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TLM Annual Environmental Watering Plan 2010–11

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1. INTRODUCTION

The Living Murray (TLM) was established in 2002 in response to evidence that the health of the Murray River system[1] is in decline. In November 2003 the Murray–Darling Basin Ministerial Council announced its historic Living Murray First Step Decision. As part of this decision an additional average of 485 GL per year has been recovered for the environment and a structural works program is currently underway to deliver this water efficiently. The Living Murray's First Step focuses on the achievement of agreed ecological objectives at six 'icon sites' along the River Murray with a combination of 'water and works'. The six icon sites are:

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

This document is the Annual Environmental Watering Plan 2010–11 which focuses on the water delivery aspects of TLM. It has been jointly developed by the Murray-Darling Basin Authority (MDBA) and Environmental Working Group (EWG). The plan outlines the decision framework for prioritizing the use of TLM water for environmental watering actions across the Murray River system between 1 July 2010 and 30 June 2011.

The annual water planning process is responsive to changing water resource conditions, opportunities and environmental priorities throughout the season. Implementation of the TLM Annual Environmental Watering Plan 2010–11, including any changes to priorities or other aspects of the Plan, is recorded separately and reported at the end of the year.

For information about TLM go to http://www.mdba.gov.au/programs/tlm

1 Murray River system includes: the main course of the Murray River 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.

2. ENVIRONMENTAL WATERING ACTIVITIES 2009–10

In 2009–10 68.545 GL was allocated for environmental watering actions throughout the year from a total available allocation of 155.66 GL. These environmental watering actions were targeted at critical locations within icon sites that would provide a material benefit to achieving TLM objectives. A summary of these actions and the allocated water volumes is provided in Table 1.

Table 1: TLM environmental watering activities 2009–10

Icon Site	Locations within icon site	Volume committed (GL) (of 155.666 GL available)	Period of watering	Benefit
Barmah-Millewa Forest	Douglas Swamp, Walthours Swamp, Reed Beds, & Gulf Creek	2.37	Oct'09 – Dec'09	Facilitate the maintenance and recovery of wetland vegetation, and contribute to the maintenance of bird breeding and foraging habitat.
Chowilla Lindsay-Wallpolla	Punkah Creek, Twin Creeks, Coppermine, Werta Wert, Lake Littra, Monoman Island Horseshoe, Kulkurna, Pilby Lagoon, Wallpolla Island, & Lindsay Island	10.39	Nov'09 – Jun'10	Contribute to preventing the decline in health of long lived vegetation, including mature River Red Gum, Black Box and other high priority vegetation; provide a drought refuge.
Gunbower-Koondrook-Perricoota	Reedy Lagoon (Gunbower Forest)	2.201	Nov'09	Maintain drought refuge, and contribute to the maintenance of bird breeding and foraging habitat.
Hattah Lakes	Chalka Creek, Lake Lockie, Little Lake Hattah, Lake Hattah, Lake Bulla, & Lake Arawak	5	Apr'10 – May'10	To halt or reverse the decline of fringing River Red Gums in Hattah Lake and surrounding wetlands and to extend the duration of drought refuge.
Lower Lakes, Coorong and Murray Mouth	Narrung, Boggy Creek, Turveys Drain, & Lake Albert	48.585	Nov'09 – Dec'09 & Feb'10 – June'10	Maintain drought refuge for threatened waterbirds and fish species; and prevent loss of aquatic vegetation. Assist the process of recovery in Lake Albert through the inundation of high risk sediments reducing the risk of broad scale acidification and reducing salinity.
	TOTAL	**68.546**		

To facilitate future environmental water delivery, 4.45 GL was also committed to repay encumbrances attached to some TLM entitlements. The remaining 82.67 GL will be carried over to spring 2010–11 to maximize the environmental benefits from use of this water.

Table 2 presents the reliability class of entitlements held by TLM in 2009–10 with their associated entitlement, allocation and net use volumes and the volume remaining at June 30 2010–11. A total of 967.425 GL of entitlements are currently held on TLM Environmental Water Register across a range of security classes. A volume of 0.068 GL of River Murray Increased flows (RMIF) was not used in 2009–10. The interim RMIF rules allow for this water to be carried over for use until October 2010.

Table 2: TLM Entitlements 2009–10

Entitlement Type	Entitlement (GL)	Allocation available to TLM**(GL)	Environmental watering use (GL)	Volume remaining at June 30 2010 (GL)
NSW High Security	1.597	1.564	1.561	0.003
NSW General Security	205.796	91.545	48.84	26.508*
NSW Supplementary	363	0	0	0
VIC High Reliability	57.071	38.451	13.45	25.001#
VIC Low reliability	298.177	0	0	11.747*#
SA Water Licence	41.784	24.038	4.695	19.343
RMIF carried over from 2008–09***		0.068	0	0.068
TOTAL	**967.425**	**155.666**	**68.546**	**82.67**

* 4.45GL was used to pay back encumbrances. 11.747 GL was transferred to Victorian low reliability entitlements to reduce the risk of forfeiture of allocation in 2010–11.

** some water allocated to entitlements in 2009–10 has been utilised by the previous owner.

*** MDBA managed environmental water entitlement (not specifically TLM). This water is permitted to be carried over to October 2010.

5% transmission loss fee for carryover of allocation against some Victorian water entitlements.

3. FORECAST 2010–11

3.1 Inflows

Inflows for the 2009–10 water year (June 2009 to May 2010) were the highest since 2005–06, however still well below the long term average (Figure 1).

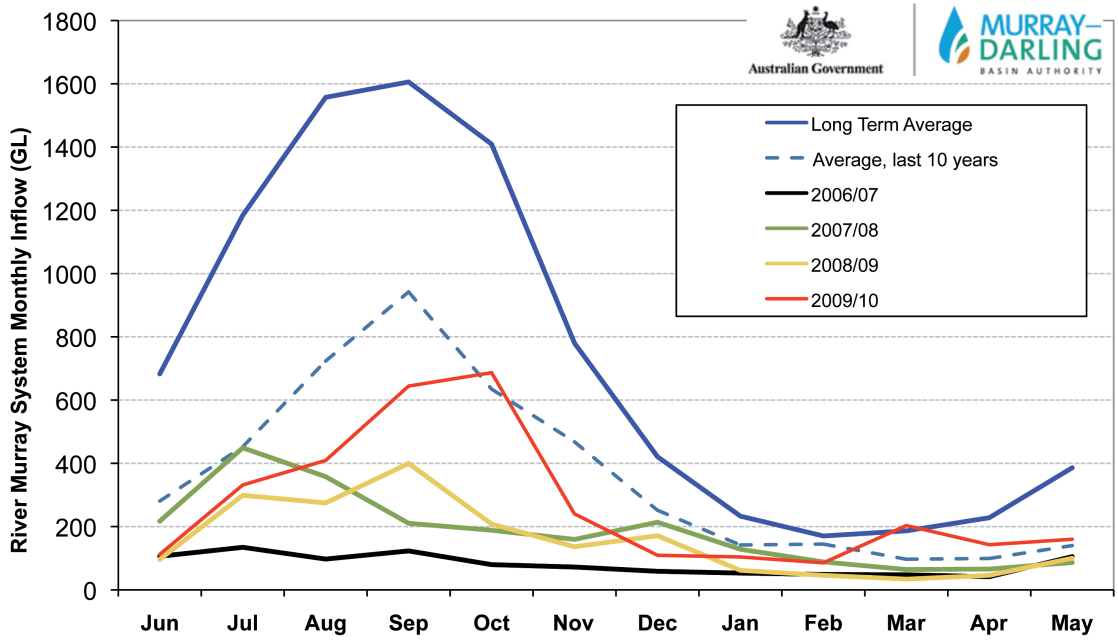

Figure 1: Comparison of inflows to River Murray system (excluding the Darling River and Snowy River) in selected years

3.2 Storage

Total MDBA active storage for the Murray system at the end of May 2010 was 2963 GL (34% of capacity) which is well below the end of May long term average of 4,670 GL (Figure 2). MDBA active storage was significantly increased in April 2010 when control of the Menindee Lakes system was transferred from NSW to MDBA control.

