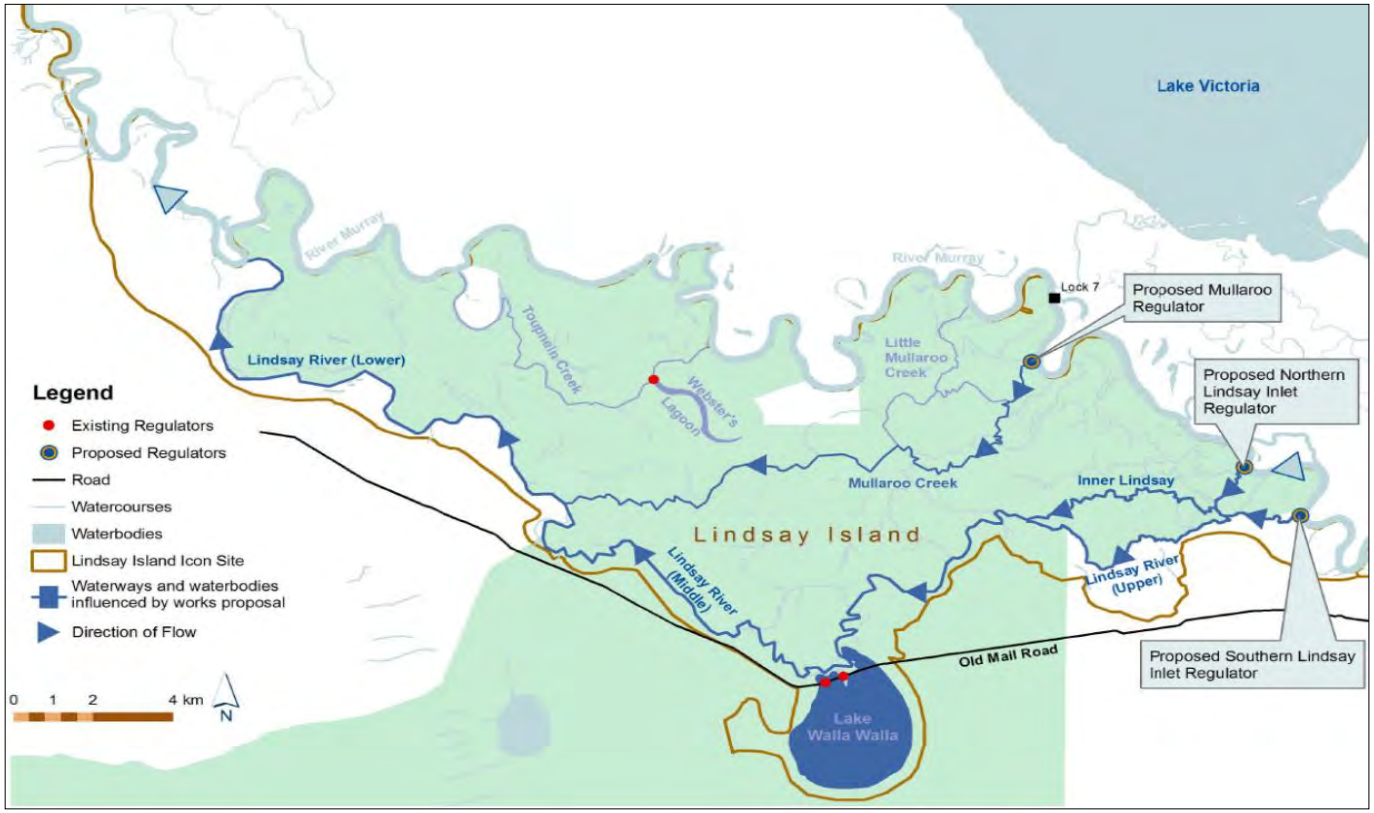

Figure 1-1: Map of Lindsay Island showing location of structures (to be updated when plan is finalised including location of flow measurement sites within the system)

As part of The Living Murray program, ecological objectives were created for each Icon Site (MDBA, 2012). Seven TLM ecological objectives were created for the Lindsay, Mulcra and Wallpolla Islands. These ecological objectives are dependent on the hydrology of the Lindsay River and the Mullaroo Creek and their connected wetlands and refer to increases in productivity, diversity and availability of habitat for flora and fauna as well as diversity and distribution of native fish. For further information on the ecological objectives, refer to the Ecological Watering Guide (MCMA, 2015). These ecological objectives will also provide a mechanism for evaluation and monitoring to help determine the success of the project.

To achieve these objectives, a package of engineered water management structures has been completed, with the aim of aiding water management within the Lindsay River and Mullaroo Creek, as well as to manage delivery of environmental water to Lake Wallawalla. The completed works include:

- Regulators on the northern and southern inlets of the Lindsay River (completed 2013)
- Sill lowering in the southern inlet of the Lindsay River (completed 2013)
- Regulator on Webster's Lagoon (completed 2006)
- Two regulators on the Lake Wallawalla inlets/outlets (completed 2006)
- Regulator and fishway on the Mullaroo Creek (completed 2015)

The works have been designed to provide a more appropriate hydrological regime to the Lindsay River and Lake Wallawalla to meet the requirements of native fish, riparian vegetation and associated biota, and to maintain appropriate passing flows in the Mullaroo Creek under a range of River Murray flow conditions.

2 Purpose of the Operating Plan

This document is an interim operating plan for the Lindsay Island regulators only. It is intended to inform operations until a comprehensive Lindsay-Mulcra-Wallpolla Operating Plan is developed. The Lindsay-Mulcra-Wallpolla Operating Plan will encompass works across the Icon Site including Lindsay Island, Mulcra Island and Wallpolla Island.

This Operating Plan provides the framework for the operation of the Lindsay Island TLM structures to meet key ecological objectives within the broader context of TLM, legislative requirements and governance. The purpose of the operating plan is to:

- Summarise the governance arrangements for environmental watering activities at the site;
- Summarise the roles and responsibilities of partner agencies;
- Aid in decision making and planning prior to and during watering events;
- Summarise operational risks and mitigation strategies;
- Outline water measurement arrangements;
- Outline communication and consultation requirements; and
- Provide links to documents containing further detail.

The operating plan also defines the obligation of the various parties to manage and operate the structures as required under the Murray-Darling Basin Agreement (S 52 – 54).

The Operating Plan is not intended to prescribe particular watering events. The audience for the Operating Plan is summarised in Table 2-1.

It is important to note that this document is a 'living document' that will be further refined and developed regularly over time and with each watering event, by the Mallee CMA. It is expected that knowledge and information in relation to adjusting and optimising structure operations will improve with each event. Revision of the document will enable future operational decisions to be based upon the best available knowledge.

Table 2-1: Intended Audience for the Operating Plan

Audience	Key Requirements	Primary Interest		
		Ecological	Operation	Risk
Event Managers (Mallee CMA, RM Operations)	Adaptive management	✓	✓	✓
Land Manager (Parks Vic)	Adaptive management	✓		✓
Other Environmental Managers (DELWP)	Adaptive management	✓		✓
Operators (South Australia Water & RM Operations)	Operation of structures Accountability		✓	✓
Water holder/funder (TLM-MDBA, CEWH, VEWH)	Accountability	✓	✓	✓
MDBA (BSMS)	Meet legal requirements			✓
Asset Manager (MDBA Assets)	Meet legal requirements		✓	✓
Victorian Murray Resource Manager (GMW)	Accountability		✓	✓

Additional Documents

This document is one of four schedules to the Lindsay-Wallpolla Islands Environmental Water Management Plan (EWMP) (MDBA, 2012). Each schedule focuses on a specific area of environmental water management for the Lindsay, Mulcra and Wallpolla Islands (Table 2-2). This document will refer to the EWMP and its schedules, as well as other documents that are relevant to environmental water management at the icon site (Table 2-3).

Table 2-2: Documents supporting environmental water management at the Lindsay-Wallpolla Islands Icon Site

Document	Purpose
Lindsay – Wallpolla Islands Environmental Water Management Plan (MDBA 2012)	Long term strategic plan that outlines the site's overall management arrangements, objectives, environmental water requirements, and scope of environmental works to manage the water. Supported by detailed schedules.

Schedule 1 (This Document) Interim Operating Plan for the Lindsay Island Environmental Works and Measures which sits alongside the Mulcra Island Interim Operating Plan (to be replaced with the Lindsay, Mulcra and Wallpolla Icon Site Operating Plan)	Describes the environmental works, how the works relate to the ecological objectives, and defines the governance, risk management and water measurement principals for operation of the structures to deliver environmental water.
Schedule 2 Risk Management Plan for Mulcra Island and Lindsay Stage 1 (in preparation)	Currently incorporated within this document but to be further refined and updated post commissioning.
Schedule 3 Condition Monitoring plan for the Chowilla-Lindsay-Wallpolla Icon Site (MDFRC, 2011)	Describes the condition monitoring activities at the site. Currently under review.
Schedule 4 Communication Plan (MCMA 2010)	Overview of communications roles and responsibilities

Table 2-3: Additional documents supporting environmental water management at the Lindsay-Wallpolla Islands Icon Site in 2015-16

Document	**Purpose**
Lindsay-Mulcra-Wallpolla Watering Guide (MCMA, 2015)	Provides detail on ecological objectives, water requirements and tolerances, preferred watering regime, and role of each structure in delivering water to meet the objectives. This document also encompasses the adaptive management process for achieving the site ecological objectives.
Event plan 2015-16 – Manipulation of Lock 7, 8 and 9	Guiding document for current year weir pool manipulation activities as well as event record for previous year's activities.
Annual Intervention Monitoring Proposal (including risk monitoring)	Describes the intervention, risk and compliance monitoring undertaken at the site. Prepared by the Mallee CMA annually.

Lock 7 Operations, Maintenance and Safety Manual incorporating supporting and Environmental Water Management structures	Currently being updated by South Australia Water as a standalone document for agency staff to guide physical operations of the structures.
Emergency Management and Escalation Plan	Forms part of the Commissioning Plan and broader operation and maintenance manual described above, details risk to populations from potential structure failure.

3 Interactions with Other Systems or Structures

This section looks at the interaction of other water management structures, river systems and sites, with the Lindsay Island system.

The volume of water flowing past Lindsay Island is influenced by the upstream operations of five major storages/river systems:

- The River Murray and the Edward-Wakool system including operation of the Hume Dam and Yarrawonga Weir
- The Goulburn River and the operation of Eildon Dam
- The Murrumbidgee River
- The Darling River; and
- Lake Victoria

A combination of river levels and the operations of each of the major structures on these rivers will determine the volume of water flowing past Lindsay Island. Additionally, Lindsay Island spans the Lock 6 and Lock 7 weir pools and the influence of these structures in particular is also a key driver of the island's hydrology.

