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MURRAY–DARLING BASIN AUTHORITY

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The Living Murray

Annual Environmental Watering Plan 2011-12

August 2011

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Cover image: *Young cormorants, Barmah Forest* (Photo by Keith Ward © MDBA)

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1 Introduction

The Living Murray (TLM) was established in 2002 in response to evidence of the declining health of the River Murray system. In November 2003 the Murray–Darling Basin Ministerial Council announced its historic The Living Murray First Step Decision. This decision was to recover an average of 500 GL per year for the environment. As at 30 May 2011, 477.8 GL had been recovered. This volume is expected to increase to 486 GL in 2011–12. A structural works program is currently underway to deliver this water efficiently.

The Living Murray's First Step focuses on achieving a set of agreed ecological objectives at six 'icon sites' along the River Murray through a combination of 'water and works'. The six icon sites are:

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

This document, The Living Murray Annual Environmental Watering Plan 2011–12, outlines the decision framework for prioritising the use of recovered TLM water for environmental actions across the River Murray system in 2011–12. The Plan has been jointly developed by the Murray–Darling Basin Authority (MDBA) and Environmental Watering Group (EWG) which consists of the partner governments for The Living Murray Initiative.

The annual water planning process is responsive to changes in water resource conditions, opportunities and environmental priorities throughout the season. Implementation of The Living Murray Annual Environmental Watering Plan 2011–12, including any changes to priorities or other aspects of the Plan, is recorded separately and reported at the end of the year in The Living Murray implementation report.

For information about The Living Murray go to www.mdba.gov.au/programs/tlm.

[1] The River Murray system includes: the main course of the River Murray and all its effluents and anabranches downstream of Hume Dam to the sea including the Edward–Wakool River system, the Mitta Mitta River downstream of Dartmouth Dam and the Darling River and Great Darling Anabranch downstream of Menindee Lakes.

Water access entitlement: a perpetual or ongoing entitlement, by or under law of a State, to exclusive access to a share of the water resources of a water resource plan area.

Unregulated flows: water that cannot be captured in Lake Victoria and is, or will be, in excess of the required flow to South Australia.

River Murray Unregulated Flows: unregulated flows in the River Murray occurring after jurisdictions have exercised their existing rights.

Water resource scenarios: the extreme dry, dry, median and wet resource scenarios are based on anticipated inflows to River Murray system and the associated climate conditions.

2 Environmental watering activities 2010–11

2.1 Inflows 2010–11

Inflows for the 2010–11 water year (June 2010 to May 2011) were among the highest on record, with the highest rainfall on record occurring in the southern half of the Basin and in parts of south-east Queensland (figure 1).

Although similar inflow volumes have occurred historically the inflow pattern in 2010–11 was very unusual. Inflows until the end of November were modest, however inflows over the summer period were about 6,700 GL, which was more than double the previous highest of about 2,980 GL recorded in the summer of 1992–93.

The dramatic increase in inflows resulted in floods occurring multiple times along parts of the Murray, Barwon–Darling, Murrumbidgee, Goulburn, Ovens, Campaspe, Loddon and many other rivers in the Basin. The extent of this flooding varied across the River Murray system due to the pattern of rainfall and the nature of the floodplain.

2.2 Environmental watering activities 2010–11

At the beginning of 2010–11, the outlook for inflows into the River Murray system still looked grim. Opening allocations were expected to be very low and the drought in many areas of the southern basin was not over. The Living Murray had carried over environmental water from the previous water year to provide sufficient water to trial a large multiple watering in spring at the Barmah–Millewa Forest and the Lower Lakes, Coorong and Murray Mouth.

Whilst environmental water was initially allocated to a small number of watering actions, the high inflows in late spring, with the accompanying increase in allocations provided the opportunity to increase both the number and size of environmental watering actions. This included the release of 428 GL of environmental water (comprised of 10 GL of entitlements held by NSW, 199 GL from The Living Murray and 219 GL from the Barmah–Millewa Environmental Water Account) from Hume Reservoir.

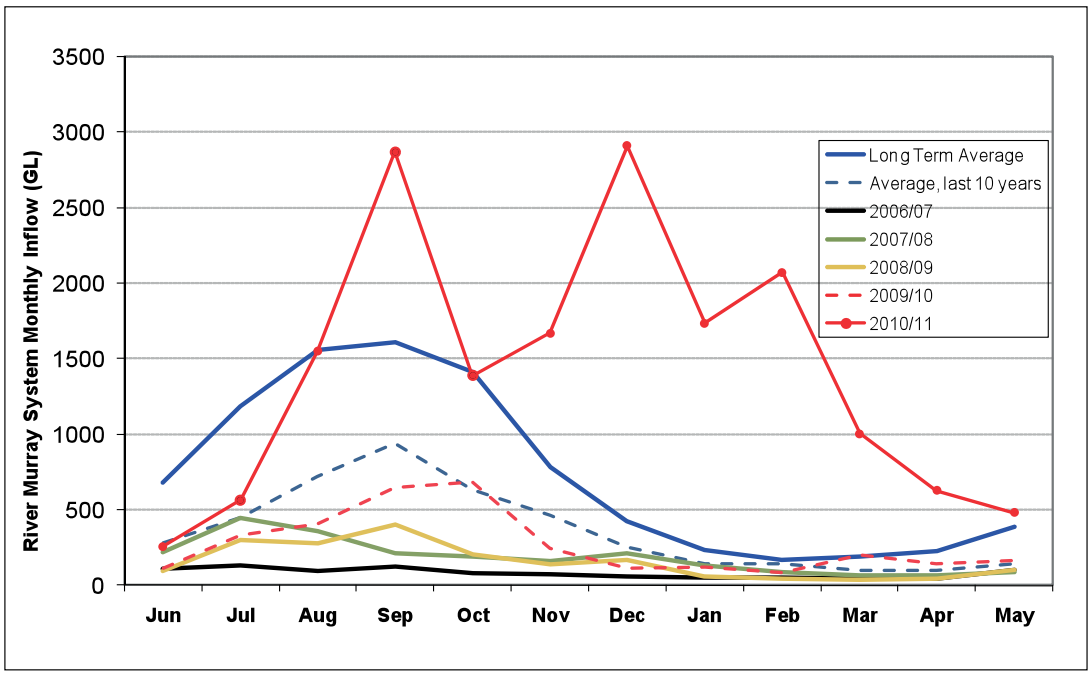

Figure 1 Comparison of inflows to the River Murray system (excluding the Darling River and Snowy River) in selected years

These releases were timed to maintain water levels in key colonial waterbird breeding areas and other wetlands in the Barmah–Millewa Forest during periods of lower flow rates so that fledgling chicks were not abandoned.

Whilst 317 GL of TLM allocation was committed by November 2010 for environmental watering activities, the subsequent higher inflows meant that some of these watering actions were partially or fully met by the floods. For example, TLM, New South Wales and the Commonwealth initially provided environmental water to the Lower Darling Anabranch which was then extended by the flooding. Although flows are now receding in the Anabranch, most billabongs and lakes have now been inundated for the first time in ten years and the landscape continues to flourish.

In 2010–11 a total of 270.175 GL of allocation was delivered to sites within the River Murray system. A summary of these actions and the allocated water volumes is provided in table 1.

