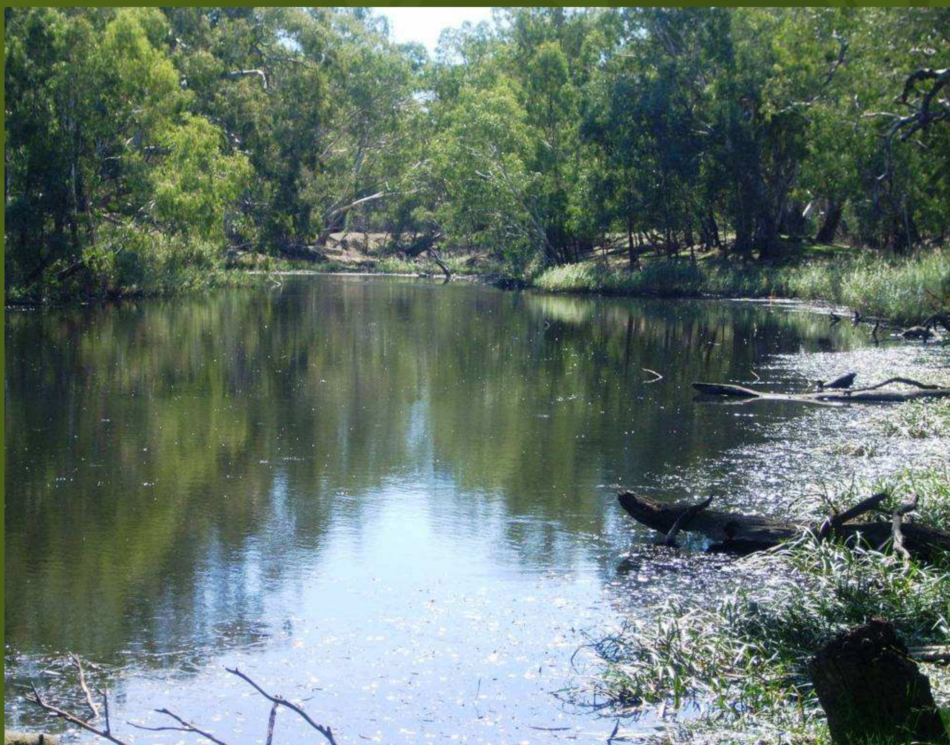
QON 12 & 13 - Attachment B (part 1 of 2)

Connecting Rivers, Landscapes, People

2010-2011
Annual Watering Plan
For the Campaspe River
Downstream of Lake Eppalock



NORTH CENTRAL
Catchment Management Authority
Connecting Rivers, Landscapes, People

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Annual Watering Plan

For the Campaspe River

Downstream of Lake Eppalock

DM No. 37458

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Contents

Abbreviations

AWP – Annual Watering Plan

BE – Bulk Entitlement

CEWAG – Campaspe Environmental Water Advisory Group

CHEW – Commonwealth Environmental Water Holder

CMA – Catchment Management Authority

CRG – Community Reference Group

DICP – Dry Inflow Contingency Plan

EPA – Environment Protection Agency

EWR – Environmental Water Reserve

G-MW – Goulburn-Murray Water

HRSW – High Reliability water supply

IVT – Inter-Valley Transfer

ML – Mega-litres

LRWS – Low Reliability water supply

POE – Probability of exceedance

QoR – Qualification of Rights

TAG – Technical Advisory Group

VWQMN – Victorian Water Quality Monitoring Network

The **White Paper** – The Victorian Government's White Paper *Our Water Our Future,* Securing our Water Future Together

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1. Campaspe River catchment overview

The Campaspe Catchment (Figure 1) extends from the Great Dividing Range in the south to the Murray River in the north, a total distance of approximately 150 km. The catchment has an average width of approximately 25 km for a total area in the region of 4,000 km². This represents in the order of 17% of the North Central CMA region (NCCMA 2006a).

The major waterways of the catchment are the Upper Campaspe River, the Coliban River (both upstream of Lake Eppalock) and the lower Campaspe (downstream of Lake Eppalock). Major tributaries are the Axe, McIvor, Mount Pleasant, Wild Duck and Pipers Creeks.

Major Thomas Mitchell named the Campaspe River in 1836. The catchment has undergone significant changes since Europeans first traversed it. The cumulative effects of the introduction of European farming techniques, native vegetation clearance, the gold rush plus the construction of reservoirs and water supply systems for agriculture and urban developments are reflected in the current condition of the catchment (NCCMA 2006a).

The Campaspe Annual Watering Plan is limited to the Lower Campaspe River downstream of Lake Eppalock. This reach of the river meanders across almost level alluvial plains for approximately 140 km to the confluence with the Murray River at Echuca. The floodplain of the river is narrow at approximately only 1 km wide until closer to Echuca, where it broadens out to more than 2 km (NCCMA 2006b).

The Campaspe River is now a regulated river to supply water for irrigation and urban demands. In 1882, the Campaspe Weir was constructed 12 km south of Rochester. This structure has a capacity of 2,700 ML and delivers irrigation water through the east and west channels. In 1902, the Campaspe Siphon was constructed 2 km north of Rochester. The Waranga Western Channel crosses the river at this point and the siphon structure allows water from the Goulburn River to be inflowed into the river, or continue its flow to the western irrigation districts. The Campaspe pumps located at the siphon also allow water from the Campaspe River to be inflowed into the Waranga Channel for delivery to western irrigation areas.

The most significant structure on the Campaspe River is Lake Eppalock. While first mentioned in the 1890s, it was not until 1930 that construction began. Construction ceased due to the depression in 1933 when the dam had a capacity of 1,500 ML. Construction then recommenced in 1963 and when completed, capacity had increased to the present 304,000 ML. Lake Eppalock was constructed to secure water for the Campaspe irrigation area, to safeguard the Coliban Supply system and allow increased development of urban areas.

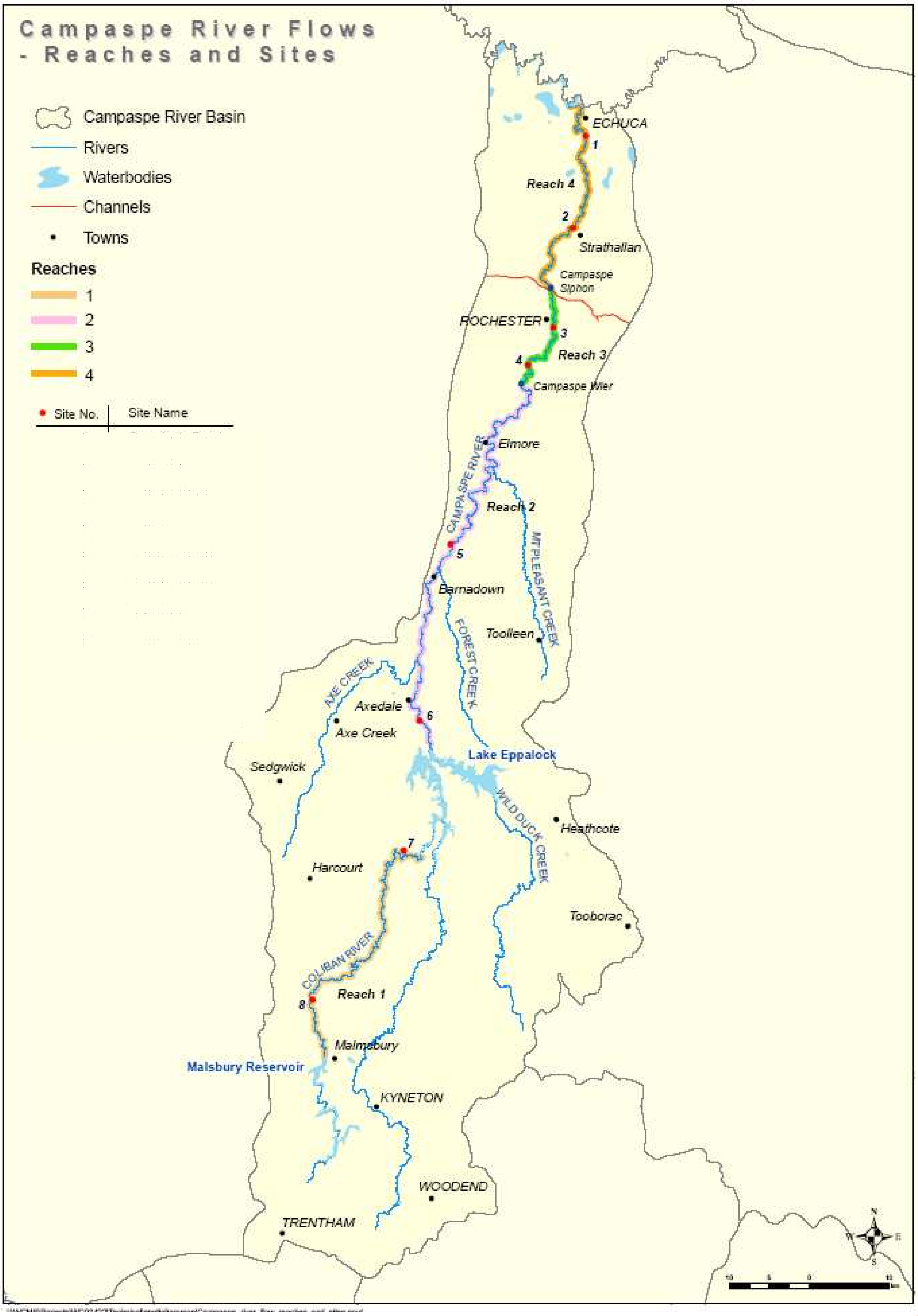


Figure 1- Overview of the Campaspe River catchment

2. Scope of Document

This Annual Watering Plan documents how the environmental water, as provided by the Bulk Entitlement (Campaspe System - Goulburn-Murray Water) Conversion Order 2000 and the current Qualification of Rights will be distributed. The Bulk Entitlement provisions provide the over-riding legal framework for the delivery of environmental water. The temporary qualification of this Bulk Entitlement affects the environment's rights to water until the 30th of June 2011, the Qualification of Rights is revoked, whichever is earlier.

2.1 Purpose

The purpose of the Annual Watering Plan is to:

- review the previous seasons usage of environmental water
- document the decision making process used to determine the distribution of environmental water
- identify and where possible, address issues or constraints which may affect the distribution of environmental water
- provide a communication forum between the North Central CMA, stakeholders and the local Campaspe community

While this document aims to provide a plan for the delivery of environmental water, it must be recognised that there are a number of uncertainties, particularly relating to climatic conditions, when planning for the delivery of environmental water. Additionally system, infrastructure, delivery and maintenance constraints may influence how environmental water can be distributed. For these reasons, environmental water must be delivered through an adaptive framework to provide the flexibility necessary for effective management.

2.2 Underlying principles for environmental water reserve management

North Central CMA has adopted nine principles for the management of the environmental water reserve which govern the operation of environmental flow releases:

1. Releases will be made to achieve maximum benefits with the goal of sustaining and where possible, restoring ecological processes and biodiversity of aquatic dependant ecosystems
2. The best regional environmental outcomes are sought through inter-agency and community cooperation
3. The environmental contribution derived from natural and managed flows will be recognised in the development of the Annual Watering Plan
4. All decisions are to be made on the best available science
5. Decisions are to be transparent, consistent with ecological objectives, accountable and in accordance with state and federal law and policy
6. The Environmental Water Reserve Manager (North Central CMA) must work closely with the Storage Operator (Goulburn-Murray Water), to maximise EWR benefits and consider opportunities for cost efficiencies

7. Monitoring, reporting and evaluation of the effectiveness of environmental flow releases is to provide feedback for the continuous improvement in the use of environmental water
8. Delivery of the environmental flow allocation must occur in a flexible manner in response to changing conditions and in response to monitoring and an improved understanding of environmental water requirements; and
9. Community members are to be informed of improvements to the environment and engaged wherever possible in the process

2.3 Approach to the preparation of this document

To effectively manage the Environmental Water Reserve, the North Central CMA has established the Campaspe Environmental Water Advisory Group (CEWAG).

The Campaspe Environmental Water Advisory Group provides advice at key decision points in the planning process to the Environmental Water Reserve Manager on the best use of environmental water for the Campaspe River downstream of Lake Eppalock. It will ensure environmental water is used effectively to maximise environmental benefits based on existing knowledge and in response to ongoing monitoring and research, ecological objectives, system constraints, previous usage and climatic conditions.

The Campaspe Environmental Water Advisory Group contains the following community and agency representatives:

- Environmental Water Reserve Manager (North Central CMA)
- Storage Operator and Bulk Entitlement holder (Goulburn-Murray Water)
- Bulk Entitlement holder, Coliban Water
- Northern CMA's Environmental Water Flows Coordinator
- Department of Sustainability and Environment - Sustainable Water Environment and Innovation Division
- Community representatives

The Campaspe Environmental Water Advisory Group meets at least twice a year. The first scheduled meeting in May provides an opportunity for the group to have input into the last season review and the preparation of the Annual Watering Plan. The North Central CMA then prepares a draft watering plan that is presented to the group at the June meeting for review. The group can be reconvened at other times should the need arise.

3. Environmental Water Reserve

3.1 Environmental Water Reserve in the Campaspe River system.

The right to water in the Campaspe River was defined in 2000 through the Bulk Entitlement (Campaspe System - Goulburn-Murray Water) Conversion Order. While there is no separate Environmental Bulk Entitlement, water for the Campaspe environment is defined as 'passing flows' within Goulburn-Murray Water's and Coliban Water's Bulk Entitlements (Table 1) as well as unregulated river flows. The Campaspe Bulk Entitlement (2000) provides for minimum passing flows in sections of the Campaspe River downstream of Lake Eppalock to protect environmental values based upon recommendations by an environmental flows scientific panel (Marchant et al. 1997). It is important to note that there is no passing flow requirement for the reach between the Campaspe Weir and the Campaspe Siphon, however in most cases water will be passed down this reach to supply requirements below the Campaspe Siphon (unless sourced from the Waranga Western Channel.)

The Loddon Campaspe Drought Response Group was established in 2004 to manage risks to river health during the prolonged drought conditions and to aid in the long-term recovery of the Campaspe System. The group is chaired by Goulburn-Murray Water and comprises of representatives from the Department of Sustainability and Environment, Department of Primary Industries, Coliban Water, Environment Protection Authority and the North Central CMA.

On the 20 October 2005, due to ongoing drought conditions and advice from the Loddon Campaspe Drought Response Group, the Minister for Water permanently amended the passing flow clause within the Campaspe Bulk Entitlement. This amendment allows for the storage of part of the passing flow from below the Campaspe Siphon during winter/spring (July - November). The remainder is held in the Eppalock Passing Flow account and can be used during the hotter summer/autumn months (December - June) when environmental risks are greater. A summary of the Bulk Entitlement's passing flow requirements is included in Table 1.

Table 1 - Passing flows in the amended Campaspe Bulk Entitlement Order (2005)

River / reach	Lake Eppalock storage volume (ML)	Passing Flow (ML/d) (whichever is lower)
Campaspe River - Lake Eppalock to Campaspe Weir	≤ 150000	10 or actual inflow*
	> 150000 but ≤ 200000	50 or actual inflow
	> 200000 but ≤ 250000	80 or actual inflow
	> 250000	90 or actual inflow – Jan, Mar, May, Jun & Dec 80 or actual inflow – Feb & Apr 150 or actual inflow – Jul & Nov 200 or actual inflow – Aug, Sep & Oct
Campaspe River - Campaspe Siphon to River Murray	≤ 200000	20 or modified natural flow** – July to Nov + 35 or modified natural flow – Dec to June
	> 200000	70 or modified natural flow

**actual inflow: The storage operator must measure actual inflow into Lake Eppalock based on water balance or through a method based on gauged flows at Redesdale & Lyell (whichever provides the best estimate of daily flows).*
***modified natural flow: The storage operator must measure the modified natural flow in the Campaspe River immediately downstream of the Siphon based on water balance or a method based on gauged flow at Eppalock, Longlea & Runnymede (whichever provides the best estimate of daily flows).*
+ From Jul to Nov, the additional passing flow that would have been passed below the Siphon (up to 15ML/d) can be stored in an account and used anywhere along the Campaspe below Lake Eppalock from Dec to June.

In 2006/07, it was realised there were inadequate water resources to maintain the requirements of the Bulk Entitlement and a water shortage was declared. A joint proposal from Goulburn-Murray Water and the North Central CMA was submitted to the Minister for Water on the 17th of October 2006 to reduce passing flows in order to extend the period over which flows could be released down the Campaspe River.

Based on the information supplied, the Minister for Water conveyed support for the proposal in a formal letter dated 31st of October 2006. A Ministerial Direction under Section 307 of the Water Act was issued to cease all passing flows unless water is required to mitigate environmental risk. This was invoked to prolong water for the Campaspe stock and domestic supply.

The Environmental Water Reserve for the Campaspe System below Lake Eppalock has a number of components. Under the Bulk Entitlement, the Environmental Water Reserve consists of the 'passing flow' requirements in two reaches of the river based upon the volume held in Lake Eppalock and the inflows recorded. A portion of the flows downstream of the siphon can be stored during the winter months and this is recorded in the Eppalock Passing Flow account. This is a store of water held in Lake Eppalock that is deployed under advice by the North Central CMA, guided by the Annual Watering Plan. Under the Qualification of Rights, the passing flow requirements are removed and the Environmental Water Reserve consists of the Eppalock Passing Flow Account only.

3.1.1 Qualification of Rights

Rights to water on a river system are specified in the bulk entitlements and water cannot be taken outside of its provisions. In extreme dry years, the minister has emergency power to declare a water shortage and to qualify rights to water. This power is generally only used to meet critical human needs. The qualification of rights changes the water sharing rules, setting some specific BE requirements aside. All BE requirements not covered the qualification remain in place.

There have been two qualification of rights invoked by the Minster for Water for the Campaspe (including the Coliban) River system. The first qualification of rights covered the period July 2007 to June 2009 (section 3.1.1.1) and is the qualification that the 2008-09 seasonal review is conducted under. The second qualification covering the July 2009 to June 2011 period dictates the availability of environmental water for this planning year (section 3.1.1.2) The qualifications are fundamental to the Annual Watering Plan process, dictating the volume and availability of environmental water

3.1.1.1 July 2007 to June 2009 Qualification

Goulburn-Murray Water, under its delegated Ministerial powers, declared a water shortage on the Campaspe System (including Coliban). As a result, on 30 June 2007, the former Minister for Water, Environment and Climate Change, temporarily qualified rights to water on these systems.

The temporary qualification was to put in place until the relevant Declaration of Water Shortage or the Qualification of Rights was revoked; or until 30 June 2009. Under the Qualification of Rights:

- At zero percent water allocation, no passing flows are to be released and the Eppalock Passing Flow account is not available
- The water that would have been released under the Bulk Entitlement is to be recorded in the Eppalock Passing Flows Account

- Between 1-99% water allocation, the Eppalock Passing Flow Account is available with releases made upon advice from the North Central CMA
- At 100% water allocation, passing flows are reinstated
- On expiry of this Qualification of Rights, any volume held in storage must be released in accordance with the requirements of the bulk entitlement relating to the Eppalock Passing Flow Account

3.1.1.2 July 2009 to June 2011 Qualification

Due to the ongoing dry conditions and low inflows, the Minister for Water qualified rights to the Campaspe River System for the 2009-2011 period. The Qualification sets the volume and availability of environmental water and forms that basis of this plan. Tim Holding, Minister for Water made the qualification on 22 June 2009. Under the Qualification:

- At zero percent irrigation allocation, no passing flows are to be released and the Eppalock Passing Flow account is not available
- The water that would have been released under the Bulk Entitlement is to be recorded in the Eppalock Passing Flows Account
- Once G-MW's volume in Lake Eppalock exceeds 6,500 ML, 1,000 ML from the Eppalock Passing Flow Account is available for release based upon advice from the North Central CMA
- At 1% water allocation, all of the water recorded in the Eppalock Passing Flow Account is available for release based upon advise from the North Central CMA
- At 100% water allocation, passing flows are reinstated
- On expiry of the Qualification of Rights, any volume held in storage must be released in accordance with the requirements of the bulk entitlement relating to the Eppalock Passing Flow Account

Please note that the Department of Sustainability and Environment has called for a late season review of the existing qualification for the 2010-2011 year. It is anticipated that this will not have a significant impact on water availability.

3.1.2 North Central CMA's Role

The North Central CMA, as the caretaker for River Health, is responsible to advise Goulburn-Murray Water, the Storage Operator, on the best release pattern to protect environmental values in the Campaspe River System. In order to ensure the best use and release pattern for the available Environmental Water, Annual Watering Plans were prepared for the 2006-07, 2007-08, 2008-09 and 2009-10 seasons for the Campaspe River below Lake Eppalock. An Annual Watering Plan for the Campaspe River below Lake Eppalock 2010-11 has been developed (this Plan) to advise the best use and release pattern for environmental water in the Campaspe system for the 2010-11 water year or until the 2011-12 Annual Water Plan is in place.

3.2 Other sources of environmental water

There are two other sources of environmental water that may become available in the near future in the Campaspe River System. The North Central CMA does not manage or control these water reserves. However, as the intent of the any environmental water is to benefit the Campaspe River environment, then a collaborative management response is required. To maximise efficiency of water use in the system, the North Central CMA has considered where this water could be used to supplement the use of the state EWR to drive the best outcome for the Campaspe River system.

3.2.1 Commonwealth Water

Under the federal water buyback scheme or Restoring the Balance in the Murray-Darling Basin Program, as at 30 April 2010, a total of 5,094 ML of High Reliability Water Supplies (HRWS) and 395 ML of Low Reliability Water Supply (LRSW) have been purchased in the Campaspe Catchment. The stated objective of this program is to purchase water entitlements so that the water can be used for environmental purposes (DEWHA 2010a). Water purchased from the Campaspe River catchment can be used to benefit environmental assets in this catchment and downstream. This water will be transferred to the Commonwealth Environmental Water Holder (CEWH), which will be responsible for its management and deployment. This buyback scheme is still in progress with the third round of purchases recently commenced.

Recently the Northern Victoria Irrigation Renewals Program (NVIRP 2010) have announced that a majority of irrigation entitlement holders in the Campaspe Irrigation District elected to accept an exit package and either leave the irrigation industry or connect to alternative water supplies. As a result, up to 12,000 ML of water entitlements may be purchased by NVIRP and eventually transferred to the CEWH. When combined with the existing water purchases (above) the total environmental water holding by the CEWH in the Campaspe system could be approximately 17,000 ML HRWS.

3.2.2 The Living Murray

The Living Murray aims to recover up to 500 GL of environmental water to achieve environmental benefits for six icon sites (not including the Campaspe River) along the River Murray. This entitlement is managed by the Murray Darling Basin Authority. Due to the unbundling process and the 80:20 sales deal water package, the Living Murray initiative holds 126 ML of HRWS and 5,048 ML of LRWS. This water will not be available until the later wetter scenarios in the Annual Watering Plan and its primary target will be for deployment to the icon sites.

4. 2009-2010 Season Review

The 2009-2010 season continued to be challenging from an Environmental Water Reserve perspective due to the ongoing drought and lack of flows into the system. There was no irrigation allocation for the season for the Campaspe River. In previous seasons, this would have resulted in no passing flows for reaches 2 & 4 of the river and no access to the Eppalock Passing Flows Account. Under the 2009-2011 Qualification of Rights, once inflow to the Campaspe System exceeded 6,500 ML, limited access of 1,000 ML from the Eppalock Passing Flows Account became available for deployment by the North Central CMA. Inter-Valley Transfers from the Goulburn System were again used to provide a series of flows to reach 4 of the Lower Campaspe River (section 8) in the summer and autumn months.

4.1 Eppalock Passing Flow Account

Under the current Qualification of Rights, the volume of water available for deployment is based upon the volume of water that would have been released under clause 11.1 (a) of the Bulk Entitlement and recorded in the Eppalock Passing Flow Account. For 2009-10, the volumes in the Eppalock Passing Flows Account were as follows.

Eppalock Passing Flows Account balance as at 1/7/2009	2,970 ML
Environmental Water Reserve inflow for the season	1,086 ML
Environmental Water deployed as at 3/5/2010	805 ML
Balance 3/5/2010 and carry forward to 2010/2011 season	**3,251 ML**

4.2 Flow review

Flows in the Campaspe River over the 2009-2010 season were reduced when compared to the historical flows. Zero irrigation allocation and limited environmental water available, reduced flows in all reaches of the Campaspe River system. The amended 2010/11 QoR provided 1,000 ML of water from the Eppalock Passing flow Account. This small volume of water combined with the use of the Inter Valley-Transfer and G-MW's stock and domestic releases in the upper reaches, provided the Campaspe River with a small, continuous flow in the high risk summer period for the first time since the 2004/05 season.

The resource position and lack of inflows in the winter inflow period provided early an indication that the Campaspe River system was at risk of ceasing to flow during the high risk summer period. Initially there was only sufficient water for G-MW to provide critical human needs to the reach immediately below Eppalock and then only until December. The river would cease flow from the middle of reach 2 from December onwards. This was a dire situation for the river and two public meetings were held at Rochester to engage the community. Fortunately, inflows did eventuate and the resource position improved and some flows were provided to the river.

4.2.1 Flows in reach 2 (Lake Eppalock to Campaspe Weir)

During the 2009-10 season, passing flows to this reach were suspended under the qualification. At the start of the season, no environmental water was available for deployment. In November, system inflows exceeded 6,500 ML, triggering 1,000 ML for deployment from the Eppalock passing flow account (Section 3.1.2.1). Due to the resource position, the North Central CMA and G-MW's management objectives for reach 2 coincided. G-MW's objective was to run low flows from Lake Eppalock to the Campaspe Weir to enable delivery of Stock and Domestic supplies to customers in this reach for critical human needs. As identified in Cottingham et al (2009) scientific panel report, the highest value environmental assets for the Campaspe are the deep river pools located immediately downstream of Lake Eppalock. The flow provided by G-MW and the need for environmental flows targeting reach 3 traversing this reach ensured that the deep river pools water levels and water quality were maintained for the season.

Flows in reach 2 are controlled by releases from Lake Eppalock and inflows from tributaries such as Mount Pleasant and Axe Creek. Flow data supplied by Goulburn-Murray Water is presented in Figure 2. Earlier in the season, there was a continuous stock and domestic release of 6 ML/d from Lake Eppalock (blue line) until early October. This is a small release for the river, reflected in the period of cease to flow at Barnadown (brown line). Barnadown is located downstream of Axe and McIvor Creeks and inflows from the tributaries provided small elevated flows of no more than 20 ML/d until the beginning of November.

Increasing stock and domestic demand and on the onset of warmer climatic conditions resulted in the flow release from Lake Eppalock being increased from October onwards. The flow varied between 15

ML/d to 40 ML/d and reached a peak of 50 ML/d for a two week period in January. The flow then slowly stepped down to 15 ML/d. Flows at Barnadown over this period are a result of the flow release from Eppalock and inflow from rainfall. The flow varied, a maximum daily flow rate of 110 ML/d was recorded. The flow at Barnadown had less magnitude and lags behind the Eppalock release during the summer period. This is due to extraction enroute and evaporation. Flow in the reach has been reduced in comparison to what the reach has experienced since regulation.

CEWAG member's field observations are that the river maintained some flow throughout the year and the deep river pools water levels maintained near full. Early in the season, there was some slight discolouration of the water, but no adverse impacts such as stressed fish were observed.

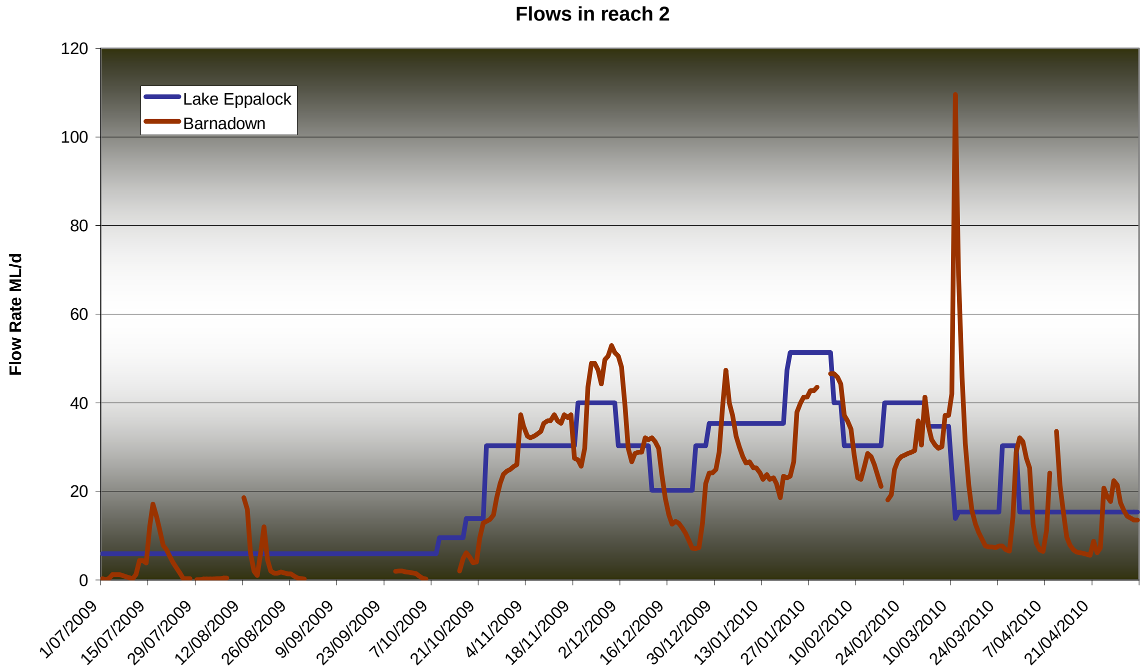


Figure 2 - Lake Eppalock weir daily flow release (blue) and daily flows (brown) recorded at Barnadown Gauging Station (reach 2)

4.2.2 Flows in reach 3 (Campaspe Weir to Campaspe Siphon)

Under the BE, this reach of the Campaspe River is the only regulated reach of the Campaspe River that does not receive passing flows under the BE. In previous seasons this reach has experienced extended cease to flow periods. There is no gauging station in this reach, and the only indication of flow are G-MW's releases from the Campaspe Weir and the level sensor located at the Bonn Road continuous water quality site. This provides an indication of flows in the reach; however, it does not provide an accurate flow measurement.

The only managed flow for this reach was an environmental flow release of 5 ML/d from the Campaspe Weir that commenced 24th November 2009 (Figure 3). This release was not possible until the trigger point under the QoR was obtained, providing 1,000 ML from the Eppalock Passing Flow account (Section 3.1.3). This was a pre-emptive flow to prevent water quality decline over the high risk summer period. Experience from previous releases made in response to declining water quality indicates that this is a risky management action due to the time required to detect declining trends and the time for the flow to traverse to where it is required in the reach. A safer and more precautionary management option where resources permit is to maintain a small base flow preventing the decline in the first instance. The Campaspe Siphon pool was identified as a key refuge area (mainly for fish and macrophytes (Cottingham et al 2009)) and ranked high for the delivery of water under the worst-case drought scenarios. This flow ensured the Siphon weir pool water levels and WQ was maintained. G-MW spot monitoring of the Siphon weir pool indicated that while DO at times reduced to below the ANZECC minimum levels, the extremely low levels of 1-2 ppm experienced on other parts of the system were not observed at this site.

An additional benefit of this flow release was that as the water traversed reach 2, it increased the low level flow that G-MW were providing in reach 2 for stock and domestic purposes. This flow release commenced on 24 November 2009, ceased at 11th May 2010, and consumed 840 ML of water from the Eppalock Passing Flows Account.

A major consideration for deploying this release was the negotiations completed with G-MW at the regular Loddon Campaspe Drought Response Group meetings. The community, on regular basis with both organisations raised the issue of the contraction of the river to pools and declining water quality. An agreement with G-MW was reached, as they needed to run small flows to the Campaspe Weir for stock and domestic demand. The North Central CMA could ‘float’ water required for delivery from the Campaspe Weir on top of G-MW’s flows and not incur any losses in reach 2. Additionally, any water that traversed through reach 3 and flowed over the Campaspe Siphon would be accounted reducing any IVT losses.

CEWAG members advise that this management action was well received by the local community. While only a small base flow, the river’s connectivity was maintained throughout the summer period and there was no evidence of the stagnant water observed in previous summers. The release of the base flow should commence as early as possible in the season to prevent the river ‘drying down’ and increasing losses at the commencement of the flow.