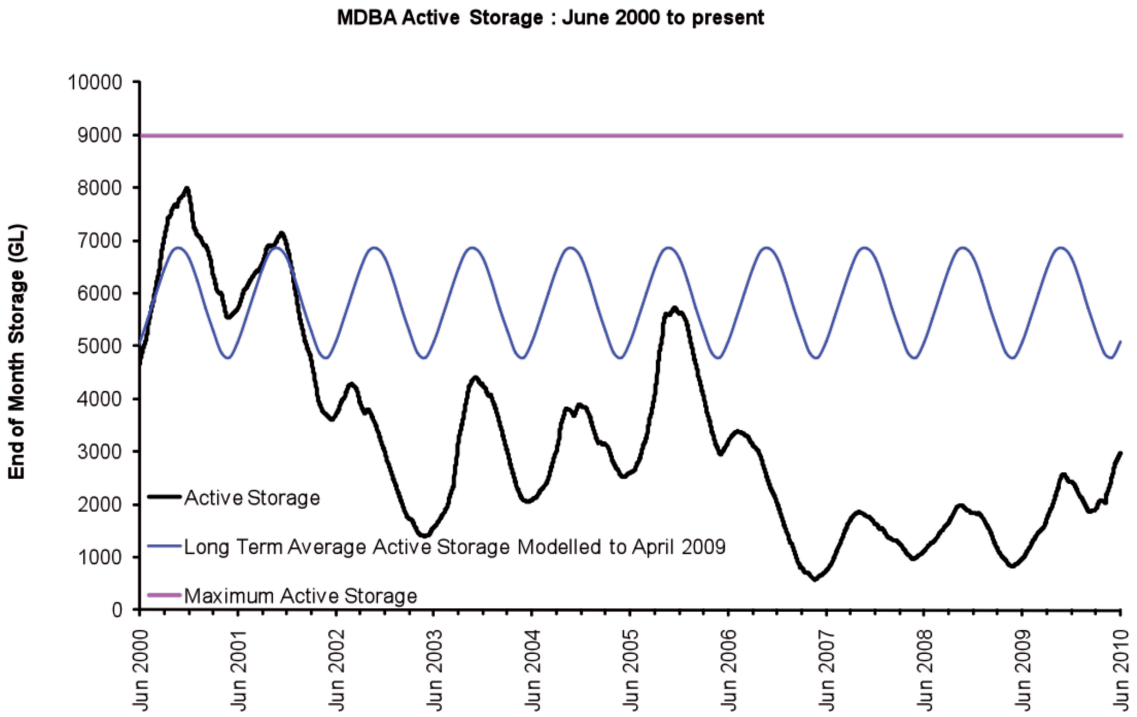

Figure 2: Comparison of active, long-term average and maximum storage levels in the River Murray system June 2000 to June 2009

3.3 Outlook

In early 2010, there were two flood events in the northern Basin and over 2,000 GL of water passed along the Darling River, much of which was stored in Menindee Lakes. As a result, Menindee Lakes will hold about 1,400 GL by the end of May 2010, having come under Authority control in mid-April 2010. This has provided a modest, but nonetheless very welcome, boost to the outlook for the River Murray System. With about 1,700 GL in Hume and Dartmouth storages, the opening season water availability will be the best since 2006.

There is sufficient water in the River Murray System in the 2010–11 water year to meet critical human water needs, basic evaporation and storage losses, basic distribution losses and private carry-over. However, without further improvements in inflows, opening allocations for irrigators are expected to be low or zero. Irrigation allocations in 2010–11 rely on the extent to which future inflows exceed the minimum levels used for planning.

The situation in the other large irrigation systems in the southern Basin is understood to be similar to or poorer than the Murray because they have not had the benefit of the Darling flows.

The prospects for floodplains in the River Murray System remain grim. Significant flooding, sufficient to first fill, and then spill depleted headwater storages, would be required to significantly improve environmental outcomes on these floodplains.

The levels in the Lower Lakes in South Australia have improved over the past year and are currently -0.45m AHD. However, it could take substantial unregulated flows to South Australia for the Lakes to fully recover.

In summary the drought for many irrigators and the riverine environment, particularly in the southern Basin, is not over. Recovery could still take multiple years of above average inflow.

3.4 Outlook for TLM water entitlements 2010–11

The majority of entitlements (97%) recovered by the TLM water recovery process have now been listed on the TLM Environmental Water Register. It is anticipated that a further 19 GL will be listed on the TLM Environmental Water Register in early 2010–11. Table 3 provides details of the estimated volumes and reliability classes of the entitlements to be listed in 2010–11.

Table 3. Entitlements expected June 2010–11

Reliability	Entitlement volume (GL)*
Low	0
General	4.94
High	14.88
TOTAL	**19.82**

* Approximate forecasts only. Note the volumes are not Long Term Cap Equivalents.

It is anticipated that flow conditions could be similar to 2009–10 based on current weather forecasts. Assuming similar allocation levels to 2009–10, an estimate of potential allocations to the TLM water portfolio in 2010–11 is given in Table 4. These estimates include 82 GL of carryover from 2009–10.

Table 4: Forecasted available TLM water 2010–11

Season	Forecasted allocation amounts (GL)	Carryover available (GL)	Cumulative Total (GL)
Spring 2010	20–45	81.12	100–125
Summer 2010–11	80–120	0	180–245
Autumn 2011	20–40	0	200–250

4. TLM WATER PLANNING 2010–11

4.1 Background

The TLM First Step decision in 2003 sought to achieve ecological objectives at six icon sites through a package of 'water and works'. These two core components of TLM provide some exciting challenges and opportunities that have been incorporated into the decision framework for water planning in 2010–11.

TLM water availability

The aim of the First Step decision was to recover an additional 500 GL average per year for the environment. To date 97% of this target has been achieved and is now available on the TLM portfolio. As the number of entitlements has gradually increased on the TLM portfolio, the volume of allocation has also risen. In 2009–10 EWG began to investigate opportunities to deliver larger volumes of environmental water in a manner that provided environmental benefits to multiple watering sites. Whilst this investigation highlighted a number of potential constraints including river operations and trade protocols, it was evident that multiple watering events could provide an efficient and effective use of environmental water.

By September 2010 it is anticipated that TLM will have a significant volume of water available due to the carryover of 82 GL from 2009–10. In order to use this water efficiently, EWG has recommended that TLM investigate the merits of trialing a multiple watering action at Barmah Millewa Forest and the Lower Lakes in spring 2010, including to ensure the feasibility of this proposal, assess its merits against the agreed criteria, assess the implications of River Murray operations and any approvals required from Basin Official's Committee..

TLM works

In 2010–11 the construction of infrastructure works designed to optimise the delivery of environmental water will be underway at most TLM icon sites. 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.

4.2 Ecological watering objectives

In order to respond to the potential variability in water resources, EWG utilises 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 model provide guidance on how TLM water would be utilised under different flow and climatic conditions.

The increased number of entitlements held by TLM has led to a potentially greater range of allocation volumes available in 2010–11 depending on climatic variability. Due to the varying ecological condition of icon sites and the potentially greater range of allocation volumes, it is anticipated that the icon sites may be across a continuum of the water resource scenarios during 2010–11.

The forecasts for water availability for 2010–11 may provide the opportunity for some icon sites to utilise the objectives for the dry or median water resource scenarios, depending on flows within the River Murray system. However the serious decline in ecological condition of sites such as the Lower Lakes and the subsequent lag in recovery may need to be addressed by the management objectives for the extreme dry water resource scenario.

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 incl. over-bank Use carryover to provide optimal seasonal flow patterns in subsequent years
Avoid catastrophic loss/maintain capacity for potential recovery	→ Improved capacity for recovery	→ Protect ecological health	→ Improved health and resilience	

4.3 Ranking criteria

The primary objective of the Annual Environmental Watering Plan 2010–11 is to provide environmental benefit (in terms of the stated objectives for each site). In order to prioritise between individual watering actions throughout the year, EWG has agreed to use the following ranking criterion outlined in Table 6, regardless of climatic conditions.

Table 6: Ranking criterion for prioritization 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 may include the previous history 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 including such as ASS, salinity spikes, black water events, algal blooms and the adequacy of mitigation measures.
	Cost effectiveness	An estimate of the overall costs of delivering the watering action (per ML) including delivery, pumping and associated infrastructural costs.

4.4 Framework for prioritization 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 2010–11 (Table 7). This decision framework provides the focus for the prioritization of environmental watering actions, an assessment of the associated risks 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 EWG have identified proposed watering actions that align with the decision framework (refer Schedule A, B, C & D). Schedules A, B, C and D provide a list of watering proposals for the extreme dry, dry, median and wet water resource scenarios, respectively. Watering proposals may be assessed across a range of schedules depending on the condition of icon sites and water availability at the review periods. As outlined in the framework, actions recommended for implementation throughout the year will not be limited to those identified in the schedules to this plan.

The watering proposals within the four schedules have been reviewed by EWG members to assess the watering opportunities over the next year, including multiple watering actions. Watering proposals have also been analysed to ensure that potential watering activities are compatible with the River Murray Operations Plan 2010–11.

The review periods during 2010–11 will assess the water availability against the environmental benefit to all proposed watering sites using the agreed ranking criteria. Real-time factors that may impact on the delivery of environmental water will also be considered during the review periods. These factors include the 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. EWG will then provide advice to the MDBA on whether any environmental watering actions should be implemented at that stage.

During the 2010–11 water year, EWG will review the schedules of environmental watering proposals at designated periods utilizing the process outlined in Figure 3. Based on the outcomes of the review, EWG will provide advice to the MDBA on whether any environmental watering actions should be implemented at that stage.