Both the Lindsay River and Mullaroo Creek diverge from the River Murray within the Lock 7 weir pool. Under current conditions the normal Full Supply Level (FSL) of Lock 7 is 22.10 m AHD whilst the normal Lock 6 weir FSL is 19.25 m AHD (Ecological Associates, 2007). This head difference drives the fast flowing reaches of the upper Mullaroo Creek, which diverges from the River Murray about 2 km upstream of Lock 7. Mullaroo Creek is the primary inflow point for Lindsay Island. A secondary inflow point is the northern Lindsay River inlet, which diverges from the River Murray about 10 km upstream of Lock 7.

The influence of the Lock 6 weir pool extends into the lower reaches of the Lindsay River and Mullaroo Creek where it creates a permanent, slow flowing environment. Low lying creeks and waterways on Lindsay Island are inundated by the Lock 6 backwater, including Toupnein Creek and Webster's Lagoon. Other anabranches, wetlands and the floodplain within Lindsay Island remain dry under normal weir pool levels.

Multi-site Watering

The main operational scenario for through-flows, water will be returned to the River Murray. An important consideration when re-using water in this manner is the quality of the water and Basin Plan water quality targets. Potential also exists for the operation of this site in conjunction with River

Murray operations, icon site watering and other environmental watering activities, to achieve multiple benefits from a single release of environmental water from storage. Flows released from environmental watering upstream can be re-used at Lindsay Island.

Interactions within the Site

There are two privately owned properties within Lindsay Island and a group of irrigators at Lindsay Point which may be affected by operations of the works, but will not be inundated. Additionally, there are three properties on the NSW side which may be affected by weir pool raising at Lock 7. Mallee CMA will work to engage with those who may be affected on the Victorian side by the TLM operations and the NOW for the NSW side weir pool operations. Dilution flows provided via the Mullaroo creek are critical to the management of salinity within the Lindsay River which provides water to the Lindsay point irrigators. Monitoring of salinity impacts of operation of the Lindsay and Mullaroo regulators is critical to ensure that irrigators are not adversely affected.

4 GOVERNANCE

This section describes the high level program governance as well as the roles and responsibilities for stakeholder groups, for operation of the Lindsay Island works.

For more detail on Victorian legislative frameworks and agreements, as well as planning and policy frameworks, please refer to the *Regional Context Document for Environmental Water Management Plans: Mallee CMA Region* (MCMA, 2014). Additional details on the Living Murray governance structure as well as relevant Commonwealth and New South Wales legislation can be found in the Lindsay-Wallpolla Islands Environmental Water Management Plan (MDBA, 2012).

4.1 Overview of TLM governance

TLM is a joint initiative between the Australian, South Australian, New South Wales, Victorian and Australian Capital Territory governments. It is governed by:

a) Intergovernmental Agreement (2004) on addressing water over-allocation and achieving environmental objectives in the Murray-Darling Basin (IGA 2004);

b) Supplementary Intergovernmental Agreement (2006) on addressing water over-allocation and achieving environmental objectives in the Murray-Darling Basin (IGA 2006);

c) Further agreement (2009) on addressing water over-allocation and achieving environmental objectives in the Murray-Darling Basin (IGA 2009).

The TLM Business Plan 2007 also complements the IGA (2004) and provides operational policies to guide the implementation of TLM.

The groups with a direct role in TLM governance are the Murray Darling Basin Ministerial Council, the Murray Darling Basin Authority, the Basin Officials Committee (BOC), TLM Committee (TLMC) and the Southern Connected Basin Environmental Watering Committee (SCBEWC). Detailed governance and planning arrangements for use of TLM water are contained within the Lindsay-Wallpolla Islands Icon Site Environmental Water Management Plan.

While the MDBA is responsible for implementation of TLM (under Section 18H of the *Commonwealth Water Act 2007*), the management and delivery of TLM activities at the Icon Sites are primarily undertaken by relevant agencies in the jurisdictions where the Icon Sites are located. The Victorian Department of Environment, Water, Land and Planning (DELWP) oversees TLM activities within Victoria. The Chief Executive Officer of the Mallee CMA is the Regional Icon Site Coordinator for the Lindsay-Wallpolla Islands Icon Site and is responsible for delivering all aspects

of the TLM program. In addition, Parks Victoria, the MDBA, South Australia Water, Victorian Environmental Water Holder (VEWH) and Commonwealth Environmental Water Holder (CEWH) also play key roles.

4.2 Governance arrangement for operating the Lindsay Island structures

The MDBA manages the assets in accordance with: the *Commonwealth Water Act 2007*; the Murray-Darling Basin Agreement (Schedule 1 to the *Commonwealth Water Act 2007*); the MDBA's annual Corporate Plan; the Asset Agreement; and the Asset Management Plan for River Murray Operations Assets. Operation and maintenance of the assets is conducted by the MDBA River Management Division in conjunction with the relevant State Constructing Authority (in this case, South Australia Water). MDBA river operations staff coordinate the delivery of water (both irrigation and environmental) and manage unregulated flows throughout the River Murray System.

Management arrangements for an event are as follows:

- Following approval of environmental allocations, the Lindsay-Mulcra-Wallpolla Islands Operations Group (LMWOG) is convened by the Icon Site managers (MCMA).
- This group will oversee the event, and make recommendations to MDBA River Operations regarding environmental water delivery, and the operation of structures using the environmental water order template.
- MDBA River Murray Operations will consider the water order, and determine a course of action.
- MDBA River Murray Operations will issue instructions to SA Water regarding the operation of the structures.
- SA Water will report back to RMO and the LMWOG on execution of an order.
- Risks will be monitored as determined in annual TLM and VEWH watering plans and proposals. Any advice regarding management of structures or delivery of water will be provided to MDBA via the LMWOG (or direct to RM General manager where action is urgent).

4.3 Lindsay-Mulcra-Wallpolla Operations Group

The MCMA convenes the LMWOG to provide advice to the MDBA River Operations regarding event management and the day-to-day management of the structures during an event. The group is convened via teleconference during event planning and operation of the site once allocations have been sourced weekly, or otherwise as required, to plan ahead for operations and to provide feedback on current operations. The key responsibilities of the group are to ensure the necessary planning, monitoring, communication and reporting arrangements are established prior to and during events as well as to identify and monitor any event risks or issues.

The group is chaired by the MCMA and membership includes agency representatives with delegated responsibilities, including those involved in day-to-day management of the structures. Representatives with delegated responsibilities include SA Water, Parks Victoria, MCMA and MDBA River Murray Operations (Table 4-1). Other agencies, including MDBA TLM Planning and Delivery, DELWP, VEWH, CEWH, GMW, NOW and SA DEWNR may attend as members, guests or observers.

The purpose of the group is to ensure responsible agencies are aware of and have input into decision making and ensure that recommendations made to RMO are sensible and practical. The operating scenario/strategy is forwarded to the MDBA River Murray Operations for consideration in light of broader river operations and issues. When the MDBA Operators confirm the strategy is consistent with operating procedures they then will request SA Water Lock and Weir staff implement the operating scenario/strategy.

Table 4-1: Roles and responsibilities supporting environmental watering at the Lindsay, Mulcra and Wallpolla Islands

Organisation	Main Roles	Tasks/Responsibilities		
		Event Planning	Event Management	Event Reporting
Icon Site Manager - Mallee CMA	Event Coordination Communications Monitoring	-Convene Lindsay-Mulcra-Wallpolla Operations Group (LMWOG) -Ensure planning process is to annual schedule -Review and Revise Operating Plan and Risk Management Plan with other LMWOG input -Prepare Annual Watering Plan with OG input	-Convene and coordinate weekly (or as required) meetings/teleconferences. -Coordinate event monitoring (ecology/environment/water use) -Coordinate Community Communications and Consultation	-Prepare Annual Watering Report with other stakeholder input -Compile/Collate Monitoring Results
River Management (MDBA)	Instruct Operations Water Delivery Modelling	-Provide advice on basin wide river operations and any implications -Provide advice to assist in planning	-Issue Operating Instructions (both in river and at relevant structures) -Provide advice on basin wide river operations and any implications -Re-calibrate the water use model during the event	-Assist GMW with water accounting -Provide advice on any water delivery implications encountered and future considerations -Report on the confidence of the model vs the actual
SA Water	Structure Operation & Maintenance Data collection	-Provide advice on structural or maintenance issues and any implications -Conduct maintenance	-Operate structures to meet instructions -Provide advice on structural or maintenance issues and any implications -Data collection and provision of data to MDBA during events, including flow, level and water quality monitoring	-Provide details on performance of structures and any issues or future considerations -Provide details of issues associated with operational costs
GMW	Water accounting	-Provide advice on water accounting planning and preparedness and any implications for an event	- Water accounting – calculate weekly diversion volumes	-Watering accounting against Victorian entitlements – provide the water holder with volumes used and inform LMWOG
Parks Victoria	Land Manager	-Provide advice on achieving ecological objectives -Advise the group regarding site ecological values or threats and any implications - Approve watering on public land	-Manage Public Access (during and after event) -Advise site ecological values or threats and any implications	-Provide details of site ecological responses and any future implications
VEWH	Water Availability Approvals	-Approve Victorian state wide watering priorities -Approve Annual Watering Plan – Victorian priorities -Co-ordinates water use with other environmental water holders, including advising on water availability for the site from all environmental water holders.	- Approves all watering activities through Seasonal Watering Statements - Provides indication on water availability for watering activities -Seek further water if required -Water accounting verification of volumes, use and coordinate return flows	-Assist with report compilation and review -Review volumes of environmental water used
TLM – Planning and Delivery (MDBA)	Water Availability (If TLM water used)	-Advise on annual TLM watering objectives -Advise on TLM water availability -Coordinating activities across TLM Icon Sites	OBSERVER ROLE ONLY if contributing environmental water	-Assist with report compilation and review
CEWH	Water Availability (If Commonwealth water used)	-Advise on Commonwealth watering objectives -Advise on Commonwealth water availability -Coordinating other CEWH activities	OBSERVER ROLE ONLY if contributing environmental water	-Assist with report compilation and review
Scientific consultants	Event Monitoring	-Provides advice on achieving ecological objectives	-Undertake monitoring activities as directed by the Mallee CMA or other contracting agency.	-Report monitoring results

		-Identify monitoring issues and costs estimates for planned events as directed	-Data collection	-Advise if monitoring appropriate to assess ecological responses against objectives -Advise any monitoring issues and implications
Scientific Advisors	Specialist Advice	-Assist setting ecological objectives	-Provide specialist advice when required	NO ROLE EXPECTED
SCBEWC inc. TLM partner governments	Allocation of TLM entitlements Coordination of environmental water the southern connected Murray Darling Basin	-Decision making on the use of TLM portfolio, River Murray unregulated flows and River Murray increased flows	NO ROLE –unless site or in river conditions lead to substantial change from planned event	-Review TLM Watering summaries provided by Icon Site Managers
NSW Office of Water	Event Coordination (weirpool manipulation) Communications	-Ensure planning process is to annual schedule (Weir pool Manipulation) -Review and Revise Weir pool Operating Plan and Risk Management Plan with other LMWOG input -Prepare Annual weir pool manipulation plan with OG input	-Coordinate event monitoring (NSW)(ecology/environment/water use) -Coordinate Community Communications and Consultation (NSW)	Compile/Collate Monitoring Results (NSW)

4.4 Stakeholder Roles and Responsibilities

Mallee Catchment Management Authority (CMA) – Icon Site Manager
The Icon Site manager for Lindsay Island is the Chief Executive Officer of the Mallee CMA. Catchment Management Authorities are the caretakers of river health and responsible for the management of environmental water in Victoria, as specified in the *Water Act 1989*. The Mallee CMA is the coordinator of the delivery of the TLM program at the icon site level, where it works closely with its partner agencies, SA Water, Parks Victoria and DELWP and is supported by a number of site-specific committees.