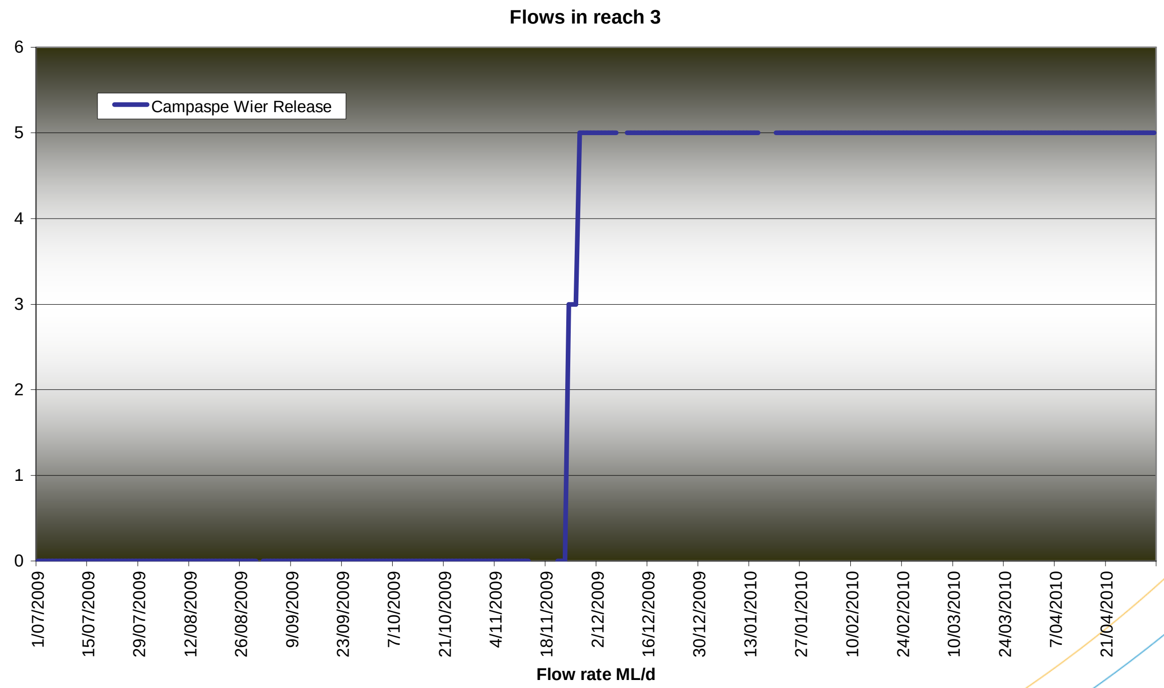


Figure 3 – Campaspe Weir release to reach 3 of the Campaspe River

4.2.3 Flows in reach 4 (Campaspe Siphon to Murray River)

Under the Qualification of Rights passing flows required under the BE to this reach were suspended during the 2009-10 season. Without the provision of the IVT, this reach of the Campaspe River would have been severely flow stressed, as there was no general irrigation allocation and only 1,000 ML from the Eppalock Passing Flow Account water available for deployment. The IVT was the preferred option to provide flows during the irrigation season. This was only possible after DSE agreed to underwrite operating losses from the Murray Flora and Fauna entitlement to a maximum of 1,000 ML.

Flows in reach 4 of the Campaspe River are presented in Figure 4. The flow data is captured just below the Campaspe Siphon and is representative of the flow input to the system. Flow in the early reporting period varied between 1 – 4 ML/d and at times ceased to flow. There was no managed flow release until the IVT commenced on 13 November 2009 at 10 ML/d as per the environmental flow recommendations for the reach (SKM 2006a). Apart from some small fluctuations and the delivery of summer freshes, the flow was held at 10 ML/d until the end of the irrigation season on 15 May 2010. During this time, three freshening events were released of 100 ML/d for 6 days with managed rates of rise and fall. These freshes commenced on the first day of February, March and April.

CEWAG members advise that the flow was well received by the local community and the river WQ did not decline over the summer period. While the higher fresh events assist with WQ, a potential negative is the higher flow also brings the native fish population on the bite and increases angler take. It was considered that the other benefits of the fresh outweigh the increased angler take and should continue to be provided

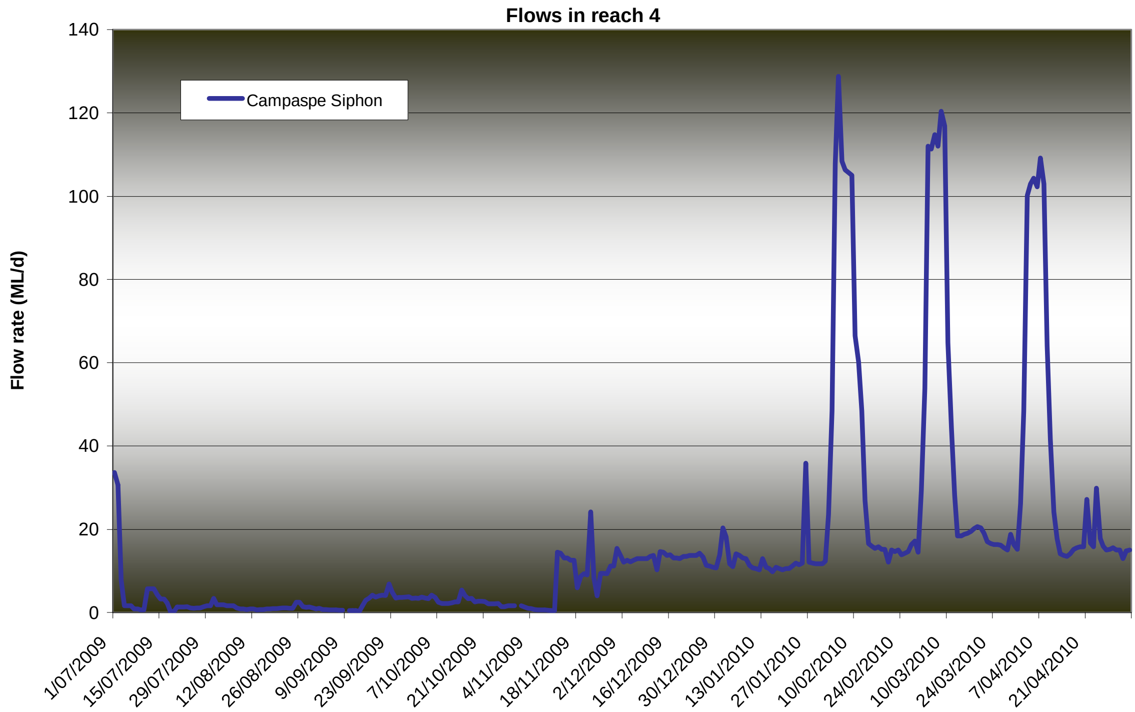


Figure 4 - Campaspe River daily flow downstream of Campaspe Siphon (reach 4)

4.3 Environmental releases for 2009-2010 season

During the 2009-2010 season a total of 840 ML of water was deployed from the Eppalock Passing Flow Account to the Campaspe River. System inflows in November have exceeded the trigger point of 6,500 ML and 1,000 ML was made available for deployment. This flow was 'floated' on G-MW's releases from Eppalock and deployed to reach 3 at the Campaspe Weir. The flows objective was to prevent water quality decline in this reach. Over the summer period approximately 3 ML/d of this reach spilled over the Campaspe Siphon and entered reach 4. This quantity will be accounted and used to reduce losses associated with the use of the IVT. A series of flows were provided to reach 4 through the IVT as detailed in section 4.3.1.

4.3.1 Inter-Valley Transfer releases

Inter-Valley Transfer water provided summer environmental flows for the lower Campaspe River (reach 4). These flows are not water from the Environmental Water Reserve, but were a collaborative management response between Goulburn-Murray Water, the Murray Darling Basin Authority and the North Central CMA.

Details of the flow series are:

- Summer Base Flow: 10 ML/d from 13/11/2007 to 15/5/2008
- Summer Fresh: 100 ML/d for 6 days commenced 1/2/2010 including managed rise and fall rates
- Summer Fresh: 100 ML/d for 6 days commenced 1/3/2010 including managed rise and fall rates
- Summer Fresh: 100 ML/d for 6 days commenced 1/3/2010 including managed rise and fall rates
- **Total water deployed for the 2009-10 season: 4,115 ML**

The provision of the Inter-Valley Transfer allowed the North Central CMA to shift the management objectives for this reach of the Campaspe River from short-term survival aims to a longer-term approach, seeking to improve the health of this reach. The management objectives of the flow series were to:

- Improve water quality by reducing the surface salinity levels in the pools in the river
- Maintain aquatic vegetation
- Maintain habitat and re-instate slackwaters
- Provide longitudinal connectivity during the summer period
- Provide varying flow events for investigation of saline pool behaviour

  (SKM 2006a)

Additional losses of water from the provision of the IVT flows in the Lower Campaspe will be underwritten by DSE from transfers from the River Murray Flora and Fauna Bulk Entitlement.

The first summer fresh release on 1 February 2010 caused some concern that a Blackwater Event had been triggered. Field monitoring of the event observed that after the front of the fresh had been at a site for 2-3 days, the water become dark and murky resembling a Blackwater Event (Figure 5). In-situ field monitoring revealed that the DO sagged, but not to critical levels normally associated with a Blackwater Event. This is an indication of the risk associated with managing a stressed system and the challenges that will come when moving to recovery following extended periods of low flow. A key consideration of the decision to provide the fresh was the knowledge that sufficient water was held in reserve via the IVT to continue higher flows in need.

Field monitoring was intensified during this event. Two to three days after the discoloration of the water, the river water colour returned to normal and DO levels increased (Figure 5). This event was referred to the scientific panel for consideration and advice for future management (Section 4.5.3)

Friday 5 February 2010	
Upstream Reach – Strathallan	**Downstream reach- Cox Reserve**
	
Sunday 7 February 2010	
	

Figure 5 - 1st summer fresh photo monitoring. Photos on left hand side indicate how the water at upper site (Strathallen) became dark and murky 2 days after the arrival of the fresh front while at the lower site on the right hand side the water colour was still normal. After another 2 days, the waters discolouration had reversed with the lower reach becoming dark and murky, while the upper reach had cleared.

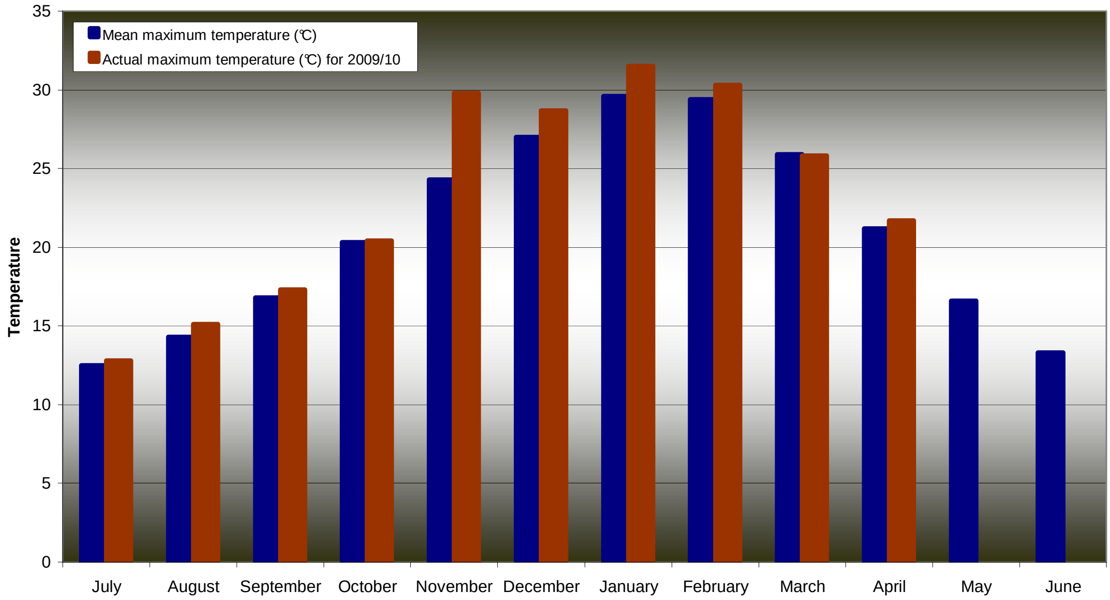
4.4 Climatic review

Rainfall conditions in the Campaspe System have been above average for the 2009-10 season. Rainfall over the February- March period have been significantly above average and this is providing some optimism that the 2010-11 season may commence with an improved water resource position. The rainfall has been reflected in Lake Eppalock's storage volume (excluding Coliban Water share*) as at 3 May 2010 of 4,775 ML in comparison to 2,358 ML held at the same time in 2009. While this is an improvement on the 2009 season, this volume only represents 1.6% of Lake Eppalock's storage capacity.

*Under the BE, Coliban Water has an 18% share of inflows into Lake Eppalock. Currently Coliban Water's share of the Storage capacity is inflated from water delivered through the Superpipe from the Goulburn System and stored in Lake Eppalock

Bureau of Meteorology mean monthly maximum temperature and rainfall for the 1991 to 2010 period and the actual mean monthly details for the water season at the Bendigo airport as an indicator of climatic conditions in the Campaspe catchment are presented in Figure 6. Mean monthly rainfall (1903 -2010) and temperature (1993-2010) for Redesdale and actual mean monthly details for Redesdale are presented in Figure 7. While Redesdale is outside of the Campaspe Environmental water area, it provides an indication of conditions in the upper catchment and likely inflows to Lake Eppalock.

Mean Monthly Temperature at Bendigo



Rainfall at Bendigo

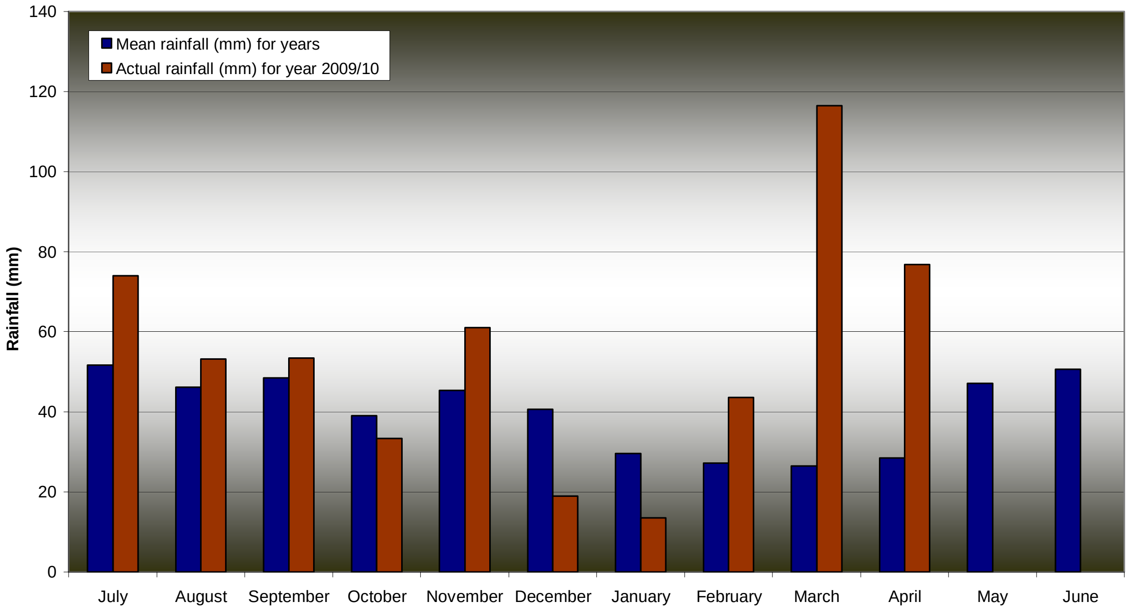
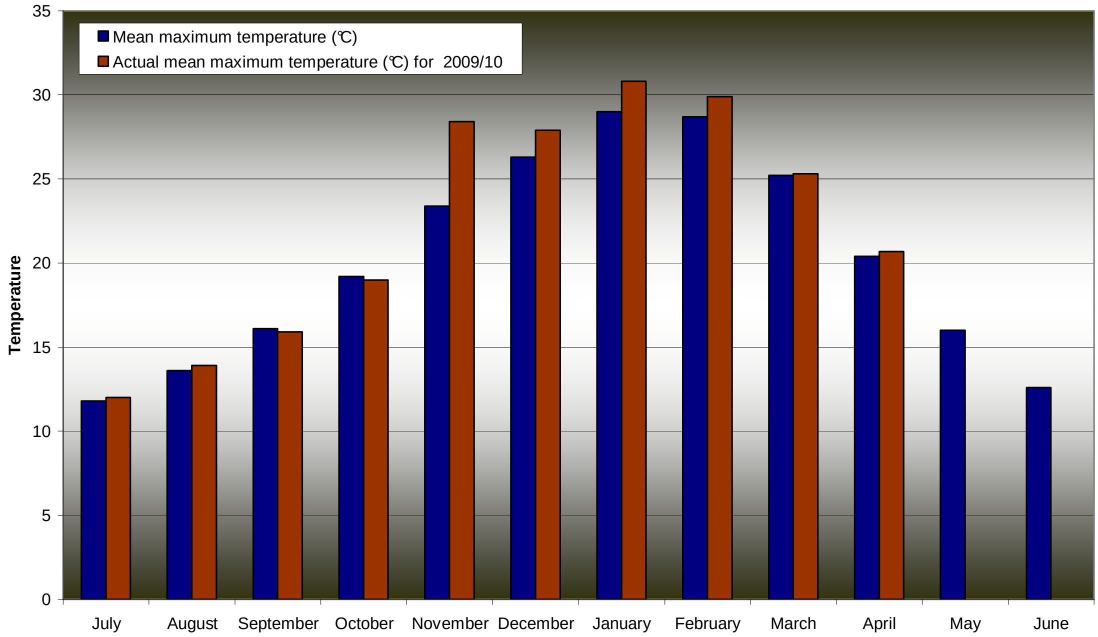


Figure 6 – Top, longer term mean maximum temperatures at Bendigo Airport between 1991 and 2010 (blue), and the actual monthly mean temperature during the 2009-10 season (brown)
Bottom, longer term mean monthly rainfall at Bendigo Airport between 1991 (blue) and actual monthly rainfall during the 2009-10 season (brown). (Bureau of Meteorology (www.bom.gov.au))

Mean Monthly Temperature at Redesdale



Rainfall at Redesdale

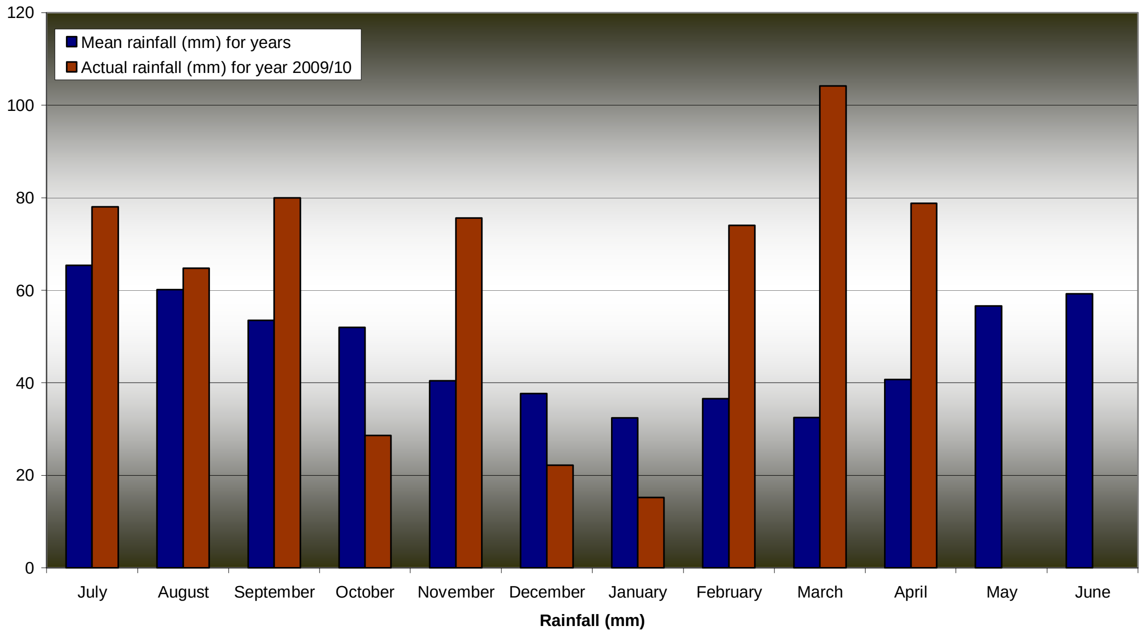


Figure 7 – Top, longer term mean maximum temperatures at Redesdale between 1903 and 2010 (blue), and actual monthly mean temperature for the 2009-10 season (brown).
Bottom, longer term mean monthly rainfall at Redesdale between 1903 (blue) and actual monthly rainfall for the 2009-10 season (brown). (Bureau of Meteorology (www.bom.gov.au))

4.5 Scientific Panel Advice

When approving the 2007-09 and 2010-11 Qualification, the Minister for Water and Climate Change directed the Water Corporations as beneficiary of the qualification, convene an independent scientific panel of environmental experts. The panel was to review the effectiveness of the water arrangements over the previous season and reassess environmental risks. G-MW in its capacity as resource manager for the Campaspe River system commissioned Peter Cottingham and Associates to conduct reviews for the 2008-09 and 2009-10 seasons. Before this, Lloyd Environmental was commissioned to review the 2007-08 season.

4.5.1 Scientific advice for 2007-08 Advice

Lloyd Environmental engaged Dr Andrew Sharp (Sinclair Knight Merz) and Dr Paul Humphries (Charles Sturt University) to conduct the season review. Previous advice commissioned by the North Central CMA was that fish assemblages are the most critical of all river values to preserve in drought. Therefore, water volume and quality in the refuge pools must be maintained if viable fish populations are to survive. Lloyd Environmental reviewed the season management, providing management advice for 2008-09 season. The focus of this advice was management actions required short term with no consideration for sustained drought conditions.

4.5.2 Scientific Advice for 2008-2009

Peter Cottingham and Associates convened a panel of scientific advisors to review the 2008-09 season. Members were Peter Cottingham, Tim Doeg, Paul Humphries, Lance Lloyd, Jane Roberts and Andrew Sharp. The panel built upon previous scientific advice solicited for the 2007-2009 qualification.

The new panel were engaged to provide specific advice in relation to on-going drought (rather than the short term focus of previous advice) and its impacts upon the Campaspe River system. The 2009 panel considered that the original advice was sound, that pool volume and water quality of refuge pools was the first priority to maintain native fish populations. However, some modification was required due to the continued low flow stress experienced by the river. The original advice assumed that the extreme conditions would only persist for one to two years. Therefore, a focus of the 2009 advice was the environmental risks in extended drought conditions and how to mitigate them. The panel developed the following overarching principles for management of the rivers system under extreme low flow conditions:

1. River pools are priority – best habitat and drought refuge, particularly for native fish populations
2. Maintain water quality for fish habitat
3. Then improve native fish food supply

The scientific panel considered the ecological implications commencing with ‘worse-case’ historical inflows, and then increasing water availability. After consideration of the extreme dry scenarios, the scientific panel prioritised water usage in the Campaspe River system, providing the following advice (Cottingham et al 2009):

- Maintaining baseflow along the upper sections of Reach 2, commencing in winter-spring and persisting for as long as possible where high quality deep pools exist.

- Maintaining or improving the volume and water quality in the weir pool of the Campaspe Siphon, which is recognised as a key refuge for biota (mainly fish and aquatic macrophytes) along the Campaspe River.
- Reinstating baseflow along the entire length of Reach 2.
- Delivering freshes in early spring-summer, particularly to Reach 2 to improve habitat quality and provide life cycle cues for biota (macroinvertebrates).
- Reinstating baseflow along Reach 3 (and into Reach 4).
- Assuming summer Inter-valley Transfers are available, increase baseflow and deliver freshes along reach 4 in winter.

The advice from the scientific panel is pertinent and guides the North Central CMA's management of the river during the drier scenarios.

4.5.3 Scientific Advice for 2010-2011

Peter Cottingham and Associates convened a panel of scientific advisors to review the 2009-10 season. Panel members were Peter Cottingham, Mike Stewardson, Paul Humphries, Jane Roberts, Simon Treadwell, Nick Bond, Tim Doeg, Alison King and Lance Lloyd.

In previous years, Scientific Panel advice has focused on a range of potential flow scenarios, including a worst-case (continued record low inflows) and then scenarios of increasing water availability. This advice was critical in the planning completed in the previous Annual Water Plan and for the extreme dry scenarios in this plan.

Storages are still at very low levels resulting in no irrigation allocations for the system. In comparison to previous years, there is an improvement in the water resource position and rainfall, and the federal government buy-back of water (Section 3.2) raises the prospect of more water being available to the environment. Therefore there are improved prospects for management aims moving from existing survival, and undertaking some recovery actions. The advice sought for the Campaspe River system was:

- Review the 2009-10 river management and system response to determine if any new learnings have been gained.
- Develop previous advice for the delivery of freshes, including a consideration of whether a fresh is to be delivered in Spring to 'prime' the river for later in the summer

The Panel recommended, should water resources permit, a fresh should be delivered earlier (e.g. September-October) rather than later in the water year (summer-autumn), as the release of a fresh in spring is likely to better match antecedent climatic conditions, such as air pressure, temperature and humidity (Cottingham et al 2010). A winter-spring fresh will reduce organic load in the river channel, reducing the risk of triggering a Blackwater event. Should there be insufficient water resources to deliver a winter-spring fresh, then delivery of summer freshes should be cancelled, or at least postponed until there is sufficient water available to maintain baseflow for long enough to allow the risk of Blackwater to dissipate/recover along the length of the river. There needs to be sufficient follow-up water available to overcome localised sags in DO. Maintaining flows following freshes helps draw higher oxygenated water through the system and dilute the lower DO water generated by the initial increase in the hydrograph (Cottingham et al 2010).

It is important to note that the release of this fresh will only reduce the organic load in channel and therefore mitigate the risk of a Blackwater Event occurring from a simulated fresh event. Should there be sufficient rainfall during the year that generates flow in the dry tributaries such as the Axe and McIvor Creeks, these tributaries will entrain a significant organic load into the Campaspe River and are likely to trigger a Blackwater Event.

Due to the poor state of the Campaspe fish population, any fresh delivered to reaches 2 and 3 is unlikely to meet any fish based objectives for recruitment. Management consideration of the fresh objectives therefore should be based around maintaining water quality and providing refuge habitat for biota such as fish and invertebrates. However, as reach 4 is connected to the Murray River, maintaining baseflows and introducing freshes (especially in spring) may attract fish and so increase abundance and diversity of the fish population in this reach.

5. Annual Watering Plan by scenario

The seasonally adaptive management plan for the lower Campaspe River is based on the Northern Victorian Dry Inflow Contingency Plan (DICP) that the Department of Sustainability and Environment requested Water Corporations develop. In contrast to previous DICPs, this years plan has been formulated to plan for the worst-case scenario through to a season with a 100% irrigation allocation. The scenarios were developed in January 2010 based upon 119 years of inflow statistics held. The plan details the proposed management actions for each scenario, it does not imply the probabilities of each scenario occurring.

The use of contingency planning in the formation of the North Central CMA's Annual Watering Plan ensures that a wide range of scenarios from drought to a wet year for the coming season are included. Using the scenarios, the Annual Watering Plan will have an adaptive management framework for the management of the environmental water for the likely challenges for the 2010/11 season.

The overall aim of the Annual Watering Plan is to ensure that the Environmental Water Reserve for the 2010/11 season is adequately planned, covering a range of possibilities from drought through to a year with an irrigation allocation of 100% or greater. Additionally environmental water held by the Commonwealth Environmental Water Holder and The Living Murray is considered. The use of the Dry Inflow Contingency Plan provides a range of possible outcomes. Conditions could range from extremely dry, through to above average rainfall for the year. The examination of each scenario allows consideration and the development of an appropriate management response. Thus, the use of the scenarios in the plan allows the exploration of the possible flows in the river, Goulburn-Murray Water's management and the planned response for the North Central CMA. The scenarios define how the North Central CMA wish to manage under specific water resource availability possibilities and highlight how management should change as more water becomes available. The scenarios are not meant to be prescriptive, rather setting broad management principals and targets to guide the North Central CMA as the season unfolds.

The development of the five possible scenarios and the planned environmental water management are detailed in Sections 5.1 to 5.5. The plan has been expanded this year to consider other environmental water held by the Commonwealth Water Holder and The Living Murray. Due to the Qualification of Rights, environmental water becomes available at set trigger points, resulting in step changes for water availability (Figure 8). As the more water becomes available, more management options for the use of environmental water also become available. This has some correlation with the Northern Victorian Sustainable Water Strategy's (NSWS) targeted category approach (Figure 9). Each category sets a longer-term average of the objectives that management is aiming to achieve. In the earlier categories, management actions are to provide base flows for drought refuge where possible. As more water becomes available, additional flow components are provided, building upon those already delivered and seeking better environmental outcomes for the river.

The scenarios in this water plan follow a similar pattern of water availability. The NSWS categories are a generalised approach designed for application to a number of river systems across northern Victoria. The scenarios in the water plan are more specialised and for application to the Campaspe River only.

Schematic overview of planning scenarios and increasing environmental water availability

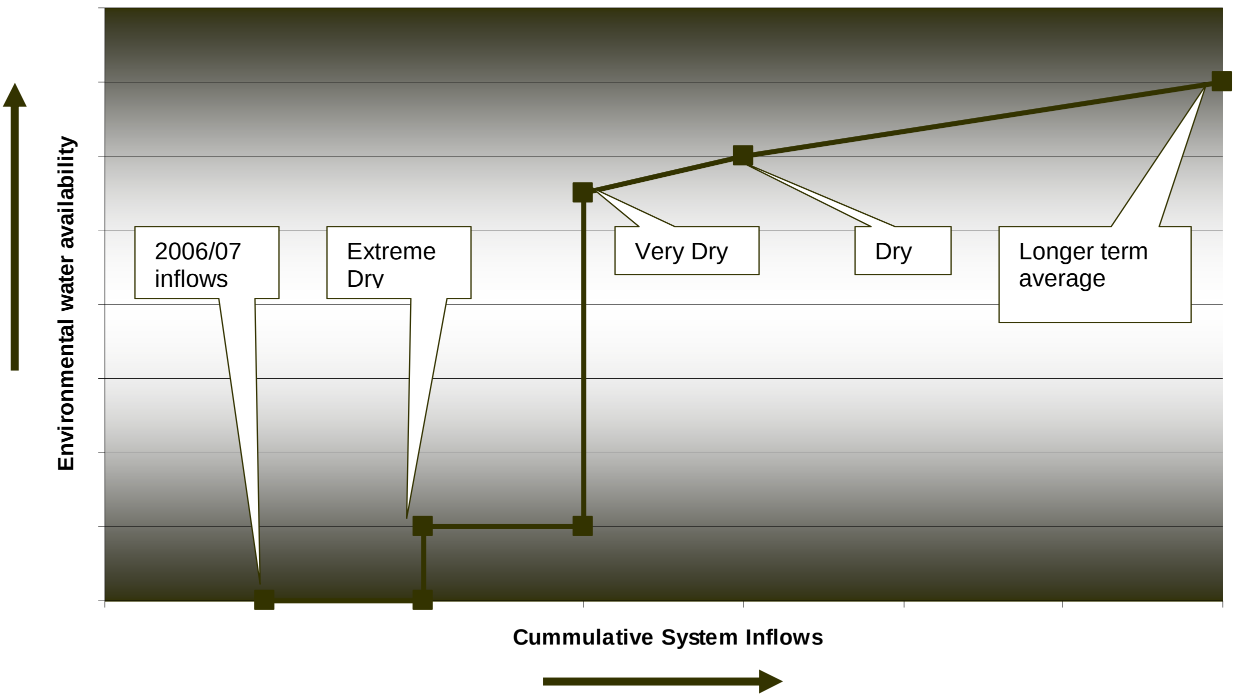


Figure 8 – Conceptual overview of planning scenarios, system inflows and environmental water availability under the current ministerial qualification of rights

RIVER SYSTEMS (IN-STREAM)

	Environmental outcome	Flow component
4	Sustainable population of all in-stream species	Category 3 plus bankfull flows
3	Sustainable population of priority in-stream species	All summer and winter minimums and freshes at recommended frequency
2	Protection of drought refuge plus dry spell breaking	Summer minimums throughout the year and every third year deliver winter minimums and freshes
1	Protection of drought refuge	Baseflows

Figure 9- Northern Sustainable Water Strategy targeted categories for environmental water (NSWS 2009)

5.1 Scenario 1 – Drought

This is the worst possible scenario for the Campaspe River, a repeat of similar inflows received in the 2006-2007 year, which were record low inflows for the Campaspe System. This level of inflows would result in G-MW storage capacity being insufficient to provide full critical human needs after all identified changes to operations to conserve water have been implemented. Zero irrigation allocation and no stock and domestic releases result in no flows being released to the river. To meet critical human needs, the Campaspe Weir is likely to be pumped and there will be extensive carting of rural stock and domestic supplies.