2.3 River Murray Unregulated Flow event

The high inflows in 2010–11 resulted in a prolonged period of unregulated flow being announced for the River Murray and Lower Darling systems from spring 2010 until June 2011. The availability of River Murray Unregulated Flows (RMUF) allowed the Environmental Watering Group to trial the prioritisation of environmental watering actions during RMUF for the first time. For the purposes of the trial, the Environmental Watering Group ensured that water was made available to watering actions with the best potential environmental outcomes, including the consideration of certainty of outcome and risks which are also considered for regulated watering actions.

The trial showed that during the early stages of the event when smaller volumes of RMUF water was available, the process undertaken by the Environmental Watering Group to review and coordinate environmental watering actions was beneficial. However as larger amounts of unregulated water became available, this coordination was not required as flows naturally inundated most of the priority environmental watering sites. .

Table 2 provides a summary of the environmental watering actions prioritised by the Environmental Watering Group in the early stages of the RMUF event.

2.4 Combined impacts of inflows and environmental watering activities

The flooding in 2010–11, combined with targeted environmental watering activities, has been critically important for many species recovering from the recent unprecedented drought sequence experienced over the past decade. For example, the environmental watering action at Barmah–Millewa Forest has resulted in the largest bird breeding event in 60 years.

The Central Murray Floodplain, including the Barmah–Millewa Forest, Gunbower–Koondrook–Perricoota Forests and the Edward–Wakool system experienced prolonged, but relatively low level, flooding (that would generally occur on average once every ten years). Over 90% of the Barmah–Millewa Forest was inundated and approximately 27,000 hectares of Koondrook–Perricoota and 9,000 hectares of Gunbower Forest were also estimated to have been inundated. At the Hattah Lakes icon site, most of the lakes were inundated naturally and water was pumped to Lake Kramen for the first time since 1993.

Menindee Lakes was effectively spilling for eight months with releases into the Lower Darling River of up to 34,000 ML/day. The flooding has provided much needed water to floodplains along the Darling River and Great Darling Anabranch as well as the River Murray in South Australia.

The high inflows that entered the River Murray system in the 2010–11 water year have improved condition in the River Murray Channel. The removal of locks and weirs during the floods allowed fish to move freely and helped to flush saline water out of the system. It also provided connectivity between the channel and adjacent billabongs and wetlands, thereby improving the condition of vegetation and providing habitat for a range of species.

These flows continued throughout the River Murray system. By the end of May 2011, the total annual flow across the South Australian border was approximately 14,000 GL, which was the highest since 1975–76. The high River Murray flows and increased local rainfall have resulted in more than 60% of the Chowilla Floodplain being inundated. This has mainly watered river red gum and wetland areas, and has also reached some black box communities for the first time in over ten years.

Table 1 The Living Murray regulated environmental watering activities 2010–11

Site	Locations within site	Volume delivered (GL)	Period of watering	Benefit
Multiple site watering	Barmah–Millewa Forest (NSW and Vic)/ Lower Lakes, Coorong and Murray Mouth (SA)	199.000	September–February	Facilitate the recovery and maintenance of wetland vegetation, and contribute to a successful bird breeding event.
	Murrumbidgee River (NSW)/Lower Lakes, Coorong and Murray Mouth (SA)	23.039	May–June	Improve water quality in the Murrumbidgee River and River Murray as well as provide and prolong inundation of the river red gum forest and associated wetland systems. Benefits of flows at the Lower Lakes include continued fishway releases through winter 2011. Continued barrage releases also helped reduce salinity in the Lower Lakes and Coorong.
	Goulburn River (Vic)/ Lower Lakes, Coorong and Murray Mouth (SA)	33.000	November–December	Provide a dilution flow from the Goulburn River to the River Murray to help mitigate an emerging blackwater event. Flows to Lower Lakes contribute to fishway and barrage releases.
	Lower Darling Anabranch (NSW)/ Lower Lakes (SA)	15.000	September–October	To improve the health of drought stressed vegetation communities, improve native fish stocks, provide habitat and food production for bird species and other fauna such as frogs.
Chowilla Lindsay–Wallpolla Islands	Chowilla Horseshoe, Lock 6 depression, Monoman Depression, Punkah Island Depression	0.045	September–November	Facilitate the recovery and maintenance of floodplain vegetation, and maintain habitat for birds and frogs, including threatened species such as the southern bell frog.
	Punkah Creek Floodrunner, Punkah Creek aquadam, Punkah Creek Depression (Chowilla)	0.034	December	Contribute to improving the health of long lived vegetation, including mature river red gum, black box and other high priority vegetation. Provide habitat for frog populations, including the threatened southern bell frog.
	Twin Creeks, Monoman Creek Depression, Gum Flat (Chowilla)	0.057	September–November	Contribute to improving the health of fringing wetland vegetation. Provide breeding opportunities for waterbirds and frogs including the southern bell frog.
	Total	**270.175**		

Table 2 The Living Murray RMUF environmental watering activities 2010–11

Icon site	Locations with in site	Volume delivered (GL)	Period of watering	Benefit
Gunbower–Koondrook–Perricoota Forest	Gunbower Creek	6	To be advised	To facilitate the recovery and maintenance of native fish populations in wetlands.
Hattah Lakes	Lake Kramen	3	To be advised	To maintain habitat for native fish and waterbirds and provide occasional breeding for waterbirds.
Chowilla Lindsay–Wallpolla Islands	Wertawert Wetland, Lake Littra, Coppermine Waterhole and Monoman Island Horseshoe	2.13	December 2010–March 2011	Facilitate the recovery and maintenance of floodplain vegetation, and maintain habitat for waterbirds and frogs.
Lower Lakes, Coorong and Murray Mouth	Lake Alexandrina, Coorong estuary and Murray Mouth	34.3	December 2010–March 2011	TEnhance migratory water bird habitat to allow for greater fish passage across the barrages between the Coorong/Murray Mouth and Lake Alexandrina.
River Murray Channel	Reid Flat and Morgans East Lagoon	0.265	December 2010–March 2011	Maintain and improve health of long-lived vegetation for regent parrot habitat. Promote successful breeding events in frog and threatened water bird communities.
	16 wetlands located along the River Murray Channel	3.7	November–December 2010	Improve groundwater conditions surrounding the wetlands. Provide habitat for frog and waterbird species. Improve condition of vegetation.
	Total	**49.395**		

The levels in Lake Albert and Lake Alexandrina have returned to the 'normal' range after significant flows entered the system in 2010–11. Lake levels in March 2011 were around +0.7 m AHD (Australian Height Datum) after experiencing levels below sea level. These lake levels are now well above the critical acidification threshold water levels. The large flow volumes arriving in Lake Alexandrina from the River Murray have generated a range of ecological benefits. The flows have enabled extensive connectivity between Lake Alexandrina and the Murray Mouth estuary, facilitating movement of diadromous fish; increased the extent of the Murray Mouth estuary; and opened and enlarged the Murray Mouth. The flows have also raised the level of the Lower Lakes, increasing habitat for threatened birds, fish and frogs.

As all the icon sites received significant volumes of water during the spring/summer period, the Environmental Watering Group decided to carryover the remaining 90 GL of allocation available in The Living Murray portfolio to spring 2011 to maximise the environmental outcomes that could be achieved.