Parks Victoria – Public Land Manager
Parks Victoria is the public land manager responsible for management of the Murray Sunset National Park. Under the *Parks Victoria Act 1998*, Parks Victoria is responsible for providing services to the state and its agencies for the management of parks, reserves and other public land and is responsible for all areas reserved under the *National Parks Act 1975*.

Murray-Darling Basin Authority – River Management (Operations, Modelling and Data Management)
The water delivery structures (assets) within Lindsay Island are part of a suite of River Murray Operations Assets, which are managed by the MDBA on behalf of the "asset controlling governments" (NSW, Victoria, SA and the Commonwealth). Strictly, the assets are owned by the body that owns the land on which the asset sits, however ownership is not outright for the relevant body but beneficial on behalf of the four asset controlling governments.

For a managed event to take place the Operators support the advice from the LMWOG to enable SA Water to operate the structures at Lindsay Island. The data collected throughout the event is stored on the MDBA data system and is available for all to use upon request. The modellers provide advice to Mallee CMA during any process of the event – from the water bid proposal to the end of the event. The modellers also utilise the data stored on the MDBA data system and re-calibrate the model as the event takes place.

Murray-Darling Basin Authority – TLM Planning and Delivery
The MDBA – TLM Planning and Delivery coordinates the planning and delivery of TLM environmental water to TLM Icon Sites. This is achieved in close consultation with the Southern Connected Basin Environmental Watering Committee (SCBEWC), which is chaired by the MDBA and consists of the TLM partner states and the Commonwealth Government. The SCBEWC is responsible for the planning and delivery of the TLM portfolio.

South Australian Water (SA Water) – External Projects
SA Water is the MDBA-delegated constructing authority for the icon site. As such, the SA Water External Projects Team is responsible for the construction of all water delivery structures within Lindsay Island that have been constructed under TLM on behalf of the MDBA.

South Australian Water (SA Water) - River Murray Operations Unit (RMOU)
RMOU is responsible for the operation and maintenance of all water delivery structures within the Lindsay-Mulcra-Wallpolla Icon Site that have been constructed under TLM on behalf of the MDBA. This is undertaken as part of an asset agreement between the MDBA and SA Water. Under this agreement, SA Water is responsible for "accounting for the assets, recording, reporting and auditing as well as specific high level requirements in relation to construction, maintenance and operation

of assets" (MDB Agreement, Clause 55). It is anticipated that SA Water may engage local contractors to undertake some operation and maintenance activities if required. As is consistent with the operation of any River Murray asset by RMOU, all directions for the operation of the water management infrastructure at Mulcra Island will be issued by MDBA River Murray Operations. The structures will NOT be operated outside of these instructions unless there is an issue of public safety or the integrity of the structures is at risk.

SA Water is also responsible for collecting data during the event and providing it to the MDBA River Management to assist with real-time management and modelling.

Goulburn-Murray Water – Water Accounting

GMW is the delegated Resource Manager for the Victorian River Murray system under the *Water Act 1989* and coordinates the accounting of resources associated with operations in this reach. In this role, GMW liaises closely with the River Murray Operations team of the MDBA to ensure bulk and retail water accounts are correctly credited and debited.

New South Wales Office of Water

New South Wales Office of Water (NOW) will participate in the multi-jurisdictional and interstate coordination of the TLM site commissioning and Weir Pool Manipulation Program for Locks 7, 8 and 9. As part of this role, NOW will communicate with NSW landholders in the context of TLM commissioning events at Lindsay Island and weir pool manipulation, as well as possible impacts to their operation.

Victorian Department of Environment, Land, Water and Planning (DELWP)

In Victoria, the overall TLM program is delivered by DELWP, which provides high level policy input and coordinates the delivery of TLM across all Victorian icon sites. One of the key roles for DELWP is to provide statutory and strategic guidance to the planning of Victoria. DELWP is also the site owner for most Crown land in Victoria and may delegate the management of Crown land to others on its behalf, as is the case with Parks Victoria.

Victorian Environmental Water Holder (VEWH)

The VEWH was established in Victoria on 1 July 2011. The main areas of responsibility for the VEWH are holding and managing Victoria's environmental water entitlements and coordinating the delivery of Victorian environmental water allocations with other environmental entitlement holders to maximise benefits to the environment. The VEWH works closely with catchment management authorities and Melbourne Water to ensure that environmental water entitlements are used to maximise ecological outcomes for the water available. In terms of Lindsay Island, the VEWH will consider environmental watering proposals along with all others in the state to determine environmental watering priorities from a state perspective.

If Lindsay Island is determined to be an environmental priority for the year and water is made available to the site, the VEWH then authorises the use of water by Mallee CMA through a Seasonal Watering Statement.

Commonwealth Environmental Water Holder (CEWH)

As a component of Murray-Darling Basin reforms, the Australian Government has acquired a number of water entitlements with the objective to return more water to the environment. These entitlements have become a part of the Commonwealth environmental water holdings and are managed by CEWH. The volume of environmental water held by CEWH is significant and may constitute an important source of environmental water for Lindsay Island and other significant sites.

Southern Connected Basin Environmental Watering Committee (SCBEWC)

The Southern Connected Basin Environmental Watering Committee (SCBEWC) was established in 2014 and replaces the former Environmental Watering Group (EWG). The committee has dual functions:

i) decision making on The Living Murray portfolio, River Murray Unregulated Flows and River Murray Increased Flows water

ii) coordination of the delivery of environmental water to maximise environmental outcomes in the southern connected system

The committee consists of jurisdictional representatives working in environmental and river operational management and is chaired by MDBA.

4.5 Sourcing environmental water for a watering event

Environmental water for Lindsay Island may be sourced from a number of environmental water holders. These sources include The Living Murray (TLM) Program, Victorian Environmental Water Holder (VEWH) and Commonwealth Environmental Water Holder (CEWH). There is also an unregulated flow component that is attached to some Victorian TLM entitlements.

Before a watering action at Lindsay Island can commence, a Seasonal Watering Proposal must be prepared by the Icon Site manager and approved by the VEWH (Figure 4-1). Submissions for environmental water allocations are presented by the VEWH to the relevant water holders who subsequently prioritise the watering proposals against all other watering proposals.

Once a watering action is approved, the VEWH ensure sufficient water is in the appropriate allocation bank account (ABA). This may require a transfer of water from one ABA to another. The VEWH will then issue a Seasonal Watering Statement to the MCMA allowing access to an allocation of water in the ABA. Once the Seasonal Watering Statement is approved a water order can be placed by MCMA with GMW, enabling a diversion to commence.

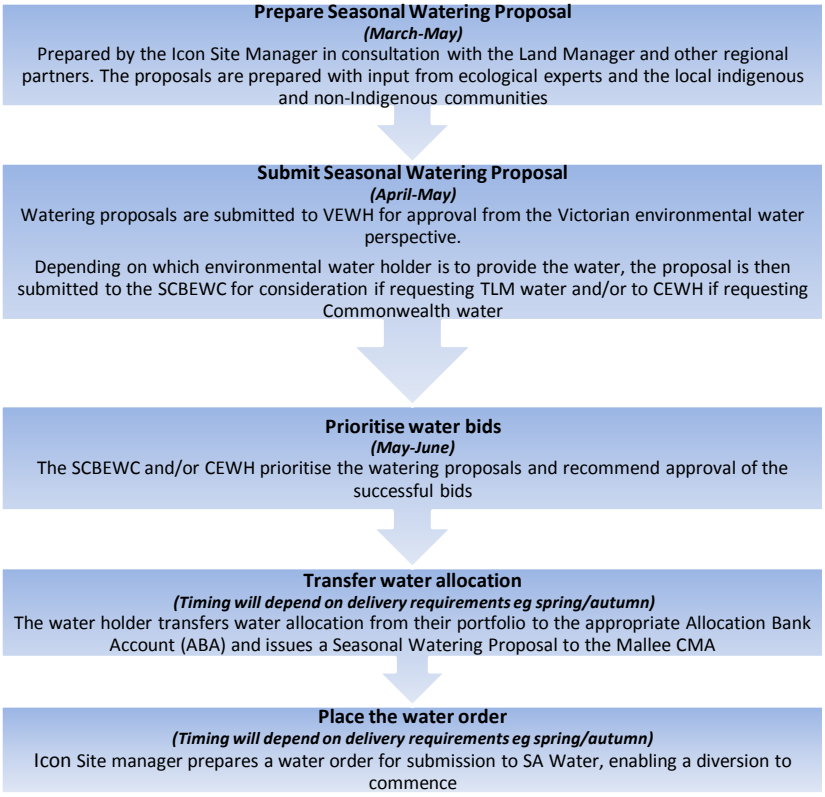

Figure 4-1: Sourcing environmental water for a watering event at Lindsay Island

5 Site Characteristics Guiding Environmental Watering

Pre-regulation river hydrology

Lindsay Island is located between Locks 8 and 6, downstream of the River Murray and Darling River junction. The River Murray flows are influenced by the Murray, Murrumbidgee, Wakool and Goulburn tributaries and are typically highest from late winter to early summer. The Darling River, which drains the northern basin, is often influenced by sub-tropical weather systems that generate large flows in summer. Lindsay Island experiences its largest floods when both the Darling and Murray systems are in flood (Ecological Associates, 2014a).