Under this scenario, to reduce operation losses, G-MW's planned management of the river is for a small stock and domestic release to reach two only. Due to insufficient water, flow will be provided as far as the Campaspe Weir until the end of December only. There is no environmental water available, and reach 2 will cease to flow from January onwards and contract to a series of isolated pools. This upper part of the reach of the river has some deep pool habitats and provided water quality does not deteriorate, should support fish populations. As previously identified, these populations are essential for re-colonisation of the reach once flows are returned to the river. It is important that these pool habitats are identified and where possible protected as refuge for the fish population. These refuge pools may come under considerable angler pressure with the remainder of the river essentially dry. In consultation with the community, local anglers and VR Fish, consideration needs to be given to a public educational program to convey the importance of these populations along with further consideration of temporary fishing moratoriums.

Reach 3 will have no flow for the whole year and will contract to a series of isolated pools. Water quality in the lower end of reach 3 may become a problem with elevated salinity from groundwater intrusion in the deeper pools that exist in the lower reach. Reach 4 will have no flow and contract to isolated pools. Water quality is expected to be highly saline and possibly with low dissolved oxygen. The pools salinity is likely to be in the range of 5,000 to 15,000 EC at the surface and 10,000 to 15,000 EC at depth. This will reduce the quantity and quality of available fish habitat. This reach has a large Murray Cod population, along with other fish species and will be placed at risk due to deteriorating water quality. Management action will be to identify and where possible, protect and monitor deep refuge pools as critical habitat for fish populations to provide for re-population of the river after the drought.

The Inter-valley Transfer will be deployed to reach 4 should it be available. The provision of the Inter-valley transfer is dependant upon factors outside of the Campaspe River system. Sales of water from the Goulburn to the Murray System, agreement with Goulburn Murray Water and the Murray Darling Basin Association, plus water sourced from the Murray Flora and Fauna entitlement to underwrite losses are all required if the IVT is to be made available.

Commencement of the summer base flow should be initiated as early as possible, before the salinity levels have increased to equate with that of the groundwater. The availability of the Inter-Valley Transfer allows the longer-term desirable summer flow regime to be provided and limits the impact of low winter/spring drought flows. A summer base flow of 10 ML/d plus the provision of three summer freshes of 100 ML/d for six days are to be deployed (SKM 2006a).

The lack of any flows in the Campaspe River will see the fish population in the river placed under considerable pressure. Water levels in the refuge pools will reduce over the high risk summer period, mainly through evaporative losses but also through seepage. Water quality in the remaining refuge pools will decline and there is a high probability of fish deaths.

The environmental water available, likely flows and their impact on the river, and the environmental responses and management objectives are summarised in Table 2. Management actions are consistent with Northern Sustainable Water Strategy category 1 of protecting drought refuge

Table 2 - Summary of Scenario 1 - Drought

Scenario	Reach No.	Qualification Rule	G-MW Management	Impact on river	Management Objec
DROUGHT (repeat of inflows similar to 06/07 inflows)	2	• Zero irrigation allocations • Eppalock Passing Flow account not available - no environmental releases	• No Irrigation flow released • Small steady stock and domestic flow release from Eppalock until December only • Carting essential supplies for rural and urban • Pumping from Campaspe Weir pool and harvesting local tributary flows	• Reach cease to flow from January onwards • Deep river pools immediately below Lake Eppalock water level maintained until beginning of January • Reach contracting to a series of isolated pools with falling water levels from January • Lower reach river pools and Campaspe weir pool water levels falling over season • No unregulated flows and therefore lack of base flows, freshes and other flow components	• Maintain deep pools in upper pa critical fish refuge habitat for as
	3	• Zero irrigation allocations • Eppalock Passing Flow account not available - no environmental releases	• No flows released from Campaspe Weir pool • Pumping from Campaspe Weir pool and any upstream flows harvested in Campaspe Weir pool • Carting of essential supplies (rural domestic and stock & urban)	• Reach ceases to flow for whole year • Reach contracts to a series of isolated pools with falling water levels over the year	• Maintain pools as critical fish ref the whole of reach 3
		• Zero irrigation allocations • Eppalock Passing Flow account not available - no environmental releases	• No flows released below Campaspe Siphon • Carting of essential supplies	• River ceases to flow • River contracts to a series of isolated pools with falling water levels over the year • High salinities (5,000 to 15,000 EC) in river pools and probably	• Maintain pools as critical fish ref the whole of reach 4 **<u>If IVT is available:</u>** **Provide summer base flow to:**

5.2 Scenario 2 – Extreme Dry

This scenario is similar to the 2009-10 season and inflows have a 93% probability of exceedance under the Northern Victoria Dry Inflow Contingency Plan. In comparison to historical records, this is equivalent to the driest 7 years of inflows into the system. G-MW will have sufficient resources to provide stock and domestic supplies and delivery of irrigation carry over, but a general irrigation allocation is not possible. System inflows will exceed 6,500 ML, releasing 1,000 ML from the Eppalock Passing Flows Account for deployment by the North Central CMA. This is the first scenario in which environmental water for the Campaspe River System becomes available.

The stock and domestic flow in reach 2 should maintain a connected river to the Campaspe Weir maintaining the previously identified deep pool habitats. G-MW operations should provide sufficient flow to maintain the pools water level and provided water quality does not deteriorate, these pools should support fish populations through the season. Should water quality deteriorate in this reach, then the availability of the Eppalock Passing Flows Account allows water to be pulsed as per Section 7. Experience indicates that pulsing flows become less effective the further downstream of the release point due to the lag time in getting the water to the required pool. Pulses will be more effective immediately below Lake Eppalock and therefore should protect the identified deep pool refuges.

Reach 3 may receive occasional lows flows for stock and domestic demand. The reach will cease to flow and contract to a series of isolated pools with declining water quality due to groundwater intrusion in the lower reach. Similar to the 2009-10 season, the management option is to provide a pre-emptive flow of 5 ML/d to maintain the water levels in the pools preventing water quality decline. This option also provides a number of other positive outcomes for the river. It will increase the low flows in reach 2 as the water is delivered to the Campaspe Weir for release to reach 3. At this level of release, the water will traverse the entire reach to assist to maintain the Campaspe Siphon weir pool, an area of high environmental values. Any flow that spills over the Campaspe Siphon will provide small flows to upper reach 4 or to assist reduce losses should the IVT be delivered.

Reach 4 below the Campaspe Siphon is unlikely to receive any flow from G-MW's operations. While carry over is available for the Campaspe System, it is likely that G-MW will announce that it cannot be delivered in the reach. Additionally stock and domestic release are also unlikely. Salinity is expected to be high and possibly with low dissolved oxygen levels. The saline pools salinity is likely to be in the range of 5,000 to 15,000 EC at the surface and 10,000 to 15,000 EC at depth. This will reduce the quality and availability of suitable fish habitat. There are 2 management options for this reach. The pre-emptive flows release of 5 ML/d from the Campaspe Weir is likely to spill over the Siphon providing a small flow (~3 Ml/d) in reach 4. In the absence of an IVT release, this flow may maintain the river pools in the upper reach only. Lower in the reach, the river is likely to contract to a series of pools with declining water quality. Should the IVT be available, then the summer eflow recommendations will be delivered and the flow from reach 3 will reduce any losses associated with the IVT use.

The Inter-Valley Transfer will be deployed to reach 4 should it be available. Experience from previous seasons indicates that the commencement of the summer base flow should commence as soon as possible and early in the season to prevent further water quality decline and to reduce losses. The availability of the Inter-Valley transfer allows the longer term desirable summer flow regime to be provided and limits the impact of winter/spring drought flows. A summer base flow of 10 ML/d plus the provision of three summer freshes of 100 ML/d for six days are to be deployed (SKM 2006a).

The environmental water available, likely flows and their impact on the river, and the environmental responses and management objectives are summarised in Table 3. Management actions are consistent with the Northern Sustainable Water Strategy category 1 of protecting drought refuge.

Table 3 - Summary of Scenario 2- Extreme Dry

Scenario	Reach No.	Qualification Rule	G-MW Management	Impact on river	Management Objectives
93% probability of exceedance of inflows	2	• Zero irrigation allocations • Eppalock Passing Flow Account available (capped at 1,000 ML) • Carry over available for delivery	• Possible small carry over delivery flows • Stock and domestic flow to the whole of reach	• G-MW's flows should maintain connection of reach to the Campaspe Weir • River largely a series of pools, but stock and domestic flows will keep pools topped up • Possible small winter/spring natural inflows	• Maintain pool volume and water c principally dissolved oxygen level population survival in reach 2
	3	• Zero irrigation allocations • Eppalock Passing Flow Account available (capped at 1,000 ML) • Carry over available for delivery	• Carry over delivery flow may not be deliverable in this reach	• River will contract to a series of isolated pools with falling water levels over the year	• Maintain pool volume and water c principally dissolved oxygen level population survival in Siphon weir • Maintain pool volume and water c principally dissolved oxygen level population survival in reach 3
	4	• Zero irrigation allocations • Eppalock Passing Flow Account available (capped at 1,000 ML) • Carry over available for delivery	• Carry over delivery flow may not be deliverable in this reach	• River will contract to a series of isolated pools with falling water levels over the year • High salinities (5,000 to 10,000 EC) in river pools and probably low dissolved oxygen	• *Maintain deep pools as critical fis habitat in reach 4* ***<u>If IVT is available:</u>*** *Provide a summer base flow to* o *Maintain aquatic vegetation* o *Maintain fish habitat and crea water habitat* o *Maintain Water quality*

5.3 Scenario 3 - Very Dry

This scenario is defined as a 92% probability of exceedance inflow under the Northern Victoria Dry Inflow Contingency Plan. Under this scenario, inflows of 13GL will result in a 1% general irrigation allocation and provision of stock and domestic water supplies from Lake Eppalock to the Murray River. The trigger point of 1% irrigation allocation results in the full Eppalock passing flow account being available for deployment by the North Central CMA. Passing flows are not necessarily released, but stored in the account and can be deployed at any time as required. The ability under the QoR to store the flows and release when required provides additional flexibility over operations under the BE.

Stock and domestic flows will provide a small base flow in reach 2 of the river for the entire year. Releases for delivery of carryover and the general allocation will see higher flows in the irrigation season of up to 100ML/d. The reach will also benefit from some winter/spring flushes from local catchment runoff after rainfall events and this will provide additional flows during the winter period when stock and domestic releases may be low. Based upon the scientific panels' advice, a late winter-spring fresh is a priority for this reach. In addition to the other objectives, the principal objective is to clean the river of organic material and other nutrients after the winter low flows, in effect readying the river or priming for the summer higher flows. The winter-spring fresh should assist with water quality issues later in the season, in particular a Blackwater Event. The provision of the fresh is dependant upon sufficient inflows early in the season to trigger the 1% allocation and access to the full Eppalock Passing Flow Account. Should there be insufficient inflows early in the season, then the late winter-early spring window of opportunity may pass. The fresh cannot be delivered after the beginning of December, as it will have a detrimental effect on the small-bodied fish in the river with the higher flow washing juveniles out of slack water nursery habitats (SKM 2006, SKM 2007).

Reach 3 may receive occasional lows flows for stock and domestic demand. At this level of allocation, only limited releases for irrigation supply is expected. The reach will intermittently cease to flow and contract to a series of isolated pools with declining water quality due to groundwater intrusion in the lower reach. The late winter-spring fresh delivered to reach 2 is to be continued over the Campaspe Weir and through reach 3. This fresh has the same objectives, to prime the reach for the summer period and prevent water quality issues later in the summer. Following on from the fresh, a pre-emptive summer base flow of 10 ML/d is to be delivered to this reach when G-MW are not releasing for the irrigation. This flow will ensure that the reach receives a continuous summer base flow to prevent water quality decline. Outside of the irrigation season, pulse flows in response to deteriorating water quality as a short-term objective to enable the survival of the reach are to be released. Experience indicates that pulsing flows will be effective in improving water quality in the river, but have little effect in the Siphon Weir pool.

Reach 4 may receive some flow due to stock and domestic requests, but at this allocation level, releases for irrigation demand are expected to be limited. Salinity is expected to be high and possibly with low dissolved oxygen levels. Over summer the river pools salinity is likely to be in the range of 5,000 to 15,000 EC at the surface and 10,000 to 15,000 EC at depth, reducing the quantity and quality of fish habitat in the reach. As per the scientific panel's advice, should resources permit, then a late winter-early spring fresh is to be provided to the reach. Water required will be provided from the Eppalock Passing Flows Account should early season inflows trigger account availability. The fresh is to commence from Lake Eppalock and traverse the entire river to reach the Murray. A pre-emptive base flow of 10 ML/d is to be provided to the reach over the high risk summer period. This may required more than 10 ML/d to be released from the Campaspe weir to cover losses in reach 3 before the flow enters reach 4. In the February to May period, 3 summer freshening flows of 100 ML/d are to be provided. Should the late winter-early spring fresh have been provided, then only 2 freshes are required over this period. Releases can be made at other times should water quality decline placing the native fish populations at risk.

Under this scenario, the environments reliance upon the IVT is diminished, but not eliminated. The volume of water available in the Eppalock passing flows account is sufficient to provide the pre-emptive base flows and required freshes to the entire river system. The river is starting to be managed more holistically as a continuous river rather than disjunct reaches with flow release at Eppalock, traversing the entire system to the Murray River. However, should the volume in the Eppalock Passing Flow Account be insufficient to make these releases up stream, then the IVT will be used to provide these flow in reach 4.

The environmental water available, likely flows and their impact on the river, and the environmental responses and management objectives are summarised in Table 4. Management actions are consistent with Northern Sustainable Water Strategy category 2, providing summer minimum flows to protect drought refuges and provide dry spell breaks.

Table 4 - Summary of Scenario 3 - Very Dry

Scenario	Reach No	Qualification rule	G-MW Management	Impact on river	Management Objectives
92% probability of Exceedance Inflow	2	• 1% estimated irrigation allocation • Eppalock Passing Flow Account available ~5,500 ML	• Small releases for stock and domestic and pulsed higher flows during irrigation season	• Base flow maintained all year with higher Irrigation flow up to 100 ML/d during summer • Some winter/spring flushes from local catchment runoff and regular low summer flows maintain pool habitat and some connectivity	• Maintain water quality principally dissolved oxygen for fish population survival • Provide late winter-spring fresh to prime reach for summer and reduce channel organic load • Provide 2 (3 if late winter-spring fresh is no delivered) summer-autumn freshes if comparable flow not provided by G-MW operations to : o Maintain riparian and in-channel recruitment vegetation o Provide longitudinal connectivity o Flush and mix pools o Inundate additional snags and flush sedimen off biofilms
	3	• 1% estimated irrigation allocation • Eppalock Passing Flow Account available ~5,500 ML	• Occasional pulse releases from Campaspe Weir to supply irrigation needs	• Generally no flow, but with occasional pulses • River contracts to a series of isolated pools for much of year	• Maintain water levels and water quality in pools, principally dissolved oxygen for fish population survival • Provide late winter-spring fresh to prime reach for summer and reduce channel organic load • Provide 2 (3 if late winter-spring fresh is no delivered) summer-autumn freshes if comparable flow is not proved by G-MW operations or rainfall events to: o Maintain riparian and in-channel recruitment vegetation o Provide longitudinal connectivity o Flush and mix pools o Inundate additional snags and flush sediments off biofilms
		• 1% estimated irrigation allocation • Eppalock Passing Flow Account available ~5,500 ML	• Some pulse releases past Campaspe Siphon to supply irrigation needs	• Without IVT, generally no flow, but with some pulses • River contracts to a series of	• Maintain water quality principally dissolved oxygen for fish population survival • Provide late winter-spring fresh to prime

5.4 Scenario 4 – Dry

This scenario is defined as an 85% probability of Exceedance Inflow under the Northern Victoria Dry Inflow Contingency Plan. Inflow of 23.3 GL to the Campaspe System will result in a general allocation of 30%. Full access to the balance of the Eppalock Passing Flows account is available for deployment. Passing flows are not necessarily released, but stored in the account. Stock and domestic demand will be provided by G-MW. Irrigation flows will be highest in reach 2 with perhaps pulse releases in reaches 3 and 4 for irrigation demand. In addition to environmental water available under the Campaspe QoR, 5,100 ML will also be held by other agencies and is included to provide additional benefit to the Campaspe River.

The available water provides the opportunity for multiple management actions to be implemented at all reaches and the river can be managed in a continuous manner rather than a disjunct reaches.

At this level of allocation, irrigation flows will be delivered in reach 2 and may peak at 100 ML/d or more during peak demand periods. At this level of inflows, there will need to be useful inflows into the system in the late winter-early spring period. As detailed in the previous scenarios, a key objective is to provide a late winter- early spring fresh to prime the river for later in the summer. The river may receive this naturally from catchment runoff. Should this not eventuate, then a managed release will be required. This fresh of 100 ML/d for 6 days is to traverse the entire system and travel through reaches 3 and 4 to the Murray River. G-MW operation should maintain flow in reach 3 for the duration of the irrigation season. During the February to May period, 3 summer freshes (2 if a fresh has been delivered in late winter-early spring) of 100 L/d for 6 days are to be provided to the river. These freshes will be delivered from Eppalock to flow the entire length of the river through reaches 3 and 4. These releases will not be required if comparable flows are provided by G-MW releases for irrigation.

During the summer period, flow in the river will be primarily driven by G-MW operations. Base flows are to be provided consistent with the environmental flows recommendations. In effect, releases from the environmental reserve will be required to maintain the minimum summer flows between G-MW operational releases. It is anticipated that this will not be required in reach 2 due to consistent irrigation demand. In reaches 3 and 4, there will be small releases by G-MW for stock and domestic and occasional higher pulses to meet irrigation demand. In these reaches, the water is to be released when G-MW flows fall below the summer base flow of 10 ML/d to ensure that water quality does not deteriorate.

At other times outside of the irrigation seasons, should water quality decline in any reach then a pulse releases are to be made. This management option is more effective closer to the release point due to lag time required for the flow to travel down the reach to reach the location of the water quality problem. Flow during the irrigation season should maintain water quality with the result that this option will only be required during the winter period when water quality problems are less likely to occur.

The management considerations so far have only utilised environmental water that is under the direct management of the North Central CMA. An irrigation allocation of 30% would result in approximately 5,100 ML of environmental water being available under the Commonwealth Environmental Water Holder and the Living Murray control. The North Central CMA's preference for this water would be providing winter base flows of 100 ML/d in the river system. Due to timing issues, it may be necessary to carry over this water to the next season and provide the flows in the 2011/12 season. During the ongoing critical water shortage, the river has not received the important winter flow components necessary for the river's ecology and are reflective of a natural flow regime for the Campaspe River. Under this scenario inflows and the associated higher river flow could be supplemented from the environmental water to provide the winter base flows for much of the winter period.

The environmental water available, likely flows and their impact on the river, and the environmental responses and management objectives are summarised in Table 5. Management actions are consistent with Northern Sustainable Water Strategy category 2 providing summer minimum flows and some winter flows to protect drought refuges and provide dry spell breaks.

Table 5 - Summary of Scenario 4- Dry

Scenario	Reach No	Qualification rule	G-MW Management	Impact on river	Management Objectives
85% probability of Exceedance Inflow	2	• 30% estimated irrigation allocation • Eppalock Passing Flow Account available ~5,500 + ML	• River flows of 10 to 100 ML/d released to supply irrigation and domestic and stock water use throughout the year	• Irrigation flow of approximately 40 ML/d for most of summer increasing up to 100 ML/d during peak demand • Some winter/spring flushes from local catchment runoff and regular low summer flows maintain pool habitat and some connectivity	• Maintain water quality principally dissolve oxygen for fish population survival • Provide late winter-spring fresh to prime reach for summer and reduce channel organic load • Provide summer-autumn freshes to: o Maintain riparian and in-channel recruitment vegetation o Provide longitudinal connectivity o Flush and mix pools o Inundate additional snags and flush sediments off biofilms
		Other environmental water that may be available at this allocation - 5,100 ML			
					• Provide winter low flow o Provide longitudinal connectivity o Maintain access to riffle habitat and maintain water quality for macroinvertebrates o Maintain permanent connecting flow for water quality o
		• 30% estimated irrigation allocation • Eppalock Passing Flow Account available ~ 5,500	• Steady base flow and occasional pulse releases from Campaspe Weir to supply irrigation needs	• Generally small baseflow, but with occasional pulses	• Maintain water quality principally dissolve oxygen for fish population survival • Provide summer base flow to : o Maintain aquatic vegetation o Maintain fish habitat and create slac water habitat o Maintain water quality o Maintain macroinvertebrate habitat • Provide late winter-spring fresh to prime reach for summer and reduce channel organic load • Provide summer-autumn freshes to: o Maintain riparian and in-channel

	Reach	Qualification Rule	G-MW Management	Impact on river	Management Objectives
	4	• 30% Estimated irrigation allocation • Eppalock Passing Flow Account available ~5,500 ML)	• Occasional pulse releases past Campaspe Siphon to supply irrigation needs	• Without IVT, generally no flow, but with occasional pulses • River contracts to a series of isolated pools for much of year • Fluctuating salinities up to 10,000 EC in river pools and probably low dissolved oxygen	• Maintain water quality principally dissolve oxygen for fish population survival • Provide summer base flow to : o Maintain aquatic vegetation o Maintain fish habitat and create slac water habitat o Maintain Water quality o Maintain macroinvertebrate habitat • Provide late winter-spring fresh to prime reach for summer and reduce channel organic load • Provide summer-autumn freshes to: o Maintain riparian and in-channel recruitment vegetation o Provide longitudinal connectivity o Flush and mix pools o Inundate additional snags and flush sediments off biofilms • Provide freshes to: o Maintain riparian and in-channel recruitment vegetation o Provide longitudinal connectivity o Provide cue for fish movement from Murray River o Flush and mix pools o Inundate additional snags and flush sediments off biofilms
		Other environmental water that may be available at this allocation - 5,100 ML			
					• Provide winter low flow o Provide longitudinal connectivity for fish o Maintain aquatic habitat for macroinvertebrates o Maintain permanent connecting for flow for water quality

5.5 Scenario 5 – 100% or Greater Irrigation Allocations

This scenario is defined as 55% probability of exceedance under the Northern Victorian Dry Inflow Contingency Plan. 55 GL of inflows into the Campaspe System would result in a general irrigation allocation of 100%. At this level of allocation, passing flows required under the BE are returned to reaches 2 and 4 and water previously accrued in the Eppalock Passing Flows Account is available for deployment under advice from the North Central CMA.

The management options for this scenario take those deployed under the dry (scenario 4) and build additional flows into the river from the greater resource position. Reach 2 of the river will have passing flows of 10 ML/d 'or natural' restored under the Bulk Entitlement. Irrigation flow will be in excess of 100 ML/d depending upon demand during the irrigation season and as such will be in excess of the environmental flow recommendations. Due to the use of this reach as an irrigation conduit, there is limited management flexibility for environmental flows. There is little environmental value in providing more water in the summer period. Reach 3 does not have passing flow requirements, however water will need to traverse this reach to meet passing flow requirement of 20 ML/d or natural July to November and 35 ML/d or natural December to June in reach 4. Irrigation releases for reach 3 and 4 will be pulsed to meet customer demand but will not be the same magnitude as those in reach 2.

Based upon the scientific panels' advice, a late winter-spring fresh is a priority for this reach. In addition to the other objectives, the principal objective of this flush is to prime the river after prolonged low flows to prevent water quality issues later in the summer. Substantial inflows will be required for a 100% irrigation allocation and the fresh may be provided by catchment runoff. Should this not eventuate, then a managed release will be required. This fresh of 100 ML/d for 6 days is to traverse the entire system, however; and should there be insufficient inflows early in the season, then the late winter-early spring window of opportunity may past. The fresh cannot be delivered after the beginning of December as it will have a detrimental effect on the small bodied fish in the river with the higher flow after November washing juveniles out of the slack water nursery habitats (SKM 2006, SKM 2007).

G-MW operations and passing flows required for reach 4 should maintain flow in reach 3 for the duration of the irrigation season. During the April to May period, 3 summer freshes (2 if a fresh has been delivered in later winter-early spring) of 100 ML/d for 6 days are to be provided to the river. These freshes will be delivered from Eppalock to flow the entire length of the river through reaches 3 and 4. These releases will not be required if comparable flows are provided by G-MW releases for irrigation.

At other times outside of the irrigation season, should water quality decline in any reach, then a pulsed release is to be made. This management option is more effective closer to the release point due to lag time required for the flow to travel down the reach to reach the location of the water quality problem. Flow during the irrigation season should maintain water quality with the result that this option will only be required during the winter period when water quality problems are less likely to occur.

The management considerations so far have only considered environmental water that is under the direct management of the North Central CMA. An irrigation allocation of 100% would result in approximately 17,000 ML of environmental water being available under the Commonwealth Environmental Water Holder and The Living Murray control. In the previous scenario, the North Central CMA preference for this water was to provide winter base flows of 100 ML/d in the river system. During the winter period, G-MW will deliver small flows to meet stock and domestic demand only. To provide the maximum benefit to the Campaspe River, the North Central CMA's preference for the additional water is the delivery of 2 winter high flow events of 1,500 ML/d for 4 days in addition to the winter base flows. Reach 2 only requires a magnitude of 1,000 ML/d under the environmental flow recommendations. The higher magnitude of 1,500 ML/d has been chosen as a flow of 1,000 ML/d from Lake Eppalock, after losses will reduce in magnitude and not meet the objectives in the lower system. It is likely due to timing issues that one of the winter high flow events may need to be carried over for delivery in the 2011-12 season.

Management objectives under this scenario are to move from short-term survival to the longer-term recovery of the river after a high stress period. Flows to reach 4 are to be provided by the Inter-Valley Transfer to add to flows from upstream to allow the Eppalock Passing Flow Account to be used in the upper reaches, maximising efficiency of the available water.

The environmental water available, likely flows and their impact on the river, and the environmental responses and management objectives are summarised in Table 6. Management actions are consistent with Northern Sustainable Water Strategy category 3 providing all summer and winter minimum flows for sustainable populations instream.

Table 6 - Summary of Scenario 5 – 100 % irrigation allocations

Scenario	Reach no	Bulk Entitlement Rule	G-MW Management	Impact on river	Management Objectives
55% probability of Exceedance	2	• Irrigation allocation of 100% • Minimum passing flows released (no longer stored) based upon Lake Eppalock Storage volume • Eppalock Passing Flow Account available ~5,500 ML	• Full irrigation flows • Passing flows returned to reach based upon inflows and storage volume of Lake Eppalock	• Irrigation flow of up to 100 ML/d • Passing flow of 10 ML/d or natural • Winter/Spring high flow events from rainfall	• Maintain water quality principally dissolved ox for fish population survival • Provide late winter-spring fresh to prime reach summer and reduce channel organic load
		Other environmental water that may be available at this allocation – 17,000 ML			
					• Provide winter low flow o Provide longitudinal connectivity for fish o Maintain aquatic habitat for macroinverte o Maintain permanent connecting for flow water quality • Provide winter/spring high flow to: o Reduce encroachment of exotics and te vegetation o Enhance River red gum recruitment o Cue fish movement and allow movemen downstream reaches o Flush and mix pools for water quality an macroinvertebrates
	3	• Irrigation allocation 100% • Eppalock Passing Flow Account available ~5,500+ ML	• Full irrigation flows	• Irrigation flow of up to 20 ML/d • Residual flows from reach 2	• Maintain water quality principally dissolved ox for fish population survival • Provide late winter-spring fresh to prime reach summer and reduce channel organic load • Provide 2 summer-autumn freshes to: o Maintain riparian and in-channel recruitn vegetation o Provide longitudinal connectivity o Flush and mix pools o Inundate additional snags and flush sedi off biofilms • Provide winter low flow

	Reach	Qualification Rule	G-MW Management	Impact on river	Management Objectives
	4	• Irrigation allocation 100% • Minimum passing flows released (no longer stored) based upon lake Eppalock Storage volume • Eppalock Passing Flow Account available ~5,500 ML	• Full irrigation flows • Passing flows returned based upon inflows and storage volume of Lake Eppalock	• Irrigation flow of up to 20 ML/d • Passing flow of 35 ML/d or natural released December to June and 20 ML/d or natural July to November	• Maintain water quality principally dissolved oxy fish population survival • Provide late winter-spring fresh to prime reach summer and reduce channel organic load • Provide summer-autumn freshes to: o Maintain riparian and in-channel recruitn vegetation o Provide longitudinal connectivity o Flush and mix pools o Inundate additional snags and flush sedi off biofilms • Provide winter low flow o Provide longitudinal connectivity for fish o Maintain permanent connecting flow for quality o Maintain aquatic habitat for macroinverte
		Other environmental water that may be available at this allocation – 17,000 ML			
					• Provide winter/spring high flow to: o Reduce encroachment of exotics and te vegetation o Enhance River red gum recruitment o Cue fish movement and allow movemen downstream reaches o Flush and mix pools for water quality an macroinvertebrates

5.6 Environmental water deployment

The previous scenarios define how the North Central CMA wish to manage under quite specific water resource availability possibilities, and highlight how management should change as more water becomes available. The challenge will be to determine appropriate management responses as the season unfolds and various windows of opportunity to intervene open and close.

The Campaspe River system is likely to commence the season under extremely dry conditions with no environmental water available. The only option is for the North Central CMA to work with G-MW to carefully use whatever water is available to have as much as possible of the river survive the whole year, initially targeting the deep river pools immediately below Lake Eppalock. As more water becomes available, more environmental objectives can be targeted (e.g. increased river length and increased objectives within reaches), and the discretionary environmental water deployment shifts to different gaps in the river flow regime.

In effect, there are key triggers that determine when to seek more environmental outcomes and to shift the management of the environmental water. The key triggers for management in 2010-11 are:

1. The amount of unregulated flows generated downstream of Lake Eppalock
2. The minimum river flow which can be routinely provided by Goulburn-Murray Water in delivering water to its customers
3. The availability of Inter-valley Transfers from the Goulburn River to the River Murray
4. The amount of water in the Eppalock Passing Flows Account that is available for deployment
5. Availability of water from the CEWH and The Living Murray, once sufficient inflows generate entitlements

Under the worst case scenario, there is effectively no water to release from Lake Eppalock and no catchment runoff below Lake Eppalock and no environmental water, so there is little river flow for the whole year. Moving into the warmer months, the river would dry to pools and the water quality in pools would deteriorate.

If there are unregulated flows from catchment runoff below Lake Eppalock, they will help to keep the river running for longer, delaying the risk from the warmer months. They are usually in the winter/spring, but could be during summer or autumn months. They may also provide some of the desirable winter/spring flow environmental regime.

Once inflows into Lake Eppalock exceed 6,500 ML, restricted access to 1,000 ML from the Eppalock Passing Flows Accounts becomes available. Similar to last season this allows the provision of a pre-emptive base flow to be provided to reach 3 and then into reach 4.

As inflows increase and an irrigation allocation is made, more options for environmental water management are available. Should an allocation be made early in the season, as per the scientific advice (Section 4.5.3) a late winter- early spring fresh is to be delivered to the river for the high risk summer period. Summer autumn fresh as per the environmental flow recommendations can then also be delivered later in the season.

As allocations increase, water then becomes available from the CEWH and the Living Murray. The North Central CMA will need to work closely with these agencies to deliver a collaborative management response. The availability of this water provides an opportunity to provide the critical and in recent seasons, missing winter low flow components should an agreement be reached with the water holders.

5.6 Environmental water delivery risks

The delivery of environmental water will provide many benefits to the Campaspe River system environment and it associated ecosystems. There is however inherit risk when delivering environmental flows to a stressed natural system that need to be considered and appropriate mitigating actions (if available) need to be considered. The key risks are:

5.6.1 Blackwater Event

Black water events are a naturally occurring phenomenon in our rivers. They are characterised by the dark appearance of the water and are usually associated with low dissolved oxygen levels. Increased flows entrains organic material from in-channel benches or from previous dry tributaries. Decomposition of the organic material leads to increase bacterial action and oxygen consumption, releasing dark tannins. Severe event's can result in anoxic conditions throughout the water column and elevated water temperatures due to increased absorption of solar radiation from the waters dark colour. This can lead to a major fish death incident.

Experience from previous season indicates that the introduction of higher flow events can trigger a Blackwater event. Cottingham et al (2010) noted that freshes that are provided over the summer-autumn period carry increase risk of triggering an event (section 4.5.3). There are two management actions that reduce the risk of triggering a Blackwater Event and reducing the impacts should it occur. As per Cottingham's advice, a fresh delivered late winter-spring reduces the risk due to lower air temperatures and slower decomposition rates leading to reduced oxygen depletion. The delivery of this fresh is the highest priority in scenarios 3-5. The second management action is that a fresh will not be initiated unless there is sufficient water available to follow up the fresh and overcome the reduced DO levels through dilution and reaeration from flow.

5.6.2 Winter high flow events

A key management action in scenario 5 is the delivery of winter high flow events from Lake Eppalock to the Murray River. These flows of 1,500 ML/d for 4 days with managed rise and fall rates will be well contained within the channel of the Campaspe River and will not exit the banks to inundate the flood plain. Reach 4 has the smallest channel capacity at 9,000 ML/d, ensuring sufficient channel capacity above the maximum managed flow release of 1,500 ML/d should a rainfall event occur simultaneously. Flood risk is therefore considered low.