All watering actions will be implemented in accordance with the decision framework and prioritisation process outlined in the Annual TLM Environmental Watering Plan 2010–11. The approval of any watering actions recommended by EWG within icon sites is delegated to the Executive Director of Natural Resource Management, Murray-Darling Basin Authority.

Table 7: TLM Environmental Watering Decision Framework

Exceptions	Timing	Decision steps	Associated risks
Any exceptions that rise throughout the water year will be reviewed by EWG as required using the process outlined in the decision framework	June – September/ October 2010	Review of all watering actions against the agreed criteria*, including critical refuge sites and a multiple watering proposal at Barmah Millewa Forest and the Lower Lakes. This multiple watering proposal will be subject to an assessment of the implications of River Murray operations, any approvals required from Basin Official's Committee and a thorough assessment of the environmental benefits of this multiple watering proposal. Real-time factors to be considered at review periods include local site conditions / status of TLM works/ multiple site watering actions / other potential sources of environmental water / antecedent flows/forecasted flows.**	• Use of all available water could limit larger watering actions in the future
	October-November 2010	Review of TLM water availability against the environmental benefit to all proposed watering sites using the ranking criteria. Based on the review, EWG will either recommend: EITHER allocate all available TLM water to sites that may include, but not be limited to, those identified in the Schedules. OR bank any water allocation to enable a wider scope of watering actions to be considered in February OR a combination of banking and use of TLM water.	• Banking could limit the water available for water refugia and sites supporting threatened species and communities • Use of all available water could limit larger watering actions in autumn
	November-February 2011	Bank any water allocation to enable a wider scope of watering actions to be considered. Banking would not be considered if other proposed watering sites could be irretrievably lost during this period.	• Banking could limit the water available for water refugia sites
	February-June 2011	Review of TLM water availability against the environmental benefit to all proposed watering sites using the ranking criteria to recommend: Based on the review, EWG will either recommend: EITHER allocate water to proposed sites OR continue to bank water to enable wider scope of watering actions to be considered in following months OR carryover water to spring to maximize ecological outcomes	• Banking could limit the water available for water refugia and sites supporting threatened species and communities • Use of all water would limit larger watering actions in spring 2011 • Risk associated with carryover

* Watering actions will be prioritized within this framework using the ranking criteria outlined in this Plan

** The availability of other sources of environmental water will be considered for any proposed watering actions

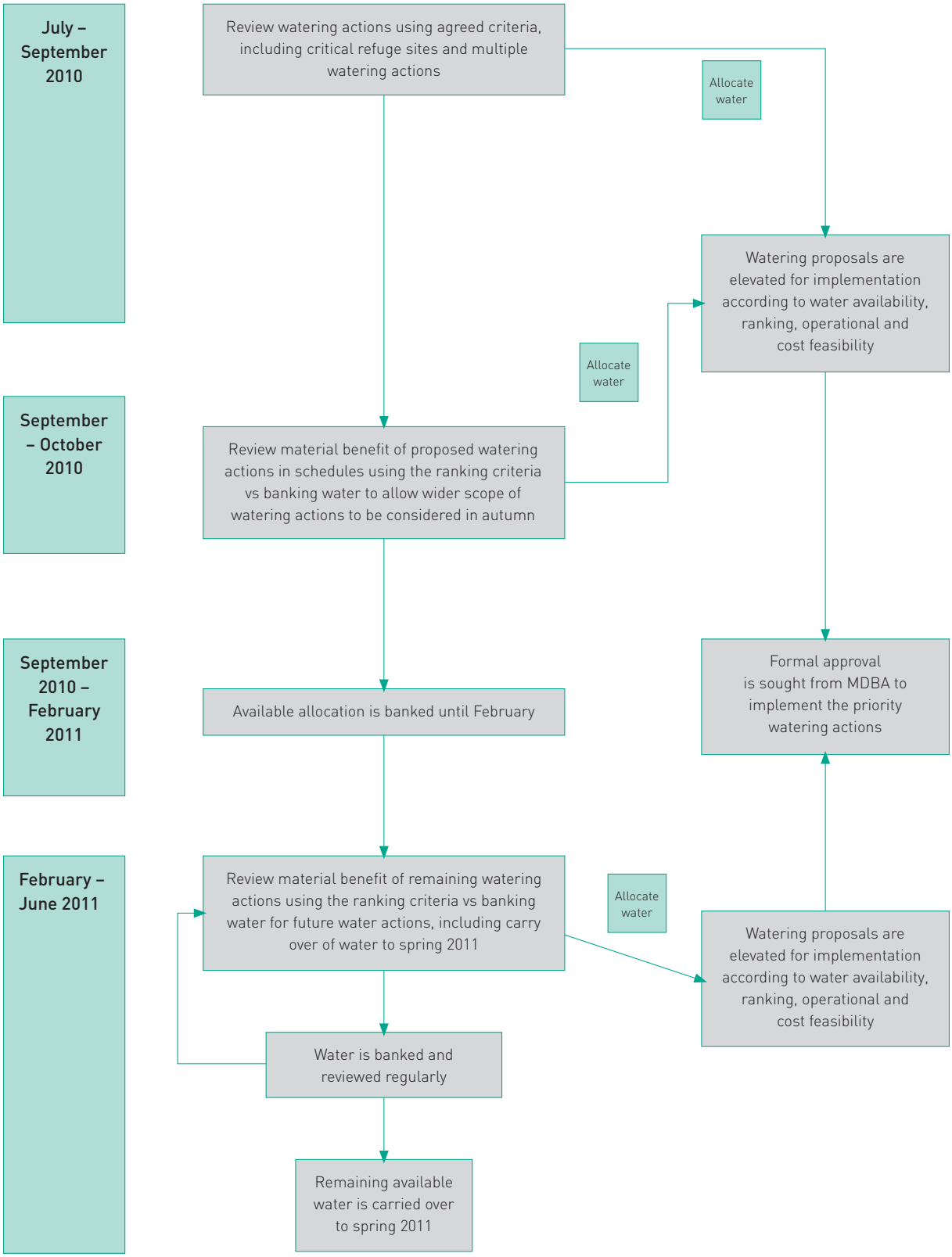

Figure 3: Flow chart of prioritization process for regulated flows

4.5 Framework for prioritization of River Murray Unregulated Flows

In 2008–09 EWG agreed to trial the prioritisation of environmental watering actions during a River Murray Unregulated Flows (RMUF) event. Although a simulation exercise was held in April – May 2009, there has been no opportunity to test this prioritisation process during a real-time RMUF event. Therefore it is proposed that this trial will continue during 2010–11.

As each RMUF event varies in location, duration and operational opportunities, it is not possible to prioritise watering proposals prior to a RMUF event. To be event ready EWG has prepared watering proposals for a range of water resource scenarios in 2010–11 (refer Schedules A-D, respectively). These actions will need to be reviewed/updated 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, initiatives and rights
- maximize/optimize environmental outcomes including integration with planned environmental water releases
- be based upon opportunity and relative environmental priority following ranking criteria agreed by the EWG; and
- 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 4 outlines the process for prioritising watering actions during a RMUF event. This process was refined during the RMUF simulation exercise in April – May 2009. 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 EWG agreed principles.

The environmental water volumes delivered during a RMUF event will be collated by the EWG 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.