2.5 Adaptive management

The trial of a larger multi-site watering at Barmah–Millewa Forest and the Lower Lakes, Coorong and Murray Mouth in spring 2010 raised several operational and water accounting issues that meant that TLM could not deliver environmental water in the manner proposed initially. The Living Murray is currently working to resolve these issues with the jurisdictions. Some of the issues included:

- challenges in the ability to deliver and protect environmental flows
- challenges in identifying and tracking the different flows which made up the event
- challenges to deliver and protect environmental flows under historical river operations practice.

A set of principles to guide multi-site watering have been agreed by the Basin Officials Committee as:

1. The efficient use of environmental water which optimises beneficial environmental outcomes:
    - in an accountable and transparent manner
    - in accordance with the rights of the underlying environmental water portfolio
    - without creating unacceptable material third party impacts.
2. The efficient use of environmental water which optimises beneficial environmental outcomes will be achieved by:
    - adaptively applying learnings from trials
    - using a method which is as simple and cost effective as possible.

The Basin Officials Committee has agreed that achieving multi-site environmental watering on the River Murray will require short-, medium- and long-term solutions. A limited number of practical options are being explored in the short term to achieve the best possible environmental outcomes.

The extensive overbank flooding in the River Murray system this year also resulted in large areas being affected by blackwater. Blackwater events occur naturally due to the rapid breakdown of leaf litter on the forest floor causing water discolouration and at times low dissolved oxygen levels.

Although this blackwater event resulted in fish deaths being reported in several rivers, it also provided positive impacts by providing nutrients back into the river system thereby promoting the growth of many aquatic organisms. Several actions were implemented jointly by TLM parties and MDBA with the aim of diluting the blackwater event. This included the release of 33 GL of TLM water in the Goulburn River.

The collaboration undertaken by a range of state agencies to monitor this event and provide information to the public has provided a process for monitoring and reporting that could be utilised if similar events arise in the future.

Monitoring during the drought has shown that it takes a number of watering activities to build up resilience following periods of severe ecological stress. Although the drought has broken, some areas of the floodplain will require several flood events to fully recover.

2.6 The Living Murray portfolio summary

Table 3 presents the reliability class of entitlements held by TLM in 2010–11 with their associated entitlement, allocation, net use volumes and the volume remaining at June 30 2011. A total of 982.7 GL of entitlements are currently held on The Living Murray Environmental Water Register across a range of reliability classes.

Higher flows within the River Murray system in 2010–11 meant the threshold for the repayment of Snowy Borrow Encumbrances attached to some TLM entitlements was met in 2010–11. A total of 7.153 GL was repaid, thereby removing all remaining encumbrances on TLM licences. The remaining 90 GL of unused allocation will be carried over to spring 2011–12 on TLM entitlements in the Goulburn Valley that have spillable water accounts. A 5% transmission fee for water carried over in Victoria reduces the volume to 85 GL. If there is a likelihood of spills in Eildon Reservoir, carryover held in these accounts will not be made available immediately.

Table 3 The Living Murray entitlements 2010–11

Entitlement Type	Entitlement (GL)	Long Term Cap Equivalent (LTCE)[6]	Allocation available to TLM[2] (GL)	Environmental watering use (GL)	Volume remaining at 30 June 2011[5] (GL)
Regulated water entitlements					
NSW High Security	1.887	1.792	1.887	1.877	0.01
NSW General Security	212.927	165.81	209.593	182.873	19.966[1]
VIC High Reliability	62.979	62.908	87.899	75.0604	33.093
VIC Low Reliability	263.877	127.805	19.222	11.1597	8.062
SA Water Licence	43.765	41.528	49.697	0.1368	29.36
RMIF carried over from 2008–09[3]			0.068	0.068	0
Unregulated/supplementary water entitlements					
NSW Supplementary	350	40.9	tba[4]	tba[4]	0
NSW Unregulated	12.965	9	tba[4]	tba[4]	0
VIC Unregulated	34.3	28.1	34.3	34.3	0
Total	**982.7**	**477.843**	**402.666**	**305.4759**	**90.491**

[1] 17.153 GL was used to pay back encumbrances.

[2] This volume includes carryover and allocation to Victorian unregulated entitlement. Note: some water allocated to entitlements in 2010–11 was utilised by the previous owner.

[3] MDBA managed environmental water entitlement (not specifically TLM). This water was permitted to be carried over to October 2010.

[4] NSW unregulated and supplementary entitlements for TLM do not receive allocation; rather, they increase the size of existing unregulated flow events in the River Murray. To gain an understanding of the volume of water that these entitlements have contributed to the total volume of unregulated flows, modelling will have to be undertaken retrospectively once the unregulated flow event has been completed and as annual accounts are finalised.

[5] Throughout the 2010–11 water year a number of water allocation trades were completed. For this reason allocation remaining does not necessarily reflect the volume allocated to that specific type of licence.

[6] The Long Term Cap Equivalent is the long term average volume per year.

3 The Living Murray water planning 2011–12

3.1 Storage

Total MDBA active storage for the River Murray system at the end of May 2011 was 6,886 GL (80% of capacity) which is above the end of May long-term average of 5,089 GL (figure 2). Whilst high inflows have contributed to storage levels, it is also partly due to new carryover provisions in Victoria.

Hume Reservoir is currently at around 93% capacity. The situation in the Goulburn and Murrumbidgee catchment is similar to the Murray, with many water storages at near to full levels. If there is average inflow conditions throughout winter and spring of 2011 there could be significant releases from Hume Reservoir. If these releases are combined with high inflows from the Kiewa, Ovens and Goulburn Rivers, this could result in another significant flood event along the River Murray in 2011–12. Figure 3 provides preliminary flow forecasts for different water resource scenarios in 2011–12.

3.2 Outlook for The Living Murray entitlements

The aim of the First Step Decision was to recover an additional 500 GL average per year for the environment. To date 477.843 GL has been recovered and this figure is expected to increase to 486 GL average per year in 2011–12.

MDBA active storage levels are significantly higher than any other water season since TLM was established. It is anticipated that TLM will have a significant volume of environmental water available in early spring from carry-over and early season allocations. Table 4 provides estimates of potential allocation to TLM water entitlements, including carryover from 2010–11.

With high storage levels, there is also a high risk of spills. This may delay the availability of water carried over in spillable water accounts. The volume of carryover in these accounts may also be reduced in 2011–12 if spills occur before this carryover is made available.