The network of waterways, wetlands and floodplain on Lindsay Island support a hydraulically diverse landscape that would have experienced inundation to varying degrees in almost every year. Lindsay Island predominantly received inflows in spring and autumn associated with peak flow in the River Murray and Darling Rivers.

Current Floodplain Hydrology

Lindsay Island is located within a highly regulated reach of the River Murray, situated between Lock 6 and Lock 8 and adjacent to Lock 7 and the Lake Victoria outlet (Rufus River). These regulating structures strongly influence the current hydrology of Lindsay Island.

The lower regions of Lindsay River, approximately 30 kilometres upstream of Lock 6, are significantly influenced by the Lock 6 weir pool. This weir has an operating level of 19.25 m AHD and the backwater effect extends beyond the confluence of Mullaroo Creek with the Lindsay River. This ponds water in the channels in the west of the island, particularly affecting the western parts of Lindsay River, Toupnein Creek and lower Mullaroo Creek (Ecological Associates, 2014a).

Lock 7 is located adjacent to Lindsay Island, 2 river kilometres downstream of the Mullaroo Creek inlet. In regulated conditions, Lock 7 maintains a pool level of 22.1 m AHD. This creates a permanent hydraulic gradient across Lindsay Island and generates permanent high flows in the Mullaroo Creek (GHD, 2009).

Lake Victoria is a major balancing storage and lies on the New South Wales (NSW) side of the River Murray. The lake stores water diverted from the River Murray above Lock 9 and releases water to the river just downstream of Lock 7. Releases can be up to 9,000 ML/d and can create a significantly higher flow below Lock 7 than above (Ecological Associates, 2014a). This can cause inundation in the west of Lindsay Island.

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Storages, regulation and diversions on both the Murray and Darling Rivers have reduced the occurrence of high flows and created extended periods of low flows, delayed the onset of floods and reduced the frequency and duration of floods at Lindsay Island (Ecological Associates, 2007; SKM, 2004). Further, river management has resulted in significant changes to winter and spring flows as these flows are now captured in upstream storages and gradually released over summer, resulting in a relative continuous flow year round. This is illustrated in Figure 8-1.

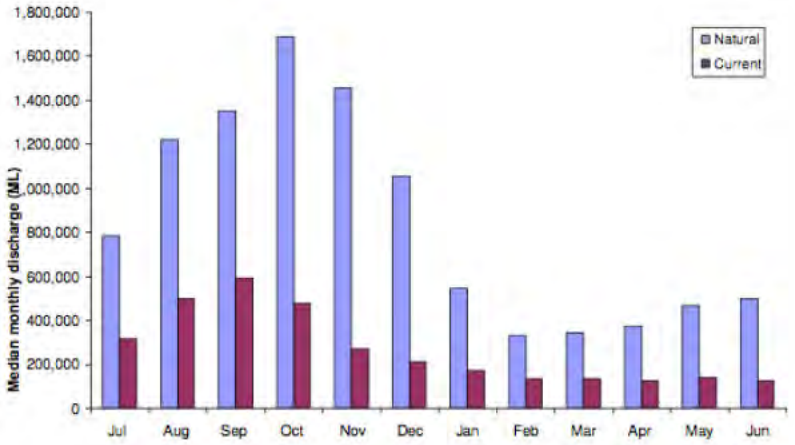

Figure 8-1. Monthly discharge at Lock 8, upstream of Lindsay Island, for modelled natural flows and modelled current system. Based on 115 years of data (1894-2009), provided by the MDBA.

Rating Curves

Rating curves or tables are developed for weir or regulating structures by the designers of the structures. These curves or tables use empirical formulae to provide a theoretical estimate of the flows through the structures based on the fixed geometry of the regulators and on a number of variables including the upstream water level, the downstream water level, the level of the controlling weir edge and the number or combination of gates in operation. If available, third party flow gauging can be used to calibrate the rating curves.

Not all structures have or need rating curves. Only structures required to manage or control the flows through the structures must have a rating curve.

The rating curve for the Mullaroo Creek regulator is currently in development, and will be available within the Mullaroo Creek Regulator and Fishway Commissioning Plan and the Operations and Maintenance Manual for the regulating structure when drafted.

Mullaroo Creek Inlet Regulator and Fishway

The Mullaroo Creek inlet is located 2 km upstream of Lock 7. The Mullaroo Creek inlet is an active waterway and the main source of water entering Lindsay Island under normal Lock 7 weir pool levels (22.1 m AHD). Prior to the construction of the regulator and fishway, water entered the creek over a fixed crest weir (cement mortared rock causeway) located 100 m downstream of the inlet point.

The new regulator and fishway replaces the old fixed crest weir, constructed in 1977 as part of a scheme to dilute salinity in water drawn by irrigators. Originally a flow of approximately 250 to 500 ML/d was planned (Ogyris Ecological Research, 2001), but due to changes in the operation of Lock 7 and significant and ongoing deterioration of the fixed crest weir, this had increased to approximately 1000 ML/d under normal regulated flow conditions. The new regulator is capable of

managing flows in the Mullaroo Creek at river flows of up to 30,000 ML/day at which point the structure will be overtopped.

Lindsay River Inlet Regulators

The main inlet for the Lindsay River (the northern inlet) diverges from the River Murray about 10 km upstream from Lock 7. Prior to construction of the new regulator, the northern Lindsay River inlet received permanent, low inflows of approximately 20 ML/d at normal Lock 7 operating levels. Flows entered via a 450 mm pipe culvert set in a rock causeway. The new regulator, installed at the same site, lowered the invert by approximately one metre and now passes approximately 40-50 ML/d.

Prior to construction of the inlet regulator, the southern Lindsay River inlet received no inflows under normal Lock 7 operating levels, due to a constructed earthen block bank. The new regulator, at the same site, does not divert flows at normal Lock 7 operating levels due to a natural sill occurring further downstream, but water will pool in the mouth of the waterway and around the regulator. The southern Lindsay River will, however, divert flows when the operating level within the Lock 7 weir pool is raised e.g. for the Seasonal Pulse operating scenario.

6 Operational Thresholds

This section provides guidance on the operational thresholds that inform the LMW Operations Group during planning and adaptive management of events.

The critical operational thresholds for the Lindsay Island structures are the flows and water elevations at which the structures permit flow to pass and the flows and water elevations which overtop the structures. This information is summarised on the Lock 7 backwater curve showing the height of Lindsay Island structures and the flows at which they become overtopped (Appendix A)

7 Details of Structures

The Lindsay Island package of works included replacement of structures on the Mullaroo Creek, the Lindsay River and Lake Wallawalla, as well as new structures on Websters Lagoon. These structures are designed to help provide more natural water regimes to the Lindsay River, Webster's Lagoon and Lake Wallawalla whilst protecting the habitat values within the Mullaroo Creek. The descriptions below are a brief summary of those provided within the design documentation for each set of works. For more comprehensive descriprions please refer to the appropriate design report.

Mullaroo Regulator and Fishway

The Mullaroo Creek is the main source of water entering Lindsay Island. The inlet is located 2 km upstream from Lock 7 and the creek is an active waterway under normal operating levels (22.1 m AHD). The new regulator and fishway replaces a significantly deteriorated cement mortared rock causeway, constructed as part of a scheme to dilute salinity from the lower Lindsay River in the 1970s.

The fishway improves fish passage upstream between the Mullaroo Creek and the River Murray for fish of a range of sizes, including the large-bodied Murray Cod.

The new regulator can be used to provide a range of flows to the Mullaroo Creek, and can be operated independently of a range of passing flows and heights in Lock 7.

A three bay (two of equal width and one at half width) pier and concrete regulator at Mullaroo Creek with hydraulically operated lay-flat gates. The half bay is a shorter bay adjacent to the vertical slot fishway on the left abutment.

Lindsay River Northern and Southern Inlet Regulators

The northern and southern Lindsay inlet regulators allow natural flows into the Lindsay River unimpeded. The northern Lindsay inlet regulator passes flows at normal Lock 7 operating levels

Lake Wallawalla Regulators and embankment

The Lake Wallawalla regulators and embankment were designed to enhance and extend natural inundation. They sit in the flow path between the Lindsay River and Lake Wallawalla, under the Mail Route Road. They were constructed in 2006-7 to replace the existing pipe culverts, and were designed to have a more natural invert level and diameter than existing so as to reduce interference with natural inflows to the lake. They also allow managers to retain natural inflows to extend inundation duration where ecologically appropriate and the new invert level allows the lake to drain completely upon flood recession. During 2010, the eastern regulator was retrofitted to temporarily accommodate a 150 ML/d pump outlet, allowing managers to fill the lake using temporary pumps from the Lindsay River.

Webster's Lagoon Regulator

Webster's Lagoon is fed by Toupnein Creek which sits within the Lock 6 backwater. As the invert of the lagoon occurs below the normal operating level at Lock 6 (FSL 19.3 m AHD), The regulator was constructed in 2006 to reinstate a more natural, ephemeral water regime within the wetland. Prior to this, it was permanently inundated. The regulator is a cast in-situ concrete culvert with manually operated aluminium gates.

Risks Associated with structures

SA Water RMOU have responsibility for management of risks to the integrity of the structures themselves. These risks will be managed through operation of the structures within their design capabilities, monitoring of structural integrity and through maintenance. The risks associated with the structures are described in the Lock 7 O&M manual and commissioning plan. These documents are currently in the process of being updated.

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8 Operating Regimes

8.1 Watering Principles

The Icon Site Manager will recommend when a watering event should take place and provide a brief guiding the main philosophy behind initiating a watering event. This decision will be guided by the site ecological watering guide and will consider: water availability scenarios, antecedent conditions, seasonality, site conditions, weather forecasts (temperatures), ecological values and their requirements, condition and targets and River Murray system wide operations. Each managed event will have clear documented ecological objectives, a means for measuring progress against these objectives and a mechanism for recording lessons learnt. The basis for this process is encapsulated in the adaptive management process described by the site ecological watering guide.

The works have been designed to enable the replication of key components of the natural hydrology of the Mullaroo Creek and Lindsay River.

8.2 Operational Scenarios

The works have been designed to provide five operations scenarios, as standalone operations or in conjunction with the weir pool manipulation project run by NSW and SA:

- Pre-works conditions (Not an operational scenario but described here to provide context)
- Base flow (default)
- Seasonal pulse
- Seasonal pulse plus fill Wallawalla
- Cease to flow/ephemeral
- High River Murray flows/natural flooding

Operation of the structures will be guided by the environmental requirements of the sites, interactions between the regulators, interactions with other sites, the capabilities of the structures, stakeholder requirements and monitoring outputs.