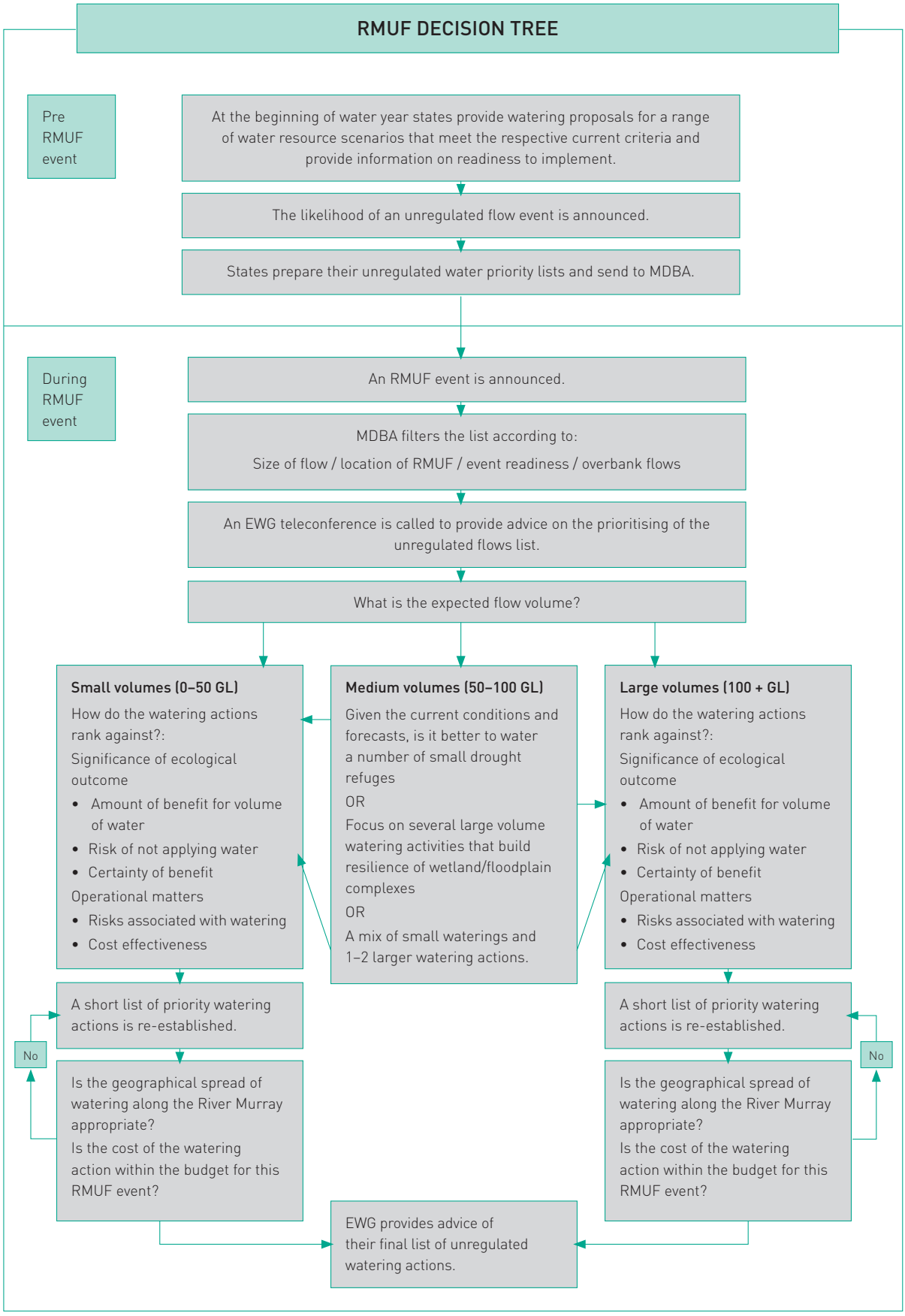

Figure 4: Prioritisation process for unregulated flows

5. ENVIRONMENTAL MONITORING FOR TLM

Monitoring and evaluating the achievement of the ecological objectives is part of the TLM Business Plan. A monitoring framework titled the Outcomes Evaluation Framework (OEF) 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 OEF are River Murray system-scale monitoring, condition monitoring, intervention monitoring, compliance monitoring and knowledge generation. More detail on these monitoring types is provided below.

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, Native Fish Strategy and Natural Resources Information, to provide a coordinated approach to monitoring across the Murray-Darling Basin.

5.1 River Murray System-scale monitoring

Monitoring at the River Murray system-scale to determine if the health of the Murray River system improves following implementation of the First Step decision and its focus on the six Icon sites. The questions addressed by monitoring at this scale differ from those of the Sustainable Rivers Audit (SRA), which provides a condition assessment for the Murray-Darling Basin (i.e. the scale is different and hence the design is not tailored to address questions at the Murray River system scale). However, some data collected through SRA will be applicable to the Murray River system and where possible, monitoring at this scale will utilise data collected for the SRA. Currently the approach for fish, birds and vegetation are:

- A coordinated fish monitoring approach is being implemented to monitor fish response to TLM.
- The Annual Aerial Waterbird Survey has been implemented in October – November, linked to the Eastern Australia Aerial Waterbird Survey, so that geographical context is incorporated.
- A Red Gum and Black Box Stand Condition assessment is being implemented using remote sensing approaches to allow reporting annually on stand condition.

5.2 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 2010–11 include ongoing monitoring as 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 2010–11 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.

5.3 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 2010–11, intervention monitoring will be focused around three broad areas.

- Monitoring the impacts of fishways and resnagging on fish populations throughout the Murray River.
- Monitoring the direct impacts of watering events at icon sites in relation to the event watering objectives.
- 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 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.

6. REPORTING ON TLM ENVIRONMENTAL WATERING

As noted in the previous section, environmental water accounting provides information on the volume of water released, delivered and used at each icon site, volume of water returned to the Murray River and the environmental water account figures. The Living Murray Business Plan requires these aspects to be reported on annually, consistent with The Living Murray Environmental Watering Plan.

Environmental water is accounted and reported for at an icon site and River Murray system scale throughout and at the end of the watering season. This information will be incorporated into the development of the National Standards for Water Accounting (Intergovernmental Agreement on a National Water Initiative 2004), the TLM Annual Implementation Report, TLM Annual Environmental Report and Murray-Darling Basin Authority Annual Report.

Schedule A: Extreme Dry (Possible TLM water available including carryover: 140 – 170 GL)

Watering Site	Reach- section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Amount of benefit for volume of water (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Barmah-Millewa – Extreme Dry															
Duck Lagoon	5	Open Warrick regulator and allow flow in Warrick Creek to rehabilitate wetland vegetation and RRG forest	Enable recovery of wetlands vegetation following wildfire. Avoid critical loss or alteration of vegetation communities Maintenance of bird breeding and foraging habitat	2.0	2.0	Nil	August – December (this is an estimate as the capacity of the regulator is unknown at this stage)	Through Warrick regulator Warrick Creek	Prevent backflow out of system	$3,000	High	Medium	High	Medium	High
Clay Island	5	Use pumps to rehabilitate wetland vegetation and RRG forest	Avoid critical loss or alteration of vegetation communities Provide drought refuge Prevent critical loss of species	0.20	0.20	Nil	September – October	Pump or siphon direct from Edward River	Pump/siphon required	$8,000 (200ML @$40/ML)	High	Medium	High	Medium	High
Millewa – Toupna Creek	3	Open regulator to allow flows through Toupna Creek	Reinvigorating wetland vegetation Help maintain healthy vegetation Support a significant population of a threatened fish species – the Southern Pygmy Perch.	3.3	3.3	Nil	September – October Wet Creek & maintain low flow Sept til end January (10days 50ML then 140days 20ML)	Via Mary Ada regulator (>4700 ML/d @Toc.)	Installation of regulator or earth bank required at boundary to private property	$3,000	High	High	High	Low	High

Watering Site	Reach- section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Amount of benefit for volume of water (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Barmah (various sites) – Top Island Boals Deadwoods Gooses Swamp Gulf Creek Smiths Creek	3	Open regulators to water small terminal wetland systems.	Provide drought refuge for water birds and other wetland dependent species, such as fish and turtles	4.05	4.05	Nil	September – November	Top Island - regulator Boals Deadwoods – regulator Gooses Swamp – regulator or pumping if Broken Creek flows are low Gulf Creek – regulator Smiths Creek – regulator	Nil	$25,000	High	Medium	High	Low	High
Wetlands, creeks and floodplain within the BMF	3	Consideration should be given to delivering all flows provided downstream of Barmah-Millewa via this icon site. the volume not used within the forest (= total – losses) will return to the River for reuse downstream.	Provide drought refuge for water birds and other wetland dependent species, such as fish and turtles	TBA		70 to 95%	August – December	Direct from the River Murray, via regulator or overbank flows	Over Bank	TBC $5,000 to $50,000 (for flow gauging to measure return flows)	High	Medium	High	Low	High

Watering Site	Reach- section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Amount of benefit for volume of water (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Gunbower-Koondrook-Perricoota Forest – Extreme Dry															
Horseshoe lagoon (17 ha)	7	Pump to stressed wetland	Provide drought refuge within stressed forest Regeneration of vegetation and endemic wetland species Prevent irreversible loss of species Provide suitable habitat (feeding and nesting) for waterbirds	0.25	0.25	nil	August – October	Pumping required	Block bank	$13,000	High	High	High	Low	High
Swan Lagoon (37 ha)	7	Pumping to improve RRG fringing vegetation	Provide drought refuge within stressed forest Regeneration of vegetation and endemic wetland species Prevent irreversible loss of species Improve fringing red gum vegetation	0.5	0.5	nil	August – October	Pumping required	Block bank	$21,500	High	High	High	Low	High
Blackbox Lagoon (17 ha)	7	Pumping to improve RRG fringing vegetation	Provide drought refuge within stressed forest Regeneration of vegetation and endemic wetland species Prevent irreversible loss of species Improve fringing red gum vegetation	0.25	0.25	nil	August – October	Pumping required	Block bank	$11,500	High	High	High	Low	High