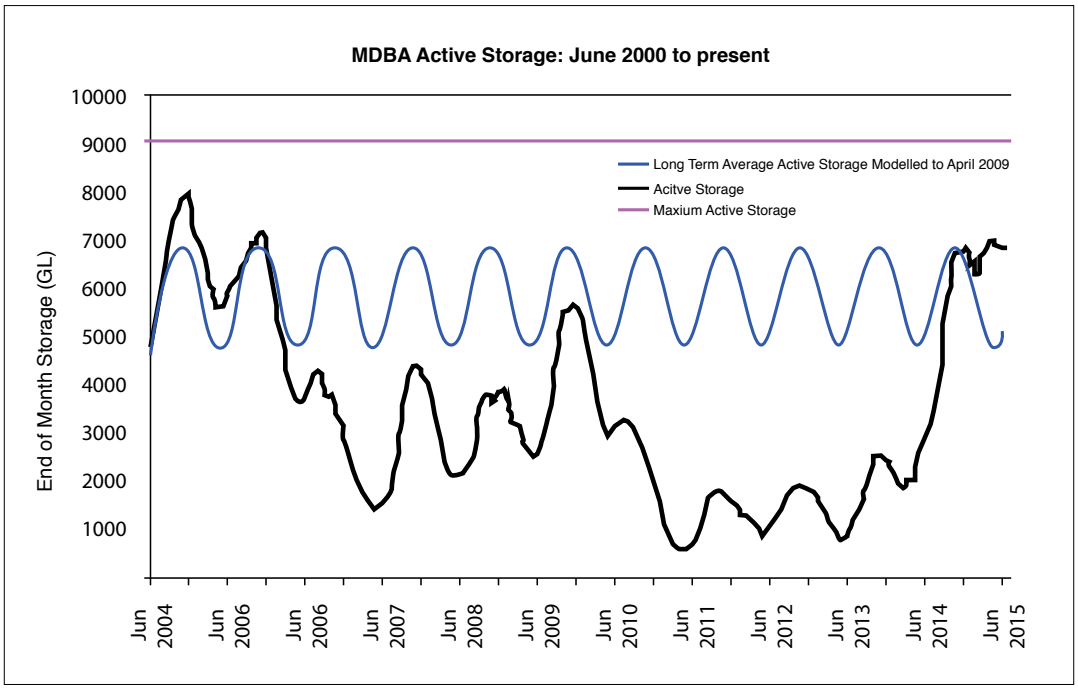

Figure 2 Comparison of active, long-term average and maximum storage levels in the River Murray system June 2000 to June 2011

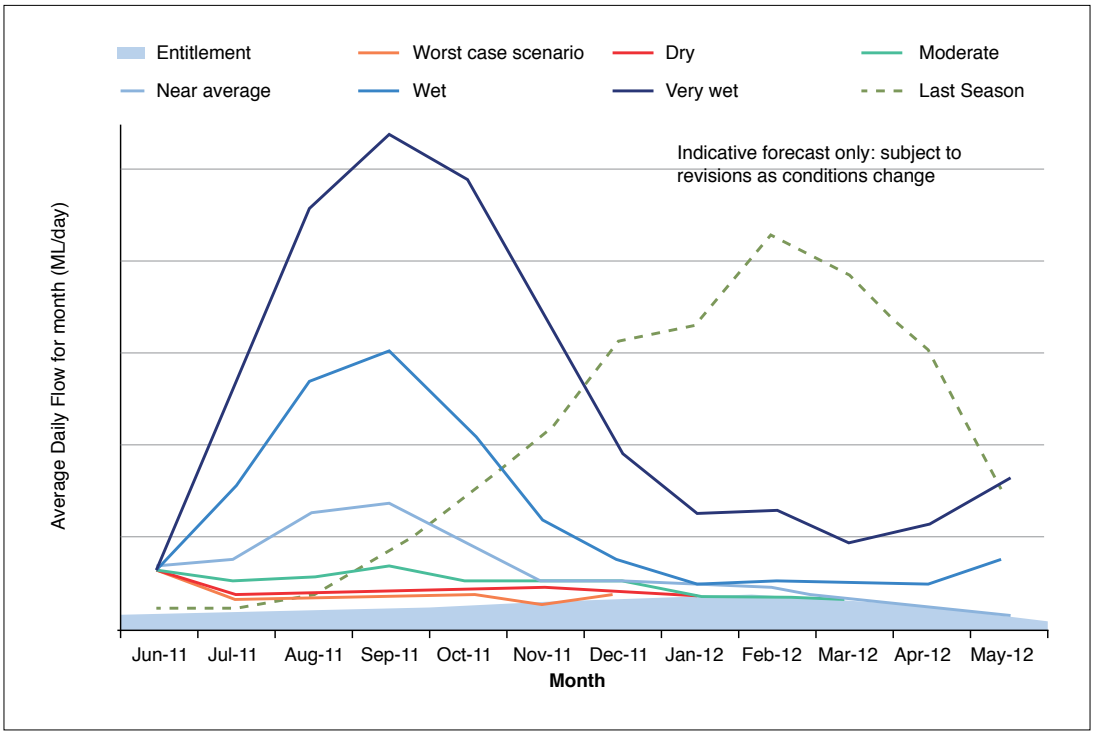

Figure 3 Preliminary flow forecasts for different water resource scenarios 2011–12 as at 30 May 2011

Table 4 Forecasted available The Living Murray water 2011–12

Season	Forecasted allocation amounts (GL)	Carryover available (GL)	Cumulative Total (GL)
Spring 2011	180–200	50	230–250
Summer 2011–12	80–100	35	345–385
Autumn 2012	10 –20	0	355–405

With allocations expected to reach similar levels to 2010–11, it provides the opportunity to consider larger watering actions at multiple sites. The high storage levels also increase the likelihood of uncontrolled flooding occurring at icon sites.

3.3 The Living Murray works

The Living Murray environmental works are designed to optimise the delivery of environmental water at icon sites. Following high river flows in 2010–11, the construction of infrastructure works was extensively delayed. Works are currently planned for completion in 2011–12 at Koondrook–Perricoota Forest, the lower landscape of Gunbower Forest and Mulcra Island in the Chowilla Lindsay–Wallpolla icon site.

During the construction phase, environmental watering actions may be limited or not possible at some sites. During this phase and upon completion of the works, it will be necessary to undertake operations in a controlled manner that tests the functionality of the structures and builds an understanding of how the structures can deliver the best environmental outcomes to the floodplain.

The volume and timing of inflows into the River Murray system will determine the ability to undertake construction and other activities at icon sites. If these sites are inundated by large unregulated flows in 2011–12 these activities could be limited and therefore provide an opportunity to provide environmental water to these sites.

Table 5 Proposed ecological watering objectives under different water resource availability scenarios (based on principles established by DSE Victoria and DEWHA)

	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
Management actions	Water refugia and sites supporting species and communities Undertake emergency watering at specific sites of priority assets Use carryover volumes to maintain critical needs	Water refugia and sites supporting threatened species and communities Provide low flow and freshes in sites and reaches of priority assets Use carryover volumes to maintain critical needs	Prolong flood/high-flow duration at key sites and reaches of priority assets Contribute to the full-range of in-channel flows Provide carry over to accrue water for large watering events	Increase flood/high-flow duration and extent across priority assets Contribute to the full range of flows including over-bank Use carryover to provide optimal seasonal flow patterns in subsequent years
Overarching objective	Avoid catastrophic loss/maintain capacity for potential recovery	Improved capacity for recovery	Protect ecological health	Improved health and resilience

3.4 Ecological watering objectives

In order to respond to the potential variability in water resources, the Environmental Watering Group uses a model that outlines management objectives for different water resource scenarios (table 5). The ecological objectives for extreme dry, dry, median and wet scenarios outlined in the table provide guidance on how TLM water is utilised under different flow and climatic conditions.