6. Management response: Identify, protect and monitoring of key refuge pools

Under the dry scenarios examined in section five, the Campaspe River will receive no irrigation releases, limited stock and domestic releases and the Eppalock Passing Flow account is not available to mitigate environmental risk. This is the worst case scenario for the river and flow management responses are limited. An option available is to attempt to locate and map the deep pools along the river that will become refuge pools. Lake Eppalock is the largest fish refuge within the Campaspe system. However, it is outside the scope of the Annual Watering Plan and with no possibility of fish passage between Lake Eppalock and the lower Campaspe River is not included.

At present, there has not been a comprehensive survey of the Campaspe River identifying the pools. A source of funding will need to be obtained to resource a survey of the river. Once the pools have been located and mapped, fencing and other complementary actions can be targeted at these areas in an attempt to protect the pools fish populations for re-colonisation once flows are returned to the river.

Native fish populations may face additional stress under the extreme dry scenarios from angler pressure. In the first scenario, much of the river will dry out and contract to a series of pools. The only pools in the river system that will be maintained are those immediately below Lake Eppalock. Anglers may target these pools and the affect upon the native fish population is unclear. There are two possible management strategies that require more consideration before implementation to protect the native fish populations.

- Public/Angler education program to demonstrate the importance of protecting the resident population of these pools as the source population for recolonisation of native fish for the river
- Legislated closure of the refuge pools to angler take
- Combination of both the above strategies

Considerably more work needs to be completed before either of these strategies are implemented. Entities such as DPI (fisheries), VR Fish, local landholders and local angling clubs will need to be engaged to discuss these actions and decide on an appropriate course of action.

7. Management response: Environmental releases (pulses) based upon water quality

The aim of environmental pulse releases in the Campaspe River based upon water quality is to:

a) Ensure the best use of the limited available environmental water for protecting aquatic biota (including fish biota) during the prolonged drought conditions.

b) Provide an adaptive management framework for the 2008-2009 season, to minimise risks to river health.

The primary objective of pulsing environmental flows is to maximise the chance of survival of aquatic biota and provide system resilience by managing ecological risks. The following principals were established by a scientific panel convened in 2006 in response to drought (Humphries 2006).

- A reduction in flow, or a cease-to-flow, will result in a decline in the availability of suitable habitat for many species, as the river becomes a series of isolated pools.
- Fish assemblages are most vulnerable as they rely on good quality water and flows for their survival. Fish assemblages do not have the ability to re-colonise after drought as the river is segmented by structures preventing fish passage if suitable conditions cannot be maintained for their survival. Re-stocking is not a viable option for all fish species.
- The macroinvertebrate populations will decline as water levels and available habitat decline. However, their life histories are relatively short, once suitable water conditions are present, re-colonisation from nearby areas is likely to occur fairly rapidly.
- Aquatic macrophytes (vegetation) are well adapted to surviving these conditions. Many aquatic plants have deep-rooted rhizomes that will enable them to survive dry conditions and provide a source for re-populating waterways, once water levels recover.
- The management of water quality to enhance the opportunity for survival of fish assemblages is critical.
- The risk of poor water quality is greater during the warmer months, and the maintenance of water quality within acceptable thresholds is easier during the cooler months.

- Cease to flow is not desirable as a long term measure. There is a lower risk of implementing cease-to-flow during cooler months. Cease to flow should only be used temporarily to maximise the availability of water over time, thereby increasing the chance of significant flora and fauna surviving in the hotter summer months.
- Complementary actions such as the management of diversions, angling pressure, stock access and protection of riparian vegetation should be undertaken to reduce stress on the systems and assist in future recovery.
- Using water judiciously, the chance of survival can be increased but cannot be guaranteed.

7.1. Water quality monitoring program

There is an ongoing water quality monitoring program of the Campaspe River conducted by the North Central CMA and Goulburn-Murray Water. This monitoring program will be used as the basis for adaptive management of the limited environmental water when available. To make best available use of the water strategically, environmental flow releases are to be made in response to perceived ecological risks. The ecological risks are primarily associated with a deterioration of water quality which may result in:

- Stratification and/or deoxygenation of bottom layers of water, especially in pools
- Blue-green algae outbreaks
- Fish deaths

The North Central CMA will base such proposals to initiate flow releases on an assessment of the monitoring data in order to reduce ecological risk. This will be primarily in response to a decline in water quality. The maintenance of water quality conditions is based upon a set of trigger levels which aim to keep the water quality above a threshold at which fish can survive. Trigger levels for water quality have been set by scientific panel advice and are set out in Table 7 (Humphries 2006).

Table 7 - Water quality trigger levels

Parameter	Trigger Levels
Water Temperature	Greater than 28^{o}C
Dissolved Oxygen	Less than 4 mg/L *
Stratification	3 days or more with a differential temperature gradient of greater than 5^{o}C

* Some pools, particularly near Echuca, can stratify. In these pools, depth of the pools is an important consideration for dissolved oxygen level triggers. The pools of the Campaspe River tend towards anoxic conditions in times of prolonged no-flow events. Flushing of these pools in recent seasons has indicated that the bottom habitats return to low dissolved oxygen and high salinity conditions within several days. While dissolved oxygen is an important water quality measure, the depth at which the reading is taken also needs to be considered. A low dissolved oxygen reading at depth needs to be considered in context with the upper readings and other water quality readings in any management decision to release any flows.

Flow releases will be undertaken in a ‘low/no flow’ - ‘fresh’ cycle, with flows released in response to water quality deterioration. Release rate is not a set rate, but will be decided upon once the water triggers have been met for release based upon the prevailing environmental conditions and resource

position at the time. If water quality does not improve following the release, then the duration of the release is to be increased as the first consideration rather than increased release rate. Previous experience indicates that the challenge will be delivering freshening flows at distance from the release point. Therefore, by increasing the flow duration, this allows the freshening flow sufficient volume to traverse the system. The duration will need to be a considered management decision based upon the best available information at the time.
When it is expected that environmental degradation will occur, for example, a trigger level has been reached or there is a downward trend in water quality toward the trigger level, the North Central CMA will advise Goulburn-Murray Water to release a fresh.

Goulburn-Murray Water is responsible for releasing flows conditional upon the volume being available in the reserve for environmental purposes.

7.1.1 Principles for environmental releases

The following principles have been established to take into consideration during decision making:

- Release environmental flow if water quality is declining and at risk of exceeding trigger levels.
- Increase duration/frequency/flow rate of environmental water releases if the current release pattern is not improving water quality.
- Reduce duration/frequency/flow rate of environmental flow releases if water quality is being improved through releases.
- Consider releasing an environmental flow if no release (environmental flow, irrigation or domestic and stock) has occurred for four weeks to reduce risk of future poor water quality and maintain volume of water in pool habitats.

The management will need to be highly adaptive and dynamic in response to environmental conditions and system operation constraints.

7.1.2 Monitoring

Water quality monitoring of the Campaspe River is required to determine whether additional flows are required to improve its environmental condition in response to the cease to flow.
Monitoring data will be used to:

- inform a management response (e.g. release freshening flow)
- track responses to management (e.g. amend the volume/rate of release etc. if freshening flows are not turning over pools)

The monitoring program used will be a combination of the North Central CMA’s four continuous monitoring probes and Goulburn-Murray Water's weekly spot monitoring at ten sites. See Table 8 for site locations and monitoring techniques undertaken. Other water quality data may also be used in the management framework, such as Waterwatch results and the Victorian Water Quality Monitoring Network.

Table 8 - Water quality monitoring sites - location and rationale

River Reach	Site Number & Location	Features / Rationale	Monitoring Technique
Reach 2: Lake Eppalock - Campaspe Weir	• Doakes Reserve	• u/s Axe Creek • Shallow-medium depth • Cumbungi & Woody habitat around island area • Identified as e-flows monitoring site for state program	• Continuous probe
	• Backhaus Road	• d/s Axe Creek • Large deep pool • Good drought refuge	• Continuous probe
	• Barnadown Bridge	• Existing monitoring site	• G-MW water quality monitoring • VWQMN data (406201)
	• Bendigo-Murchison Road "Ferguson Bridge"	• Existing monitoring site	• G-MW water quality monitoring
	• Elmore	• Existing monitoring site	• G-MW water quality monitoring
	• u/s Campaspe Weir	• Existing monitoring site	• G-MW water quality monitoring
Reach 3: Campaspe Weir - Siphon	• d/s Campaspe Weir	• Existing monitoring site	• G-MW water quality monitoring
	• Burnewang-Bonn Road	• Existing monitoring site • Deep pool (2.4m) • Identified in "Saline Pools Investigation" project • Good drought refuge	• Continuous probe (Saline Pools Project) • G-MW water quality monitoring
	• Reserve on east side river - Rochester town flood gauge	• Existing monitoring site	• G-MW water quality monitoring
	• Reserve on east side river - Rochester town flood gauge	• Existing monitoring site	• G-MW water quality monitoring
	• Rochester Rail Bridge	• Existing monitoring site • Deep pool - backed up from siphon • Experience shows using flows to change water quality has had minimal success • Cross reference data for continuous monitoring probe	• G-MW water quality monitoring • VWQMN data (406202C)
Reach 4: Siphon - Echuca Weir	• Strathallen Bridge	• Existing monitoring site • E-flows site	• G-MW water quality monitoring
	• Fehring Lane	• Deep pool (1.9m) • Identified in "Saline Pools Investigation" project • Good drought habitat	• Continuous probe (Saline Pools Project)
	• U/s Echuca Weir	• Existing monitoring site	• G-MW water quality monitoring

(orange)	Continuous monitoring site
(pink)	Spot monitoring run site

8. Management response: Deploy Inter-Valley Transfer

In previous seasons, a collaborative management response has been implemented through Goulburn-Murray Water, River Murray Water and the North Central CMA. Depending upon irrigation allocations in the Goulburn and Murray systems, past sales of water entitlement can result in water from the Goulburn system, stored in Eildon being delivered to the Murray System. The water is delivered via the Lower Goulburn River to the Murray River. An alternative delivery route is if some of this flow is diverted via the Waranga Western Channel and inflowed into the Campaspe River at the Siphon (Figure 10). This arrangement delivers flow to reach 4 during the high risk/high stress summer-autumn period. The water is not from the Environmental Water Reserve and as such, the environment has no legal entitlement to the flow. System operating losses are a concern for Goulburn-Murray Water in the current drought where operational efficiency must be maximised. In the 2008-09 season DSE provided for looses from the Murray Flora and Fauna entitlement, which totalled 755 ML. DSE again agreed to provide for losses to a maximum of 1,000 ML so the IVT could be deployed on the 2009-10 season. The provision of the IVT for the 2010-11 season will remain dependant upon either the North Central CMA through the Eppalock Passing Flows account or DSE through the Murray Flora and Fauna entitlement to cover losses.

Examination of the flow rates and the resultant salinity levels for the commencement of the Inter-Valley Transfer indicates that at the commencement of the IVT each year, salinities in this reach are evaluated. Since the introduction of the qualifications with no flows being provided during the winter/spring period, salinity levels are increasing elevated on previous seasons. As a result, the commencement date of the IVT needs to be as early as possible in the season. It also takes time for the reach to adjust to the new inflows and for water quality to improve. At a flow rate of 10 ML/d, it takes approximately twenty days for the flow rate to increase at Echuca and forty five days before the salinity reduces to within guidelines at Echuca. The salinity level reduction of a steady decrease over a period of approximately twenty days prevents salinity shock to the biota; a steady decrease rather than a rapid decrease allows biota to acclimatise to the changed conditions.

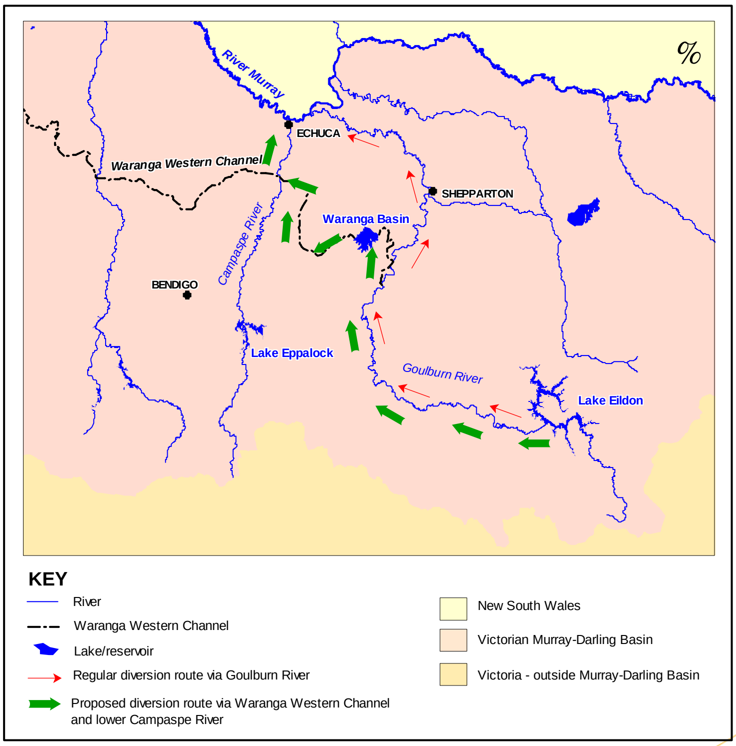


Figure 10: Schematic diagram of lower Campaspe Inter-Valley Transfer release

9. Communication

During the current drought, with record low or no irrigation allocations, the release of environmental flows can potentially be highly controversial and cause community angst. It is therefore prudent for the North Central CMA, as the manager of the Environmental Water Reserve to ensure that during such times, the organisation's community engagement processes clearly identify its rationale, processes and communication activities. Thus ensuring all stakeholders are kept informed of its operational activities in relation to the release of water for environmental purposes through factual and prompt information.

The following primary and secondary audiences have been identified as requiring factual and prompt communication engagement.

- Primary audience - Bulk Entitlement holders, Goulburn-Murray Water and Coliban Water as storage operator and holders of the Bulk Entitlements need to be informed of the North Central CMA's management of the environmental flows and to ensure that consistent messages are delivered to the audience

- Primary audience - Campaspe Environmental Water Advisory Group, members of this group assisted in the development of the Annual Watering Plan and are the key community representatives along the Campaspe River and therefore need to be informed of the North Central CMA's management of the environmental flows

- Primary audience - diversion licence holders, farmers, irrigators, landholders etc. Individuals within this group have an entitlement to water to carry out their business activities and need to be informed of the North Central CMA's management of water for the river.

- Primary audience - the general community who use the water for recreational and social purposes. It is important this group are made aware of the role and functions of the North Central CMA as manager of the Environmental Water Reserve.

- Secondary audience - stakeholders (DSE and DPI), although already informed, they are an important group because the North Central CMA's activities require their input and support. They need to be continually engaged with up to date information and involved in the process.

9.1 Communication delivery channels

The delivery of our key messages will be via:

- Media releases - wherever practical these are to be joint releases with input from the North Central CMA and Goulburn-Murray Water. A media release should precede any environmental flow release.

- Advertising - to minimise the potential for key messages to be lost when media outlets editorialise media releases, paid public notices will accompany any media release. This ensures balance is provided in the North Central CMA's community engagement of any environmental flow release.

- North Central CMA Website - all current and future proposed environmental flows will be displayed on the website and updated on a fortnightly basis. All media releases are also to be displayed.

- Community consultation – a copy of any media release is to be provided to any interested Campaspe Environmental Water Advisory Group members to ensure they are informed and have up to date information that can be passed on to their local networks.

9.2 Stakeholders

The following key stakeholders have been identified, as well as how and when they should be engaged:

- Goulburn-Murray Water – Storage Operator and Bulk Entitlement holder. Regular phone and email contact and attendance at the Loddon Campaspe Drought Response Group meetings.

- Department of Sustainability and Environment Melbourne – they oversee policy and operational objectives for the Environmental Water Reserve. Regular contact via phone and weekly updates by email.

- Department of Primary Industry & Environmental Protection Agency – regional organisations. Regular phone and email contact and attendance at the Loddon Campaspe Drought Response Group meetings.

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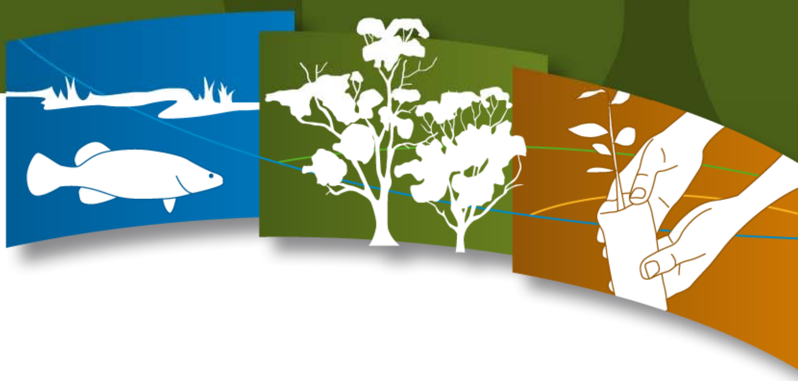
Connecting Rivers, Landscapes, People

2010 - 2011
Annual Watering Plan

Loddon River System



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Catchment Management Authority
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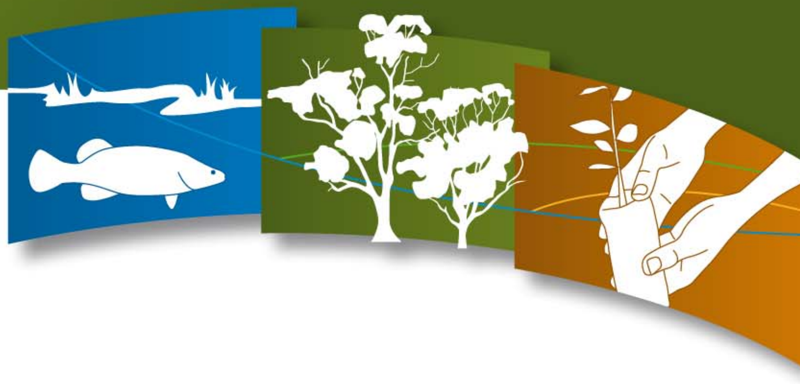

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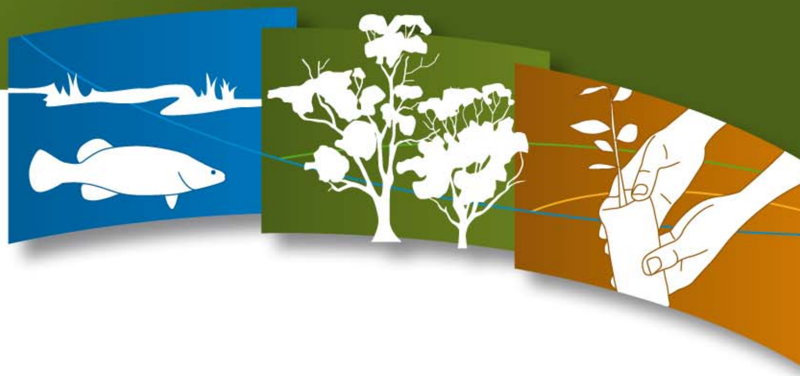

Contents

Abbreviations

AWP – Annual Watering Plan

BE – Bulk Entitlement

CMA – Catchment Management Authority

DICP – Dry Inflow Contingency Plan

Environmental Reserve BE – Bulk Entitlement (Loddon River - Environmental Reserve) Order 2005

EOS – Environmental Operating Strategy

EPA – Environment Protection Agency

EWR – Environmental Water Reserve

G-MW – Goulburn-Murray Water

LEWAG – Loddon Environmental Water Advisory Group

LREFSP - Loddon River Environmental Flows Scientific Panel

LSWFA – Loddon System Withheld Flows Account

ML – Megalitres

NRMC – Natural Resource Management Committee

POE – Probability of Exceedance (the probability that a given value or flow scenario will occur, using 119 years of previous flow data)

QoR – Qualification of Rights

TAG – Technical Advisory Group

The White Paper – The Victorian Government’s White Paper *Our Water Our Future,* Securing our Water Future Together

VWQMN – Victorian Water Quality Monitoring Network

Volumes of water:

One litre	1 litre	1 litre	1L
One thousand litres	1,000 litres	1 kilolitre	1KL
One million litres	1,000,000	1 megalitre	1ML
One billion litres	1,000,000,000	1 gigalitre	1GL

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- Pat Russell (Central Highlands Water)

1. Loddon River Catchment Overview

The Loddon River catchment covers approximately 1.5 million hectares or about 6.8% of the area of Victoria. The river rises on the northern slopes of the Great Dividing Range, south of Daylesford, before flowing 430 kilometres northward to join the Murray River (North Central CMA, 2005). The average annual rainfall varies from 1100mm in the southeast of the catchment (upper catchment area), to 400mm in the north of the catchment (lower catchment area). Small tributaries such as Bet Bet Creek and Birches Creek flow into the Loddon Catchment in the upper area. The major towns of the Loddon Catchment include Bendigo, Swan Hill, Kerang, Castlemaine and Maryborough. Intensive horticulture occurs in the upper catchment and mixed farming and cereal growing dominates the mid and lower catchment (North Central CMA, 2005).

Three main streams of the upper catchment (Loddon River, Tullaroop Creek and Bet Bet Creek) all meet at Laanecoorie Reservoir, where the Loddon River then flows into a single thread toward Serpentine (Figure 1).

The Waranga Western Channel crosses the Loddon River basin, transporting water from the Goulburn System to the east of the catchment, through to Western Victoria (DSE, 2005a). There are 60 artificial water storages in the basin including the three main storages in the upper catchment (Cairn Curran Reservior, Tullaroop Reservoir, and Laanecoorie Reservoir). Cairn Curran and Tullaroop Reservoirs are the main storages that collect water from the upper parts of the catchment. Laanecoorie Reservoir is used as a re-regulating storage for releases from Cairn Curran and Tullaroop Reservoirs (North Central CMA, 2006). Since its construction, Laanecoorie Reservoir has lost more than 50% capacity due to siltation (LREFSP 2002a). This infrastructure is primarily used to control Loddon River flows for irrigation and domestic water supply, however it has also had a major influence on the river's natural flow regime (DSE, 2005b). The Loddon River is highly regulated with approximately 40% of stream flow diverted for consumptive uses (LREFSP 2002a).

In 2004 and 2005, Bulk Entitlements (BE) were established for the Loddon System. These BEs set out the water sharing rules for the Loddon System and under the Bulk Entitlement (Loddon River - Environmental Reserve) Order 2005 (the Environmental Reserve BE), an Environmental Water Reserve (EWR) was established. This allows for environmental water provisions for use on the Loddon River between Cairn Curran Reservoir and Kerang Weir, and in Tullaroop Creek between Tullaroop Reservoir and Laanecoorie Reservoir (Victorian Government, 2005). These reaches are shown in Figure 1 and outlined in Table 1.

Table 1. ***Reaches of the Bulk Entitlement (Loddon River – Environmental Reserve) Order 2005***

Reach Number	Reach Location
Reach 1	Loddon River – Cairn Curran Reservoir to Laanecoorie Reservoir
Reach 2	Tullaroop Creek - Tullaroop Reservoir to Laanecoorie Reservoir
Reach 3a	Loddon River - Laanecoorie Reservoir to Serpentine Weir
Reach 3b	Loddon River - Serpentine Weir to Loddon Weir
Reach 4	Loddon River - Loddon Weir to Kerang Weir

The Loddon Environmental Reserve BE does not provide for:

- the upper reaches of the Loddon River system above Tullaroop and Cairn Curran Reservoirs, or
- the Loddon River downstream of Kerang Weir (Reach 5) as the whole reach is located within the Torrumbarry Irrigation Region and outside of the Loddon Environmental Reserve BE zone.

Additionally, a provision of up to 2,000ML per year is provided under the Environmental Reserve BE for environmental use in the Boort District Wetlands. The Boort District Wetland group includes Lake Boort, Lake Yando, Lake Leaghur, Lake Meran and Little Lake Meran as well as other priority wetlands in the region (Figure 1). These wetlands are considered to be bioregionally important. They represent depleted and threatened wetland types including shallow and deep freshwater marshes and provide important habitat for threatened flora and fauna for breeding, feeding and refuge.

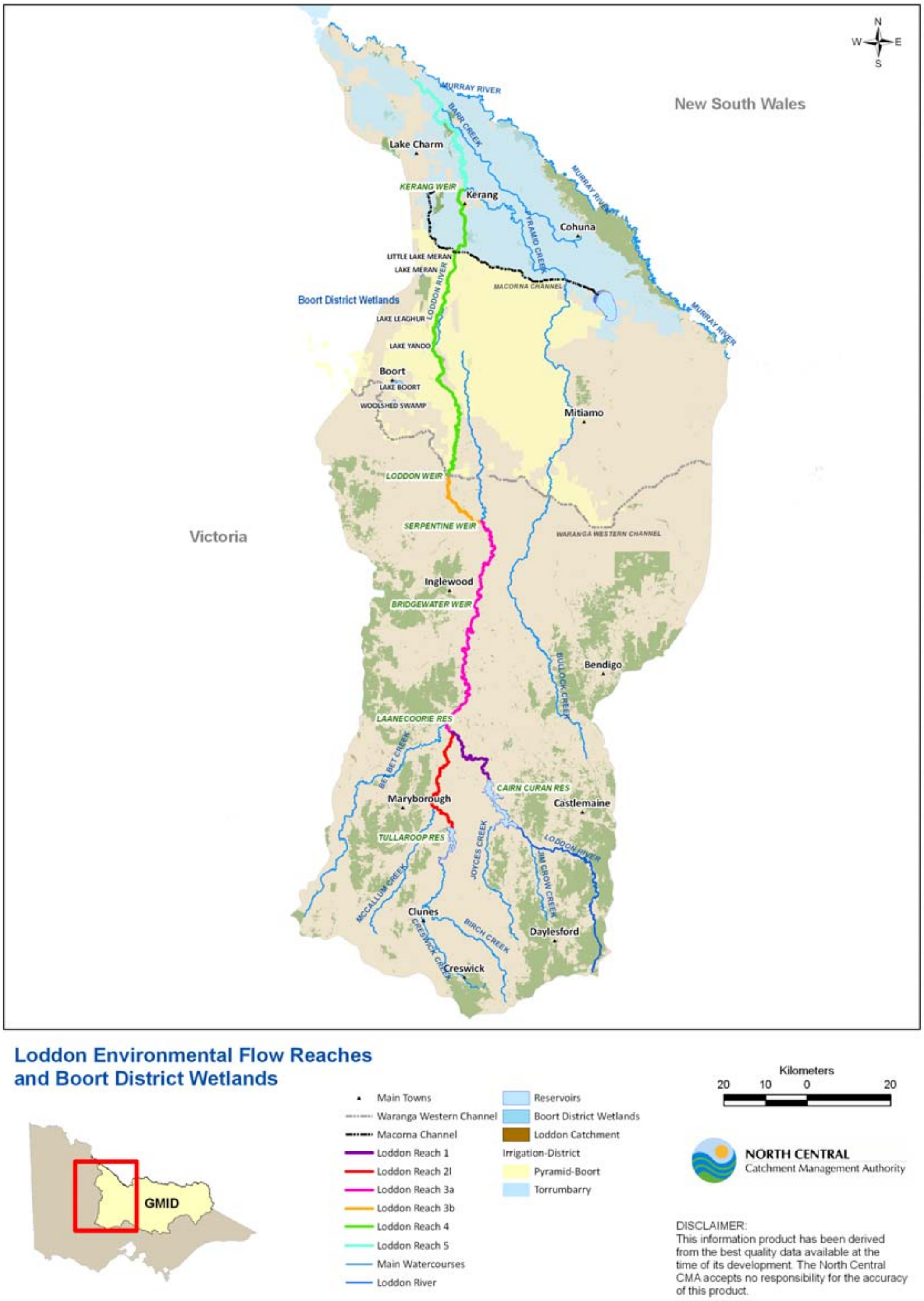

Figure 1. Loddon River Catchment

2. Background

This Annual Watering Plan documents how environmental water available for use in the Loddon System will be managed in 2010-11. The environmental water is available for use from the Bulk Entitlements for the Loddon System which provides the over-riding legal framework for management and use of water by all stakeholders (i.e. water authorities, irrigators and the environment) through the whole of the Loddon System.

Under extremely dry conditions, some provisions set out under the Bulk Entitlements are modified or suspended under a Declaration of Water Shortage and instigation of Temporary Qualification of Rights. The Loddon System has been under a Qualification of Rights over the past three seasons. Current Qualifications were developed and implemented in the 2009-10 season, and will be in operation until the Qualification of Rights is revoked; or until the 30th of June 2011, whichever is earlier.

The responsibility for the operational management of one of these Bulk Entitlements, the Environmental Reserve BE has been delegated by the Minster for Water to the North Central CMA as the Environmental Water Reserve (EWR) operational manager (DSE 2004).

The management of the EWR will (DSE, 2004):

- *"be aimed at achieving ecological objectives for the protection and/or restoration of priority river, wetland and aquifer assets*
- *be undertaken as one key component of an integrated program of river, wetland and aquifer restoration aimed at achieving ecological objectives (e.g. covering land management, water quality, habitat restoration and groundwater management)*
- *aim to achieve the most effective use of environmental water, achieving the greatest level of environmental benefits possible and minimising as far as possible any adverse impacts on water users*
- *engage communities, particularly where these are likely to be affected by the water management regime."*

DSE 2004, pg 62.

As part of this responsibility, and as recommended in the Victorian Government's White Paper *Our Water Our Future* (the White Paper, DSE 2004), the North Central CMA has developed an Environmental Operating Strategy (EOS) for the Environmental Reserve BE. The EOS (North Central CMA, 2006) outlines:

- the principles for the management of the Loddon Environmental Reserve BE
- the roles and responsibilities of key stakeholders
- the process for determining annual releases.

Each year the North Central CMA produces an Annual Watering Plan (AWP) (this Plan) in accordance with the principles and processes outlined in the EOS, and with the advice of Goulburn-Murray Water (G-MW) and other key stakeholders represented on the Loddon Environmental Water Advisory Group (LEWAG).

The AWP provides a transparent process for implementing environmental flow releases in the Loddon System (Loddon River and the Boort District Wetlands). The AWP is the tool through which the EWR is managed each year for this system. Decisions and priorities in the AWP have been based on a number of factors including:

- season review of the Loddon River and Boort District Wetlands from the previous year (July – June)
- water resource outlook for the next year (July – June)

- environmental needs and priorities for the Loddon River and Boort District Wetlands
- scenario planning
- seasonally adaptive management program
- advise from the LEWAG

This AWP details the proposed management of the Loddon Environmental Reserve BE for the flow year from 1 July 2010 to 30 June 2011 and sees the fifth delivery season of the Environmental Reserve BE. This AWP (2011-11) is to remain in operation until such a time as the subsequent AWP (2011-12 season) has been endorsed by the Minister for Environment and Climate Change.

2a. Purpose

The purpose of the Annual Watering Plan is to:

- review the previous seasons usage of environmental water
- document the decision making process used to determine the distribution of environmental water
- identify and where possible, address issues or constraints which may affect the distribution of environmental water
- provide a communication forum between the North Central CMA, stakeholders and the local community of the Loddon River, Tullaroop Creek and Boort District Wetlands

While this document aims to provide a plan for the delivery of environmental water, it must be recognised that there are a number of uncertainties, particularly relating to climatic conditions which affect planning for the delivery of environmental water. In addition, system infrastructure, delivery and maintenance constraints may influence how environmental water can be distributed. For these reasons, environmental water must be delivered through an adaptive framework to provide the flexibility necessary for effective management.

2b. Underlying principles for environmental water reserve management

The North Central CMA has adopted nine principles for the management of the EWR which govern the operation of environmental flow releases. These principles are that:

- releases will be made to achieve maximum benefits with the goal of sustaining and where possible, restoring ecological processes and biodiversity of water dependant ecosystems
- the best regional environmental outcomes are sought through inter-agency and community cooperation
- the environmental contribution derived from natural and managed flows will be recognised in the development of the AWP
- all decisions are to be made on the best available science
- decisions are to be transparent, consistent with ecological objectives, accountable and in accordance with State and Federal law and policy
- the Environmental Reserve Manager (North Central CMA) must work closely with the Storage Operator (G-MW) to maximise environmental reserve benefits and consider opportunities for cost efficiencies

- monitoring, reporting and evaluation of the effectiveness of environmental flow releases will provide feedback for the continuous improvement in the use of environmental water
- delivery of the environmental flow allocation must occur in a flexible manner in response to changing conditions and in response to monitoring and an improved understanding of environmental water requirements
- community members are to be informed of improvements to the environment and engaged wherever possible in the process

2c. Loddon Environmental Water Advisory Group

To effectively manage the Environmental Water Reserve, the North Central CMA has established the Loddon Environmental Water Advisory Group (LEWAG).

The LEWAG provides advice at key decision points in the planning process to the North Central CMA on the best use of environmental water for the Loddon System, as defined by the Loddon System Bulk Entitlements (i.e. the Loddon River between Cairn Curran Reservoir and Kerang Weir, Tullaroop Creek between Tullaroop Reservoir and Laanecoorie Reservoir, and the Boort District Wetlands). It aims to ensure that environmental water is used effectively to maximise environmental benefits based on existing knowledge and in response to results of ongoing monitoring and research, ecological objectives, system constraints, previous usage and climatic conditions.