Successful management of flows using the structures as outlined is dependent on flows and heights at Lock 7 being within the design range of the structures.

Pre-works conditions (Not an operational scenario but described here to provide context)

Since construction of the fixed crest weir in 1977 flows through the Mullaroo Creek have risen from the original design intent of 250-500 ML/d to approximately 1,000 ML/d as the structure deteriorated over time.

The new regulators installed on the Mullaroo Creek and Lindsay River can be operated such that pre-works conditions can be re-instated in the upper Lindsay River inlets and the Mullaroo Creek via reducing or closing off flow through the regulating structures. This may be useful as a mitigation measure for operational risks, such as increasing salinity or decreasing dissolved oxygen within the Lower Lindsay River. Environmental water will not be required under this scenario.

- **Mullaroo:** As the flows in the Mullaroo Creek have changed significantly over time, the original intended flow in the Mullaroo Creek plus the requirements of the cod population were taken into consideration for this scenario. Under this scenario, flows down to 400 ML/d can be implemented, using the appropriate gate setting.
- **Northern Lindsay:** Aluminium stoplogs can be installed to achieve flows of approximately 25 ML/d
- **Sothern Lindsay:** If present, any flows through the structure can be reduced to 0 ML/d, using aluminium stoplogs

Base Flow (default)

Base Flow will be the default mode of operation, with water levels at the inlets resulting from the normal range of regulated River Murray flows and Lock 7 weir pool operating levels (normal operating level 22.1 m AHD). Under these conditions, the northern Lindsay River inlet passes approximately 40 ML/d, the southern Lindsay River inlet does not divert any flow due to natural sills

downstream. The Mullaroo Creek regulator will be set to pass flows in the range of 500-700 ML/d. Any natural or operational water level variability in the upper reaches of the Lock 7 weir pool results in varied flow rates down the Lindsay River; flow rates in the Mullaroo Creek can be maintained during variation in the Lock 7 weir pool level.

No environmental water will be sourced for this scenario, as water passing through the system is part of normal river operations to supply Lindsay point irrigators and flow to SA.

Default regulator settings – Mullaroo gates set to appropriate setting to maintain flows within range taking into account Lock 7 operations and/or River Murray variability, northern Lindsay open, southern Lindsay closed.

Cease to flow/ephemeral

Under the influence of natural flow conditions in the River Murray, the Lindsay River would have experienced periods where flows may have ceased altogether. This scenario can be used to mimic such natural conditions, where managers may occasionally reduce flows for a short period of time, in accordance with environmental, water supply, climatic and Lock 7 operational considerations.

This scenario applies to the Lindsay River and its inlet regulators only. If desired, Mullaroo flows can be reduced to approximately 400 ML/day during this scenario. Whilst flows through the Mullaroo Creek regulator can be ceased for short periods for gate maintenance, flows should not be ceased for long periods of time due to ecological and water supply constraints.

Environmental water will not be required under this scenario.

Stop logs can be used in the Lindsay River inlet regulators to provide short periods of low to no flows (at up to 23.35 m AHD in Lock 7 weir pool).

Seasonal Pulse

A period of higher flow (Seasonal Pulse) is considered to be of benefit to native fish and will mimic more natural flow conditions. A Seasonal Pulse will be provided to the Lindsay River and Mullaroo Creek one or two times in winter to early spring to mimic natural flow patterns. The Seasonal Pulse scenario could be implemented when equivalent River Murray flows (greater than 17,000 ML/d) have not occurred in the preceding nine months.

During this scenario Lock 7 will be raised from FSL by up to 0.5 m. Under these conditions, modelling suggests that the northern Lindsay inlet will pass approximately 250 ML/d and the southern Lindsay inlet would pass approximately 60-70 ML/d.

During these operations, the Mullaroo creek regulator will allow flow through Mullaroo Creek to be managed, maintaining an inflow of up to 1,000 ML/d throughout the pulse to provide high flow benefits to the Mullaroo creek. This will still allow variation in flows within the Mullaroo while mitigating the risks posed to the resident cod population by wide fluctuations in water velocities. Potential erosion risks can also be mitigated by reducing flow rates if necessary. Alternatively the regulator can be used to maintain Base Flows within the Mullaroo Creek, depending on environmental and operational requirements.

The Seasonal Pulse will end as Lock 7 is returned to the normal operating level. It is intended that monitoring outcomes from the initial operation of the Seasonal Pulse scenario will be used to inform adaptive management for future operations.

Environmental water will be sourced to account for increased seepage and evaporation losses incurred under this scenario.

Seasonal Pulse plus Fill Wallawalla

Inundation of Lake Wallawalla via pumping was trialled beginning in March 2010. A temporary pump was installed, with the aim of pumping 100 ML/d from the Lindsay River for 120 days at normal operating heights in the Locks 6 and 7 weir pools. Hydraulic modelling suggested that the Lock 6 backwater within the lower Lindsay River would enable this extraction rate to be maintained; however during the first few days of pumping, priming issues emerged and persisted, despite a reduction in pumping rate to 60 ML/d. Return flow from the Lock 6 backwater was restricted, apparently by fallen timber and aquatic plants, resulting in drawdown of the Lindsay River.

Raising Lock 7 to provide a spring pulse in the Lindsay-Mullaroo system will increase water levels within the middle reaches of the Lindsay River from upstream of the pump location and provide an opportunity to pump water into Lake Wallawalla. Pumping under these conditions will reduce the lift required and improve the availability of water to the pump site, reducing the cost of pumping and the time required to fill the lake.

Arrangements for temporary pumps will be made on an event-by-event basis and will account for pumping rates and days required to fill the lake to the desired level.

Environmental water will be sourced for this scenario. The amount of water required will vary depending on existing water levels within the lake as well as the proposed fill. Filling to full from dry conditions requires approximately 14-16 GL.

High River Murray flows / natural flooding

During periods of high River Murray flows or natural flooding above 30,000 ML/d all structures are to be completely opened to allow passage of flood flows.

Weir pool manipulation program

Whilst not the subject of this document, weir pool manipulation is critical to the successful operation of the Lindsay Island Structures.

A detailed plan for the manipulation of the Locks 7,8 and 9 during the 2015/2016 water year has been developed by the NSW Office of Water. The implementation of this plan will be overseen by the LMWOG and River Murray Water. A brief summary of the plan is included below to provide context for the operation of the Mullaroo and Lindsay Inlet structures. For full details of the proposed weir pool manipulation

Weir pool manipulation provides an opportunity for river operators and environmental water managers to contribute to achieving the environmental objectives of the Basin Plan while also staying consistent with the Basin Environmental Watering Strategy. Weir pool manipulation has been used to increase variability in weir pool levels and mimic a more natural riparian inundation

regime. The ecological outcomes sought under this program include provision of more complex hydraulic diversity and episodic drying of benches within the main stem of the River Murray.

NSW and Victoria, as a collaborative effort with SA Water and MDBA have been trialling weir pool manipulation at Locks 8 and 9, in conjunction with commissioning of environmental works at TLM icon sites, including the Mulcra Island Works.

Beginning in July 2015 and continuing over a 12 month period, Lock 7, 8 and 9 weir pools will be manipulated as detailed in Table 8.1. The Lock 8 raising/lowering pattern may be adjusted to align with any watering events being undertaken at Mulcra Island TLM works. Lock 7 raising/lowering will be adjusted to align with commissioning events being undertaken for the Mullaroo Creek and Lindsay river regulators.

Subject to prevailing operational and commissioning considerations, the rate of change shall be no more than 0.3 m/week. Adjustments to the monthly target will be made in the first week of the calendar month and held at the target level for the remainder of the month.

The manipulation program will be suspended if and when flow below Lock 10 exceeds 25,000 ML/d.

Table 8.1: Proposed weir manipulation for 2015/16

Month	Lock 7 adjustment (m)	Lock 8 adjustment (m)	Lock 9 adjustment (m)
	0.0	+0.0	+0.0
	+0.25	+0.6	+0.20
	+0.5	+0.8	+0.2
	+0.25	+0.5	-0.1
	-0.5	-0.5	-0.1
	-0.5	-0.8	-0.1
	-0.25	-0.8	-0.1
	-0.25	-0.6	-0.1
	0.0	-0.6	+0
	0.0	-0.25	+0
	0.0	+0	+0
	0.0	+0.4	+0

Note: Consideration of other parameters and potential system limitations may apply, please refer to the Weir Pool Manipulation event plan Locks 7, 8, 9 for more details.

8.3 Proposed Operations

The package of works at Lindsay Island can be operated in a number of ways to achieve TLM ecological objectives, subject to variations in water availability, operational constraints and the ecological objectives of the current water year. Table 8-2 describes the main watering scenarios and Table 8-3 sets out the desirable seasonality and timing for watering. For information on how each scenario meets TLM ecological objectives, as well as an assessment of ecological risks, please refer to the Lindsay-Mulcra-Wallpolla Islands Watering Guide (MCMA, 2015).

It is anticipated that commissioning and future operation of the structures will further develop the description of the scenarios. This Operating Plan will be updated regularly to include lessons learnt from events, to provide the basis for adaptive management.

Table 8-2: Main watering scenarios

	Operating Scenario					
	Pre-works conditions	Base flow (default)	Seasonal pulse	Seasonal pulse plus fill Wallawalla	Cease to flow/ephemeral	High River Murray flows/natural flooding
Mullaroo regulator	Down to a minimum of 400 ML/d	In the range of 500-700 ML/d. Aim for approximately 600 ML/d	Up to 1000 ML/d	Up to 1000 ML/d	Flow maintained at a minimum of 400 ML/d	Fully open
Northern Lindsay inlet	25 ML/d	Approximately 40 ML/d	Up to 250 ML/d	Up to 250 ML/d	0 ML/d	Fully open
Southern Lindsay inlet	0 ML/d	0 ML/d	Up to 60-70 ML/d	Up to 60-70 ML/d	0 ML/d	Fully open
Lake Wallawalla east	N/A	N/A	N/A	Closed but accommodating temporary pump infrastructure passing up to 150 ML/d		Fully open
Lake Wallawalla west	N/A	N/A	N/A	Closed to retain inflows		Fully open

Table 8-3: Suggested seasonality and timing for the watering scenarios

	Base Flow	**Seasonal Pulse**	**Seasonal Pulse plus fill Wallawalla**	**Cease to Flow**

Season	Year round	Winter to early spring	Winter to early spring	Late summer
Duration	Ongoing	Nine weeks	Up to 120 days	Long enough for drying of target reaches.
Frequency	N/a	When no equivalent River Murray flows in the preceding nine months	TBC	TBC
Climate conditions	All years	Median to wet year	Wet year	Dry to median year
Max area inundated	N/a	Extra bank area within the channel Adjacent low lying areas	800 ha	N/a
Max. net water use*	N/a	Modelled Water Use	Modelled Water used plus 13 GL	N/a

*Max net water use to be informed by operations.