The anticipated strong opening allocations plus allocation carried over from 2010–11 means TLM is likely to have between 230–250 GL of environmental water available in spring 2011. This suggests that the median water resource scenario should be utilised initially for planning the use of environmental water in 2011–12. The water resource scenario will be reviewed through the year to take into account any significant changes to conditions at the icon sites and inflows into the River Murray system.

3.5 Ranking criteria

The primary objective of the Annual Environmental Watering Plan 2011–12 is to provide environmental benefit consistent with the stated objectives for each icon site. In order to prioritise between individual watering actions throughout the year, the Environmental Watering Group has agreed to use the following ranking criterion outlined in table 6, regardless of climatic conditions. Further details on the method for applying the criteria is provided at appendix A.

3.6 Framework for prioritisation of regulated flows

In order to accommodate the potential range in water allocation volumes and varying icon site conditions, a flexible decision framework has been developed by TLM that will guide the prioritisation of environmental watering actions in 2011–12. This decision framework provides the focus for the prioritisation of environmental watering actions and the timeframes for the review of all other potential watering actions. These reviews will assess TLM water availability against the environmental benefit to all proposed watering sites using the ranking criteria.

To be event ready the Environmental Watering Group has identified and ranked watering proposals that align with the decision framework (refer appendix B). These watering proposals have been identified to assess watering opportunities over the next water year, including multiple watering actions, and ensure that potential watering activities are considered during the development of the River Murray Operations Plan 2011–12. Further consideration of proposals will still be required before a commitment is made to undertake the watering actions in 2011–12.

The broad strategy for 2011–12 is to prioritise those watering actions that are most likely to deliver the best environmental benefits, given water availability and operational constraints. This is likely to be larger watering actions that maximise opportunities to deliver environmental water to multiple sites.

Table 6 Ranking criterion for prioritisation of TLM watering actions

Ranking criterion		Description
Significance of ecological outcome	An assessment of the predicted ecological outcomes provided by the watering. This should reflect the value and condition of the asset, threatened species and communities and magnitude of benefit, including:	
	Amount of benefit for the volume of water	An assessment of the predicted ecological benefit relative to the volume of water required. This may include the opportunity for return flows.
	Risk of not watering	An assessment of ecological risks of not watering. This includes the previous history, desired watering frequency, resilience period and protection of previous investment.
	Certainty/likelihood of benefit	An assessment of the certainty of getting the predicted outcomes; whether the benefit of watering a site can be maintained in the short and long term and the implications for future management.
Operational matters	Risks associated with watering	An assessment of any risks associated with the delivery of water such as acid sulfate soils, salinity spikes, black water events, algal blooms, operational constraints and the adequacy of mitigation measures.
	Cost	An estimate of the overall costs of delivering the watering action (per ML) including delivery, pumping and associated infrastructure costs.

Smaller watering proposals will also be considered a priority where the ecological health of high value sites needs to be consolidated and maintained.

During the 2011–12 water year, the Environmental Watering Group will review the schedule of environmental watering proposals at designated periods utilising the process outlined in figure 4. These review periods will assess the water availability against the environmental benefit to all proposed watering sites. Depending on the conditions at the review periods, watering proposals may be assessed across a range of water resource scenarios.

Multiple watering proposals will be subject to an assessment of the implications for River Murray operations, any approvals required from Basin Officials' Committee and a thorough assessment of the environmental benefits.

Real-time factors that may impact on the delivery of environmental water will also be considered during the review periods. These factors include river operations, availability of other sources of environmental water, status of TLM works, status of delivery budget, opportunities for multiple site watering actions, conditions at the sites, antecedent and forecasted flows.

Based on the outcomes of the review, the Envrionmental Watering Group will provide advice to the MDBA on whether any environmental watering actions should be implemented at that stage. The approval of any watering actions recommended by the Environmental Watering Group is delegated to the Executive Director of Natural Resource Management, Murray–Darling Basin Authority.

All watering actions will be implemented in accordance with the decision framework and prioritisation process outlined in the Annual TLM Environmental Watering Plan 2011–12. Any other watering proposals that are developed throughout the water year will be reviewed by the Environmental Watering Group as required using the process outlined in figure 4.

3.7 Framework for prioritisation of River Murray Unregulated Flows

In 2008–09 the Environmental Watering Group agreed to trial the prioritisation of environmental watering actions during a River Murray Unregulated Flows (RMUF) event. The Environmental Watering Group had its first opportunity to prioritise environmental watering actions during a RMUF event in 2010-11. Following this successful trial, the Basin Officials Committee has agreed that the Environmental Watering Group should continue the trial prioritisation of environmental watering actions during RMUF events to maximise the environmental benefits.

As each RMUF event varies in location, duration and operational opportunities, it is not possible to provide precise information on watering proposals prior to a RMUF event. To be event ready the Environmental Watering Group plans to develop potential unregulated flow management scenarios at the beginning of 2011–12. These scenarios will be subject to an assessment of the implications for River Murray operations, any approvals required from Basin Officials' Committee and an assessment of the environmental benefits.

Watering proposals will need to be reviewed as an unregulated event occurs and supplementary information will be included so that filters such as location, magnitude and feasibility can be evaluated before the prioritisation of the environmental watering actions in real time.

The prioritisation of environmental watering actions during RMUF events in the River Murray system will in principle:

- be based upon a RMUF event declared by River Murray Operations
- be consistent with a one-river approach in that the areas of highest environmental need and benefit are given priority
- recognise existing obligations and rights
- maximise environmental outcomes including integration with planned environmental water releases
- be based upon opportunity and relative environmental priority following ranking criteria agreed by the Environmental Watering Group
- be agreed on a case-by-case basis in real-time.

To assist in a real-time event, the ranking criteria adopted for the prioritisation of TLM regulated watering actions are also applied to the unregulated watering actions.

Figure 5 outlines the process for prioritising watering actions during a RMUF event. The decision to implement a RMUF environmental watering action is the responsibility of the relevant jurisdiction in both physically implementing the agreed priority and in allowing the declared RMUF to be used according to the Environmental Water Group agreed principles.

During a RMUF event it is possible that unregulated flows may be substituted for TLM allocation if approved watering actions have not yet been completed. This ensures that watering actions are undertaken in the most effective manner.

The volumes and benefits of water prioritised by the Environmental Watering Group and delivered during a RMUF event will be collated and reported as part of TLM environmental water reporting. This will enable a more comprehensive understanding of environmental water delivered in the River Murray system.