The LEWAG contains the following representatives:

- Environmental Water Reserve manager (North Central CMA)
- Storage Operator and Bulk Entitlement holder (Goulburn-Murray Water)
- Bulk Entitlement holder in Tullaroop System (Central Highlands Water)
- Northern Victoria CMA's Environmental Water Flows Coordinator
- Department of Sustainability and Environment
- Community representatives from the Loddon River and Boort District Wetlands

The LEWAG meets at least twice a year. The first scheduled meeting in April provides an opportunity for the group to have input into the last season review and the preparation of the Annual Watering Plan. The North Central CMA then prepares a draft watering plan that is presented to the group at the May meeting for review. The group can be reconvened at other times should the need arise.

3. Environmental Water Reserve

3a. Environmental Water Reserve in the Loddon Catchment

During 2004 and 2005, five Bulk Entitlements relating to the Loddon Water System were gazetted by the Victorian Government:

1. Bulk Entitlement (Loddon System – Goulburn-Murray Water) Conversion Order 2005
2. Bulk Entitlement (Loddon System – Coliban Water) Conversion Order 2005
3. Bulk Entitlement (Loddon System – Environmental Reserve) Conversion Order 2005
4. Bulk Entitlement (Loddon System – Part Maryborough – Central Highlands Water) Conversion Order 2005
5. Bulk Entitlement (Creswick) Conversion Order 2004

This AWP deals with the management of the third of these Bulk Entitlements (Bulk Entitlement (Loddon System – Environmental Reserve) Conversion Order 2005). An Environmental Water Reserve (EWR) was established in order to manage environmental water under this Bulk Entitlement and was an objective of the Victorian Government White Paper *Securing Our Water Future Together* (DSE 2004).

The North Central CMA, as the caretaker for river health, has been delegated to manage this EWR and to advise the storage operator (G-MW), of the quantity and release pattern required to protect environmental values in the Loddon System.

The Environmental Reserve BE includes a number of provisions (Table 2) which include the following characteristics:

- minimum passing flows for the Loddon River over both the low flow and high flow period. Most flows have an “or natural” qualifier, meaning that a lower flow can be released if the natural flow is less than the specified flow (in all reaches except below Loddon Weir). The minimum passing flow over the high flow period may be reduced in response to low storage volumes for all reaches (refer to Appendix 1)
- river freshening flows for the Loddon River over the low flow period. These also have an “or natural” qualifier and are not provided in some reaches if the fresh does not occur naturally during the period (refer to Appendix 1)
- 2,000ML Wetland Entitlement for the Boort District Wetlands (available water is equal to the percentage allocation as Loddon entitlement holder’s licensed diverters)
- flexibility in managing unregulated water resources
- Deficit and Reimbursement Account – management of a water account to reimburse the accrued deficits of environmental minimum flows in the Loddon River Reaches
- Low Reliability Entitlement Allocation – certain rights to water have been converted to new entitlements, including the creation of a new low-reliability entitlement (‘sales’ water) to enhance the environmental reserve in the Loddon River and Boort District Wetlands.

Table 2. Environmental Water Reserve management under the *Bulk Entitlement (Loddon River – Environmental Reserve) Order 2005*

Bulk Entitlement (Loddon River – Environmental Reserve) Order 2005	
Loddon River Entitlement	Minimum passing flows and river freshening flows
Reach 1	Loddon River - Cairn Curran Reservoir to Laanecoorie Reservoir
Reach 2	Tullaroop Creek - Tullaroop Reservoir to Laanecoorie Reservoir
Reach 3a	Loddon River - Laanecoorie Reservoir to Serpentine Weir
Reach 3b	Loddon River - Serpentine Weir to Loddon Weir
Reach 4	Loddon River - Loddon Weir to Kerang Weir
Wetland Entitlement	Boort District Wetlands: Lake Mean, Little Lake Meran, Lake Boort, Lake Yando, Lake Leaghur or other priority wetlands in this region as opted by the Environmental Water Manager
Unregulated Water Resources	Loddon River Reaches and Boort District Wetlands
Accounting Procedures	Deficit and Reimbursement Account – Loddon River Loddon System Withheld Flows Account – Loddon River and Boort District Wetlands (set up under the Qualification of Rights)
Low Reliability Water Share (>100% allocation)	Loddon River Reaches and Boort District Wetlands

There are three environmental water accounts which relate to the EWR in the Loddon System. These accounts are detailed below:

i. Deficit and Reimbursement Account

Under the Environmental Reserve BE, a Deficit and Reimbursement Account was set up to reimburse the accrued deficits of environmental minimum flows in the Loddon. In essence, flow volumes which should have been released as part of the operation of the Environmental Reserve BE, but were not (due to water shortage for example), are accrued in this account for use at a later date. There is a cap placed on this account at 25,000ML and the account is currently sitting at this level.

ii. Boort District Wetland Entitlement

The Wetland Entitlement is a component of the Environmental Reserve BE for the Loddon System. Schedule 3 of the BE states that the wetland entitlement:

"shall be used to maximise the flora and fauna values within the Boort District Wetlands and supplied to wetlands on the principle of environmental water to the highest environmental use."

Bulk Entitlement (Loddon River – Environmental Reserve) Order 2005 pg. 2677.

The wetlands in this category are Lake Meran, Little Lake Meran, Lake Boort, Lake Yando, Lake Leaghur or other priority wetlands in this region as opted by the Environmental Water Manager (Little Lake Boort has been added to these wetlands under the Qualification of Rights). Up to 2,000ML per annum is provided under the Environmental Reserve BE (including delivery losses incurred beyond the monitoring points) to water these wetlands. When G-MW is able to allocate the full licence volume or more to its licensed diverters (i.e. 100% HRWS allocation), the full wetland entitlement will also be allocated (i.e. 2,000ML). Conversely, where there is less than 100% irrigation allocation (e.g. 50%), the same allocation will be provided to the wetland entitlement (e.g. 50% of 2,000ML = 1,000ML). Up to 2,000ML can be carried over in this account for use in the following year.

iii. Loddon System Withheld Flows Account

The Loddon System Withheld Flows Account (LSWFA) was established under the 2009 Qualification of Rights, and has been updated from the previous Loddon Weir Withheld Flows Account (LWWFA).

This account has been established to record the volumes of minimum flows which would otherwise be released through the Loddon System had the Qualification not been in place.

Up to 2,000ML from this account can be transferred into the Boort District Wetland Entitlement (depending on total volume held) when this water becomes available.

iv. Other Sources of Environmental Water

There are a number of other environmental water sources that are either available, or set to become available into the future. While some of these sources do not hold a great deal of water from a Loddon environmental flows perspective at this stage, a short description of each is provided below. Due to the uncertainty of the volume and timing of this water becoming available, these sources of water have not been explicitly considered in the scenario planning section of this Plan. It is acknowledged however, that the scenarios set out could still be met by utilising these sources of water if, and when, the water becomes available.

Commonwealth Environmental Water

As part of the *Restoring the Balance in the Murray-Darling Basin* program (DEWHA 2010), a total of 1,029ML of HRWS water has been purchased by the Commonwealth Government in the Loddon catchment. An additional 644ML of LRWS has also been purchased. The expected average annual volume of water available for the environment is 978ML of HRWS and 174ML of LRWS (DEWHA 2010).

The goal of the program is to:

"purchase water entitlements so that the water allocated to them can be used for the environment. This will improve the health of the Basin's rivers, wetlands and floodplains."

DEWHA 2010

The water rights secured under the program are set to become part of the Commonwealth environmental water holdings, and are managed by the Commonwealth Environmental Water Holder.

Wimmera-Mallee Pipeline Water

The Wimmera-Mallee Pipeline was opened in April 2010 and was a joint project between the State Government, Federal Government and Grampians Wimmera Mallee Water Corporation (DSE 2010). This project aims to save water by building reticulated pipelines to replace open channel systems, with water savings generated to return environmental flows to five major river systems (Loddon included), and nominated recreational lakes and other water bodies (DSE 2010).

While the volume of environmental water available is still to be finalised, there is potential for 2GL of high reliability of water to be available every year, with up to an additional 24GL available every second year (during May to September) at Loddon Weir.

Murray Flora and Fauna Entitlement

Similar to the Loddon Environmental BE, the Murray River also has its own Environmental BE. This is known as the Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999, and is herein referred to as the Murray Flora and Fauna Entitlement.

This entitlement has 27,600ML allocated to it at 100% allocation on the Murray River which can be used for delivery to high priority environmental assets along the Murray River, and connected basins. There are a number of objectives that the use of the Murray Flora and Fauna Entitlement aims to achieve. These are listed below (DSE 2006):

- *"Protect the physical structure of the waterbody for habitat for flora and fauna*
- *Improve water quality*
- *Maintain the geomorphic structure of the waterbody (channel maintenance)*
- *Increase biodiversity and species richness*
- *Reinstate or maintain natural flooding pattern (seasonality/duration/frequency of wetting events)*
- *Reduce the impact of manmade barriers (especially for fish species)*
- *Improve/increase the health of riparian and instream vegetation"*

DSE 2006 Pg. 6

In recent years, this Entitlement has primarily been used to maintain important drought refuges in the landscape in the Goulburn-Broken Catchment area, North Central area and in the Mallee.

The process for allocation and use of any water from this Entitlement on a site-by-site basis is subject to approval from a Northern Victorian Project Control Board. Therefore, water from this Entitlement cannot be guaranteed for any particular site, however bids can be submitted for sites as the needs arise.

Northern Victorian Irrigation Renewal Project

The Northern Victorian Irrigation Renewal Project (NVIRP) is a $2 billion works program which aims to upgrade ageing irrigation infrastructure through the Goulburn-Murray Irrigation District (GMID) and save water which is currently lost through leakage, evaporation and system inefficiencies (NVIRP 2009).

It is expected that long-term water savings of 225GL (Stage 1) will be realised through this project, with up to 75GL of this available for environmental use to improve the health of priority wetlands and waterways within Northern Victoria and provide benefits to Living Murray Icon Sites (NVIRP 2009).

Mitigation Water

In addition to the 75GL of environmental water, mitigation water may also be provided. NVIRP provide the following information specifically about mitigation water:

- "*Water savings are the total (gross) volumes saved less the volume of water required to ensure no net impacts due to the project on high environmental values.*
- *The water that is required to ensure no net impacts due to the project on high environmental values is called 'mitigation water' (also sometimes referred to as 'requisite water').*
- *The need for mitigation water will be assessed and, where identified as needed, its quantification will be determined."*

NVIRP 2009 pg.43

In the Loddon River System, there are a number of sites which were identified as being potentially impacted by NVIRP works, and therefore an Environmental Watering Plan (EWP) was required to be completed. These EWPs asses the environmental impacts of NVIRP on the site, and provide a recommendation for mitigation water. Sites with EWPs in development in the Loddon River System are:

- Lake Leaghur
- Lake Yando
- Little Lake Boort
- Little Lake Meran (TBC)
- Lake Meran
- Loddon River
- Twelve Mile Creek

3b. Environmental Priorities

i. Loddon River - Objectives and Flow Components

In 2002 the Loddon River Environmental Flows Scientific Panel (LREFSP) was engaged to determine environmental flow objectives for the Loddon River (LREFSP, 2002a). Specific flow components were developed for the river that aim to ensure biodiversity objectives are met. Table 3 shows each biodiversity objective and flow component required to target that objective.

Table 3. Environmental Flow Objectives for the Loddon River study area (LRESFP, 2002a)

Biodiversity Objective	Process		Flow Objective	
			Flow Component	Timing
Restore or maintain River blackfish population	1a	Habitat availability	Low (depth >0.4 m)	All year
	1b	Breeding/Recruitment	Low	Spring
	1c	Movement	Low	All year
Restore or maintain native fish community (Murray cod, Golden perch and Silver perch)	2a	Available habitat and movement for all fish	All (depth > 0.5 m)	All year
	2b	Breeding cues for Murray cod	Freshes	Winter/Spring
	2c	Breeding cues for Golden perch	Freshes	Winter/Spring
	2d	Breeding cues for Silver perch	Freshes	Winter/Spring
Restore or maintain natural invertebrate community	3a	Disturbance	Cease-to-flow	Summer
	3b	Habitat maintenance	Freshes	Winter/Spring
	3c	Habitat availability	Low (depth >0.1 m)	Spring/Summer
Reinstate or maintain a mosaic of aquatic macrophytes	4a	Colonisation	Low	Spring
	4b	Disturbance	Low/Cease-to-flow	Summer
	4c	Habitat maintenance	Freshes	All year
Improve in-stream macrophyte habitat	4d	Colonisation/growth	Low	Spring/Summer
Improve submerged macrophyte habitat	4e	Colonisation/growth	Low (depth <0.3m)	Spring/Summer
Reinstate a mosaic of bank vegetation	5a	Colonisation/growth	All	Spring/Summer
	5b	Disturbance	Low/Cease-to-flow	Summer
	5c	Wetting	Freshes	Winter/Spring
Reverse terrestrialisation of bank/bench grasses	6	Disturbance	Freshes/High	Winter/Spring
Maintain red gum regeneration	7a	Wetting	Overbank	Spring
Restore or maintain floodplain/wetland processes	7b	Inundation	Overbank	Spring
Clean bed surface	8a	Disturbance	Freshes	Any time
Restore or maintain pools	8b	Scour	High	Any time
Restore or maintain runs	8c	Disturbance	Freshes/High	Any time
Re-shape in-channel forms to maintain physical habitat diversity and complexity	8d	Scour/deposition	Freshes/High	Any time
Scour silt on bed	8e	Scour	High/Overbank	Any time
Restore or maintain snag habitat	9	Submergence	Low	Any time
Entrain organic litter – carbon cycling	10	Disturbance	High	Winter

During 2009-10, a review of the flow requirements for the lower Loddon River system was undertaken (SKM 2010). The findings from this study are described in (Section 4d). This study is referred to the 2010 study, and has some implications for the ongoing management of Reach 4 and 5 of the Loddon (downstream of Loddon Weir and downstream of Kerang Weir) which will be explored through the remainder of this Plan.

ii. Boort District Wetlands

The Loddon Water System Bulk Entitlement process primarily focused on the Loddon River. Initially the prime motivating concern was improving fish habitat and meeting fish passage requirements. Maintenance of ecosystem processes, where wetlands are associated with river systems were incorporated into the Environmental Reserve BE via the establishment of the Wetland Entitlement. This entitlement is aimed at maximising the flora and fauna values of the Boort District Wetlands by supplying water that will result in the highest environmental gain for the wetlands.

Those wetlands considered part of the Boort District Wetlands under the Environmental Reserve BE and able to receive water from the Wetland Entitlement are: Lake Meran, Little Lake Meran, Lake Boort, Lake Yando, Lake Leaghur or other priority wetlands in the region as opted by the Environmental Water Manager. The location of these wetlands is shown in Figure 2.

In addition to these wetlands, an interim supply of up to 300ML was included in the Environmental Reserve BE in order to specifically supply Little Lake Boort until such a time as water savings from the Wimmera-Mallee Pipeline Project would be realised (Clause 2 of Schedule 3). This clause was suspended under the both the 2007 Qualification of Rights and the 2009 Qualifications. However, also within the Qualification or Rights for the Loddon Water System, the Environmental Reserve BE has been amended to include Little Lake Boort as one of the wetlands of the Boort District Wetlands. In essence this means that under the Qualification of Rights, Little Lake Boort can be prioritised for watering events along with the other specified Boort District Wetlands.

As part of NVIRP, Environmental Watering Plans (EWPs) are being developed for a number of these wetlands (as described in section 3(a) part (iv)) to determine environmental impacts associated with NVIRP, and investigate the requirement for mitigation water to be provided. Further information about NVIRP and the EWPs can be found at www.nvirp.com.au.

Table 4 shows the environmental water requirements of each of the Boort District Wetlands.

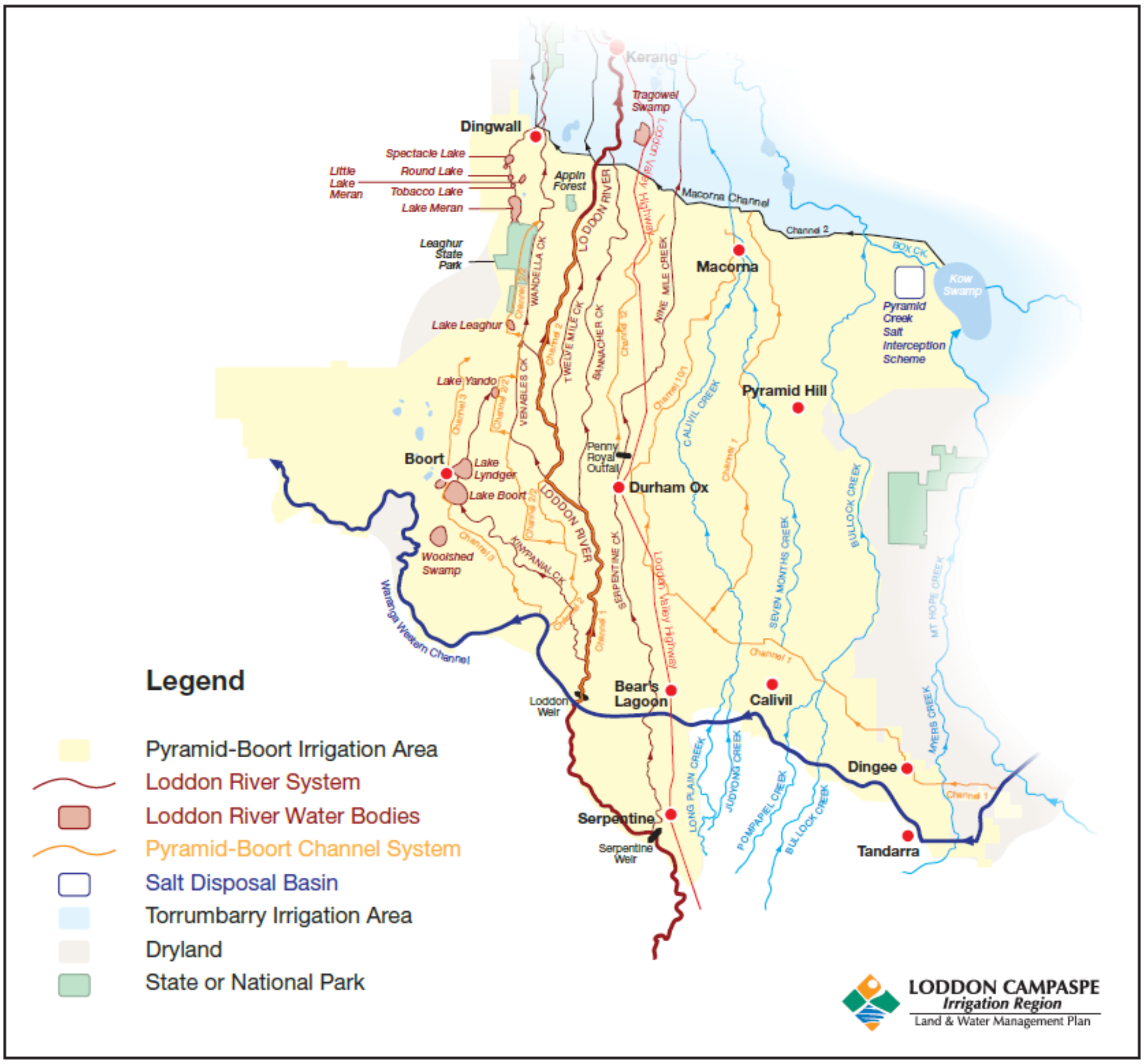

Figure 2. Pyramid-Boort Irrigation Area, including the Boort District Wetlands.

Table 4. Environmental Water Requirements for Boort District Wetlands

Wetland	Capacity (ML) / Area (ha)	Approximate volume required (ML)[4]	Historic Information	Environmental Watering Requirements[3]	Current Condition
Lake Meran	9,218ML / 180ha[1]	10,000 – 14,000ML	Permanently full for most of the last 80 years – dried out in 2002. Connected to floodplain via Wandella Creek and Pickles Canal.	Permanent inundation with fluctuating water levels.[1]	Fringing River Red Gum in moderate health. Base of wetland dominated by weeds (Tamarix control has occurred during 2009-10).[2]
Little Lake Meran	500ML / 27ha[1]	750 - 1,250ML	Permanently full for most of the last 80 years – dried out in 1999	Fill one in three years to inundate base of wetland. Provide high variability in depth of inundation. Allow natural drawdown.[1]	River Red Gum, Black Box and Moonah Trees in moderate to good health. Base of wetland dominated by weeds.[2]
Lake Boort	~6,000ML	6,000 – 9,000ML	Permanently full for most of the last 80 years – dried out in 1999	Can be filled using surplus Loddon River flows via Kinypanial Creek (only in flood events).	Fringing Red gums on high ground stressed
Lake Yando	478ML / 78ha[3]	700 - 1,000ML	Received environmental water in spring 2009. Remains connected to floodplain and has a large local catchment area (50ha)[3]	Fill to full supply level and inundate River Red Gum and Black Box communities (varying the level of inundation). Allow natural drawdown to facilitate germination of River Red Gum and Black Box. Water wetland one in three years.[2]	Trees (River Red Gum and Black Box) in watered area generally in good health. Recruitment of Black Box and River Red Gum occurring.
Lake Leaghur	664ML / 59ha[1]	900 – 1,200ML	Wetland would naturally receive water from Loddon river flood runners (Wandella and Venebels Creek). Wetland is still connected to floodplain.[1]	Fill to full supply level and inundate fringing River Red Gum. Allow natural drawdown over 18 months and facilitate germination of River Red Gum on base of wetland. Water wetland one in three years.[2]	Receiving environmental water in autumn 2010. Majority of fringing River Red Gum are in moderate health. Dead *Typha* though base of wetland, with live plants near outfall.[2]
Little Lake Boort	935ML / 72ha[3]	600 – 2,000ML	Disconnected from floodplain and maintained as a permanent lake (primarily for recreation). Lake dried in 1962, 1982 and 2002/03.[3]	Maintain water in wetland four in six years (and allow fluctuations in levels). Allow wetland to dry completely for at least one year every six years.[3]	Low water level in lake. Fringing vegetation mainly urban parkland, with small area of chenopod woodland south-east of lake. Some aquatic and semi-aquatic vegetation present.[2]

[1] Source: North Central CMA 2010a
[2] Source: Campbell et. al 2009
[3] Source: North Central CMA 2010b
[4] Volume based 1.5 times the capacity of the wetland (SKM 2009b) and some wetlands will not require a complete fill so a range of volumes has been provided. Additionally, final volumes required will be dependent on state of the wetland and climatic conditions.

Priority Wetlands

Of the five Boort District Wetlands listed in the Loddon Environmental BE, the highest wetland of ecological value is considered to be Lake Yando by the LEWAG (LEWAG 2010). This 78ha wetland is River Red Gum dominated with Gilgai micro-topography (North Central CMA 2010b) resulting in numerous creeklines through the wetland itself.

Lake Yando, and the other smaller wetlands (Lake Leaghur and Little Lake Meran) are considered priorities to receive environmental water when there is a small volume available (less than about 2,000ML and a lack of a natural flow event).

The bigger wetlands (Lake Boort and Lake Meran) should be considered as priorities when there is a large volume of water available for use, and conditions are considered wet. As will be discussed further through this Plan, there may be a requirement to divert unregulated flows from the Loddon River to one or more of the Boort District Wetlands. The destination of this water would depend on the current condition of all the Boort wetlands, the volume requiring diversion, and the ability of the irrigation system to cope with the flows.

3c. Qualification of Rights

As described earlier, there are five Bulk Entitlements in operation in the Loddon System. These Bulk Entitlements specify the rights to water of each water authority and the environment, and water cannot be used from the system outside of the Bulk Entitlement provisions.

In extremely dry years, the Minister for Water has emergency powers to declare a water shortage and to qualify rights to water (under a Qualification of Rights). The Qualification of Rights changes the water sharing rules by suspending certain Bulk Entitlement requirements, with the aim of ensuring sufficient water is available to meet critical human needs. All Bulk Entitlement requirements not modified by the Qualification of Rights remain in place.

In light of the prolonged dry seasonal conditions across Victoria, the Bulk Entitlements for the Loddon System have been qualified over the past three seasons, including a renewal in 2009-10. Two Qualifications are now in operation:

1. Temporary Qualification of Rights in the Loddon Water System, July 2009
2. Temporary Qualification of Rights in Reach Two of the Loddon Water System, June 2009 (where ‘Reach 2’ is a reference to the reach of the Loddon System between Tullaroop Reservoir (inclusive) and Laanecoorie Reservoir (exclusive) also referred to as Tullaroop Creek).

These current Qualifications will continue for the 2010-11 season.

Note: the Qualification of Rights in Tullaroop Creek is currently being revised for use in 2010-11. The planning surrounding Tullaroop Creek in this Plan assumes the current content of the Qualification does not significantly alter.

Additionally, there is potential to amend all Qualification of Rights throughout the Qualification period, with the agreement of all parties involved and final authorisation required from the Minister for Water. This Plan provides details about environmental water use under the respective Qualifications at 1 June 2010, however acknowledges that there may be minor modifications to the water availability trigger points made between now and the expiry of the Qualifications. Any modifications made to the Qualifications will be included as Amendments to the Qualification of Rights, and will be publically available from the Victorian Water Register (http://www.waterregister.vic.gov.au/Public/Reports/BulkEntitlements.aspx).

Table 5 describes the key components of the 2009-2011 Qualification of Rights as it impacts on the Environmental Reserve BE, EWR flexibility under the Qualifications, and the expected impacts on environmental flows through the Loddon System as they stand at 1 June 2010.

Table 5. Key components of the 2009 Qualification of Rights and associated impacts on the Environmental Water Reserve in 2010-11

Allocation	Environmental Water Flexibility	Cairn Curran Reservoir to Laanecoorie Reservoir (Reach 1)	Tullaroop Creek (Reach 2)	Laanecoorie Reservoir to Serpentine Weir (Reach 3a)	Serpentine Weir to Loddon Weir (Reach 3b)	Loddon Weir to Kerang Weir (Reach 4)	Boort District Wetlands
0% Allocation	LSWFA - 600ML available and may be used in Boort District Wetlands (via water transfer)	No environmental flow provisions	Unlikely to be any environmental flow provisions	No environmental flow provisions	No environmental flow provisions	Continued cease to flow	0ML available directly from Wetland Entitlement (can transfer from LSWFA)
1% Allocation	LSWFA - 3,200ML available (incl. ability to transfer 2,000ML to Wetland Entitlement)	No environmental Flows	Dependent on Tullaroop Reservoir Storage Volume	No environmental Flows	No environmental Flows	Continued cease to flow	20ML available directly from Wetland Entitlement (can transfer additional water from LSWFA)
5% Allocation	LSWFA – 8,200ML available (incl. ability to transfer 2,000ML to Wetland Entitlement)	Minimum passing flows can be restored (or stored in LSWFA)	Dependent on Tullaroop Reservoir Storage Volume	Minimum passing flows can be restored (or stored in LSWFA)	Minimum passing flows can be restored (or stored in LSWFA)	Minimum passing flows can be restored (or stored into the LSWFA account)	100-1000ML available directly from Wetland Entitlement (can transfer additional water from LSWFA
100% + Allocation	▪ LSWFA – 8,200ML and 2009/10 flows withheld (account accrual finished) ▪ 6,000ML of Deficit and Reimbursement account available at with further 19,000ML available when Cairn Curran and Tullaroop Reservoirs combined storage volume is greater than 80GL ▪ Low reliability water share available 1% to 100% (up to 2,105ML)	Minimum passing flows and river freshening flows restored	Minimum passing flows and river freshening flows restored	Minimum passing flows and river freshening flows restored	Minimum passing flows and river freshening flows restored	Minimum passing flows and river freshening flows restored	2,000ML available directly from Wetland Entitlement

3d. Scientific Panel

In order to manage environmental water during drought in the Loddon System, additional information was obtained from a scientific panel consisting of members with a good understanding of the ecology of northern Victorian river systems, and those who have provided previous drought management advise (Cottingham et. al 2010). The focus of the options developed by this group relate to the survival of critical ecological objectives during the dry period, but they also look toward managing a long term improvement in ecosystem health.

Specific Loddon River information generated through the scientific panel process as it relates to season 2010-11 is provided in Section 5c part (i).

4. 2009-10 Season Review

Rainfall-runoff conditions in the Loddon system at the end of the 2009-10 season were significantly better than 2008-09, resulting in increases in storage volumes in all the Loddon storages (Cairn Curran Reservoir, Tullaroop Reservoir and Laanecoorie Reservoir). However, due to the low levels of the storages to begin the season, the increases were still well below average conditions and the Loddon system remained under the Qualification of Rights during 2009-10.

Figure 3, Figure 4, Figure 5 and Figure 6 show the differences between the average monthly rainfall between 1981 and 2010, and monthly rainfall received during 2009-10 at Maryborough (in the upper catchment area) and Kerang (in the lower catchment area). As can be seen from the graphs, in both locations the maximum temperatures recorded during 2009-10 were slightly above the averages recorded for the period 1981 and 2010. Rainfalls recorded at both locations during 2009-10 were also above the averages from 1981 to 2010, with both locations receiving more than double the average rainfall for November 2009, March 2010 and April 2010.

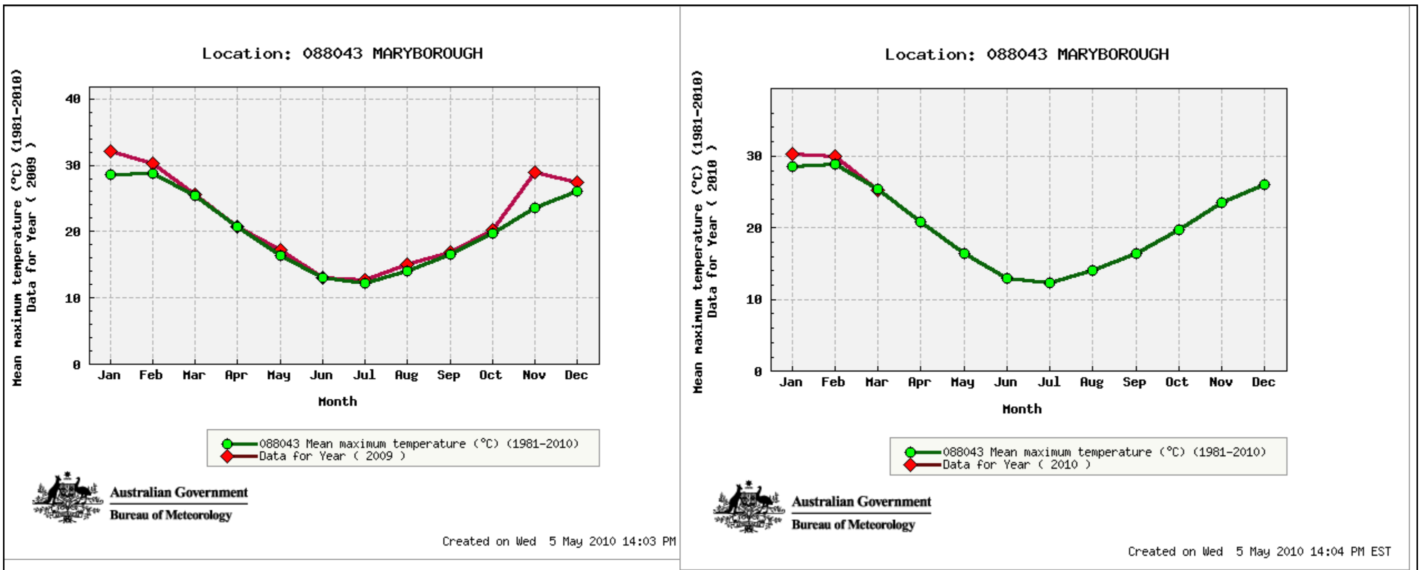

Figure 3. Mean maximum temperatures at Maryborough between 1980 and 2010 (shown in green), and 2009-10 (shown in red). Source: Bureau of Meteorology (www.bom.gov.au).
Note that temperatures recorded through 2009-10 were slightly above average.