8.5 Commissioning Operations

There are five stages to commissioning the site. As part of stages 1-4, the operational and structural components of the Mullaroo regulator have been commissioned and tested to ensure the structure is functionally sound and operates in accordance with the design at normal Lock 7 pool levels. An additional stage of commissioning, Stage 5, will test the interaction of the structure with increasing Lock 7 pool levels, up to 0.5 m above FSL. During this event, a Seasonal Pulse scenario will be operated in the Mullaroo Creek and Lindsay River.

In general, during the raised weir pool event, the following activities will be undertaken to monitor the performance of and impacts on the Mullaroo Regulator, Lindsay River structures and other structures:

- Regularly monitor water levels
- Regular Water Quality monitoring at targeted locations
- Regularly monitor and adjust flows through the Mullaroo regulator
- Monitor structures for any indications of movement (sliding, rotation, joint movement, etc.) using established survey points
- Monitor structures for any indications of seepage or settling (wet patches, slumping in embankments, etc.)
- Regularly monitor structures for obstructions and accumulation of debris,
- Monitor subsidiary channels (Little Mullaroo Creek at bridge, Un-named creek “Navara Crossing”) for any erosion and or deterioration.

Inspection and monitoring requirements for the Mullaroo Creek Regulator and Fishway are detailed in the Mullaroo Creek Regulator and Fishway Commissioning Plan.

The monitoring of the performance of Lock 7 at raised and lowered levels will be the responsibility of SA Water RMOU and will be in line with monitoring undertaken during previous weir pool manipulation events at Locks 8 and 9.

Table 8.4 provides a provisional description of activities planned to be undertaken during commissioning and weir pool raising operations at the time of writing.

Table 8.4: Details of commissioning and first operation.

	Details									
Activity		Month	Lock 7 weir pool adjustment (m)	Lock 7 stage height (m AHD)	Mullaroo gate setting/passing flow (ML/d)	Northern Lindsay inlet setting	Southern Lindsay inlet setting	Wallawalla settings	Related operational scenario	Guiding Plan
	Practical completion of Mullaroo Structure	Month 0 (July)	N/A	22.1	600	Open Inflows of approximately 40	Open Water present but not flowing	Gates closed	Base Flow	Commissioning Plan
	Begin Lock 7 weir pool raising	Month 1 (August)	+0.25	22.35	Test for ability to maintain 600 Raise to 700-800 in line with Seasonal Pulse operation	Open Inflows driven by River Murray passing flows. Rate to be confirmed during operation	Open Inflows driven by River Murray passing flows. Rate to be confirmed during operation	Gates closed Temporary pumps in operation to deliver a partial filling of Lake Wallawalla	Base Flow Seasonal Pulse Seasonal Pulse plus fill Wallawalla	Commissioning Plan Weir Pool Manipulation event plan Locks 7, 8, 9

	Lock 7 weir pool raising	Month 2 (September)	+0.5	22.6	Test for ability to maintain 600 Raise to 800-1000 in line with Seasonal Pulse operation	Open Expected to pass inflows of approximately 250	Open Expected to pass inflows approximately 60-70	Gates closed Temporary pumps in operation to deliver a partial filling of Lake Wallawalla	Base Flow Seasonal Pulse Seasonal Pulse plus fill Wallawalla	Commissioning Plan Weir Pool Manipulation event plan Locks 7, 8, 9 Lindsay Island Interim Operating Plan
	Lock 7 weir pool raising	Month 3 (October)	Maintain additional 0.5	22.6	Maintain 1000 in line with Seasonal Pulse operation	Open Expected to pass inflows of approximately 250	Open Expected to pass inflows approximately 60-70	Gates closed Temporary pumps in operation to deliver a partial filling of Lake Wallawalla	Seasonal Pulse Seasonal Pulse plus fill Wallawalla	Weir Pool Manipulation event plan Locks 7, 8, 9 Lindsay Island Interim Operating Plan
	Lock 7 weir pool return to FSL	Month 4 (November)	-0.5	22.1	Lower to 600 in line with Base Flow operation	Open Default position under Base Flow scenario, to pass flows of approximately 40	Closed Default position under Base Flow scenario, to prevent growth of cumbungi	Gates closed Cease pumping Retain water, natural seepage and evaporation	Base Flow	Weir Pool Manipulation event plan Locks 7, 8, 9 Lindsay Island Interim Operating Plan

	Lock 7 weir pool return to FSL	Month 5 (December)	Maintain FSL	22.1	Maintain 600 in line with Base Flow operation	Open	Closed	Both regulators closed Retain water, natural seepage and evaporation	Base Flow	Weir Pool Manipulation event plan Locks 7, 8, 9 Lindsay Island Interim Operating Plan
	Lock 7 weir pool return to FSL	Month 6 (January)	Maintain FSL	22.1	Maintain 600 in line with Base Flow operation	Open	Closed	Both regulators closed Retain water, natural seepage and evaporation	Base Flow	Weir Pool Manipulation event plan Locks 7, 8, 9 Lindsay Island Interim Operating Plan
	Lock 7 weir pool drawdown	Month 7 (February)	-0.25	21.85	Test for ability to maintain 600 Lower to ?? in line with Ephemeral operation??	Closed Allow drying and full loading of structure to complete commissioning	Closed Allow drying and full loading of structure to complete commissioning	Both regulators closed Retain water, natural seepage and evaporation	Base Flow Ephemeral	Commissioning Plan Weir Pool Manipulation event plan Locks 7, 8, 9 Lindsay Island Interim Operating Plan
	Lock 7 weir pool drawdown	Month 8 (March)	-0.25	21.85	Maintain….	Closed No passing flow	Closed	Both regulators closed	Base Flow Ephemeral	Commissioning Plan

							No passing flow	Retain water, natural seepage and evaporation		Weir Pool Manipulation event plan Locks 7, 8, 9 Lindsay Island Interim Operating Plan
	Return to default position/scenario	Month 9 (April)	+0.25	22.1	Maintain 600	Open	Closed	Both regulators closed Retain water, natural seepage and evaporation	Base Flow	Lindsay Island Interim Operating Plan

Note: Flows in both Lindsay River inlets are subject to passing flows in the River Murray and stage height at Lock 7. Flow rates for different scenarios are approximate and will be confirmed during operations.

9 External Considerations for Operations

Upstream and Downstream Considerations

- Minimum/max passing flows within Lock 7
- Lake Victoria operations
- Reuse of net flows from upstream
- Water quality of releases, particularly with regard to water quality targets outlined in the Basin Plan, including targets for salinity, blackwater, cyanobacteria
- Dilution flows required in the advent of the release of water impacted by a blackwater event
- Flow rates to South Australia
- Requirements of Lindsay Point Irrigators
- Other weir pool and Living Murray site operations

10 Water Use (This section is currently subject to review by Water Liaison Working Group)

This section details the water requirements and accounting methodology for operations.

Flow Types

There are six general operating scenarios:

- Pre-works Conditions
- Base flow
- Seasonal Pulse
- Seasonal pulse plus fill Wallawalla
- Cease to flow/Ephemeral
- High River Murray Flows / Natural Flooding

These scenarios are described in detail in Section 8.

Water Requirements

Lindsay – to be informed by modelling and verified through operation

Mullaroo – to be informed by modelling and verified through operation

Lake Wallawalla from empty to full – 14- 16 GL

Accounting for Water Use

The following is the proposal to account for the 2015/16 commissioning, first operation and weir pool manipulation event. The supply and accounting arrangements will be reviewed, amended in subsequent editions of this document.

The estimated usage figures within this section are based on modelling therefore are not always consistent with those provided in the remainder of the document. It is proposed that usage figures will be verified during operation and will be in the next edition of this document.

1.1 Water Measurement Complexity

To develop an appropriate water measurement and water accounting methodology during environmental watering of Lindsay Island, it is necessary to understand the hydraulic complexity within the Lindsay River and Mullaroo Creek system and its interactions with the measurement on the Flow to South Australia (SA).

The system can be separated into the Lock 7 weir pool, Mullaroo Creek, Lindsay River and Lake Wallawalla as outlined below.

Lock 7 weir pool

During environmental watering of Lindsay Island, Lock 7 weir pool will be raised by up to 50 cm above FSL resulting in inundation of fringing wetlands and floodplain on the NSW and Victorian banks. The water use is distributed along the bank between Lock 7 and Lock 8. No feasible method of direct measurement of water use into the incrementally wet up bank areas has been determined.

Given that direct measurement of water use is not feasible, the most appropriate method of assessing the water use associated with the weir pool raising is to use a water balance model that relates the water level at Lock 7 to the incremental area of inundation and then calculates the evaporative and seepage (wetting up and ongoing) losses using daily evaporation and rainfall data recorded at Lake Victoria

At the normal weir pool operating level of 22.1 m AHD, Mullaroo Creek via the regulator (Figure 1) is the main source of water entering the Lindsay River system is Mullaroo Creek via the regulator (Figure 1). When raising the pool level by up to 50 cm above FSL, water will also enter the Lindsay system via the northern and southern inlet regulators, and to a lesser extent, via a number of additional unregulated flow points that will connect the Lock 7 weir pool to the floodplain. Most of the water entering the Mullaroo and Lindsay systems during managed watering events is confined to the creek and river channels.

Figure 10-1: Map of Lindsay River and Mullaroo Creek

Mullaroo Creek

Mullaroo Creek leaves the River Murray 2 km upstream of Lock 7 via the Mullaroo Creek regulator (Figure 10-1). The creek is the main source of water entering the Lindsay River system under normal Lock 7 operations (at 22.1 m AHD). However, a small ungauged flow also enters Mullaroo Creek (downstream of the Mullaroo Creek gauging station) from the Lock 7 weir pool via the Little Mullaroo Creek (Point 7). Initial modelling suggests inflow at additional flow Point 7 during the Lock 7 pool raising to 50 cm above FSL is expected to be around 40 ML/day.

Flow into Mullaroo Creek is measured at the Mullaroo Creek gauging station around 3 km downstream of the new regulator. Real-time level and flow data will be available from this gauging station via telemetry when installation is complete. Flow measured at this gauging station will also include any inflows from additional flow Points 4 and 5 (Figure 10-1) during the Lock 7 pool raising to 50 cm above FSL. Initial modelling suggests inflows at additional flow Points 4 and 5 during the Lock 7 pool raising to 50 cm above FSL are expected to be around 10 ML/day and 15 ML/day respectively.