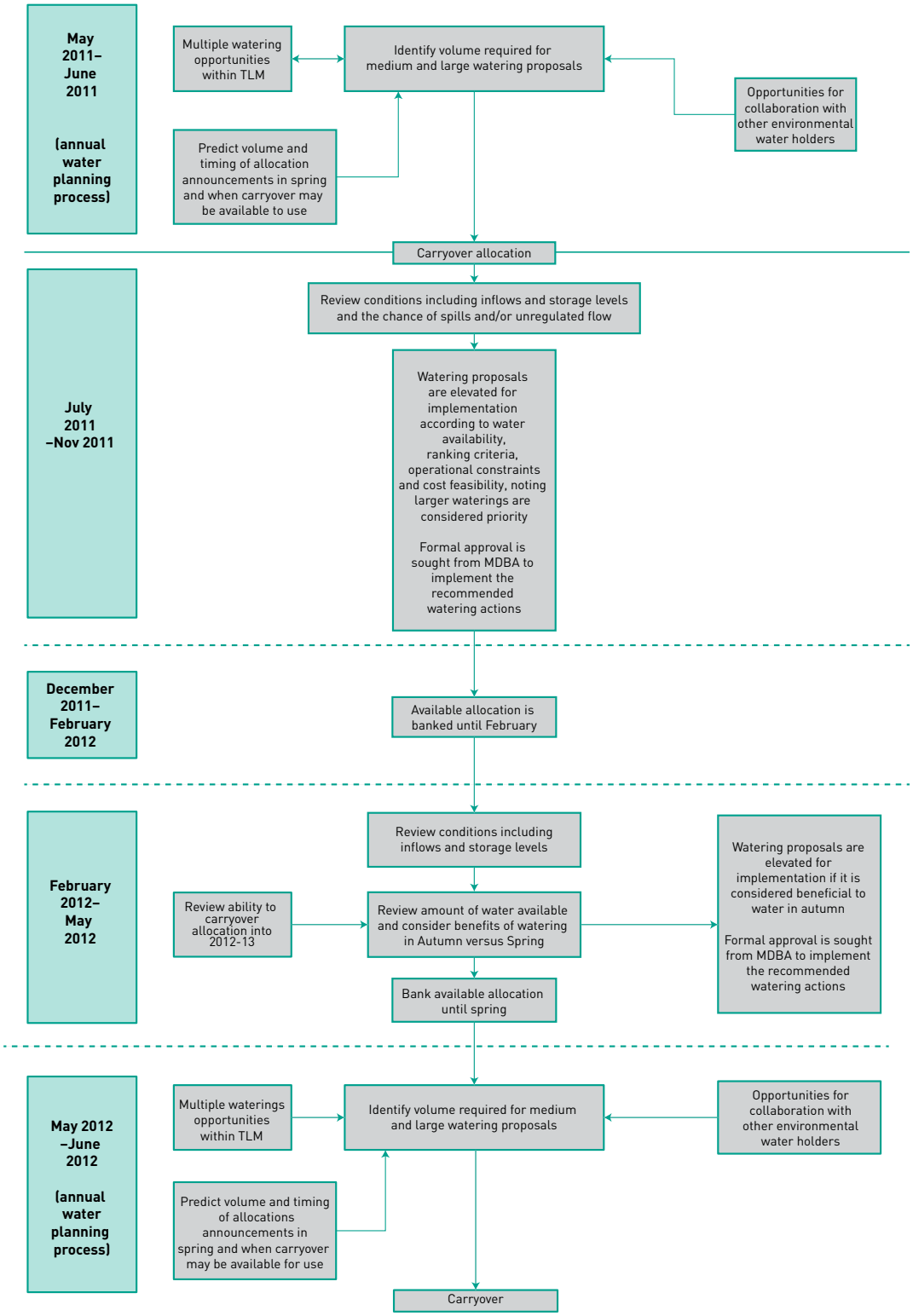

Figure 4 Flow chart of prioritisation process for regulated flows

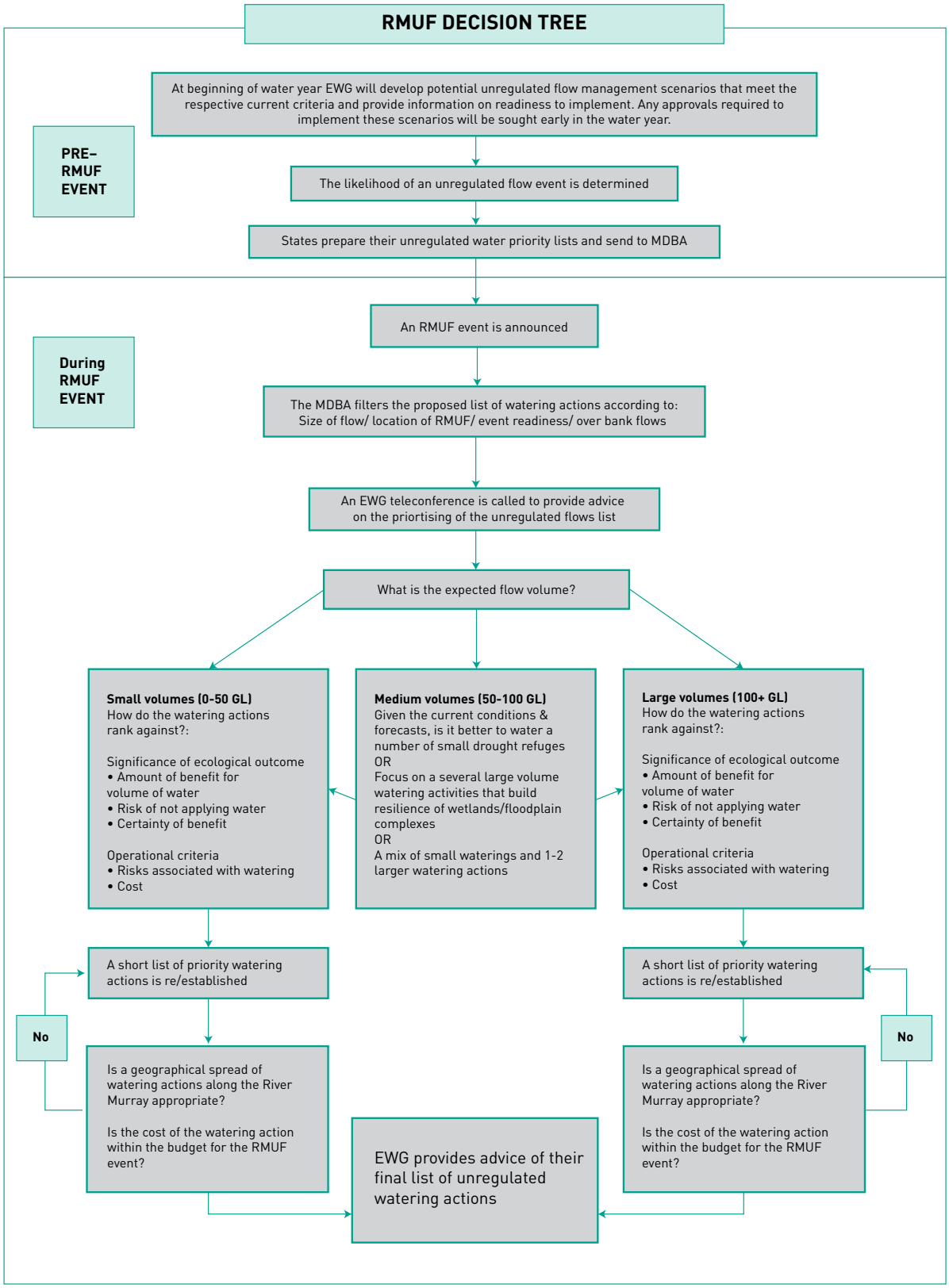

Figure 5 Prioritisation process for unregulated flows

4 Environmental monitoring for The Living Murray

Monitoring and evaluating the achievement of the ecological objectives is part of The Living Murray Business Plan. A monitoring framework titled the Outcomes Evaluation Framework has guided the development of monitoring arrangements and outlines the types of monitoring necessary to monitor progress toward the ecological objectives of TLM. The monitoring types listed in the Outcomes Evaluation Framework are River Murray system-scale monitoring, condition monitoring, intervention monitoring, compliance monitoring and knowledge generation.