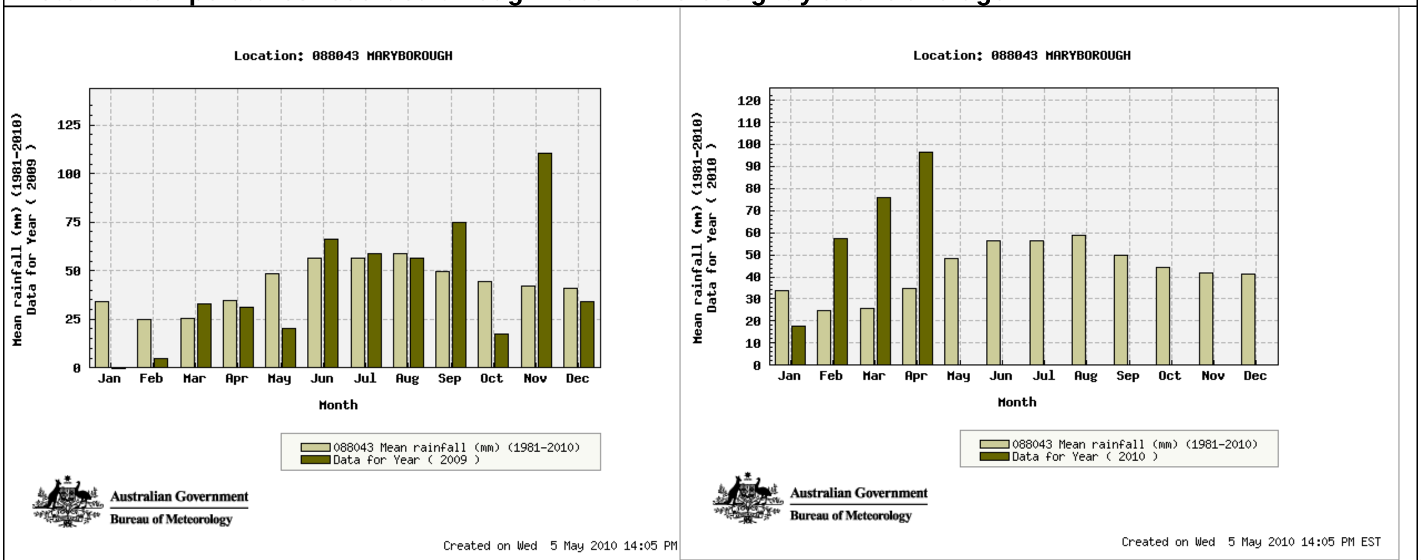

Figure 4. Mean monthly rainfall at Maryborough between 1980 and 2010 (shown in light green), and 2009-10 (shown in dark green). Source: Bureau of Meteorology (www.bom.gov.au).
Note that rainfalls recorded through the later part of 2009-10 were above average.

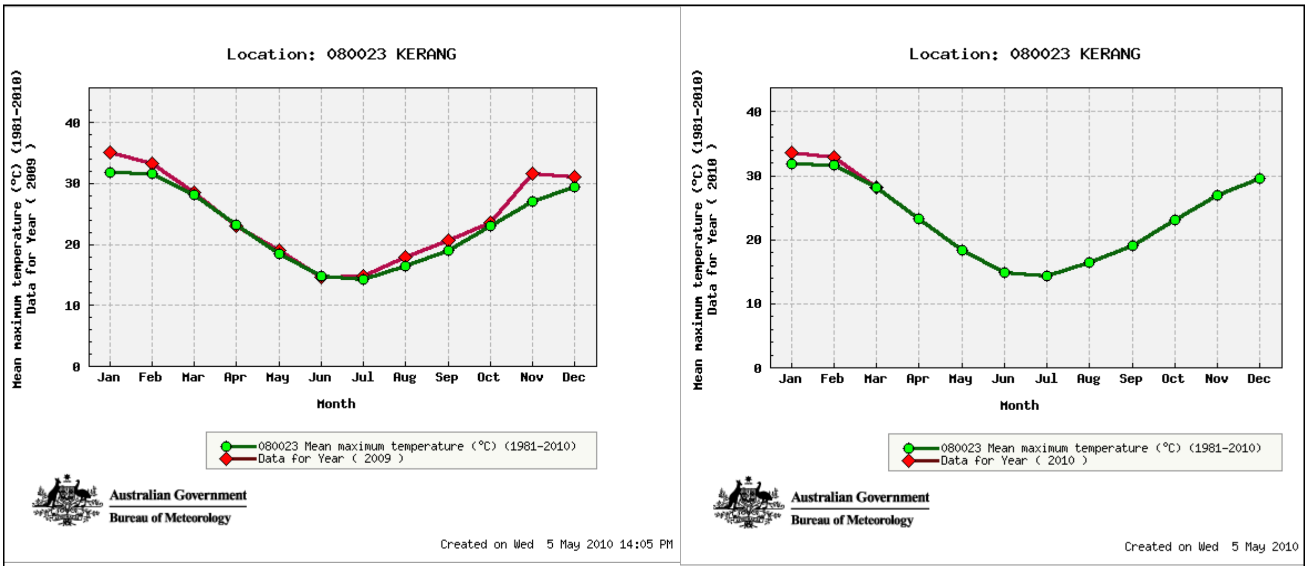

Figure 5. Mean maximum temperatures at Kerang between 1980 and 2010 (shown in green), and 2009-10 (shown in red). Source: Bureau of Meteorology (www.bom.gov.au).
Note that temperatures recorded through 2009-10 were slightly above average.

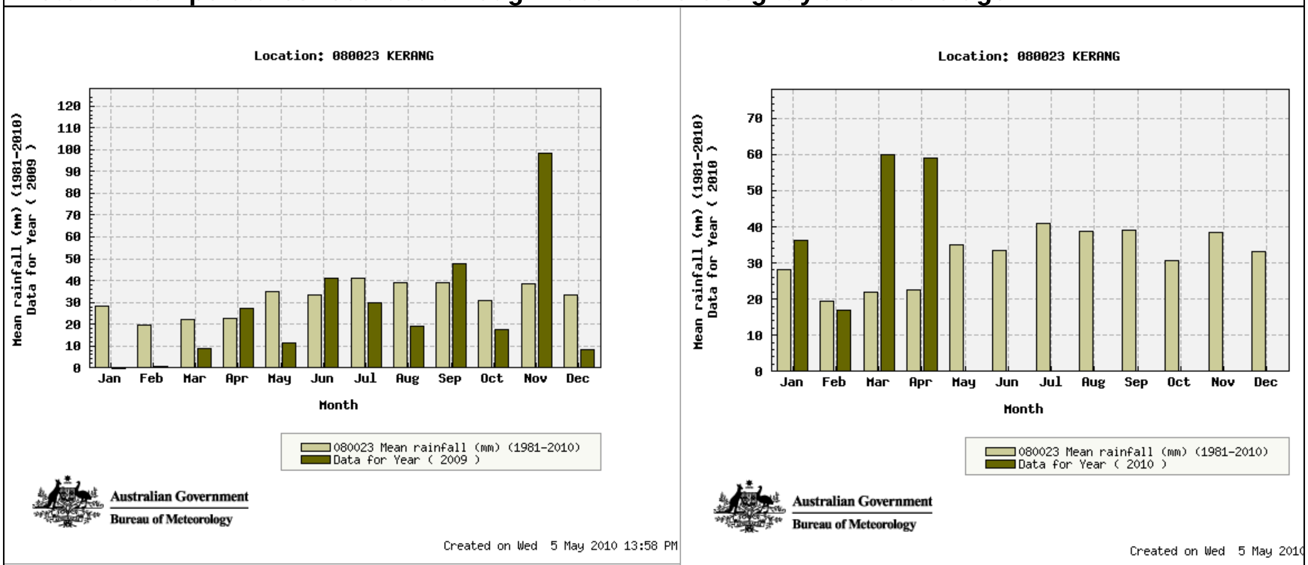

Figure 6. Mean monthly rainfall at Kerang between 1980 and 2010 (shown in light green), and 2009-10 (shown in dark green). Source: Bureau of Meteorology (www.bom.gov.au).
Note that rainfalls recorded through the later part of 2009-10 were above average.

After significant rain was received during March 2010, a three percent allocation of HRWS was made on the Loddon System (excluding Tullaroop Creek). Due to this allocation being made relatively late in the irrigation season, there are a number of G-MW customers who intend to carry over their allocation and use the water in 2010-11 (G-MW, pers. comm 2010). This was the first allocation made on the Loddon since 2007-08.

The following Bulk Entitlements and Qualification of Rights were in operation during 2009-10:

- Bulk Entitlement (Loddon System – Part Maryborough – Central Highlands Water) Conversion Order 2005
- Bulk Entitlement (Loddon System – Coliban Water) Conversion Order 2005
- Bulk Entitlement (Loddon System – Environmental Reserve) Conversion Order 2005
- Bulk Entitlement (Creswick) Conversion Order 2004
- Bulk Entitlement (Loddon System – Goulburn-Murray Water) Conversion Order 2005
- Temporary Qualification of Rights in the Loddon Water System, July 2009
- Temporary Qualification of Rights in Reach Two of the Loddon Water System, June 2009

The use of environmental water through 2009-10 is highlighted below, and will be discussed further in the following section:

- Tullaroop Creek (Reach 2) received a flow regime of 5ML/day for three days and 2ML/day for four days throughout summer. Two 6ML/day events were delivered for approximately one week each
- Loddon River between Serpentine Weir and Loddon Weir (Reach 3b) received 760ML of environmental water from the LSWFA which was transported through this reach for delivery to Little Lake Boort and Lake Yando
- Little Lake Boort received three deliveries of 150ML (450ML in total) of environmental water from the LSWFA (via a transfer to the Wetland Entitlement). This was supported by 100ML of water from the Little Lake Boort Committee of Management
- Lake Yando received a total of 756ML of environmental water from the LSWFA, Wetland Entitlement and Murray Flora and Fauna Entitlement during spring 2009
- Lake Leaghur received an allocation of 800ML of environmental water from the Murray Flora and Fauna Entitlement. Delivery begun at the end of April 2010

4a. Water Resources

Rainfall-runoff conditions during 2009-10 were slightly better than those in 2008-09. As at 17 May 2010, volumes in each of the Loddon storages were as follows:

- Cairn Curran – 6,286ML (full supply capacity is 147,130ML)
- Laanecoorie – 1,807ML (full supply capacity is 8,000ML)
- Tullaroop – 4,055ML (full supply capacity is 72,950ML)

The total combined volume currently held in storage is therefore 12,148ML of a total available capacity of 228,080ML.

Figure 7, Figure 8 and Figure 9 show the water storage level at each of the Loddon Storages during 2009-10. In each of the storages there is more water currently held in storage than at the same time last year.

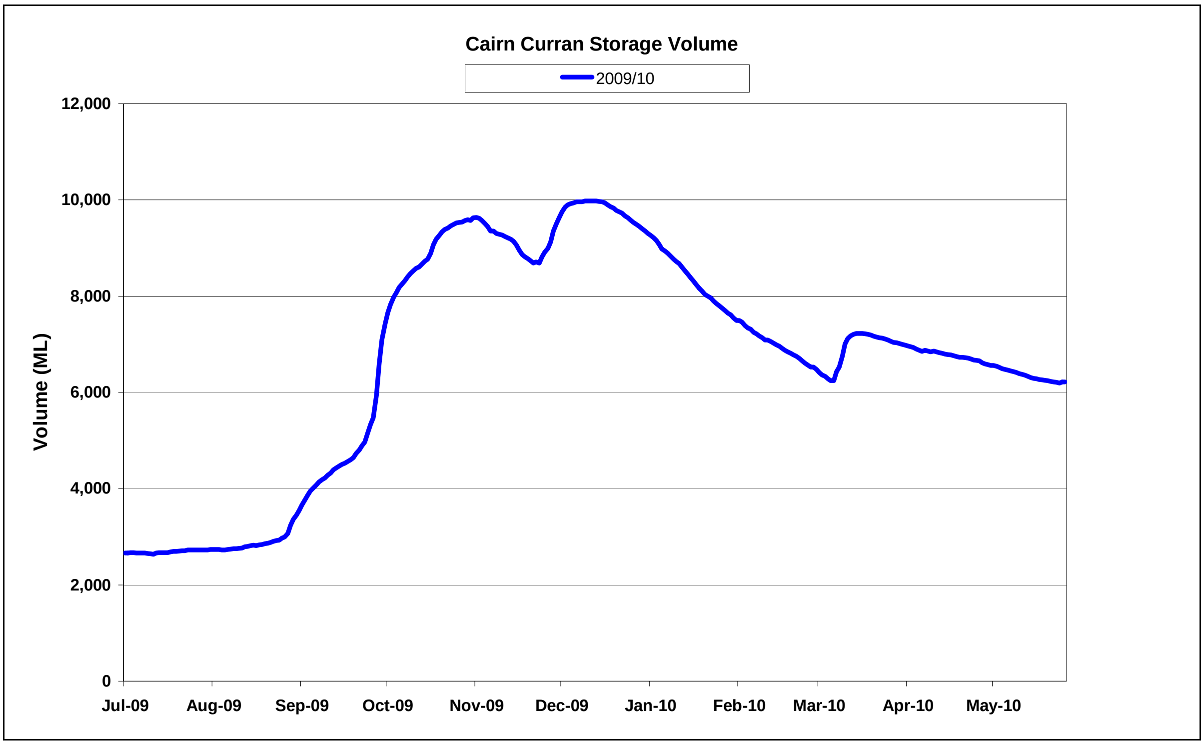

Figure 7. Storage volume of Cairn Curran Reservoir during 2009-10. Source: G-MW

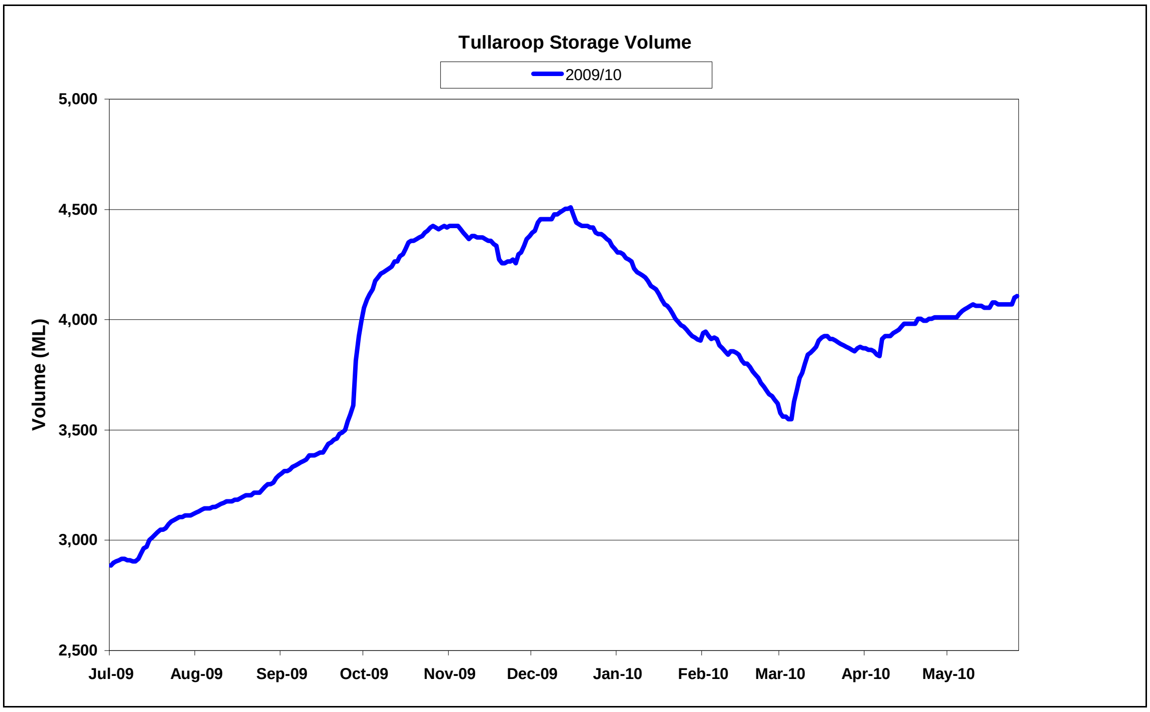

Figure 8. Storage volume of Tullaroop Reservoir during 2009-10. Source: G-MW

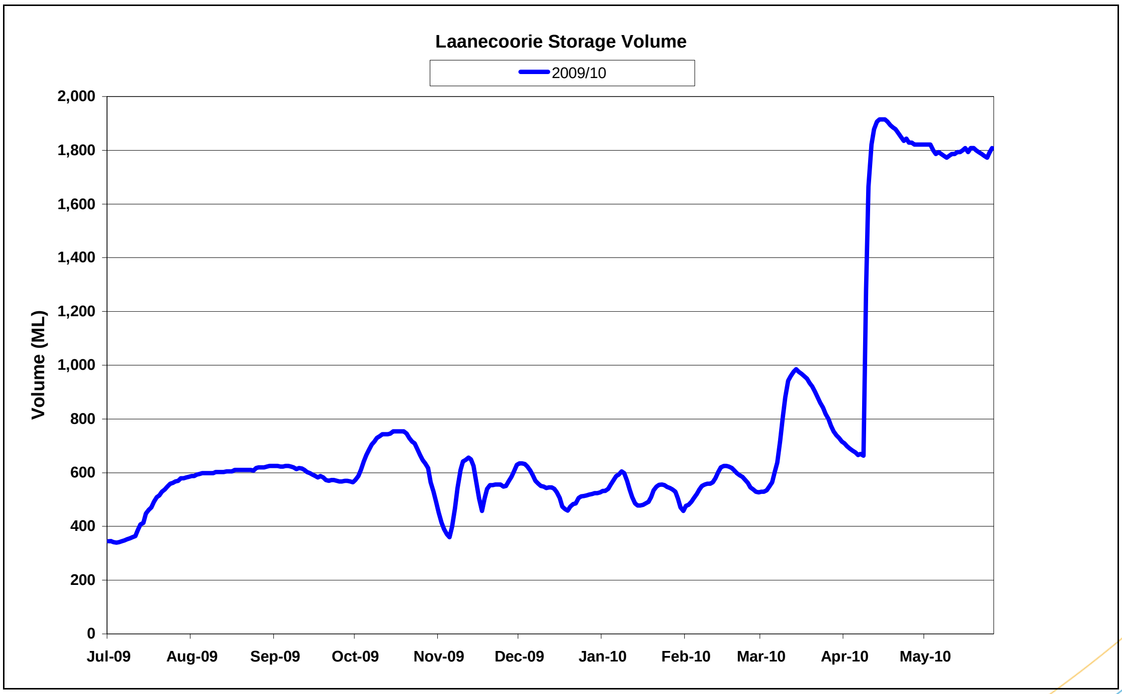

Figure 9. Storage volume of Laanecoorie Reservoir during 2009-10. Source: G-MW

4b. Environmental Flow Review

This section provides details the flow regime provided, and ecological responses observed of each reach of the Loddon River (excluding Reach 5 – downstream of Kerang Weir as it is not considered under the Environmental BE).

The 2009-10 season begun with the continued dry conditions experienced in 2008-09. Flows into Cairn Curran and Tullaroop Reservoirs remained relatively small during winter, however a large rainfall event during September increased flows and volume in storage of both reservoirs (refer to Figure 10 and Figure 11). Inflows into Laanecoorie Reservoir, and the volume hold in storage in shown in Figure 12.

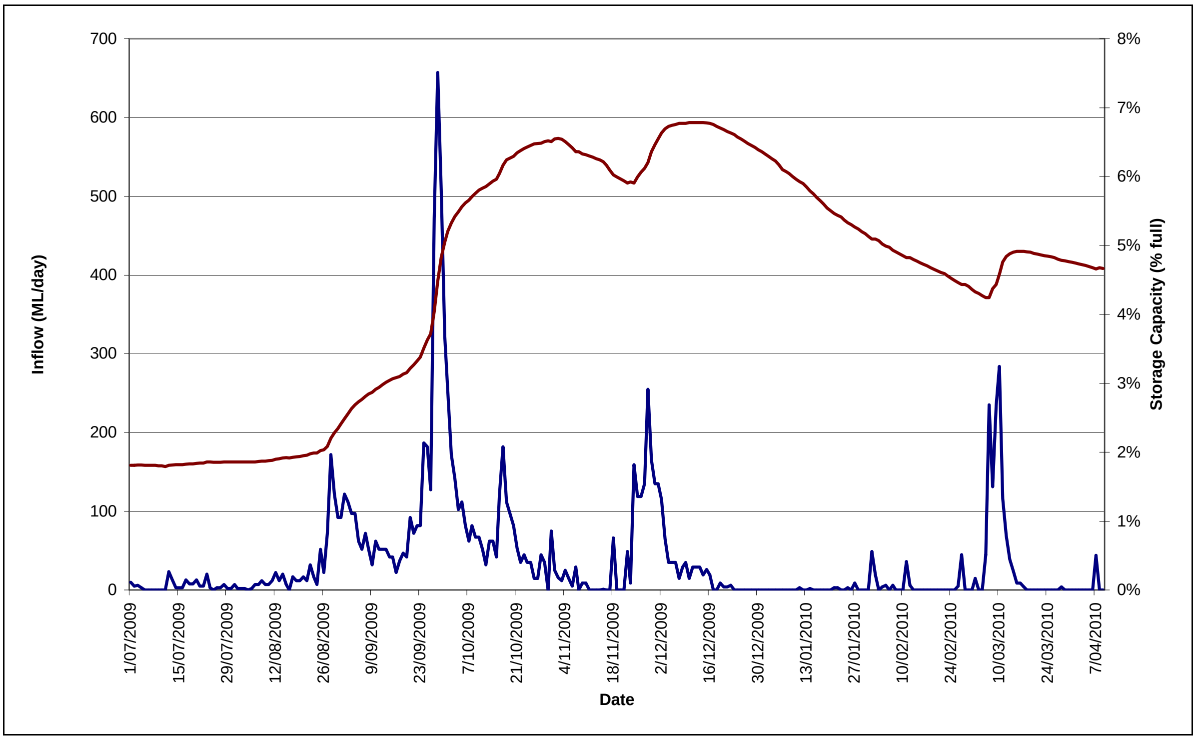

Figure 10. Inflows and capacity of Cairn Curran Reservoir during 2009-10.

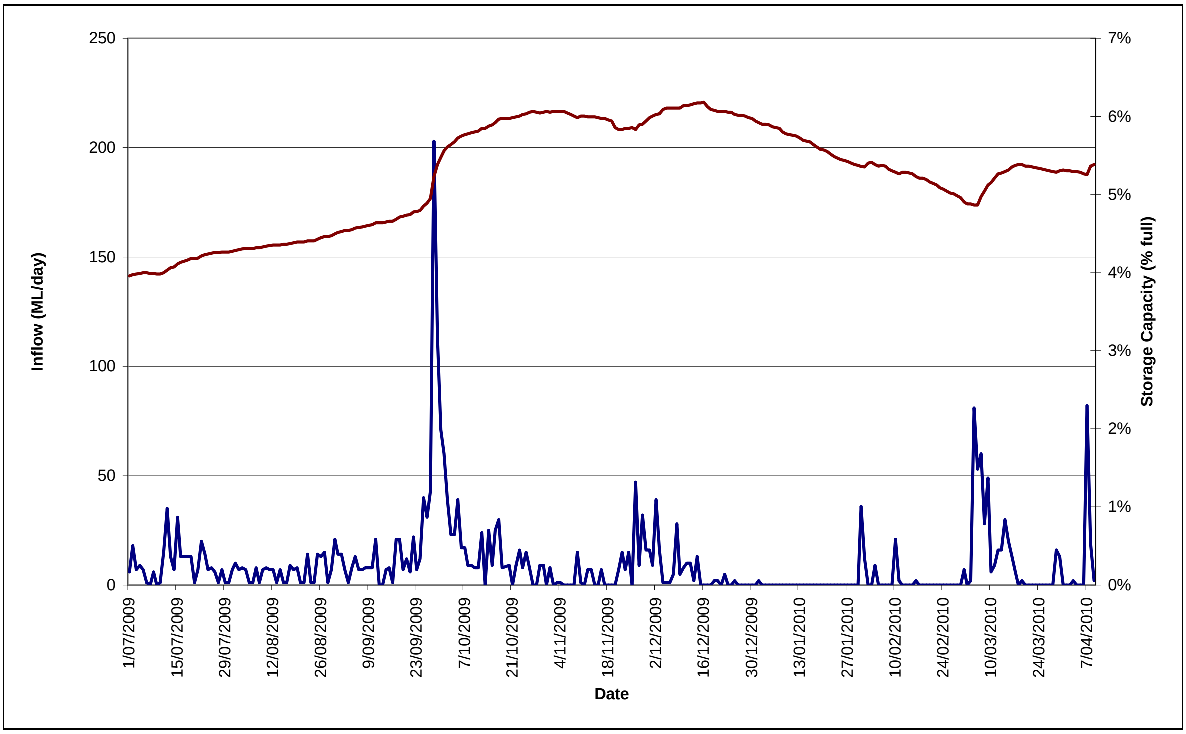

Figure 11. Inflows and capacity of Tullaroop Reservoir during 2009-10.

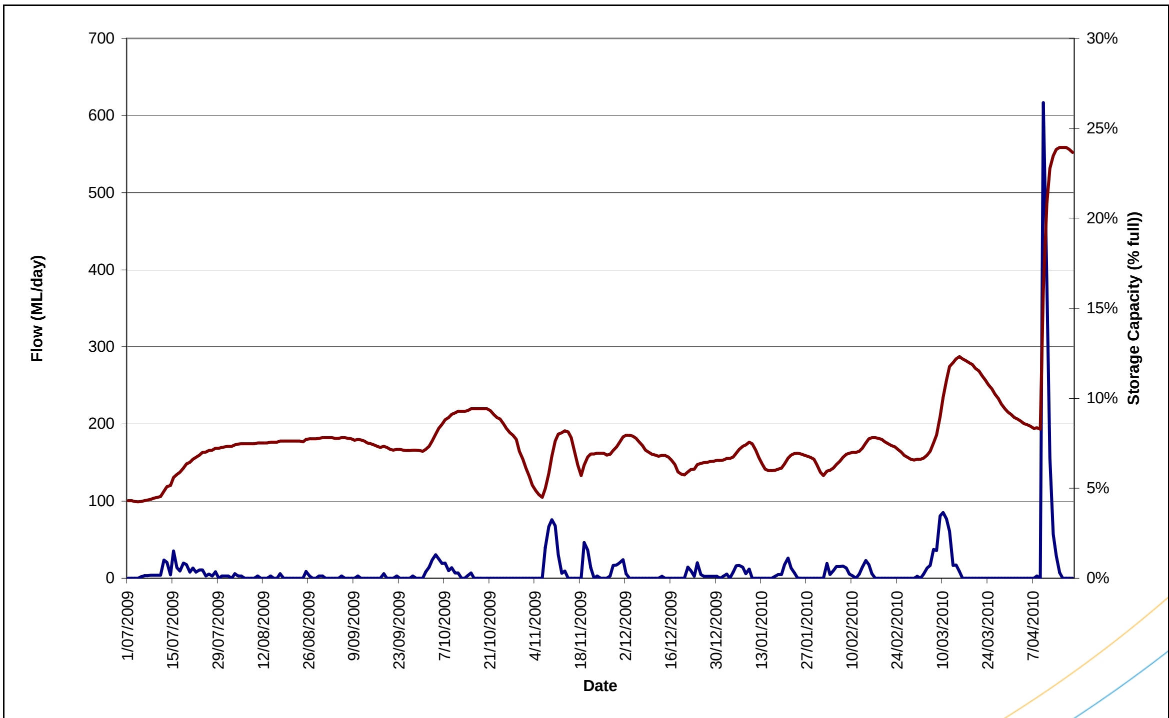

Figure 12. Inflows and capacity of Laanecoorie Reservoir during 2009-10.

The high inflows into Cairn Curran Reservoir during March 2010 meant that G-MW was able to provide a 3% allocation of HRWS on the Loddon System (excluding Tullaroop Creek) on 15 March 2010. This was the first allocation on the Loddon since 2007-08.

From an environmental flow perspective, 2009-10 again saw management of the system focusing on survival of priority species and ecosystems with the aim of ensuring (to the best possible ability) priority system assets were protected, and providing capacity for ecosystem recovery when conditions return to a wetter cycle.

While the allocation on the Loddon was welcome news from an environmental perspective, the additional water it provided for the Loddon environmental entitlement came a little too late in the season to provide worthy benefit. A total of approximately 2,200ML of environmental water became available for use through this allocation, however the priority reaches this season did not require additional water at this time. It is acknowledged that the river operations provided by G-MW supported the environmental priorities. As such, it was decided that this water be carried over to 2010-11, which will be used if an allocation is made on the Loddon system.

Additionally, this season saw water from other systems in Northern Victoria used in environmental priorities in the Boort District Wetlands. Environmental water from the Murray Flora and Fauna Entitlement was delivered to Lake Yando and Lake Leaghur, with a flourish of both flora and fauna responses observed.

The following sections outline the operations of the Loddon River and Boort District Wetlands from the 2009-10 season.

i. Reach 1: Cairn Curran Reservoir to Laanecoorie Reservoir

Under the Qualification rules no environmental flow releases were administered in Reach 1, although water transfer releases (between Cairn Curran and Laanecoorie Reservoirs) were undertaken through the season.

Spot monitoring, undertaken by G-MW as part of their drought management revealed dissolved oxygen levels between 5.9 and 10.1mg/L for the season with electrical conductivity (salinity) varying between 851 and 2,038 µS/cm.

Figure 13 shows the flow releases from Cairn Curran Reservoir during the 2009-10 season.

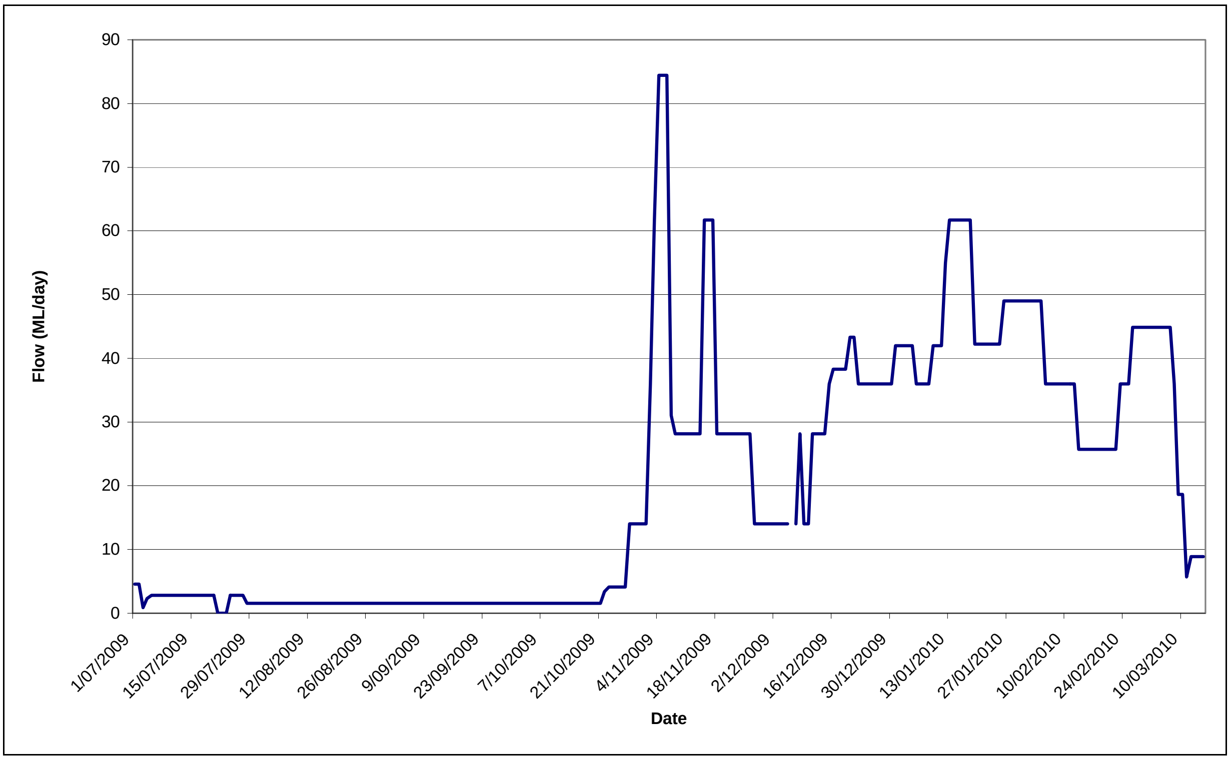

Figure 13. Flows downstream of Cairn Curran Reservoir (July 2009 – March 2010)

ii. Reach 2: Tullaroop Reservoir to Laanecoorie Reservoir

Tullaroop Creek remained under Qualification of Rights during 2009-10. 875ML was available for environmental use through the whole of the season so a base flow of 1ML/day was provided through to December 2009. During December, the summer flow regime was started with 5ML/day released for three days, and 2ML/day for four days. This regime was continued through the season, with two 6ML/day freshes provided for 6-8 days each. Figure 8 shows the flow releases from Tullaroop Reservoir during the 2009-10 season.