Watering Site	Reach- section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Amount of benefit for volume of water (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
390 mile lagoon (6 ha)	7	Pumping to improve RRG fringing vegetation	Provide drought refuge within stressed forest Regeneration of vegetation and endemic wetland species Prevent irreversible loss of species Improve fringing red gum vegetation	0.1	0.1	nil	August – October	Pumping required	Block bank	$5,500	High	High	High	Low	High
Black Charlie Lagoon (Gunbower)	4	Provide flows to wetland that's been dry for 5 years	Provide drought refuge for birds and fish in the upstream region of Gunbower Forest that would historically hold water 9 years out of 10 Avoid irreversible loss	1	1	Nil	September – October (Ideally during September – October 2010) no later than end October 2010.	Gravity fed from Torrumbarry weir pool, via Cameron's Creek and irrigation channel.	No complementary works are required.	$0 ($70,000 if temporary pumping is required to deliver 1GL)	High	High	High	Low	High

Watering Site	Reach- section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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: Amount of benefit for volume of water (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Gunbower Creek	4	This action will directly inform the detailed design for the Hipwell Road Channel Package of Works.	Calibrate the Gunbower Creek hydraulic model to inform the level requirements for the Hipwell Road Package of Works Calculate losses associated with delivering environmental water through Gunbower Creek Measure return flows to the River Murray Provide a spawning cue to native fish within Gunbower Creek.	17	5	12	July onwards	River gravity and Gunbower Creek		TBC					
Chowilla Floodplain, Lindsay and Wallpolla Islands															
Wallpolla Island	14	Water wetland to maintain breeding sites for waterbird species and habitat for other species.	Avoid irreversible loss/catastrophic event Provide drought refuge	3.2 (0.7GL in Spring + 2.5GL in Autumn)	3.2	Nil	September – October and March – June	Temporary Pumping	Nil	$160,000	High	High	High	Low	High

Watering Site	Reach- section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Amount of benefit for volume of water (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Mulcra Island	14	Raise Lock 8 to generate flows through Potterwalkagee Creek using pumps	Increase the diversity of structural aquatic habitat Increase the diversity and distribution of native fish Provide occasional breeding and roosting habitat for waterbirds Provide habitat suitable for migratory waterbird species. provide drought refuge to various habitats	3	2.5	0.5	March – June	Temporary pumping Raising Lock 8 to generate flows through Potter-walkagee Creek;	Nil	$150,000 (3000ML @$50/ML)	High	High	High	Low	High
Mulcra Island	14	Raising Lock 8 to generate flows through Potterwalkage Creek; using newly completed TLM infrastructure to deliver water to the floodplain.	Increase the diversity of structural aquatic habitat; Increase the diversity and distribution of native fish; Provide occasional breeding and roosting habitat for waterbirds; Provide habitat suitable for migratory waterbird species.	20	5	15	March – June			$0	High	High	High	Low	High

Watering Site	Reach- section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Amount of benefit for volume of water (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Lindsay Island	12	Pump water to wetlands to provide drought refuge and prevent critical loss of RRG.	Avoid irreversible loss/catastrophic event Provide drought refuge	2	2	Nil	March – June and September – October	Temporary pumping	Nil	$90,000 (2000ML @$45/ML)	High	High	High	Low	High
Coombool Swamp and Lake Limbra	15	Pumping to water to maintain Black box and lignum.	Prevent critical loss of species Provide drought refuge	9.15	9.15	Nil	March – June	Pumping		$352,500	High	High	High	Medium	High
Woolshed Creek and Chowilla Island Loop	15	Pump water to wetlands to improve RRG and Black box condition	Prevent critical loss of species Provide drought refuge	0.37	0.37	Nil	March – June	Pumping		$0	High	High	High	Medium	High
Chowilla Horseshoe, Lock 6 Depression, Monoman Depression, Punkah Island Depression	15	Pump water to wetlands to improve River red gum and Black box condition.	Prevent critical loss of species Provide drought refuge	1.27	1.27	Nil	September – November	Pumping		$0	High	High	High	Medium	High
Punkah Creek	15	Pumping to raise water levels in the anabranch to maintain water fringing vegetation.	Prevent critical loss of species Avoid irreversible loss/catastrophic event; Provide drought refuge	0.15	0.15	Nil	December	Aqua dam or Pumping		$39,000	High	High	High	Medium	Low

Watering Site	Reach- section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Amount of benefit for volume of water (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Lower Lakes, Coorong and Murray Mouth															
Goolwa Barrage,	15	Pumping water from Lake Alexandrina into Goolwa weir pool and then released through Goolwa Barrage vertical slot fishway to allow recruitment and preservation Congolli species	Prevent critical loss of species Avoid irreversible loss/catastrophic event or Provide drought refuge	5.5	5.5	Nil	November – December	Pumping	Nil	$277,500	High	High	High	Low	High
Alexandrina & Lake Albert	15	Water to be gravity fed to Lake Alexandrina to maintain water levels. Decision regarding water sharing between Lake Alexandrina & Lake Albert subject to ongoing discussions re best ecological outcomes that can be achieved with available water	Maintain water levels objective: Maintain salinity levels within Lake Albert to within threshold tolerances of key species of fish. Ensure the high risk acid sulfate soils areas remain saturated Creating a 'pulse' of water down the River Murray channel which will provide ecological benefits to RMC icon site	170	170	Nil	TBA – subject to further modelling advice.	Water will be gravity fed to Lake Alexandrina	Nil	$0	High	High	High	Low	High

Watering Site	Reach- section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Amount of benefit for volume of water (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Boggy Creek, Turvey's Drain and Dog Lake Channel	15	Pumping water from Lake Alexandrina, Goowla Weir Pool and current irrigation infrastructure to Boggy Creek, Turvey's Drain and Dog Lake Channel	To maintain a recruiting population of the nationally vulnerable Murray hardyhead at all sites and maintain recruiting population of Southern pygmy perch at Turvey's Drain. To maintain water quality within known thresholds for Murray hardyheads at the site. To maintain habitat (fringing and aquatic) at the sites)	0.084	0.084	Nil	Watering should be on-going throughout the year, starting in July 2010	Pumping	Mil	$58,950	High	High	High	Low	High
River Murray Channel															
Hume to Yarrawonga	1	Increase flows in channel to water adjacent wetlands to protect and enhance riparian ecosystems	Maintain ecological functions in adjoining anabranches and wetlands that received water in 2009/10.	Up to 3	Up to 3	0	Opportunistic watering action – most likely late spring/early summer	Gravity fed. Requires flow >or=12,000 ML/day in channel	Nil	$0	Medium	Low	Medium	Low	High
			TOTAL	246	219	27			TOTAL	$1,223,450 - 1,338,450					

Schedule B: Dry (Possible TLM water available including carryover: 200 – 250 GL)

Watering Site	Reach-river section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Barmah-Millewa - Dry															
Duck Lagoon	5	Pump to rehabilitate wetland vegetation and RRG forest	Facilitate maintenance and recovery of wetland vegetation Contribute to maintenance of bird breeding and foraging habitat	2.0	2.0	Nil	August – December (this is an estimate as the capacity of the regulator is unknown at this stage)	Warrick regulator via Warrick Creek		$3,000	High	Medium	High	Medium	High
Clay Island	3	Pump or siphon to rehabilitate wetland vegetation and RRG forest	Avoid critical loss or alteration of vegetation communities. Facilitate maintenance and recovery of wetland vegetation Contribute to maintenance of bird breeding and foraging habitat	0.2	0.2	Nil	September – October	Pump or siphon direct from Edward River	Pump/siphon required	$8,000 (200ML @$40/ ML	High	Medium	High	Medium	High
Toupna Creek	3	Wet Creek & maintain low flow Sept till end January	Support connectivity through the forest and maintain river function Water stressed RRG Improve health of wetlands ensuring maintenance of key functions eg nutrient cycling Provide drought refuge and restoration of vegetation.	4.6 (10days 50ML then 140days 20ML)	1.7	2.9	September – November and March to June	Via Mary Ada regulator (>4700 ML/d @Toc.)	Installation of regulator or earth bank required at boundary to private property	Earth bank $3,000	High	High	High	Low	High

Watering Site	Reach-river section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Douglas Swamp	3	Re-watering, to enhance health of vegetation and maintain nesting habitat	Facilitate recovery of wetland vegetation and waterbird nesting habitat. Site of importance for waterbird breeding and feeding habitat.	0.75	0.75	Nil	September – October	Via Nestrons regulator (>10,000 ML/d @Toc.)	Desilt inlet	Desilt = $1,500	High	Medium	High	Medium	High
Walthours/ Deadwood Swamps	3	Re-watering, to enhance health of vegetation and maintain nesting habitat	Facilitate recovery of wetland vegetation and waterbird nesting habitat. Site of importance for waterbird breeding.	0.30	0.30	Nil	September – October	Via Walt-hours regulator (>10,000ml/d @ Toc.) Or pumping to deliver water	Desilt inlet	Desilt = $1,500	High	Medium	High	Medium	High
St Helena		Re-watering, to enhance health of vegetation and maintain nesting habitat	Facilitate recovery of wetland vegetation and waterbird nesting habitat. Site of importance for waterbird breeding.	0.40	0.40	Nil	October – November	Via Crumps Regulator		$0	High	Medium	High	Medium	High
Barmah – Top Island Boals Deadwoods Goose Swamp Gulf Creek	3	Maintain several wetlands and creeks.	Provide drought refuge for waterbirds and water stressed vegetation including trees and wetland plants.	15.05	15.05	Nil	September – November	River gravity /Island and Sapping creek regulator		$45,000	High	Medium	High	Low	High