Lindsay River

At the normal weir pool operating level of 22.1 m AHD, the north Lindsay River regulator is kept fully open allowing around 30 ML/d to flow to the Lindsay River. This provides a small permanent flow in the upper reaches of the Lindsay River through to the junction where the main flow enters the Lindsay River from the Mullaroo Creek. At the normal weir pool operating level, the south Lindsay River regulator is kept closed because when open, the small flow through this regulator pools and evaporates downstream and does not reach the flow from the northern regulator. During an environmental watering event, the north and south Lindsay River regulators will be fully open and

an additional point connecting the floodplain to the Lock 7 weir pool is expected to flow at Point 3 (Figure 10-1). Staff gauges at the north and south Lindsay River regulator will allow daily levels to be recorded upstream and downstream of the regulators, however, the north and south Lindsay River sites will not be rated. Initial modelling suggests inflows from the north and south regulators and the additional flow Point 3 during the Lock 7 pool raising to 50 cm above FSL are expected to be around 170, 20 and 20 ML/day respectively.

During transition from a watering event to a natural flood, as the grade on the river increases the connectivity of the upper end of the Lindsay River will increase with multiple points of connection.

Two gauging stations located on the Lindsay River will provide useful level data for calibrating the water balance model:

- 414218A (Lindsay River U/S Lake Wallawalla). This site measures water level continuously and has a rating table, but this needs revision in the low to mid-range of flows (up to 2,000 ML/day. This site does not have telemetry, but stored data can be downloaded during site visits.
- 414213A (Lindsay River U/S Mullaroo Creek). This site measures water level continuously, but has no current rating table because it is likely to be backwater-affected. This site does not have telemetry, but stored data can be downloaded during site visits.

Lake Wallawalla

During an environmental watering event, the water level in the Lindsay River will not be of sufficient height to flow into Lake Wallawalla and so any water delivered will need to be pumped. A portable pump with a capacity of around 160 ML/d is planned to be used. The volume pumped will be measured using a calibrated meter (in accordance with national metering standards) on the pump and is expected to be around 80 ML/day. Under managed flow conditions during watering events, Lake Wallawalla is a terminal system and water will not return to the Lindsay River.

1.2 Interim Water Accounting for 2015-16

The MDBA has developed a water balance model to assist in determining water use in the Lindsay River system. The water balance model is similar to the models that have been used for calculating water use during weir pool raisings at Lock 8 and Lock 9. The water balance model will be trialled and undergo calibration during the 2015-16 watering event.

During a watering event, MDBA will be responsible for recording the water balance model inputs in daily time steps including actual levels, rainfall and evaporation across the key areas of operations. Hydrographers will also gauge the flow rates during the event at key locations to help calibrate and validate the model. The number of gaugings undertaken will be determined by agreement with Victoria and South Australia and will be appropriate to ensure confidence in the flow volumes. More frequent gaugings are anticipated while building confidence in the model.

During a watering event the MDBA will run the model for calibration and validation. At the end of the event, once the model is calibrated, the modelled losses will be compared to modelled losses if there was no intervention using the TLM or Lock 7 infrastructure. The difference between these two modelled outcomes will be used to estimate the total use due to the weir pool raising. The volume of water pumped into Lake Wallawalla will be measured and accounted separately.

The total use due to an intervention using both TLM and Lock 7 infrastructure will be treated as a Victorian event and there will be no requirement for NSW to debit water unless otherwise specified.

During periods of regulated flow Victoria will need to debit the water use against a Victorian Murray account. During periods of declared unregulated flow in the reach between Wentworth to the South Australian Border this volume may be debited against the Victorian Unregulated Flow Entitlement, which is provided for under the Flora and Fauna Bulk Entitlement and have a capped combined volume of 74.3 GL/year. Under a River Murray Unregulated Flows (RMUF) event, RMUF may be used if supported by the States and the Southern Connected Basin Environmental Watering Committee.

1.3 Measuring flow to South Australia when delivering environmental water to Lindsay Island in 2015-16

SA Water determine the daily flow to SA as the sum of the water flowing in:

- the River Murray between the confluences of the Rufus and Lindsay Rivers with the River Murray (ie the flow measured at gauging station 426200A); and
- the Lindsay River near its confluence with the River Murray.

To date it has not been possible to accurately measure flow in the Lindsay River near its confluence with the River Murray using a rating table or in-situ flow meter due to the shallow, broad and slow moving nature of the stream and the backwater influence of the Lock 6 weir pool. MDBA will continue to liaise with hydrographic experts to test and evaluate flow measuring technologies, as they are developed, at this flow measurement site in order to accurately measure flow. In the future, if flow can be accurately measured in the Lindsay River near its confluence with the River Murray, MDBA will work toward using flow measured at this site to determine flow to SA and replace the current and proposed methods outlined below.

Currently, the flow in the Lindsay River near its confluence with the River Murray is determined as the daily flow measured at Mullaroo Creek regulator gauge (414211A) less the Lindsay River allowance of 250 ML/day.

When Lock 7 is raised to deliver environmental water to Lindsay Island this method of determining flow in the Lindsay River near its confluence with the River Murray (as describe above) is not appropriate and will need to be modified to accommodate the additional inflows due to the changed operation.

When Lock 7 is raised and the environmental watering is underway, SA Water RMO will determine flow in the Lindsay River near its confluence with the River Murray as outlined below:

MDBA will run the water balance model weekly and provide SA Water RMO with:

- modelled daily inflow to the Lindsay River. This value will be based on the inflows to the Lindsay River system at Points 1, 2 and 3 (see Figure 1) (which are dependent on the Lock 7 upstream level and the flow rate downstream of Lock 8 (including inflows from the Lower Potterwalkagee regulator));
- modelled daily inflow from the flood runner off the Lock 7 weir pool (located downstream of the inlet to Mullaroo Creek) at Point 7 (see Figure 1). Daily inflows from two other flood runners off the Lock 7 weir pool (located upstream of the inlet to Mullaroo Creek) at

Points 4 and 5 (see Figure 1) join with the Mullaroo Creek upstream of the Mullaroo Creek gauge (414211A) and will be included in the measured flow at this gauge.

- the modelled daily incremental loss associated with raising the weir pool and delivering environmental water to Lindsay Island.

Mallee CMA will provide MDBA with the daily planned and actual volumes pumped into Lake Wallawalla on a weekly basis. MDBA will provide SA Water RMO with these volumes weekly.

SA Water RMO will obtain daily the measured flow at the Mullaroo Creek gauge (414211A).

SA Water RMO will determine the flow in the Lindsay River near its confluence with the River Murray (for the purpose of determining daily flow to SA) each day using the following formula:

(Modelled daily inflow to the Lindsay River) + (measured daily flow at Mullaroo Creek gauge (414211A)) + (modelled daily inflow to Mullaroo Creek from the flood runner at Point 7) – (daily modelled incremental loss associated with raising the weir pool and delivering environmental water to Lindsay Island) - (daily planned volume pumped into Lake Wallawalla) – (the Lindsay River allowance of 250 ML/day).

As the watering event proceeds, measured data will be used to calibrate and validate the water balance model. MDBA will notify SA Water RMO of any variation between forecast modelled flows (ie water already delivered) and actual modelled flows in the Lindsay River system so that any adjustments required to the flow to SA can be made by SA Water RMO in a timely manner.

11 Operating Risks and Mitigation Measures

The potential risks to values that may be affected by planned watering at Lindsay, Mulcra or Wallpolla Islands have been assessed by a committee consisting of Mallee CMA, Parks Victoria, MDBA, DSE (now DELWP), River Murray Operations and SA Water.

The scope of the assessment considered risks associated with water delivery to the wetlands and floodplains, water held within the wetlands and floodplain, and water released/spilling from the floodplain.

The scope excluded an assessment of risks associated with the actual structures. This assessment is undertaken by the operator and documented in the Operations, Maintenance and Safety Manual and the Commissioning Plan.

The potential risks of operating the works to environmental, social and economic values were previously assessed to inform the development of the Lindsay Stage 1 Investment Proposal (Mallee CMA 2010) (Appendix B) and the Mulcra Island Construction Proposal (2009). The potential risks for Lindsay Island were assessed by the Mallee CMA and for Mulcra Island by KBR (2008) as well as an expert panel (ecology – wetland/aquatic, geomorphology, groundwater and water quality as well as social/economic). Salinity risks were assessed independently for Lindsay Island (SKM 2010) and Mulcra Islands (SKM 2008).

Each assessment used a value, threat, likelihood, consequence approach to determining the level of risk to values (ranked low to extreme) for each operating scenario for Mulcra Island. Monitoring, mitigation and control actions were also identified.

A stakeholder meeting was convened to review the assessments and included the Mallee CMA, SA Water River Murray Operations, MDBA, NSW Office of Water and Parks Victoria. The stakeholders reviewed the methodology, values and outcomes of the risk assessment and the identified mitigation measures.

The stakeholders validated the assessment of risks to values at Lindsay Island. For Mulcra Island, additional values were identified and risks subsequently assessed. These included changes to pest terrestrial flora, cultural impacts, operations and maintenance activities and enforcement/compliance activities e.g. illegal fishing.

Comprehensive risk assessments are also undertaken and documented annually prior to watering activities as part of the process to prepare the annual seasonal watering proposals and the event-specific delivery plans.

For the interim Operating Plan, this section will focus on the operating risks associated with operation and flows for the commissioning activities. Further investigations of operating risks and mitigation measures will be completed as required after the commissioning to inform a more comprehensive risk section for subsequent versions of the Operating Plan.

Operational

Increasing Lock 8 flows in excess of 15,000 ML/day will increase the head difference between Lock 7 and the northern and southern Lindsay River regulators, increasing flows into the Lindsay River. Although the northern Lindsay River regulator will be open and the southern Lindsay Regulator closed as the default positions under the Base Flow scenario, it should be noted that the gates at both structures are not designed to be overtopped with the gates closed and should be stripped prior to flooding. This applies to all operational scenarios. SA Water will monitor the status of these structures and undertake any necessary mitigating actions to protect the structures.

Ecological

As described, the interim Operations Plan includes the Base Flow scenario and Seasonal Pulse scenarios as a part of commissioning of the Mullaroo structure in conjunction with the NOW weir pool manipulation trial at Lock 7. Both of these flow scenarios have formed part of the historic flow regime at the site since the construction of the Mullaroo Causeway in 1977. As such ecological risks are minimal based on historic evidence. Given that changes in ecological conditions will be restricted to in stream conditions any potential ecological impact will be restricted to reaches of waterway which will experience altered flows. Mallee CMA will collate observations and manage their own monitoring activities to verify this. In the unlikely event of an adverse outcome for aquatic or riparian flora or fauna, the flexible configuration of the structures will enable pre commissioning flow conditions to be reinstated.