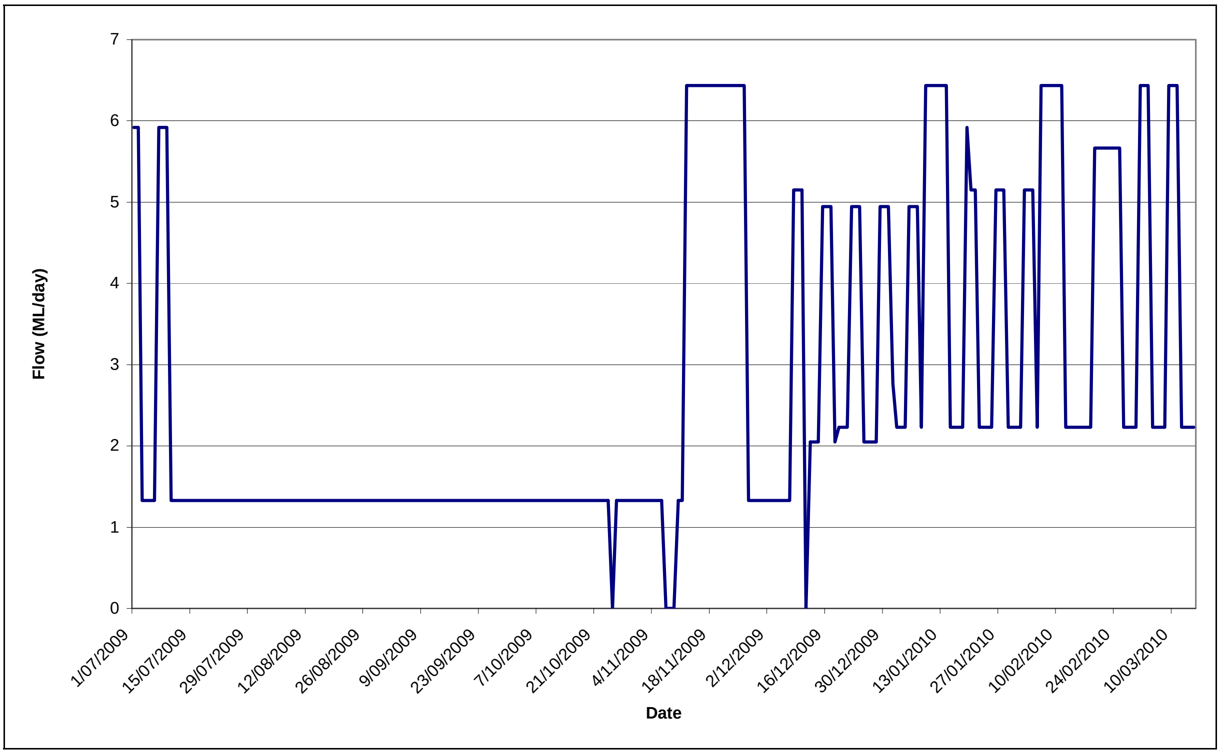

Figure 14. Flows released from Tullaroop Reservior into Tullaroop Creek (July 2009 – March 2010)

The aim of these flow releases was to maintain the wet section of Tullaroop Creek (upper section of the creek) and provide habitat for aquatic fauna species (particularly River Blackfish) (refer to Figure 15). The lower section of the creek is not completely dry, but the large pools through this section are still holding some water.

There has been a slight decline in the creek health over the past year, noted by local community members (LEWAG 2010). From a monitoring perspective, dissolved oxygen dropped to 0.3mg/L in this section of the creek. Electrical conductivity reached approximately 4,600µS/cm.

Fish monitoring undertaken through the reach found that there were more individuals caught this season than in the previous two seasons (particularly Flathead Gudgeon [33], Mountain Galaxias [19] from a native perspective and Gumbusia [100] and Goldfish [12] from an exotic perspective) (SKM 2009a). Only two River Blackfish were found through the whole creek which was less than were caught in the previous season (SKM 2009a).

Targeted River Blackfish monitoring is scheduled to be undertaken at the end of the 2009-10 season to gain more information about populations of these fish through the creek.

Figure 15. Tullaroop Creek at end of March 2010 (site is where two River Blackfish were found in 2009). Photo S. Carracher

Figure 16. River Blackfish (Gadopsis marmoratus). Photo. N. Armstrong

iii. Reach 3a: Laanecoorie Reservoir to Serpentine Weir

Under the Qualification rules no environmental flow releases were delivered in this reach, although some water releases occurred for stock and domestic proposes early in the season, and for irrigation demand later in the season. At five spot monitoring sites dissolved oxygen levels varied between 2.8 and 11.5 mg/L, with salinity levels varying between 1,220 and 5,909 µS/cm (monitoring was undertaken by G-MW).

Figure 17 shows the flows released from Lannecoorie Reservoir for the 2009-10 season.

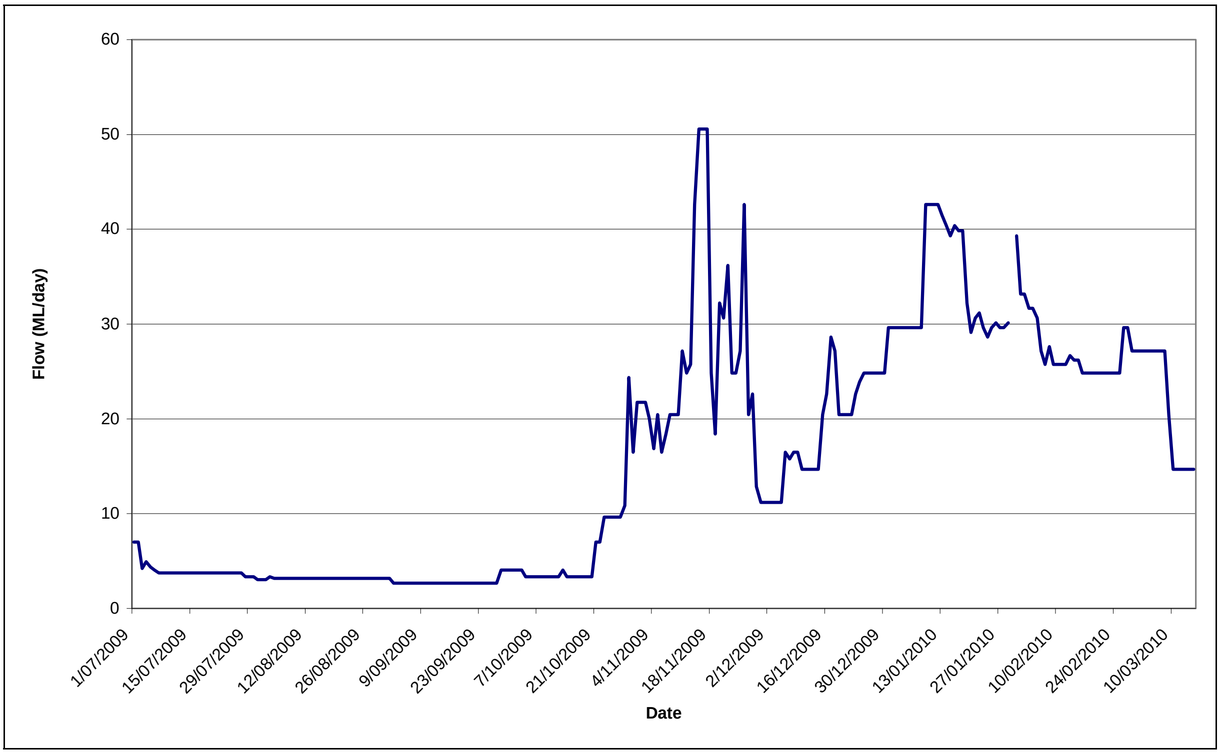

Figure 17. Flow downstream of Laanecoorie Reservoir (July 2009 – March 2010)

In the upper section of this reach there has been a noticeable build up of algae on some turtle's shells, resulting in the need to rescue some individuals by local community members (LEWAG 2010). It has been hypothesised that perhaps this could be due to a lack of high velocity water moving through the system and cleaning sediments. Additionally, it was noted that this season has seen a continued absence of platypus in the reach, and fisherman have been unable to find shrimps in reeds as they have done in previous seasons (LEWAG 2010). Again it may be possible that a lack of freshes through this reach has meant that there has been little or no cleaning of sediments from instream habitat (logs, rocks etc.) resulting in impacts on the macroinvertibrate population.
Fish monitoring showed that there similar numbers of native fish species caught than last year, however a greater number of exotics (particularly carp – 60 individuals) were caught. Fifty-six Flathead Gudgeon were caught, along with two Murray Cod and 14 Golden Perch (SKM 2009a).

iv. Reach 3b: Serpentine Weir to Loddon Weir

This reach received no water between July and November 2009. A natural flow event resulted in water overtopping Serpentine Weir in late-November which was then sustained through a combination of environmental and regulated flows through to April 2010 (Figure 18). The primary objective of this flow from an environmental perspective was to transport sufficient water through to Loddon Weir to then deliver into the Pyramid-Boort Irrigation Area and Boort District Wetlands. Additional environmental benefits were gained through the use of this water in the reach, for example Flathead Gudgeon and Carp Gudgeon were both sampled downstream of Serpentine Weir, and Flathead Gudgeon, Australian Smelt and Golden Perch sampled in the Loddon Weir pool.

In total, 932ML of water was passed downstream of Serpentine Weir, with 739ML making it though the reach to Loddon Weir. This included a number of natural rainfall events, limited G-MW stock and domestic deliveries and the environmental water. Water quality responded well with dissolved oxygen varying between 3.42 and 9.3 mg/L, and salinity varing between 3,157 and 6,072 µS/cm (monitoring was undertaken by G-MW).

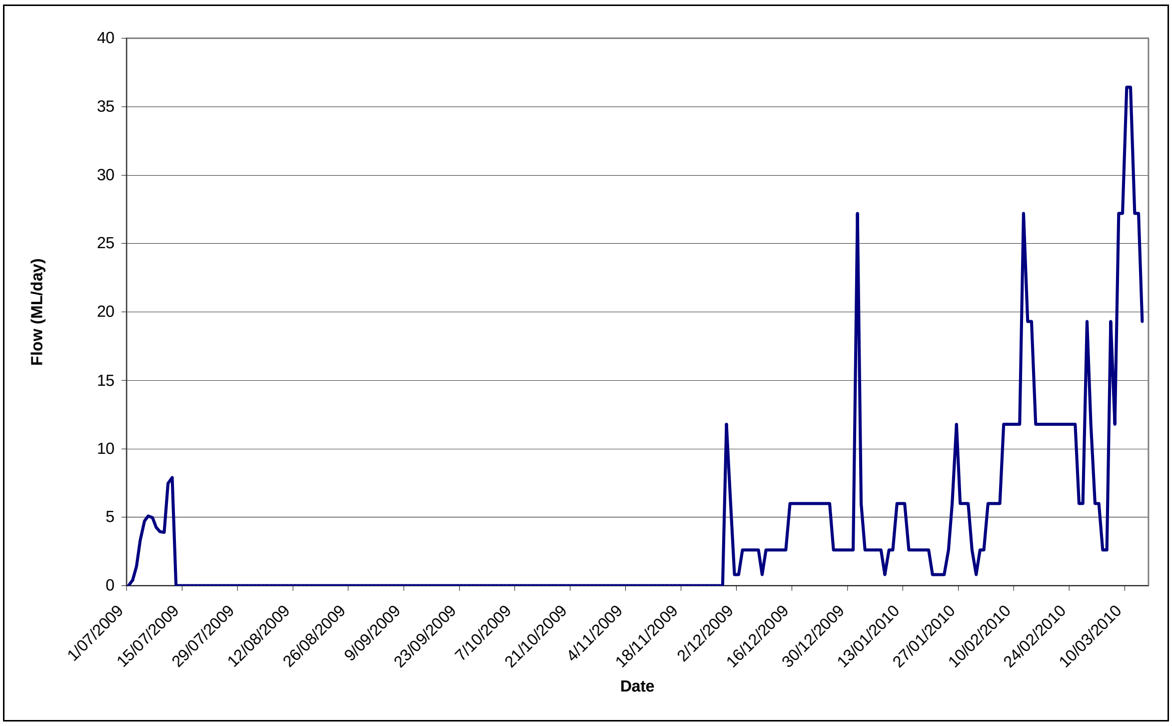

Figure 18. Flows in Loddon River downstream of Serpentine Weir between July 2009 and May 2010.

v. Reach 4: Loddon Weir to Kerang Weir

No flows were released from Loddon Weir during 2009-10 due to being unable to commit to maintaining water through 2009-10 and 2010-11. As was observed in 2008-09, the growth of instream vegetation (particularly River Red Gum – refer to Figure 19) and the questions surrounding likelihoods and threats of exacerbating acid water/Acid Sulphate Soils through the reach meant that under the dry scenarios observed, Reach 4 was kept dry.

Increasing knowledge about the ongoing management of this reach has been gained through a study which reviewed the flow recommendations for the lower Loddon System (Reaches 4 and 5 and 12 Mile Creek). This study will be discussed further in Section 4b.

It has been noticed that the River Red Gums through the base of the river in this reach are still growing prolifically, with only minimal thinning observed (LEWAG 2010). It was noted that the lack of flows through this reach has been a good thing, and that early settlers in the area observed that the Loddon River dried in summer (LEWAG 2010). Now that flows have ceased though the upper section of this reach, it was recommended that a continuous low summer flow in isolation should not occur again (LEWAG 2010).

Further through the reach, the influence of both the Macorna Main Channel and the Kerang Weir pool result in water pooling in the lower section of this reach. Fish monitoring in the Kerang Weir pool showed a lower instance of native fish species, and a higher instance of exotic species than in 2008. Six Carp Gudgeon and six Golden Perch were caught, along with Goldfish, Redfin, Gambusia and Carp (SKM 2009a).

Figure 19. Red Gum germination in Reach 4 of the Loddon River October 2009 (photo B. Velik-Lord)

vi. Boort District Wetlands

At the beginning of the 2009-10 season the only wetland in the Boort area holding water was Little Lake Boort. Given the extremely dry conditions that were being faced, and to potential to not be able to run the river through to Loddon Weir it seemed unlikely that this drought refuge would be able to be maintained through the season.

Significant flows in the Serpentine area at the end of November resulted in Serpentine Weir overtopping, and flows being reinstated into the reach between Serpentine Weir and Loddon Weir. Given this opportune rainfall, it was decided that some environmental water would be used to maintain flow through this reach, with the primary objective of getting sufficient water through to Loddon Weir to deliver through the irrigation system to Little Lake Boort and maintain it as had been done over the past two years. Water was also provided to Lake Yando through this mechanism.

During this time, irrigation allocations on the Murray System were also increasing. Like the Loddon System, The Murray River System also has an Environmental BE, where environmental water can be used for delivery to high value environments in the connected Murray Basin. Water was sourced from the Flora and Fauna Entitlement by the CMA to deliver to Lake Yando. This wetland had continually been prioritised by the LEWAG as the wetland containing the highest ecological value of the Boort District Wetlands, and was in need of water after 12 years without a fill event (LEWAG 2009).

In addition to Little Lake Boort and Lake Yando, environmental water was sourced from the Murray Flora and Fauna Entitlement for delivery to Lake Leaghur. Through previous Loddon AWPs, Lake Leaghur had been the second priority wetland in the Boort District Wetland complex. It is expected that up to 800ML of water will be delivered to the site during autumn 2010. An additional 300ML will be sourced either through the Loddon Entitlement, or the Murray Entitlement to provide a subsequent top-up of the site during spring 2010.

Specific observations from the watering of these three wetlands are detailed below.

Figure 20 shows the condition of some Boort District Wetlands during 2009-10.

Figure 20. Lake Boort (foreground), Little Lake Boort (on left, holding water), Lake Lyndger (background) and Lake Yando (in the distance) from the air, December 2009. Photo P. Haw.

Little Lake Boort

A total of 550ML of water was delivered to Little Lake Boort during 2009-10 (450ML of environmental water from the Loddon Entitlement, and 100ML from the Little Lake Boort Committee of Management). 2009-10 was the third year that the CMA has been involved in the watering of Little Lake Boort as a drought refuge, and once again, water dependant species were observed utilising the site (refer to Figure 21).

Note: the aim of these watering events was to maintain the lake at a low level in order to provide a continuing drought refuge function. Since these deliveries, water sourced by the Committee of Management and outfall water has been provided to the lake, increasing the depth significantly.

The following lists some water-dependent species observed on the site during 2009-10:

- Black Swan
- Australian Shelduck
- Black Duck
- Grey Teal
- Masked Lapwing
- Red-kneed Dotterel
- Black-winged Stilt
- Yellow-billed Spoonbill
- Plumed Whistling Duck
- Gull-billed Tern

From a community perspective, the watering of Little Lake Boort has been considered a good education tool with school groups studying the wetland (LEWAG 2010). There has been good growth of aquatic plants as well as good bird numbers on the lake. A number of carp have been removed by the community which has resulted in clear water (although relatively high salinity) and aquatic plant growth (LEWAG 2010).

Little Lake Boort (photo B. Velik-Lord)

Little Lake Boort (photo B. Velik-Lord)

Plumed Whistling Ducks at Little Lake Boort (photo B. Barnes)

Little Lake Boort from the air (photo P. Haw)

Figure 21. Little Lake Boort during 2009-10

Lake Yando

A total of 751ML of environmental water was delivered to Lake Yando during November 2009. This coincided with a rainfall event in the district which meant that the full 1,000ML allocated from the Flora and Fauna Entitlement was not required to complete the wetland fill. In addition, water from the Loddon accounts (LSWFA and Wetland Entitlement) was sourced for use in this wetland. A total of 756.8ML was delivered to the wetland, with 60ML originating from the Wetland Entitlement; 250ML originating from the LSWFA (via a transfer to the Wetland Entitlement); and 446.8ML originating from the Murray Flora and Fauna Entitlement.

A number of wetland-dependant fauna species have been observed utilising the site since water begun entering the wetland. Regular waterbird monitoring has shown the presence of a number of species using the site, including:

- Black Duck
- Grey Teal
- Maned Duck
- Hoary-Headed Grebe
- Australasian Grebe
- Pink-eared Duck
- Hardhead
- Eurasian Coot
- Pacific Heron
- White-faced Heron
- Sacred Ibis
- Royal Spoonbill
- Yellow-billed Spoonbill
- Dusky Moorhen
- Purple Swamphen
- Masked Lapwing
- Black-winged Stilt
- Red-kneed Dotterel

From a vegetation perspective, the watering event has provided a stimulus for recruitment and germination of native vegetation species with the area no longer being dominated by annual grasses but herbaceous species which are more typical of wetland conditions. The trees in the watered area are generally in good health with regeneration of both River Red Gum and Black Box trees.

The watering of Lake Yando has been considered a success with good vegetation recruitment and high numbers of waterbirds using the wetland (refer to Figure 22). There was no breeding activity recorded, however this may be due to the late-spring filling of the wetland. Numerous frogs used the wetland, including Peron's tree frogs and Plains froglet.

Of the Boort District Wetlands, Lake Yando is considered the most suitable and versatile wetland with a large number of creeklines running through the base of the wetland (LEWAG 2010). Existing stands of cumbungi have flourished with the water, however there are some stands which have not recovered. Visitor numbers to the wetland have been high (LEWAG 2010).

Lake Yando prior to watering (photo B. Velik-Lord)

Yellow-billed Spoonbill, Ibis and Royal Spoonbill at Lake Yando during watering (photo B. Velik-Lord)

Lake Yando during watering (photo P. Haw)

Creek lines in Lake Yando after watering (photo P. Haw)

Figure 22. Lake Yando during 2009-10

Lake Leaghur

Lake Leaghur is considered a high value wetland in the Boort area as it supports a range of state and nationally significant waterbirds. The site is known to have provided a habitat suitable for colonially nesting waterbirds, with Little Pied Cormorants breeding at the site in the past. In addition, other significant waterbird species have been recorded at the lake, including the Australasian Shoveler, Blue-billed Duck, Eastern Great Egret (also listed under CAMBA and JAMBA agreements), Freckled Duck, Glossy Ibis (also listed under CAMBA agreement), Hardhead, Intermediate Egret, Little Egret, Musk Duck, Royal Spoonbill, Whiskered Tern and White-bellied Sea-Eagle (also listed under CAMBA agreement).

Lake Leaghur is classified as a Permanent Open Freshwater wetland, however it has not held water since 2002 (North Central CMA 2010a). The optimal water regime recommended involves a wetland fill one out of every three years (North Central CMA 2010a).

800ML of environmental water from the Murray Flora and Fauna Entitlement was allocated to Lake Leaghur in February 2010. Delivery to the wetland commenced in late April 2010 (refer to Figure 23).

Lake Leaghur prior to watering (photo P. Haw)

Lake Leaghur prior to watering (photo B. Velik-Lord)

Lake Leaghur during watering (photo B. Velik-Lord)

Environmental water entering Lake Leaghur (photo D. White)

Figure 23. Lake Leaghur during 2009-10

4c. Other Studies, Investigations, Works and Policy Developments

Some key research and on-ground works undertaken in the Loddon system during the 2009-10 season included:

- Review of Environmental Flow requirements for the lower Loddon River System
- Loddon Stressed River project
- Northern Victorian Irrigation Renewal Project

Additionally, 2009 saw the publication of the Northern Sustainable Water Strategy (DSE 2009b) as part of the Victorian Government's Our Water Our Future program (DSE 2004). Key components of this document, and implications for the Loddon River System will be discussed in the following section.

Another policy document, *Securing Our Natural Future: A white paper for land and biodiversity at a time of climate change* was released by the Victorian Government in 2009. Once again, the implications of this on the Loddon River System will be discussed in the following section.

Review of Environmental Flow Requirements for the lower Loddon River System

As discussed earlier, flow requirements for the Loddon River between Cairn Curran Reservoir and the Murray River, and Tullaroop Creek were developed by the LREFSP in 2002 (LREFSP 2002a and 2002b). Over previous years it has been recognised that the environmental flow assessment in the lower reaches of the Loddon River was hampered by some information gaps (e.g. lack of flow gauges, multiple REALM models rather than one for the whole river, and a focus on aquatic dependant flora and fauna in Reach 4 which is now dry).

The culmination of this has been that during 2009-10, a project was undertaken to review the original environmental flow recommendations from 2002 in light of increased data availability and recent climatic conditions between Loddon Weir and the Murray River, and update the flow recommendations for these reaches where practical.

The Lower Loddon River System was split into six separate reaches according to key physical and ecological aspects of the river and Table 6 provides information each flow reach. Reach 5 of the Loddon River (downstream of Kerang Weir), as well as Reach 4 (downstream of Loddon Weir) was investigated as part of this study, however Reach 5 has not been considered as part of this Plan as it falls outside of the Environmental BE area.

In looking toward the 2010-11 season, these revised environmental flows recommendations have been used in the scenario planning to provide direction for flow priorities through the lower Loddon River system.

Table 6. Overview of updated environmental flow recommendations for the Lower Loddon River System

<table>
<tr><th>2002 Reach Number</th><th>2010 Reach Number</th><th>Reach Description</th><th>Reach Characteristics</th><th>Ecological Objective</th><th>Flow Recommendations</th></tr>
<tr><td>4</td><td>4a</td><td>Loddon River between Loddon Weir and 12 Mile Creek regulator</td><td rowspan="3">▪ Dry for last three years and currently does not support aquatic dependant species
▪ Terrestrialisation of river bed (River Red Gum, Common Reed and terrestrial grasses)
▪ Lack of deep pools due to sedimentation
▪ Likely to have dried throughout history (ephemeral conditions)
▪ Significant fish barrier at Loddon Weir
▪ Anabranching channels and distributary channels
▪ 12 Mile Creek formed as a natural avulsion for Loddon River</td><td rowspan="2">▪ Maintain/improve riparian and floodplain vegetation (highest priority)
▪ Maintain benches
▪ Scour pools within main channel
▪ Fill anabranches and flood runners
▪ Provide opportunistic fish habitat (i.e. only when sufficient water is available)</td><td rowspan="2">▪ High-bankfull flows 3-5 times per decade (highest priority)
▪ Winter low flows (only deliver if able to provide in most years)
▪ Other flows are recommended only if these previous flows have been delivered
▪ High-bankfull flow is required to restart the reach (i.e. this flow must be provided prior to any other flows entering the reach)</td></tr>
<tr><td>4</td><td>4b</td><td>12 Mile Creek</td></tr>
<tr><td>4</td><td>4c</td><td>Loddon River between 12 Mile Creek regulator and Macorna Channel</td><td>▪ Deliver water down distributary channels (e.g. Wandella Creek)
▪ Inundate parts of Leaghur State Park, wetlands and other floodplain forests
▪ Provide opportunistic fish habitat (i.e. only when sufficient water is available)</td><td>▪ As above, however infrastructure modifications will be required</td></tr>
<tr><td>4</td><td>4d</td><td>Loddon River between Macorna Channel and Kerang Weir</td><td>▪ Influence of Macorna channel – water backup
▪ Significant sedimentation and terrestrialisation
▪ Leaks and small oufalls from irrigation channels has maintained permanent wet (not flowing) conditions</td><td>▪ Protect self-sustaining native fish populations and other native biota from Kerang Weir pool and other connected habitats</td><td>▪ Release water from Macorna Channel to maintain water quality in upstream section of Kerang Weir pool
▪ Specific flow regime dependant on flows through reach 4, and observed conditions at the time</td></tr>
</table>

Loddon Stressed River Project

The Loddon Stressed River Project aims to improve the heath of the flow-regulated waterways of the Loddon River catchment. The project specifically focuses on the Loddon River downstream of Cairn Curran Reservoir, Tullaroop Creek and Birches Creek and complements the Loddon Environmental Flows project. A range of activities are undertaken in this project, including on-ground works in the riparian zone, investigations, capital works and community engagement. The combination of all activities have the objective of achieving an improvement in river health.

Specific activities undertaken during 2009-10 are described below:

- There was a large uptake of on-ground works incentives (27km of fencing in 2009-10 to date)
- Continuation of willow management works through the Loddon system occured
- Tamarix (an invasive weed) management works were undertaken on Lake Meran and Lake Murphy
- Community engagement activities including four community meetings and follow up field days are planned
- Surveys are being conducted into landholder involvement with the Loddon Stressed River Project and riparian management in general
- Planning is underway for reinstatement of woody habitat into Tullaroop Creek (targeting River Blackfish habitat requirements)
- Kerang Weir Fishway Monitoring Project (which aims to set up a long-term monitoring program to evaluate the effectiveness of the fishway in the provision of native fish passage) is being completed

NVIRP

Specific details about NVIRP were discussed in Section 3(a) part (iv).

Northern Sustainable Water Strategy

The Northern Sustainable Water Strategy (SWS) looks toward the next 50 years and discusses threats to water availability and water quality, as well as outlining actions which will manage the consequences of the on-going drought conditions and climate change (DSE 2009b). The document provides some direction for future policy and institutional frameworks, rules, tools and information to guide environmental decisions. While the Northern SWS looks at agriculture, environment and urban values, the primary focus from an AWP perspective is the environmental considerations.

A number of key points from the Northern SWS are included below, focusing on the environmental implications (DSE 2009b). More in depth information can be found directly from the Northern SWS (DSE 2009b).

- There is likely to be less water available during the next 50 years than in the past 100 years due to climate change and variability
- The areas likely to see the most significant effects of climate change through Northern Victoria are the Loddon and Campaspe catchments
- There will be a risk of insufficient water available in some years to run the irrigation system and there will be a disproportionate impact on the environment (i.e. the environment will be hit hardest)

- Rights to water will be reviewed, with a revision of environmental entitlements to improve the use of environmental water and share the risk of future climate change
- Recovery and use of environmental water is to be better managed into the future
- A Victorian Environmental Water Holder will be established with the view of coordinating and prioritising environmental water delivery across the Northern Victorian region
- Water availability scenarios at 2055 were modelled with the Loddon system predicted to receive a decrease in inflows of between 10% (under low climate change) and 74% (under a continuation of 1997-2007 inflows) as compared with the long-term average
- Under a continuation of 1997-2007 inflows, the Loddon will receive 92GL (84%) less environmental water than the long-term average (109GL long-term average to 17GL predicted under low inflows)

Overall, the Northern SWS aims to (DSE 2009b):

- *"identify and understand threats to water availability and quality, including the implications of climate change and variability*
- *help regional communities to adjust to reduced water availability*
- *ensure secure water entitlements for towns, industry and the environment*
- *encourage economically viable and sustainable agriculture*
- *improve choice and flexibility for entitlement-holders to manage the risks of climate change and variability*
- *protect and where possible, improve the health of river, wetland and aquifers from the impact of drought, climate change and variability and other risks*
- *recognise and respond to Indigenous and other cultural and heritage values associated with the region's river and catchment areas"*

Northern SWS, pg. 3

Securing Our Natural Future: A white paper for land and biodiversity at a time of climate change

Like the Northern SWS, this White Paper targets ecosystem management during a change in climatic conditions (generally with less water availability). It builds on the Water White Paper *Securing Our Water Future Together* (DSE 2004) and will be complemented by a forthcoming Climate Change White Paper (DSE 2009a).

The White Paper has an overall vision of *"Victorians acting together to ensure that our land, water and biodiversity are healthy, resilient and productive"* DSE 2009a pg. viii.

A number of strategic directions are described in the White Paper, some of which either cover some of the Loddon River catchment, or are related to the management of environmental water across the state. These strategic directions and actions are mentioned below, and further information can be obtained directly from the White Paper (DSE 2009a):

- Build ecosystem resilience involving landscape-scale management of land, water and biodiversity
- Maintain ecosystem services within flagship areas (the Mega Murray and Goldfields are both flagship areas and cover some of the Loddon River catchment)
- Improve connectivity within important landscapes which have been identified as biolinks (the riparian zone of the Loddon River system links the Mega Murray and the Goldfields flagship areas)

- Reform and realign Victorian Government processes and institutions which lead and facilitate sustainable management of land, water and biodiversity in Victoria
- Develop a program of structural works to facilitate the delivery of environmental water to priority rivers and wetlands, including potential partnerships with the Australian Government
- Manage rivers, wetlands and estuaries so they continue to provide ecosystem services by:
    - Developing an integrated Victorian Strategy for Health Rivers, Estuaries and Wetlands (and complementary strategies for regions)
    - Update existing prioritisation system, including identification of high conservation value aquatic ecosystems
    - Complete the third Index of Stream Condition
    - Establish a benchmark for wetlands and estuaries
- Protection of riparian land and increase productivity, connectivity and amenity

5. 2010-11 Scenario Planning

5a. Water Resources

It is likely that the 2010-11 season will begin with more water held in storage than was held at the beginning of 2009-10 however, this will still be a small relative volume. Like the previous season, the availability of irrigation allocations for the 2010-11 season in the Loddon system will rely entirely on inflows from winter and spring rainfalls. July, August, September and October are usually the peak inflow months, therefore there is potential for an irrigation allocation to be made in the Loddon System so long as the system receives substantial inflows which will ensure that water can be supplied for essential human needs.

As at 19 May 2010, total water resources held in Loddon storages were as follows:

- Cairn Curran Reservoir – 4,0784ML (5.6% capacity)
- Tullaroop Reservoir – 4,078ML (5.6% capacity)
- Laanecoorie Reservoir – 1,807ML (22.6% capacity)

The projected balances of environmental water accounts on the Loddon System expected to be held in storage at July 2010 are as follows:

- Loddon System Withheld Flows Account: 3,200ML
- Deficit and Reimbursement Account: 25,000ML (account cap has been reached)
- Boort District Wetland Entitlement: 0ML (volume dependant on irrigation allocation)
- Tullaroop Environmental Resource: 300ML

Whilst the accounts described above are provided for use in the Loddon System for environmental purposes, the water ‘contained’ in them is not always available for immediate use. Certain trigger levels must be reached before water in the accounts becomes available for use (e.g. no water held in the Deficit and Reimbursement Account will become available for environmental use until a 100% irrigation allocation is made in the Loddon System). This will be explored further in the following sections under the scenario planning for 20010-11. Consideration also needs to be given to where the water is held in storage. For example, environmental water in the Loddon System Withheld Flows Account is held in Cairn Curran Reservoir and as such may not be easily available for use in the area around Serpentine and Loddon Weirs.

5b. G-MW Dry Inflow Contingency Planning

Goulburn-Murray Water has developed six scenarios which are based on annual volumes and an assessment of the possible Loddon System operations and likely recipients under continued dry conditions in 2010-11 (G-MW, 2010).

This planning is referred to as Dry Inflow Contingency Planning (DICP) and is formulated to plan for the worst case scenarios in the coming season to ensure that the water corporations have made adequate planning provisions to deal with low water availability. The scenarios were developed in January 2010 and are based upon 119 years of inflow statistics held by G-MW. It does not imply the probabilities of each scenario occurring, and does not account for the seasonal variation of inflows and demands.

These inflow scenarios have been used as a base from which to plan environmental water use in the 2010-11 season in the following sections.