Watering Site	Reach-river section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Wetlands, creeks and floodplain within the BMF	3	Consideration should be given to delivering all flows provided downstream of Barmah-Millewa via this icon site. the volume not used within the forest (= total – losses) will return to the River for reuse downstream.	To provide drought refuge in drought conditions and enable growth, reproduction and recruitment at various scales depending on the volumes available, seasonal conditions and River operations.	TBA		70 to 95%	August – December	Direct from the River Murray, via regulator or overbank flows.	Overbank flows	$5,000 to $50,000 (for flow gauging to measure return flows) TBC	High	Medium	High	Medium	High
Gunbower-Koondrook-Perricoota Forest – Dry															
Horseshoe lagoon (17 ha)	7	Pump to lagoon to improve RRG fringing vegetation	Support connectivity through the forest and maintain river function Water stressed RRG Improve health of wetlands ensuring maintenance of key functions eg nutrient cycling Provide drought refuge and restoration of vegetation	0.25	0.25	nil	Spring	Pumping required	Block bank	$13,000	High	High	High	Medium	High

Watering Site	Reach-river section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Blackbox Lagoon (17 ha)	7	Pump to lagoon to improve RRG fringing vegetation	Regeneration of vegetation and endemic wetland species that largely been absent through the drought Improve health of wetlands ensuring maintenance of key functions eg nutrient cycling Improve health of fringing RRG vegetation	0.25	0.25	nil	Spring	Pumping required	Block bank	$11,500	High	High	High	Medium	High
390 mile lagoon (6 ha)	7	Pump to lagoon to improve RRG fringing vegetation	Regeneration of vegetation and endemic wetland species that largely been absent through the drought Improve health of wetlands ensuring maintenance of key functions eg nutrient cycling Improve health of fringing RRG vegetation	0.1	0.1	nil	Spring	Pumping required	Block bank	$5,500	High	High	High	Medium	High

Watering Site	Reach-river section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Thule Creek	7	Inundate low-lying forest areas – improve vegetation health	Avoid irretrievable loss of key environmental assets – work towards achieving 30% of River Red gum Forest in a healthy condition and improve health of 80% semi-permanent wetlands through improving connectivity	10	10	nil	Spring	Pumping required	Block bank	$401,500	High	High	High	Medium	High
Unnamed Creek (near Clarkes Lagoon Rd junction)	7	Inundate low-lying forest areas – improve vegetation health	Support connectivity through the forest and maintain river function Water stressed RRG Improve health of wetlands ensuring maintenance of key functions eg nutrient cycling Provide drought refuge and restoration of vegetation	10	10	nil	Spring	Pumping required	Block bank	$401,500	High	High	High	Medium	High
Little Reedy Complex	4	Gravity fed from Gunbower creek via Yarran Creek regulator	A large area of permanent wetland would be flooded, providing feeding and breeding habitat for a range of waterbirds, fish, frogs and turtles.	5	5	Nil	Spring	Channel system	Yarran Creek regulator (uses Torrumbarry Irrigation System)	$0 (possibility of small cost being determined with G-MW)	High	Medium	High	Low	High

Watering Site	Reach-river section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Black Charlie Lagoon (Gunbower)	4	Water to replenish wetland dry for past 5 years	Provide drought refuge for birds and fish in upstream region of Gunbower Forest	2	2	Nil	September – October (ideally during September and October 2010); no later than end October 2010	River gravity, Torrumbarry weir and Cameron Creek/ channel		$0 ($140,000 to deliver 2GL if conditions change & temporary pumping required)	High	High	High	Low	High
Gunbower Creek	4	This action will directly inform the detailed design for the Hipwell Road Channel Package of Works.	The objectives are: Calibrate the Gunbower Creek hydraulic model to inform the level requirements for the Hipwell Road Package of Works Calculate losses associated with delivering environmental water through Gunbower Creek Measure return flows to the River Murray Provide a spawning cue to native fish within Gunbower Creek.	17	5	12	July onwards	River gravity and Gunbower Creek		TBC					

Watering Site	Reach-river section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Chowilla Floodplain, Lindsay and Wallpolla Islands															
Lake Wallawalla		Temporary pumping to wetland to established vegetation within the lakebed and maintain wetland habitat for waterbirds, frogs and turtles.	Increase the diversity of structural aquatic habitat Increase the diversity and distribution of native fish Provide occasional breeding and roosting habitat for waterbirds Provide habitat suitable for migratory waterbird species.	10 (5GL in Spring + 5GL in Autumn)	10	Nil		Temporary Pumps		$330,000 (10,000 @$33/ ML)	High	High	High	Low	High
Lindsay Island	12	Temporary pumping to wetland aquatic habitat and waterbirds.	Increase the diversity of structural aquatic habitat Increase the diversity and distribution of native fish Provide occasional breeding and roosting habitat for waterbirds Provide habitat suitable for migratory waterbird species.	2.8 (1.1GL in spring + 1.7GL in autumn)	2.8	Nil	September – October and March - May	Temporary pumping		$126,000 (2800 ML @ $45/ML)	High	High	High	Low	High

Watering Site	Reach-river section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Mulcra Island	14	Raising Lock 8 to generate flows through Potterwalkage Creek; using newly completed TLM infrastructure to deliver water to the floodplain.	Increase the diversity of structural aquatic habitat; Increase the diversity and distribution of native fish; Provide occasional breeding and roosting habitat for waterbirds; Provide habitat suitable for migratory waterbird species.	20	5	15	March – June			$0	High	High	High	Low	High
Anderson Creek	15	Pumping to water Black box, River red gums, lignum and bird species	Prevent critical loss of species Provide drought refuge	0.265	0.265	Nil	March – May	Pumping		$27,950	High	High	High	Medium	Medium
Twin Creeks, Monoman Creek Depression and Gum Flat	15	Pumping to water to maintain River red gums, Black box and lignum.	Prevent critical loss of species Provide drought refuge Provide breeding opportunities and refuge for waterbirds and frogs Maintain benefits from watering program to date	1.665	1.665	Nil	September – November	Pumping		$0	High	High	High	Medium	High

Watering Site	Reach-river section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Chowilla Oxbow (Anderson Creek)	15	Pumping to water to terminal wetland sites to maintain River red gum and Black box vegetation.	Prevent critical loss of species Provide drought refuge Maintain benefits from watering program to date	0.21	0.21	Nil	December – February	Pumping		$0	High	High	High	Medium	High
Lower Lakes, Coorong and Murray Mouth															
Fringing Wetlands of Lake Alexandrina	15	Pumping to enable wetlands to function and provide critical ecological services in the interim until Lake levels increase.	Prevent critical loss of species Avoid irreversible loss/ catastrophic event; or Provide drought refuge	1.8	1.8	Nil	September – November	Pumping		$160,000	High	Medium	High	Low	Medium
Lake Alexandrina, Lake Albert	15	Water to be gravity fed to Lake Alexandrina. Decisions re water sharing with lake Albert subject to ongoing discussion s regarding the best ecological outcomes to be achieved with available water.	Maintain salinity levels within threshold tolerance of key note species. Avoid acidification of water body by maximising volume and supporting the natural bacterial cycle to neutralise existing acidity. Provide drought refuge for wading birds Provide environmental pulse along River Murray Channel and stimulate fish breeding	250	250	Nil	TBA	Pumping		$0	High	High	High	Low	High

Watering Site	Reach-river section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
River Murray Channel															
Hume to Yarrawonga	1	Increase flows in channel to water adjacent wetlands to protect and enhance riparian ecosystems	Maintain ecological functions in adjoining anabranches and wetlands that received water in 2009/10.	Up to 3	Up to 3	0	Opportunistic watering action – most likely late spring/early summer	Gravity fed. Requires flow >or=12,000 ML/day in channel	Nil	$0	Medium	Low	Medium	Low	High
			TOTAL	357	327	30			TOTAL	$1,543,950-1,588,950					

Schedule C: Median (Possible TLM water available including carryover: 310 – 380 GL)