Salinity

Salinity impacts have been assessed for management actions for both the Mullaroo Creek and the Lindsay River as a package, as the works proposed are complementary.

A salinity impact assessment was prepared by SKM (2010) using a surface water assessment, Flow Net, Dupuit Steady State Solution, Groundwater Mound Rise and Mass Balance, in line with the methodology for the Hattah Lakes and Mulcra Island investigations and taking into account existing salinity investigations for the site. Estimates were made to represent a worst case scenario, allowing for error.

The potential for salt discharge and impact on floodplain processes were investigated (SKM, 2010). Operation of the Base Flow scenario represents a continuation of existing conditions and as such will not increase salt impacts. The implementation of a seasonal pulse (referred to in the salinity assessment as a spring fresh) and pumping to Lake Wallawalla was assessed to have an impact of less than 0.1 EC at Morgan and as such was deemed not significant.

Mallee CMA monitors an existing bore network within the park and undertakes a long-term salinity monitoring program to assess the impacts of environmental watering on groundwater levels and groundwater quality. Monitoring and ongoing assessment of risks will occur consistent with the basin salinity management strategy. In addition to the regular groundwater monitoring, Mallee CMA will manage the monitoring of surface water quality at the Army Bridge (downstream of the confluence of the Mullaroo Creek and Lindsay River). These monitoring activities are critical to verify modelled salinity impacts and to provide timely advice for management of any water quality issues arising during operation of the works.

12 Operational Costs

Operation and maintenance costs are funded through the SA Water operations budget, which will be part of the O&M costs funded from the MDBA River Management Division. Monitoring costs will be met by the Mallee CMA through intervention monitoring funding provided by the TLM program.

Costs associated with pumping environmental water to Lake Wallawalla are outlined in and agreed to during the development of the environmental water delivery plan with the relevant water holder.

13 Communications

The Lindsay-Mulcra-Wallpolla Islands Icon Site has a communications and consultation plan specific to the site. Media surrounding watering actions must carried out be in accordance with The Living Murray Communication Protocol.

The Icon Site manager (Mallee CMA) is committed to establishing and maintaining strong relationships within the local community during watering operations. A vital tool in the consultation process is structured engagement with the community through engagement with key stakeholders and advisory groups.

1.1 Indigenous Engagement

To ensure the Indigenous community is provided an opportunity for input into water management, and a chance to raise and identify their cultural and spiritual links to the islands, Indigenous Stakeholders will be consulted. These stakeholders are representatives of each of the Aboriginal parties who have a vested interest in the islands.

These representatives ensure cultural heritage and values are considered and incorporated by the Icon Site manager, and the distribution of information out into the aboriginal communities. This group provides a valuable single source for Indigenous engagement, advice, input and recommendation. This process is managed via the Mallee CMA TLM indigenous facilitator and through the Mallee CMA Aboriginal Reference Group

1.2 Communication during managed events.

MCMA will lead communication activities for upcoming and ongoing TLM watering events and will coordinate these via the Lindsay-Mulcra-Wallpolla Operations Group. Key messages will be about the timing and ecological objectives of each event.

Parks Victoria will be responsible for communicating with its stakeholders and visitors regarding any impacts on visitor experience such as road closures, access restrictions to areas of the park and water quality issues.

NSW Office of Water will be responsible for communicating with NSW landholders and other stakeholders regarding changes to water access and potential for inundation of property, prior to and during operational activities.

During routine river operations or in the event of a broad, basin scale event such as blackwater, the MDBA will take the lead on communications with support from local agencies where required.

1.3 Complaints and Enquiries

Complaints and enquiries relating to the environmental watering process shall be directed to MCMA or NOW as appropriate.

Parks Victoria will be responsible for dealing with complaints and enquiries regarding visitor access to the park and water quality concerns within the park.

14 Previous Event Record

This section will contain the ongoing operations log and as such will be progressively updated as watering events occur and are examined and assessed.

15 References (Currently Incomplete)

Commented [ ]: To be completed

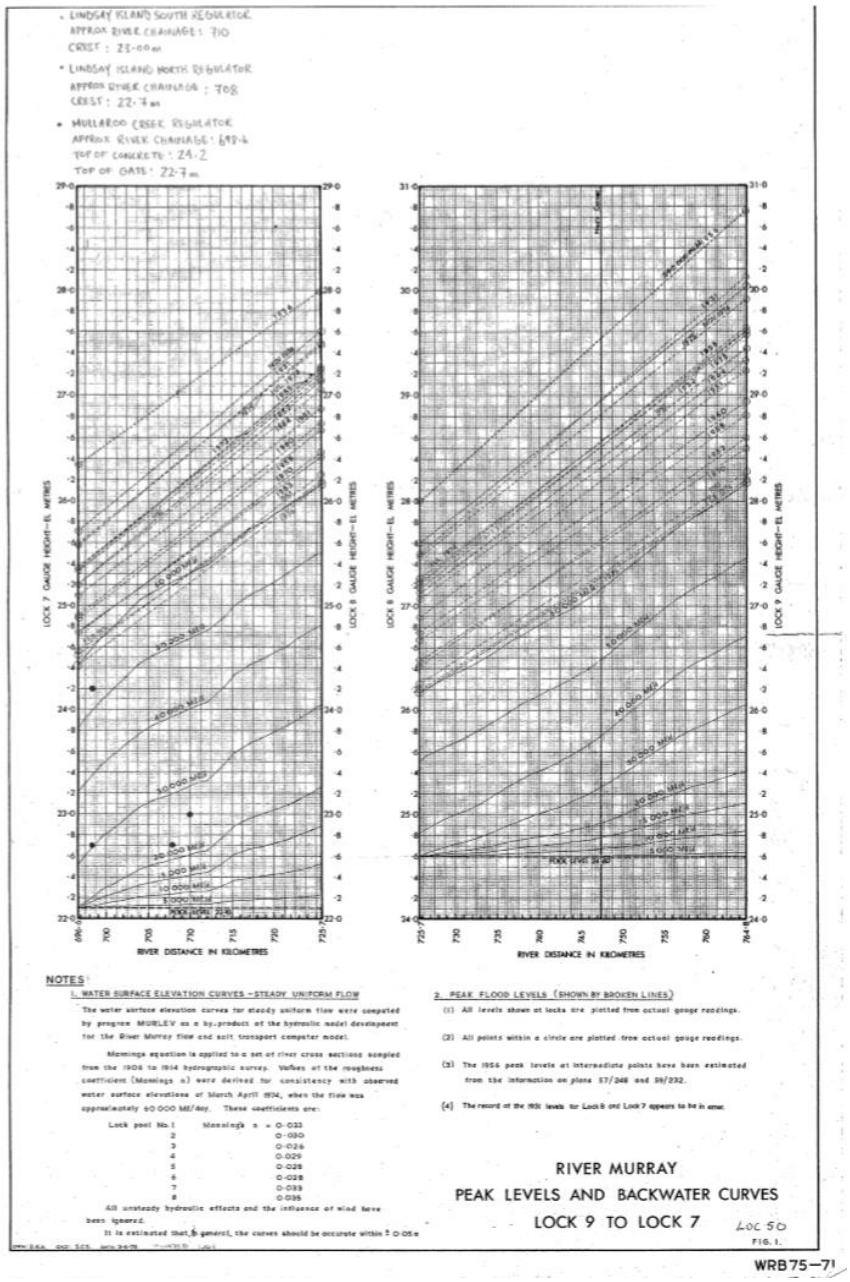
MDFRC (2011) The Living Murray: Condition Monitoring Program design for Chowilla Floodplain and the Lindsay, Mulcra and Wallpolla Islands. Development Draft 3.1. A report prepared for the Murray-Darling Basin Commission by the Murray-Darling Freshwater Research Centre.

MCMA (2015). Lindsay-Mulcra-Wallpolla Icon Site: Watering Guide.

Report for Mullaroo Creek Regulator and Fishway- Detailed Design Report' (GHD 10 April 2013).

Appendix A

Lock 7 backwater curve



Appendix B

Risk assessment for Lindsay Island Works Stage 1 Investment Proposal (Mallee CMA)

Risk	Likelihood	Consequence	Risk Rank	Mitigation	Likelihood	Consequence	Risk Rank
Increased Salinity Impact on Downstream Users	2 - Unlikely	2 - Minor	Low	Monitoring and adaptive management if necessary	2 - Unlikely	1 - Insignificant	Low
Increased Salinity Impact on New South Wales	2 - Unlikely	2 - Minor	Low	Monitoring and adaptive management if necessary	2 - Unlikely	1 - Insignificant	Low
Harmful Increase in Sediment Transport	2 - Unlikely	2 - Minor	Low	Monitoring and adaptive management if necessary	2 - Unlikely	1 - Insignificant	Low
Bank Erosion	2 - Unlikely	3 - Moderate	Moderate	Monitoring and adaptive management if necessary	2 - Unlikely	2 - Minor	Low
Blackwater Events	2 - Unlikely	2 - Minor	Low	Monitoring and adaptive management if necessary	2 - Unlikely	1 - Insignificant	Low
Benefits to Non-Native Fish Species	3 - Moderate	3 - Moderate	High	Monitoring and adaptive management if necessary	2 - Unlikely	2 - Minor	Low
Restriction of Fish Passage	3 - Moderate	3 - Moderate	High	Appropriate fishway design and operational rules. Monitoring and adaptive management if necessary	2 - Unlikely	2 - Minor	Low
Disturbance to Native Vegetation	3 - Moderate	3 - Moderate	High	Development of a Vegetation Offset Plan. Monitoring and adaptive	3 - Moderate	1 - Insignificant	Low

Risk	Likelihood	Consequence	Risk Rank	Mitigation	Likelihood	Consequence	Risk Rank
				management if necessary			
Invasion of Non-Native Vegetation	3 - Moderate	3 - Moderate	High	Implementation of equipment hygiene measures during construction. Monitoring and adaptive management if necessary	2 - Unlikely	2 - Minor	Low
Damage to Social and Cultural Heritage Values	5 - Almost Certain	4 - Major	Extreme	Development of and strict adherence to a CHMP	2 - Unlikely	2 - Minor	Low
Incomplete construction of Stage 1	3 - Moderate	4 - Major	Extreme	Sourcing of additional funds to ensure completion of project	1 - Remote	1 - Insignificant	Low