A key principle of TLM is to use information from monitoring in an adaptive management sense to optimise the approaches to achieving positive ecological outcomes at the icon sites and thereby benefit the entire River Murray system. The current focus of TLM environmental monitoring is on condition, intervention (including monitoring specific watering events) and River Murray system-scale monitoring. Compliance monitoring has been incorporated into intervention monitoring.

The Living Murray Environmental Monitoring Program coordinates with other MDBA programs including the Sustainable Rivers Audit (SRA), Native Fish Strategy and Natural Resources Information, to provide a coordinated approach to monitoring across the Murray–Darling Basin.

4.1 River Murray system-scale monitoring

Monitoring at the River Murray system-scale is designed to determine if the health of the River Murray system improves following implementation of the First Step Decision and its focus on the six icon sites. The questions addressed by monitoring at the River Murray system-scale differ from the objectives of the Sustainable Rivers Audit, which provide a condition assessment for the entire Murray–Darling Basin, whereas the design of River Murray system-scale monitoring is specifically tailored to address questions at the river system scale only. However, some data collected through SRA is applicable to the River Murray system, for example, fish data collected for the SRA and icon site condition monitoring in the River Murray adjacent to the icon sites, has been used to develop a River Murray Community Fish Assessment.

The current River Murray system-scale projects are:

- The annual aerial waterbird survey of The Living Murray icon sites, which was implemented in 2007, and will be conducted in October–November 2011. The survey will be linked to the Eastern Australia Aerial Waterbird Survey so that geographical context is incorporated. The survey will also be conducted in cooperation with the on-ground waterbird surveys conducted as part of icon site condition monitoring to ensure cryptic species not easily identified by the aerial survey, are also assessed.
- A red gum and black box stand condition assessment, which has been implemented using remote sensing approaches to allow reporting annually on stand condition.
- An approach to a system-scale assessment of the fish community, in development, will provide an overall indication of the fish response to the implementation of TLM. The approach draws on data collected as part of fish condition monitoring at the icon sites and may include data collected for the Sustainable Rivers Audit . A trial of the fish community analysis approach is planned for the second half of 2011–12 and will be reported in June 2012.

4.2 Icon site condition monitoring

Icon site condition monitoring will determine change in the environmental condition of individual icon sites resulting from water application and implementation of works programs under The Living Murray. Icon site condition monitoring is specifically tailored to determine if the objectives for each icon site are being met. Monitoring and evaluation at the icon site–scale is surveillance in type and typically undertaken on a medium frequency (months to years).

Condition monitoring activities planned for 2011–12 include ongoing monitoring per the icon site condition monitoring plans that have been developed for each icon site. These plans detail the approaches and methods for monitoring the fish, bird and vegetation communities as they relate to the ecological objectives for the site. A core set of consistent approaches to monitoring the condition of fish, birds and vegetation has been developed and agreed across the icon sites. These approaches will be implemented during 2011–12 and include linkages to the system

assessments identified in the system monitoring section. For example, the river red gum and black box on ground condition assessment will provide key support to the red gum and black box stand condition remote sensing assessments.

4.3 Intervention monitoring

Intervention monitoring assesses the ecological response to types of interventions or environmental management actions implemented under The Living Murray. In doing so, it provides the major link to understanding how the ecological responses to specific environmental management actions result in changes at icon sites. It also provides the foundation information for adopting an adaptive-management approach to implementing The Living Murray.

During 2011–12 intervention monitoring will be focused around three broad areas:

- monitoring the impacts of fishways and resnagging on fish populations throughout the River Murray
- monitoring the direct impacts of watering events at icon sites in relation to the event watering objectives and the management of risks
- addressing key information gaps on the response of vegetation, birds, habitat and fish recruitment to watering and works interventions.

Event monitoring has become important in managing the implementation of environmental watering activities during the drought to inform real-time decision making in relation to achieving ecological outcomes, quantifying and minimising risks. This monitoring is focused on the specific objectives and risks of the environmental watering event and is targeted in both temporal and spatial scales. The process for event monitoring will be responsive to the environmental watering plan, including recognition that resourcing and implementation will require planning to ensure event-ready capacity is available.

Event monitoring will be prioritised according to the water available for environmental watering and key knowledge gaps that may be addressed by specific watering actions. It is possible that events may not be monitored if resources are not available in appropriate timeframes. Reporting processes for event monitoring will recognise the level of monitoring undertaken.

Measuring the volume of water used at icon sites and the timing, volume and quality of any return flows etc is needed to account and report for the use and management of environmental water at the icon sites. This area of monitoring was previously defined in compliance monitoring; however it is now encompassed in intervention monitoring. This change has been made to ensure clear linkages between the various information requirements for managing successful watering events and informing the operation of works at icon sites. This includes systems for water measurement and accounting, monitoring risks and ecological outcomes. Further detailed work in this area of monitoring is currently underway including water accounting needs for each icon site.

The Living Murray Environmental Monitoring Program works with The Living Murray Environmental Watering Group to plan and prioritise monitoring activities prior to the start of each financial year. This involves jurisdictions documenting the monitoring needs for icon sites, then the Environmental Watering Group considering the identified requirements with regard to:

- The Living Murray works and measures coming on-line that year and the associated specific information needs for adaptive management, such as water measurement, risks and ecological response
- monitoring around specific planned watering events to inform knowledge gaps and document outcomes from watering
- knowledge generated from previous monitoring projects that may be extrapolated to future waterings
- long-term agreed priorities (e.g. fishways monitoring).

This cooperative approach ensures that the highest priority monitoring needs are resourced each year and that resources available for monitoring are used in the most efficient manner.

5 Reporting on The Living Murray environmental watering

Environmental water is accounted and reported for TLM at the end of the watering season. Information reported includes the volume of water released, delivered and used at each icon site, volume of water returned to the River Murray and environmental water account figures.

The Living Murray Business Plan requires all aspects of water accounting be reported on annually consistent with The Living Murray Business Plan. This information will be incorporated into the development of:

- The National Standards for Water Accounting (Intergovernmental Agreement on a National Water Initiative 2004)
- The Living Murray Annual Implementation Report
- The Living Murray Annual Environmental Watering Report
- Murray–Darling Basin Authority Annual Report.

The timeframes for these reports vary, but will be completed within six months of the new water year.

6 Communications and consultation

The Living Murray Communication and Consultation strategy 2011–12 provides the framework for implementing a coordinated, consistent approach to communicating the achievements, progress and future direction of The Living Murray across all jurisdictions. One of the key objectives that will direct communication and consultation activities in 2011–12 is to promote the use of The Living Murray water portfolio to achieve environmental outcomes through proactive media and communication products.

The icon site consultation reference groups provide an opportunity to seek input from community members and also inform them about the use of TLM water.

Appendix A Methodology for applying ranking criteria

The ranking of watering proposals by the Environmental Watering Group provides a basis and starting point for discussions on the prioritisation of watering proposals by Environmental Watering Group members and does NOT constitute the final decision on which proposals will be recommended for implementation. It is acknowledged that these ranking criteria are a decision support tool and that other factors will contribute to the final decision including water availability and operational feasibility.