Watering Site	Reach-section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Barmah-Millewa - Median															
Duck Lagoon	5	Open regulator to provide flow in Warrick Creek to rehabilitate wetland vegetation and RRG forest.	Provide for reproduction and recruitment of wetland species and River Redgums recovering from wildfire. Provide connectivity with other wetland areas within Moira, in particular Reed Beds that was watered twice in the last two years. Re-establish wet-dry phase to wetland	2	2	Nil	Spring/ Summer	Via Warrick Creek & Warrick regulator	Possible block banks required	TBC (approx $3,000 if block banks required)	High	Medium	High	Medium	High
Clay Island	5	Use pumps to rehabilitate wetland vegetation and RRG forest	Improve connectivity and connection with the river and between wetlands within site. Promote growth and recovery of River Redgums and wetland vegetation. Re-establish wet-dry phase to improve ecosystem function.	0.3	0.3	Nil	Spring	Pump or siphon direct from Edward River	Pump/siphon required	$12,000 (300ML @$40/ ML), less if siphoned	High	Medium	High	Medium	High

Watering Site	Reach-section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Millewa - Toupna Creek (Preferably water in conjunction with Douglas & Walthours swamps)	3	Open Mary Ada regulator to allow flows through Toupna Creek and reinvigorate wetland vegetation	Provide connectivity through low-lying areas of forest promoting growth and reproduction of River Redgums. Re-establish wet-dry phase to semi-permanent wetlands. Regeneration of wetland flora improving species diversity and abundance providing nesting and feeding habitat for waterbirds during future flood events. Broad scale watering may stimulate low scale colonial bird breeding event.	5.1	1.85	3.25	September – June	Via Mary Ada regulator	Block Bank	$3,000	High	High	High	Low	High
Douglas Swamp	3	Re-watering to enhance vegetation health and maintain nesting habitat	Build on improvements gained from prior watering (2009) and continue to restore vegetation health, reproductive capacity and key wetland processes. Provide connectivity through low-lying areas of forest promoting growth and reproduction of River Redgums. Re-establish wet-dry phase to improve ecosystem function.	0.75	0.75	Nil	Spring	Via Nestrons regulator (>10,000 ML/d @Toc.)	Desilt inlet	$1,500	High	Medium	High	Medium	High

Watering Site	Reach-section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Walthours/ Deadwood Swamps	3	Re-watering to enhance vegetation health and maintain nesting habitat	Build on improvements gained from prior watering (2009) and continue to restore vegetation health, reproductive capacity and key wetland processes. Provide connectivity through low-lying areas of forest promoting growth and reproduction of River Redgums. Re-establish wet-dry phase to improve ecosystem function.	0.4	0.4	Nil	Spring	Via Walthours regulator (>10,000 Ml/d @ Toc.)	Desilt inlet	$1,500	High	Medium	High	Medium	High
St Helena Swamp	3	Re-watering to enhance vegetation health and maintain nesting habitat	Build on improvements gained from prior watering (2009) and continue to restore vegetation health, reproductive capacity and key wetland processes. Provide connectivity through low-lying areas of forest. Watering action will enable wetland plants to mature and seed.	0.5	0.5	Nil	Spring	Via Crumps regulator	Nil	$0	High	Medium	High	Medium	High

Watering Site	Reach-section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Barmah (Top Island, Boals Deadwoods, Gooses Swamp, Gulf Creek, Smiths Creek)	3	Provide flows to maintain several wetlands and creeks	Provide drought refuge for waterbirds and other wetland dependent species, such as turtles. It would maintain key functions of several wetlands and creeks with icon site.	70	20	50	Spring	Gravity fed via overbank flows	Nil	$50,000 (modelling/ gauging costs)	High	Medium	High	Low	High
Wetlands, creeks and floodplain within the BMF	3	Provide flows to maintain wetlands creeks and possibly floodplain ecosystems	Provide drought refuge for water birds and other wetland dependent species, such as fish and turtles	TBA		70 to 95%	August – December	Direct from the River Murray, via regulator or overbank flows	Over Bank	TBC $5,000 to $50,000 (for flow gauging to measure return flows)	High	Medium	High	Low	High
Gunbower-Koondrook-Perricoota Forest – Median															
Horseshoe lagoon (17 ha)	7	Pump to lagoon to improve RRG fringing vegtation	Promote growth and reproduction of fringing Redgum vegetation. Promote regeneration of wetland flora species improving diversity and abundance. Re-establish wet-dry phase to wetland. Provide nesting and feeding habitat for waterbirds during future flood events.	0.3	0.3	nil	Spring	Pumping required	Block bank	$15,000 (pumping and block bank)	High	High	High	Low	High

Watering Site	Reach-section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Swan Lagoon (37 ha)	7	Pump to lagoon to improve RRG fringing vegetation,	Promote growth and reproduction of fringe RRG vegetation Allow re-establishment of wet-dry phase in semi-permanent wetlands that have been dry and stressed over last 10 years and stimulate nutrient cycling Promote regeneration of wetland flora, improving species diversity and abundance, and provide nesting and feeding habitat for waterbirds during future flood events.	0.5	0.5	nil	Spring	Pumping required	Block bank	$21,500 (pumping and block bank)	High	High	High	Medium	High
Swan Lagoon (37 ha)	7	Pump to lagoon to improve RRG fringing vegetation,	Promote growth and reproduction of fringing Redgum vegetation. Promote regeneration of wetland flora species improving diversity and abundance. Re-establish wet-dry phase to wetland. Provide nesting and feeding habitat for waterbirds during future flood events.	0.65	0.65	nil	Spring	Pumping required	Block bank	$27,500 (pumping and block bank)	High	High	High	Low	High

Watering Site	Reach-section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Blackbox Lagoon (17 ha)	7	Pump to lagoon to improve RRG fringing vegetation,	Promote growth and reproduction of fringing Redgum vegetation. Promote regeneration of wetland flora species improving diversity and abundance. Re-establish wet-dry phase to wetland. Provide nesting and feeding habitat for waterbirds during future flood events.	0.3	0.3	nil	Spring	Pumping required	Block bank	$13,500 (pumping and block bank)	High	High	High	Low	High
390 mile lagoon (6 ha)	7	Pump to lagoon to improve RRG fringing vegetation,	Promote growth and reproduction of fringing Redgum vegetation. Promote regeneration of wetland flora species improving diversity and abundance. Re-establish wet-dry phase to wetland. Provide nesting and feeding habitat for waterbirds during future flood events.	0.15	0.15	nil	Spring	Pumping required	Block bank	$7,500 (pumping and block bank)	High	High	High	Low	High

Watering Site	Reach-section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Thule Creek	7	Pump into creek to inundate low-lying forest areas – improve vegetation health	Provide connectivity of low-lying forest promoting growth and reproduction of fringing Redgum vegetation. Promote regeneration of wetland flora species improving diversity and abundance. Re-establish wet-dry phase to wetland. May stimulate low-scale colonial bird bereeding event. Provide nesting and feeding habitat for waterbirds during future flood events.	10	10	nil	Spring	Pumping required	Block bank	$401,500 (pumping and block bank)	High	High	High	Low	High
Unnamed Creek (near Clarkes Lagoon Rd junction)	7	Pump into creek to inundate low-lying forest areas & improve vegetation health	Provide connectivity of low-lying forest promoting growth and reproduction of fringing Redgum vegetation. Promote regeneration of wetland flora species improving diversity and abundance. Re-establish wet-dry phase to wetland. May stimulate low-scale colonial bird bereeding event. Provide nesting and feeding habitat for waterbirds during future flood events.	10	10	nil	Spring	Pumping required	Block bank	$401,500 (pumping and block bank)	High	High	High	Low	High

Watering Site	Reach-section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Swan Lagoon into Burrumbury system	7	Pump into lagoon which will then flow through creek system to inundate low-lying forest areas & improve vegetation health	Provide connectivity of low-lying forest promoting growth and reproduction of fringing Redgum vegetation. Promote regeneration of wetland flora species improving diversity and abundance. Re-establish wet-dry phase to wetland. May stimulate low-scale colonial bird bereeding event. Provide nesting and feeding habitat for waterbirds during future flood events.	10	10	Nil	Spring	Pumping required	Block bank	$401,500 (pumping and block bank)	High	High	High	Low	High
Horseshoe Lagoon into Burrumbury system	7	Pump into lagoon which will then flow through creek system to inundate low-lying forest areas & improve vegetation health	Provide connectivity of low-lying forest promoting growth and reproduction of fringing Redgum vegetation. Promote regeneration of wetland flora species improving diversity and abundance. Re-establish wet-dry phase to wetland. May stimulate low-scale colonial bird bereeding event. Provide nesting and feeding habitat for waterbirds during future flood events.	10	10	Nil	Spring	Pumping required	Block bank	$403,000 (pumping and block bank)	High	High	High	Low	High

Watering Site	Reach-section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Gunbower Forest Wetlands and Creeks	4	Gravity fed flows through Gunbower Creek, water delivered via the new Lower Landscape works	A large area of wetlands and River Redgum grassy woodland would be flooded, providing feeding and breeding habitat for a range of waterbirds, fish, frogs and turtles.	15	12	3	Autumn – Spring 2011	Channel system and Gunbower Creek and regulator	New Lower Landscape Regulators (uses Torrumbarry Irrigation System)	$0 (possibility of small cost being determined with G-MW)	High	Medium	High	Low	High
Gunbower Creek	4	This action will directly inform the detailed design for the Hipwell Road Channel Package of Works.	Calibrate the Gunbower Creek hydraulic model to inform the level requirements for the Hipwell Road Package of Works Calculate losses associated with delivering environmental water through Gunbower Creek Measure return flows to the River Murray Provide a spawning cue to native fish within Gunbower Creek.	17	5	12	July onwards	River gravity and Gunbower Creek		TBC					

Watering Site	Reach-section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Chowilla Floodplain, Lindsay and Wallpolla Islands															
Mulcra Island	14	Raising Lock 8 to generate flows through Potterwalkage Creek; using newly completed TLM infrastructure to deliver water to the floodplain.	Increase the diversity of structural aquatic habitat; Increase the diversity and distribution of native fish; Provide occasional breeding and roosting habitat for waterbirds; Provide habitat suitable for migratory waterbird species.	20	5	15	March – June			$0	High	High	High	Low	High
Lower Lakes, Coorong and Murray Mouth															
Lake Alexandrina, Lake Albert and Murray Mouth	15	Maintain salinity levels and provide critical waterbird habitat	Prevent critical loss of species Avoid irreversible loss/ catastrophic event; or Provide drought refuge Maintain river functioning with reduced reproductive capacity Enable growth, reproduction and small-scale recruitment; and Promote low-lying floodplain connectivity	360	360	Nil	TBA	Water will be gravity fed to Lake Alexandrina			High	High	High	Low	High
			TOTAL (with small volumes at Swan & Horseshoe Lagoons')	512	429	83			TOTAL	$968,500-$1,013,500					
			TOTAL (with large volumes at Swan & Horseshoe Lagoons')	530	447	83			TOTAL	$1,704,500-1,749,500					

Schedule D: Wet (Possible TLM water available including carryover: 460 – 520 GL)

Watering Site	Reach-section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Barmah-Millewa – Wet															
Toupna Creek	5	Water delivered through regulators then disperse through forest via interlinked runners and inundating wetlands	Extended period of inundation promoting growth reproduction and large-scale recruiting. Large volume may reach vegetation higher on the floodplain, including Box communities. High flood levels would enhance river and floodplain functioning and provide greater connectivity throughout the forest. Support threatened Southern Pigmy Perch population. Re-establishment of a wet-dry phase in semi-permanent wetlands.	120	20	100	Spring	Via Mary Ada regulator. (Flow at Yarrawonga >9000ML/ day)	Nil	$0	High	High	High	Low	High
Barmah (85 % Barmah forest floodplain)	3	Overbank flows to enable significant growth, reproduction and recruitment of vegetation & associated biota	Would enable growth, reproduction and large-scale recruitment of vegetation and associated biota throughout the forest.	180	9	171	Spring	Gravity fed via overbank flows	Nil	$80,000 (modelling/ gauging costs)	High	Low	High	Low	High

Watering Site	Reach-section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Wetlands, creeks and floodplain within the BMF	3	Consideration should be given to delivering all flows provided downstream of Barmah-Millewa via this icon site.	Provide drought refuge for water birds and other wetland dependent species, such as fish and turtles	TBA		70 to 95%	August – December	Direct from the River Murray, via regulator or overbank flows	Over Bank	TBC $5,000 to $50,000 (for flow gauging to measure return flows)	High	Medium	High	Low	High
Gunbower-Koondrook-Perricoota Forest – Wet															
Horseshoe lagoon (17 ha)	7	Pump to lagoon to improve RRG fringing vegtation	Extended period of inundation promoting growth reproduction and large-scale recruiting. Increase species diversity and abundance, and stimulate nutrient cycling.	0.4	0.4	nil	Spring	Pumping required	Block bank	$19,000 (Pumping and block bank)	High	High	High	Low	High
Swan Lagoon (37 ha)	7	Pump to lagoon to improve RRG fringing vegetation,	Extended period of inundation promoting growth reproduction and large-scale recruiting. Increase species diversity and abundance, and stimulate nutrient cycling.	0.75	0.75	nil	Spring	Pumping required	Block bank	$31,500 (Pumping and block bank)	High	High	High	Low	High

Watering Site	Reach-section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Blackbox Lagoon (17 ha)	7	Pump to lagoon to improve RRG fringing vegetation,	Extended period of inundation promoting growth reproduction and large-scale recruiting. Increase species diversity and abundance, and stimulate nutrient cycling.	0.4	0.4	nil	Spring	Pumping required	Block bank	$17,500 (Pumping and block bank)	High	High	High	Low	High
390 mile lagoon (6 ha)	7	Pump to lagoon to improve RRG fringing vegetation,	Extended period of inundation promoting growth reproduction and large-scale recruiting. Increase species diversity and abundance, and stimulate nutrient cycling.	0.2	0.2	nil	Spring	Pumping required	Block bank	$9,500 (Pumping and block bank)	High	High	High	Low	High
Thule Creek	7	Pump into creek to inundate low-lying forest areas – improve vegetation health	Extended period of inundation promoting growth reproduction and large-scale recruiting. Large volume may reach vegetation higher on the floodplain, including Box communities. High flood levels would enhance river and floodplain functioning and provide greater connectivity throughout the forest.	10	10	nil	Spring	Pumping required	Block bank	$401,500 (Pumping and block bank)	High	High	High	Low	High

Watering Site	Reach-section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Horseshoe Lagoon into Burrumbury system	7	Pump into creek to inundate low-lying forest areas – improve vegetation health	Extended period of inundation promoting growth reproduction and large-scale recruiting. Large volume may reach vegetation higher on the floodplain, including Box communities. High flood levels would enhance river and floodplain functioning and provide greater connectivity throughout the forest.	10	10	nil	Spring	Pumping required	Block bank	$403,000 (Pumping and block bank)	High	High	High	Low	High
Unnamed Creek (near Clarkes Lagoon Rd junction)	7	Pump into creek to inundate low-lying forest areas & improve vegetation health	Extended period of inundation promoting growth reproduction and large-scale recruiting. Large volume may reach vegetation higher on the floodplain, including Box communities. High flood levels would enhance river and floodplain functioning and provide greater connectivity throughout the forest.	10	10	nil	Spring	Pumping required	Block bank	$401,500 (Pumping and block bank)	High	High	High	Low	High

Watering Site	Reach-section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Swan Lagoon into Burrumbury system	7	Pump into lagoon which will then flow through creek system to inundate low-lying forest areas & improve vegetation healt	Extended period of inundation promoting growth reproduction and large-scale recruiting. Large volume may reach vegetation higher on the floodplain, including Box communities. High flood levels would enhance river and floodplain functioning and provide greater connectivity throughout the forest.	10	10	nil	Spring	Pumping required	Block bank	$401,500 (Pumping and block bank)	High	High	High	Low	High
Gunbower Creek	4	This action will directly inform the detailed design for the Hipwell Road Channel Package of Works.	Calibrate the Gunbower Creek hydraulic model to inform the level requirements for the Hipwell Road Package of Works Calculate losses associated with delivering environmental water through Gunbower Creek Measure return flows to the River Murray Provide a spawning cue to native fish within Gunbower Creek.	17	5	12	July onwards	River gravity and Gunbower Creek		TBC					

Watering Site	Reach-section of River Murray	Brief action description	Objectives of watering. Relate to TLM objectives or water resource scenario management objectives	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				
											Likelihood of benefit (High, Medium, Low)	Risk of not applying water (High, Medium, Low)	Certainty/ likelihood of benefit (High, Medium, Low)	Risks associated with watering (High, Medium, Low)	Cost effectiveness (High, Medium, Low)
Chowilla Floodplain, Lindsay and Wallpolla Islands															
Mulcra Island	14	Raising Lock 8 to generate flows through Potterwalkage Creek; using newly completed TLM infrastructure to deliver water to the floodplain.	Increase the diversity of structural aquatic habitat; Increase the diversity and distribution of native fish; Provide occasional breeding and roosting habitat for waterbirds; Provide habitat suitable for migratory waterbird species.	20	5	15	March – June			$0	High	High	High	Low	High
Lake Alexandrina, Lake Albert and Murray Mouth	15	Maintain salinity levels and provide critical waterbird habitat	Prevent critical loss of species Avoid irreversible loss/ catastrophic event; or Provide drought refuge Maintain river functioning with reduced reproductive capacity Enable growth, reproduction and small-scale recruitment; and Promote low-lying floodplain connectivity	360+	360+	Nil	TBA	Water will be gravity fed to Lake Alexandrina			High	High	High	Low	High
			TOTAL (with small volumes at Swan & Horseshoe Lagoons')	**718**	**420**	**298**				**$955,000 - $1,000,000**					
			TOTAL (with large volumes at Swan & Horseshoe Lagoons')	**736**	**438**	**298**				**$1,709,000 - $1,814,000**					

Australian Government

MURRAY–DARLING
BASIN AUTHORITY