Amount of environmental benefit for the volume of water

High	• contribution to key site values and/or TLM site management objectives is high (for example breeding event) • total area of target community or site watered • major outcomes at River Murray system-scale • outcomes of the watering (for example maintenance of habitat) can be sustained for a lengthy period of time (e.g. greater than 12 months)
Medium	• able to contribute partially (approximately half) to key site values and/or to TLM site management objectives • important outcomes at icon site scale • at least half of target community or site watered • outcomes of the watering is sustainable for a reasonable length of time (e.g. 6–12 months)
Low	• minor contribution to key site values and/or TLM site management objectives • outcomes at localised scale • will require follow up watering within short term (e.g. 3–6 months) in order to sustain outcomes

Risk of not applying water

High	• not watering would result in a catastrophic risk to a species or key habitat component or site value that would have a long recovery time • high loss of previous watering investment (ecological, volume or $) • site is reaching end of resilience period
Medium	• high risk of loss of a local population of a species, but limited scope for recovery (i.e. poor recolonisers) or long recovery time • loss of key habitat components that have a short recovery time • moderate loss associated with previous watering investment • may not be able to fully deliver minimum regime
Low	• risk of loss of a local population (of a common species) but scope for recovery within short term • minor loss associated with previous watering investment • may not be able to fully deliver optimum watering regime

Environmental risks associated with watering

High	•	no discernable risks (for example liability, flooding, salinity spikes, blackwater events and other water quality risks) associated with watering. Mitigation strategies ensure no short or long-term impacts
Medium	•	high localised risks associated with watering. Mitigation strategies may ensure no long-term impacts but may have negative short term impacts
Low	•	major widespread risks associated with watering. Mitigation strategies may not be able to prevent long-term negative impacts on ecosystem health

Certainty/likelihood of benefit

High	•	considerable evidence, sound conceptual model with rigorous scientific underpinning, done successfully before at this site
Medium	•	anecdotal support, sound conceptual model supported by good understanding of the processes that would lead to the outcome
Low	•	limited understanding, unsure of outcome, lack of consensus on likely outcome

Cost

High	•	total delivery costs* 0 – $30/ML
Medium	•	total delivery costs $30 – $60/ML
Low	•	total delivery costs →$60/ML

*this includes all delivery costs such as pumping charges, infrastructure costs (e.g. levee banks) and irrigation channel fees

Appendix B Watering proposals

Watering site	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	Resource scenario under which watering action will be considered (dry, median, wet)	TLM volume needed to be ordered (GL)	TLM estimated volume of use (GL)	TLM estimated return flow volume (GL)	Beneficial timing window (range)	Water delivery mechanism	Complimentary works required	Costs (water delivery and complimentary works)	Ranking criteria (high, medium, low)				
											Amount of benefit for	Risk of not applying water	Certainty/ likelihood of	Risks associated	Cost
Barmah Forest															
Top Island, Boals Deadwoods, Gooses Swamp, Gulf Creek, Smiths Creek, other small regulators and creeks which receive water under 15,000 ML/day	Provide spring flows to build on improvements made by 2010–11 event and provide for colonial waterbird breeding event improvements made by 2010–11 event and provide for colonial waterbird breeding event	Healthy vegetation in at least 55% of the area of the forest including virtually all of the giant rush, moira grass, river red gum forest, and some river red gum woodland	Median	273–450 GL depending on flow levels	28–49%	51–72%	Sept–Nov	Flows through regulators in Barmah under 15,000 ML/day	None	$0	High	Low	High	Low	High
Gunbower–Koondrook–Perricoota Forest															
Black Charlie Lagoon, Reedy Lagoon, Little Gunbower Creek Complex, Little Reedy Complex	In event of unregulated flows, water may be required to support bird breeding	Successfully recruit wetland and floodplain vegetation and to provide suitable habitat for wetland and floodplain dependant fauna. Successful waterbird breeding events Suite of waterbirds present Contribute to population recovery of threatened waterbird species	Median Wet	21.8	11.8	10	July–Dec	Delivery through TLM regulators	None	$170,040	Medium	Low	High	Low	Low
Gunbower Creek	Water provided through TLM regulators	Increase in the abundance of native fish species and restore the presence of locally extinct fish species to Gunbower Island. Allow movement of native fish in and out of habitat types	Dry Median Wet	50–80 depending on inflows	30%	70%	July–Dec	Water provided through TLM regulators	None	$390,000–$624,000 depending on volume delivered	Medium	Low	High	Low	Low
Hattah Lakes															
Lake Kramen	Pump water to Lake Kramen	Restore mosaic of hydrological regimes Maintain and restore, where possible, ecological character of the Ramsar site Restore macrophyte zone around at least 50% of the lakes Maintain habitat for freckled duck, grey falcon and white-bellied sea-eagle	Dry Median Wet	3	3	Nil	Spring	Pumping	None	$135,000	Low	Medium	High	Low	Medium

Chowilla Floodplain and Lindsay–Wallpolla Islands															
Lake Wallawalla	Watering to improve populations of threatened flora and fauna that are flow dependent	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 river and floodplain habitats Increase abundance, diversity and extent of distribution of native fish	Dry Median Wet	8	8	Nil	July–Dec	Pumping as recent floods have damaged levees		$280,000	Low	Low	High	Low	Medium
Mulcra	Low level watering autumn to improve connectivity between river and floodplain	Provide a diversity of structural aquatic habitats Maintain and improve the populations of threatened flora and fauna that are flow-dependent Restore productivity linkages between river and floodplain habitats Increase abundance, diversity and extent of distribution of native fish	Median Wet	2	2	Nil		Delivery by raising Lock 8 and operating Mulcra regulators	None	$0	Low	Low	High	Low	Low
Chowilla wetlands: Lake Limbra, Gum Flat, Coombool Swamp, Punkah Depression, Andersons Creek, Kulkurna Black Box site, Monoman Creek depression	Pumping to high value floodplain wetlands	High value wetlands maintained. Current area of river red gum maintained At least 20% of original area of black box vegetation maintained	Dry Median Wet	11.1	11.1	0		Pumping		$200,000	Medium	Medium	High	Low	Low
Lower Lakes, Coorong and Murray Mouth															
Lower Lakes, Coorong and Murray Mouth	Gravity fed to Lake Alex along RMC and then to barrages and fishways to the estuary, Murray Mouth and Coorong	Enhanced migratory water bird habitat in the Lower Lakes and Coorong More frequent estuarine fish spawning and recruitment Maintain an open Murray Mouth	Median Wet	240–300	240–300	Nil	Sept–	Gravity fed	None	$0	Medium–high	Medium	High	Low	Low
River Murray Channel															
Great Darling Anabranch	Water delivered through regulators into Anabranch	Improve native fish stocks by providing a trigger for breeding upstream of the River Murray. Improve health of drought stressed vegetation communities, particularly river red gum. Provide habitat and food production for bird species and other fauna such as frogs	Dry Median Wet	Tp to 47	TBA	TBA		Water provided through regulators		$20,000	High	Low	High	Medium	Low
			Total	**655.9–922.9**	**367.3 – 580.4**	**185–390**			**Total**	**$1,195,040 – $1,429,040**					

Australian Government