5c. Scenario planning

The overall aim of the Plan is to ensure that the Environmental Water Reserve for the 2010-11 season is adequately planned, covering a range of possibilities from drought conditions through to a year with an irrigation allocation of greater than 100% and possible storage spillage. The scenarios define how environmental water will be managed under specific water resource availability possibilities and highlights how management should change as more water comes available. Eight scenarios have been developed for planning purposes for the Loddon River and Boort District Wetlands under the following headings:

- Scenario 1 – Worst drought (repeat of 2006/07 inflows)
- Scenario 2 – Extremely dry (delivery of carryover)
- Scenario 3 – Very dry (1% irrigation allocation)
- Scenario 4 – Dry (5% irrigation allocation)
- Scenario 5 – Moderate (50% irrigation allocation)
- Scenario 6 – Average (100% irrigation allocation)
- Scenario 7 – Wet (100% irrigation allocation and over 80GL in storage)
- Scenario 8 – Very wet (storages spill)

The operations and targets for environmental water in Tullaroop Creek during 2010-11 are being considered separately to the Loddon River and Boort District Wetland planning in this Plan. The reason for this is that there is currently a separate Qualification of Rights in operation for Reach 2 of the Loddon System (Tullaroop Creek), and the creek can be operated in isolation under low flow scenarios. There is a point whereby there is sufficient water in both systems to begin operating as one (the reservoirs will be linked via Tullaroop Creek, and irrigation allocation can be delivered to both Loddon and Tullaroop entitlement holders. This will be explored in the following sections.

As the season unfolds, the availability of environmental water is not directly correlated to inflow. Due to the Qualification of Rights, environmental water becomes available at set trigger points, resulting in step changes for water availability. The scenarios are not intended to be prescriptive, rather they set broad management principals and targets to guide environmental water management as the season unfolds.

As described earlier, it is acknowledged that there is potential to amend all Qualification of Rights throughout the Qualification period. Any amendment to a Qualification requires the agreement of all parties involved and final authorisation is given by the Minister for Water. The scenarios described provide details about environmental water use under the respective Qualifications at 1 June 2010. There may be minor modifications to the water availability trigger points made between now and the expiry of the Qualifications. Any modifications made to the Qualifications will be included as Amendments to the Qualification of Rights, and will be publically available from the Victorian Water Register (http://www.waterregister.vic.gov.au/Public/Reports/BulkEntitlements.aspx).

With Loddon System water storages at relatively low levels, the river flows in 2010-11 are predominantly dependent on rainfall and associated inflows in the coming winter and spring. As a result, conditions will change over time and environmental flow management will need to respond to what actually happens in the system. An adaptive approach to the use of the EWR for the Loddon River and Boort District Wetlands has therefore been incorporated into this plan.

The environmental water availability for each of the three environmental accounts/entitlements currently in operation in the Loddon System are shown in Figure 24, Figure 25 and Figure 26. It should be noted that the volumes indicated in the LSWFA may vary slightly according to when irrigation allocations are made on the Loddon System.

These accounts and entitlements are used in planning for environmental water use in the Loddon System. The possible management of unregulated flows (e.g. from rainfall events) in the Loddon River is also planned

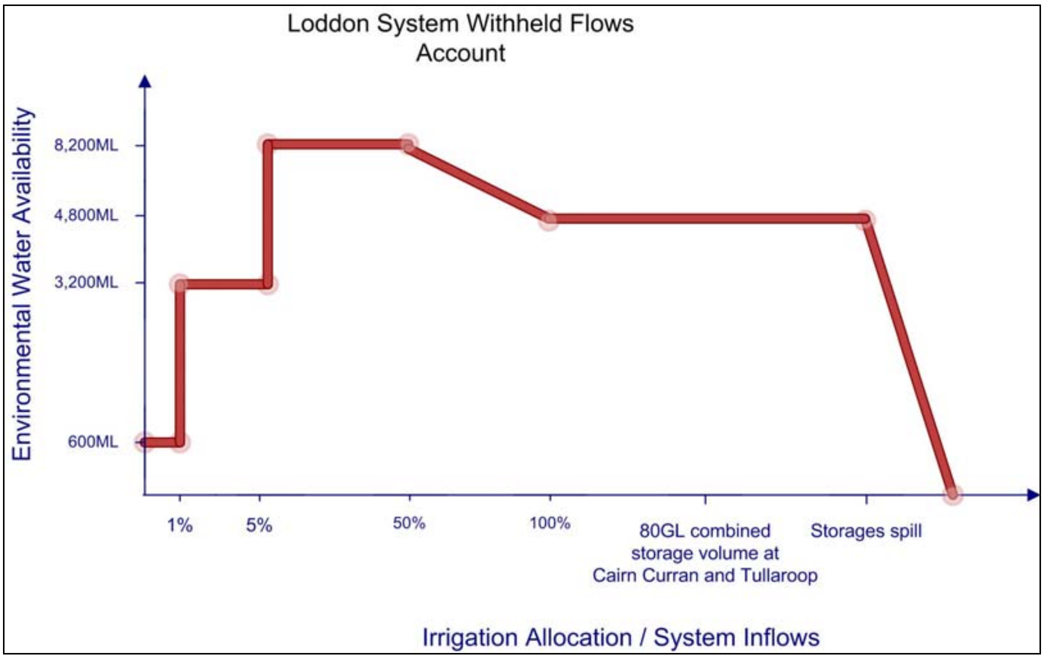

Figure 24. Environmental water availability in the LSWFA according to irrigation allocation on the Loddon System.

Note: the decrease in water availability between 50% and 100% allocation relates to a 100% allocation being made on the Loddon System, and the requirement to no longer withhold passing flows (i.e. under a 50% allocation, all passing flows that should have been released will be banked and recorded in the LSWFA, while under a 100% allocation they will be released in the river system.

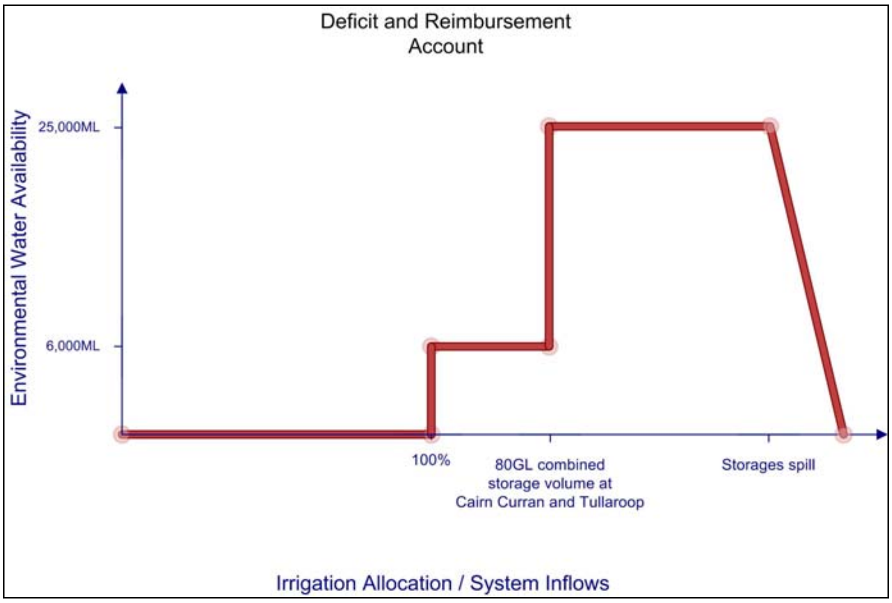

Figure 25. Environmental water availability in the Deficit and Reimbursement Account according to irrigation allocation and system inflows on the Loddon System

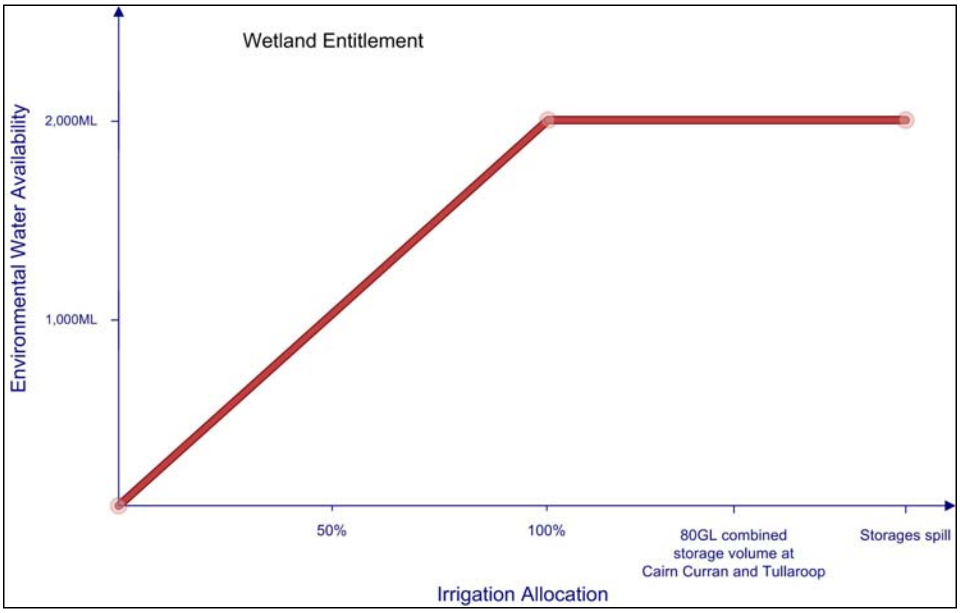

Figure 26. Environmental water availability in the Wetland Entitlement according to irrigation allocation on the Loddon System

This scenario planning explicitly acknowledges the ambiguity and uncertainty in the water resource outlook for the Loddon System. These scenarios are not predictions. Rather, they represent a plausible range of possible futures.

In addition, it is acknowledged that throughout the season there may be a requirement to utilise natural flow events which may modify the actions to be undertaken in any given scenario, or allow movement between scenarios described. These natural flow events should be used to maximise environmental potential which may involve actions such as delivering a fresh earlier or with a greater volume of water than originally planned for to increase the duration of the natural flow event.

i. Environmental Water Priorities

General:

Figure 27 shows the availability of management options according to the described scenarios in this Plan. As can be seen from the diagram, as inflows into the Loddon System increase, and Scenarios 1 through 8 are reached, there is first an increase in the available management options. This availability peaks during Scenario 6 and 7, and then decreases back to Scenario 8.

As will be discussed further, under Scenario 1 there is a very dry river, with only 600ML of environmental water available, along with restrictions in the ability to use this water. At Scenario 8, the storages have spilt and the river is running at bankfull or overbank flows. Most of the environmental water reserve will have spilt from Cairn Curran Reservoir, leaving only 2,000ML of environmental water in the Wetland Entitlement. However, most of the environmental flow needs will have met by unregulated streamflow through the Loddon River System at this stage, so the environmental water options available at this point are minimal.

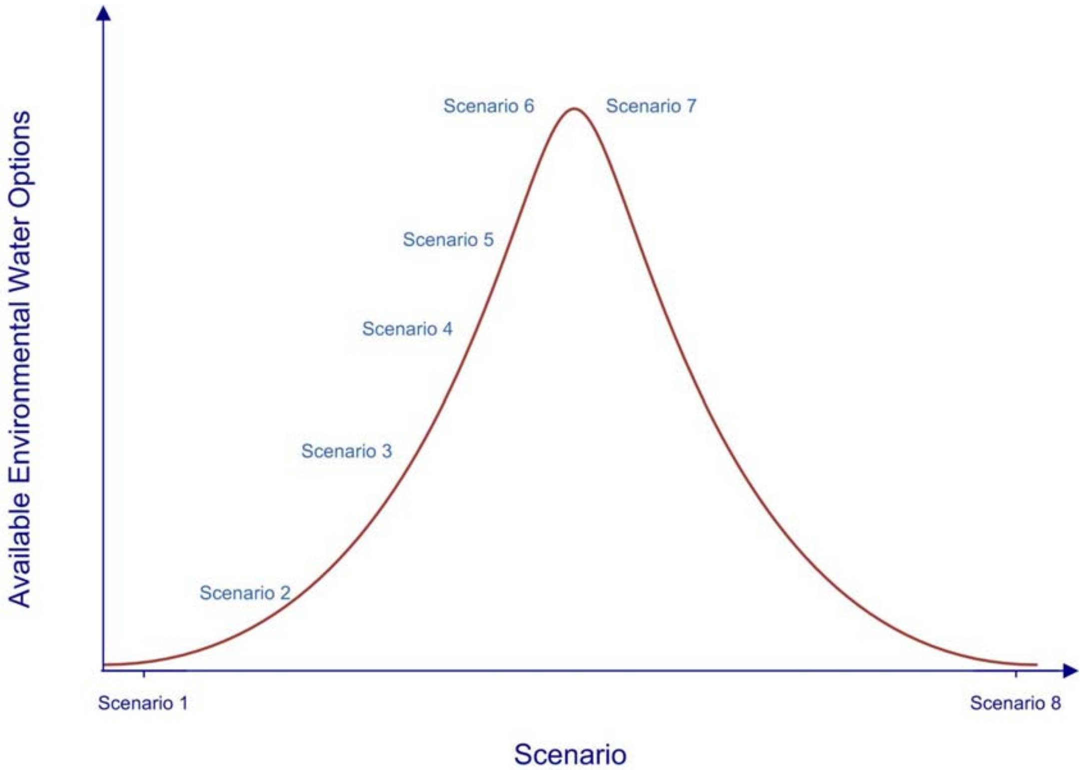

Figure 27. Conceptual availability of management options for environmental water, according to scenarios

River Channel Priorities:

The following general principles have been recommended by the scientific panel for 2010-11 (Cottingham et. al 2010):

- *"Explicitly adopt a model-based Adaptive Management approach to learning from experience by setting hypotheses, developing conceptual models, identifying and implementing actions, and evaluating ecosystem responses*
- *Avoid critical loss of imperilled species (e.g. critically endangered species, at-risk remnant populations at a catchment or regional scale)*
- *Maintain viable populations of threatened species within the river system*
- *Avoid irretrievable ecosystem damage or catastrophic events (e.g. extensive fish kills or acidification)*
- *Provide refuges for aquatic biota to allow recolonisation and facilitate recovery following drought or other disturbance*
- *Continue a long-term perspective to maintain resilience and ecosystem functioning into the future"*

Cottingham et. al (2010).

Management response this season is to recognise drought conditions but plan for recovery (Cottingham et. al 2010).

During dry conditions, environmental priorities for the Loddon River focus on keeping the river running between the storages and Loddon Weir. Associated with this is the maintenance of fish habitat (presence of water), and quality of that habitat (primarily related to water quality and the avoidance of blackwater events). With very low water availability, the environmental targets in the river system to provide this fish habitat are areas which hold sufficient water through summer. Due to the lack of deep pools in the Loddon River, the areas which provide this function are considered to be the weir pools at Bridgewater, Serpentine and Loddon Weirs. Due to the inter-connectiveness of the Loddon with irrigation infrastructure, the maintenance of these weir pools is not solely reliant on a fully connected river system (e.g. Waranga Western Channel enters Loddon weir pool carrying water from the Goulburn system).

As conditions begin to improve, there is ability to re-connect the river system and begin to provide water to achieve other environmental outcome above purely maintenance of conditions. It is at this point that providing freshes through priority river reaches becomes important to clean bio-films from sediments, and improve the macroinvertebrate populations required for fish feeding activities.

Reach 3a (Laanecoorie Reservoir to Serpentine Weir) is considered to have the highest ecological value of the Loddon River under low flow conditions (high levels of instream woody habitat and drought refuge provided by Bridgewater and Serpentine Weir pools). As such, it will be the maintenance of this reach through the provision of freshes and additional flows that will occur first when water becomes available.

As more water becomes available above this point, the overall condition of the river will begin to improve, with recommended flow regimes beginning to be provided through the system.

Boort District Wetland priorities:

Over the past three years, the main environmental priority in the Boort District Wetland complex has been Little Lake Boort. North Central CMA has been committed to delivering environmental water to Little Lake Boort throughout this time as it was the only area holding water in the wider landscape and it provided a drought refuge function for waterbirds in particular.

The lack of water over these seasons has meant that environmental water has also been scarce and additional wetlands in the Boort area could not receive environmental water. With an improvement in resource conditions across the wider landscape (Murray System in particular), the high priority wetlands identified by LEWAG in 2008 and 2009 (North Central CMA 2008b, 2009) were able to be watered (Lake Yando and Lake Leaghur) in 2009-10.

The result of these watering events has meant that the environmental needs of the Boort Wetland complex as a whole can be considered during 2010-11.

It is expected that the Little Lake Boort Committee of Management (CoM) will again take over the management of water for the lake in its entirety from 2010-11 onwards, aligning with the CMA’s changing priorities through this system. Management of the lake for environmental purposes rather than recreational purposes may occur again in the future, however this will be discussed with the CoM prior to any decisions to be made.

Under a dry scenario, the priority for environmental water in the Boort District Wetland complex is Lake Leaghur. If water is available during spring 2010, water will be delivered to this wetland with the aim of providing a spring top-up to complement water delivered during autumn 2010. This will assist with the maintenance of bird activities on the wetland, perhaps stimulate breeding activity, and will push water into the fringing vegetation communities of Black Box and River Red Gums.

Table 7 details the recommended management for the Boort District Wetlands (as specified in the Environmental Reserve BE) for 2010-11 to 2012-13.

Table 7. Recommended management for Boort District Wetlands. Note: Recommended management is dependent on water availability and climatic conditions at the time.

Wetland	Current Condition	Recommended management for 2010-11	Recommended management for 2011-12	Recommended management for 2012-13
Lake Meran	Dry, with trees in moderate health[1]	Only water if Loddon River floods	Only water if Loddon River floods	Only water if Loddon River floods
Little Lake Meran	Dry, with River Red Gum, Black Box and Moonah tree communities in moderate to good health[1]	Wetland to receive water if sufficient is available (priority 2)	Deliver water in spring 2011 (only if water not provided in 2010)	Allow to dry (only if water has been delivered in either of the previous two seasons)
Lake Boort	Dry, trees surrounding wetland in moderate health	Provide water from large unregulated flow events at Loddon Weir	Dependent on condition at end of 2010-11	Dependent on condition at end of 2011-12
Lake Yando	Drying, vegetation community considered in good condition with natural recruitment occurring	Allow to dry	Remain dry	Provide water in spring 2012
Lake Leaghur	Receiving water	Provide additional water in spring 2010 (priority 1)	Allow to dry	Remain dry

[1] Source: Campbell et al. 2010

5d. Tullaroop Creek 2010-11 Planning

As discussed earlier, 2010-11 operations in Tullaroop Creek are being considered separately in this Plan.

The current Qualification of Rights in Tullaroop Creek stipulates that the requirement to delivery environmental flows, as per the Environmental BE, are suspended while the volume held in Tullaroop Reservoir is less than 10,000ML (excluding water held to meet critical human needs), and allocations of HRWS are not delivered to water share holders who extract water from Tullaroop Creek.

In the 2002 environmental flows study undertaken by the LREFSP, the biological objectives for Tullaroop Creek were identified as (LREFSP, 2002):

- *"Maintain sustainable population of River blackfish*
- *Maintain and/or restore natural invertebrate community*
- *Maintain a mosaic of aquatic macrophytes*
- *Reverse terrestrialisation of river bank flora*
- *Maintain pools, riffles and clean bed surfaces*
- *Maintain current snag habitat*
- *Entrain litter for carbon cycling"*

LREFSP 2002, pg 23.

In 2006, the LREFSP met to analyse the options for management of environmental water during the continued drought. The panel concluded that due to the regional significance of Tullaroop Creek's River Blackfish population, cease to flow events should be avoided (LREFSP 2006, in North Central CMA 2008a). In other sections of the Loddon System (apart from Tullaroop Creek) it was advised that cease to flow events, broken by periods of flows to improve water quality were acceptable to the panel (LREFSP 2006, in North Central CMA 2008a).

In 2008, an ecological risk assessment (ERA) was undertaken on Tullaroop Creek to consider how to manage reduced flows during drought (Lloyd Environmental 2008). The following flow regime was developed utilising the information generated through the ERA project, and in the 2008-09 Adaptive Management Plan for Tullaroop Creek (North Central CMA 2008a):

- *"A base flow of 1 ML/d is required to make best use of pulsed flow releases (maintain channel moisture)*
- *Pulsed flows (freshes) should peak at the maximum possible release via the available infrastructure and operational constraints. 10 ML/day is the recommended peak volume (this allows all pools in the reach to be at least 0.75m deep or greater) although 8ML/day is the maximum volume likely for the proposed pump configuration*
- *Pulsed flow events should be for eight days to mimic duration of freshes recommended by LREFSP (2002) (which recommended a 13.5 ML/d low flow fresh for 7 days but an extra day is required to prevent an abrupt and unnatural cessation of the event);*
- *Freshes should take place every 6 weeks on average (dependent on water quality indicators)*
- *These freshes should not be seen in isolation of the whole flow regime, but integrated or added to other flows required for consumptive or other uses.*

The responses to the above recommendation would be used to refine the flow regime required for the system. The recommended flow regime requires an average of 2.4ML/day."

North Central CMA (2008a), pg 8.

It was noted that to make effective use of any freshes provided to the creek, a continuous flow of 1ML/day will be required to maintain a wet channel in between these freshes (North Central CMA 2008a). Additionally, the aspects of the physical habitat in Tullaroop Creek which are most likely to be influenced by continued changes to water release regimes are considered to be flow velocity, pool depth, riffle/run depth, woody habitat and sedimentation (North Central CMA 2008a).

While the figures described for the flow regimes in 2010-11 may be slightly different to those described above, the intent of maintaining a low base flow, with a pulsed regime on top of that flow is recommended. It is acknowledged that there may be not sufficient water available in 2010-11 to provide the recommended flows described above so modified regimes are proposed in this section.

A key objective for the management of River Blackfish through Tullaroop Creek is the maintenance of pool depth. It has been acknowledged that pool depth is a key habitat delineator as individuals are placed under increasing stress as depth decreases below 0.4m (North Central CMA 2008a). This factor is considered more important than flow through pools as River Blackfish are able to survive will in pools with little or no flow (North Central CMA 2008a). However, riffles and runs within stream systems are utilised by River Blackfish to enable movement between pools, access to food, movement out of poor conditions and movement to allow breeding activities (North Central CMA 2008a).

Unlike the entitlements on the main Loddon system, environmental water availability in Tullaroop Creek under dry conditions is entirely dependent on the total volume held in Tullaroop on 1 November 2010. If the total volume in storage exceeds 2,460ML, then the environment receives the next 875ML in storage. If the total volume exceeded 6,560ML, the environment receives the next 1,000ML.

Note: the Qualification of Rights in Tullaroop Creek is currently being revised for use in 2010-11. The planning surrounding Tullaroop Creek in this Plan assumes the current content of the Qualification does not significantly alter.

i. Scenario A

Under a continuation of conditions seen in Tullaroop Creek during 2009-10, the environment will have access to approximately 300ML of water in total for the whole season. This is water that was available for use during 2009-10, but was carried over for use in 2010-11.

Under this scenario there will only be water released by G-MW to meet critical human needs until the end of September. From an environmental perspective, the 300ML available for environmental use will be used to provide flow through the upper half of Tullaroop Creek, with the aim of maintaining water in the pools through this section of the creek over summer.

This water will need to last over 28 weeks between November and April, and therefore there will be a total of 10ML available per week. The recommended flow regime for this water will be 1ML/day for four days, followed by 2ML/day for three days. While these flows are very low, the priority will be to provide a continuous flow through the reach (as per scientific advice – North Central CMA 2008a and LREFSP 2006, in North Central CMA 2008a), through the whole season.

Figure 28 and Figure 29 show examples of the upper section of Tullaroop Creek in early 2010 which will be targeted with this flow under low water availability.

ii. Scenario B

As at 19 May 2010, the total volume held in Tullaroop Reservoir was 4,0780ML. If rainfall and runoff conditions improve during winter and spring 2010, keeping the storage at above 2,460ML on 1 November 2010, the next 875ML in water in Tullaroop Creek will be available for environmental use.

The 300ML of environmental water carried over from 2009-10 will be used to provide a flow in the creek over winter and early spring until 1 November 2010. At this time the total environmental water for 2010-11 will become available, and this water will be used for the remainder of the season.

The flow regime described for Scenario B is in line with the recommendations made by Lloyd Environmental (2008), but have been scaled down due to water availability. For example, the continuous base flow will be provided, as per the Lloyd Environmental (2008) recommendations, as will the pulsed flow events.

Recommended flows to be provided for Tullaroop Creek in 2010-11 with 875ML in total available are described in Table 8. It should be noted that the flow regime described is only one of a number of ways to utilise the 875ML available. There are numerous other flow regimes that could be delivered in Tullaroop Creek and these may be trialled during 2010-11 depending on water availability, creek condition and increasing knowledge about system responses.

Table 8. Recommended flows for Tullaroop Creek when 875ML of environmental water is available.

Flow type	Flow characteristics	Volume of water required per event	Number of events and total volume of water required
Base flow	▪ 5ML/day for 3 days followed by ▪ 2ML/day for 4 days	23ML per week	28 weeks between November and May (3 weeks covered by freshes, therefore 25 weeks required). Total required is 575ML
Fresh	▪ 6ML/day for 1 day followed by ▪ 8ML/day for 6 days followed by ▪ 6ML/day for 1 day	60ML per event	Up to three freshes to be provided between October and April. Therefore 60ML required for three freshes totals 180ML
Water held for water quality response	▪ To be determined based on the requirement to provide flows	To be determined based on the requirement to provide flows	120ML available in total

iii. Scenario C

Should rainfall and runoff conditions improve significantly and there is a total of ~7,500ML held in storage at 1 November 2010, the volume of water available for environmental use will increase by 1,000ML in addition to the 875ML already provided (i.e. 1,875ML in total).

Under this scenario, flow releases are still described for the period 1 November 2010 to 31 May 2011 (seven months in total). Once again, approximately 100ML of water will be reserved to respond to water quality issues which may occur through the year. It is at this scenario that the base flow will begin penetrating the whole of the creek, and management will move from providing water to only half of Tullaroop Creek, to providing water to the whole creek, linking with the rest of the Loddon System through Laanecoorie Reservoir.

The recommended use for this water is provided in Table 9. Once again, it should be noted that the flow regime described is only one of a number of ways to utilise the 875ML available.

Once again, Tthere are numerous other flow regimes that could be delivered in Tullaroop Creek and these may be trialled during 2010-11 depending on water availability, creek condition and increasing knowledge about system responses.

Table 9. Recommended flows for Tullaroop Creek when 1,875ML of environmental water is available.

Flow type	Flow characteristics	Volume of water required per event	Number of events and total volume of water required
Base flow	▪ 8ML/day for 3 days followed by ▪ 5ML/day for 4 days	44ML per week	28 weeks between November and May (3 weeks covered by freshes, therefore 25 weeks required). Total required is 1,100ML
Fresh	▪ 10ML/day for 1 day followed by ▪ 13.5ML/day for 6 days followed by ▪ 10ML/day for 1 day	101ML	Four freshes to occur between November and April. Therefore 101ML required for four freshes totals 404ML
Early winter fresh	▪ To be determined based on condition of creek	271ML available in total	Fresh to be provided during early winter 2011 depending on reach condition (water remaining in water quality reserve may also be used if required) and aims to set creek up for 2011-12 season)
Water held for water quality response	▪ To be determined based on the requirement to provide flows	To be determined based on the requirement to provide flows	100ML available in total

iv. Scenario D

Once rainfall and runoff conditions improve enough for flows to reach the full length of Tullaroop Creek, there will be delivery of private carryover and some irrigation supply through the creek. There will therefore, be greater volumes of water passing though the creek which will provide some of the environmental flow requirements of the reach. The water provided through reach operations by G-MW will involve the provision of some intermittent water through the season, but not a steady flow. Therefore, there will still be a requirement to manage the system from an environmental perspective as per Scenario C. Additionally, in this scenario the creek will be running though the whole reach and will link back with the Loddon River into Laanecoorie Reservoir through the use of both environmental water and G-MW operational water.

v. Scenario E

Scenario E occurs in Tullaroop Creek where the irrigation allocation for Tullaroop customers reaches ~50%. At this stage G-MW will be running the river constantly through the season, providing sufficient water for customers to extract. Additionally, some environmental objectives (e.g. maintaining a base flow through the creek) will be achieved through G-MW operations.

While no extra environmental water will be available for the environmental allocation, there will be opportunities to use the existing environmental water to provide significant flushes (as per the recommendations in LREFSP [2002] and Lloyd Environmental [2008]) through the system, and some water will be reserved for use in 2011-12.

vi. Scenario F

When irrigation allocations to Tullaroop customers reach 100%, minimum flows and freshes will be reinstated in the operation of the creek by G-MW. There will be opportunity to use environmental water to provide a winter/spring fresh if this scenario is reached early in the season, or alternatively the water will be used to provide a winter fresh in 2011 to set the creek up for the following season. There may also be possibility to hold water in Tullaroop Reservoir for use in 2011-12.

In all the scenarios described above, there is a need to adaptively manage any environmental releases according to observed conditions in the creek. For example, the water quality water set aside in the scenarios above should be used in response to an observed decline in water quality. Additionally, if a large rainfall event is observed in the area, there may be opportunity to maximise the environmental potential of the flow through the use of environmental water to extend the duration of the flow event.

If the natural flows are sufficient to reach previously isolated pools, additional environmental water should be used to maintain the flow through these pools to ‘freshen’ them before they become isolated again.

Under low flow conditions, there may be restrictions on the ability to deliver some of the flows recommended due to infrastructure constraints on the reservoir. The current low capacity of Tullaroop Reservoir has meant that pumps have been relied upon to get water out of the reservoir which is below the ordinary operational level. As such, some recommended flows may have to be modified in line with the operational requirements of the system which will be discussed throughout the season with the storage operator, G-MW.

Figure 28. Tullaroop Creek. Photo: S. Carracher

Figure 29. Tullaroop Creek. Photo: S. Carracher

5e. Loddon River and Boort District Wetland 2010-11 Planning

i. Scenario 1 – Worst drought (repeat of 2006/07 inflows)

This scenario is based on receiving similar inflows into the Loddon storages as were received during 2006-07 (the direst inflow year on record).

Under this scenarios there will be no irrigation allocation made in the Loddon system. The 2009 Qualification of Rights will be in operation and there will be minimal environmental water available for use. Under the Qualification, 600ML of water from the LSWFA will be available to the environment, however this will be put into the pool of water resources that G-MW can operate the river with. The reasoning behind this is that under this scenario, the river operations required to maintain critical human needs are aligned with those required to meet critical environmental needs. The priority environmental objective is to maintain the river through to Bridgewater Weir pool as it provides an important drought refuge function under drought conditions. G-MW operations will target Bridgewater Weir pool with the focus to provide water to Bridgewater township, Inglewood, Dunolly and Laanecoorie. These towns are all supplied from the river in the reach between Laanecoorie and Bridgewater so intermittent releases from Laanecoorie Reservoir would be made over the year to keep Bridgewater Weir pool topped up.

The result of this will be that Reach 1 (Cairn Curran to Laanecoorie Reservoirs) may be used as a transport route to move water between the two reservoirs, in essence providing a low flow to the reach during September/October, with no flow for the remainder of the year.

Approximately half of Reach 3a (Laanecoorie Reservoir to Serpentine Weir) will contain water (from Laanecoorie Reservoir to Bridgewater Weir) in order to supply Bridgewater township. There will be periods of no flow, with occasional low flow releases filling pools along the river. The remainder of this reach (below Bridgewater Weir) will have no flow, and the pools will likely dry over the season.

While the river operation will not explicitly target environmental values in the upper section of Reach 3a, they align with environmental priorities for the river under a continuing drought scenario. Reach 3a contains some of the highest environmental values along the Loddon River, and will have the most flow of any reach. There is also a need to maintain large, deep pools of water during drought. These areas provide the best habitat in the river for flora and fauna species to seek refuge while other areas of the river dry out. Through the maintenance of Bridgewater weir pool to enable water extraction for town supply, this weir pool will contain water for the whole season which will additionally maintain this area for drought refuge.

Reach 3b (from Serpentine Weir to Loddon Weir) will have no flow through the season. However, the weir pool of Loddon Weir will be maintained by water moving though the landscape from the Goulburn River in the east, though Loddon Weir and out to the Boort Irrigation Area to the west via the Waranga Western Channel. Water contained in the Loddon Weir pool will therefore not be Loddon water as such, but Goulburn water.

Reach 4 of the Loddon River (Loddon Weir to Kerang Weir) will remain dry under this scenario (as per the revised environmental flow recommendations for the lower Loddon River System discussed in Section 4c).

Table 10 shows the river system operations and environmental water use expected under Scenario 1 while Table 18 shows overall system operations (under all scenarios).

Table 10. Loddon System operations under Scenario 1 – Worst drought

Loddon System Reach	**REACH 2:** Tullaroop to Laanecoorie Reservoir	**REACH 1:** Cairn Curran to Laanecoorie Reservoir	**REACH 3a:** Laanecoorie Reservoir to Serpentine Weir	**REACH 3b:** Serpentine Weir to Loddon Weir	**REACH 4:** Loddon Weir to Kerang Weir	**Boort District Wetlands**
Key Reach Characteristics	Complex morphology present in reach with high levels of instream woody habitat. Four native fish species expected (incl. River blackfish)	Channel in-filled, lack of pools and some bank notching. Little instream woody habitat and five native fish species expected (incl. historical records of River blackfish)	Channel unstable and high levels of instream woody habitat. Four native fish species expected (incl. past distribution of Silver perch). Drought refuge provided by Bridgewater and Serpentine Weir pools.	Moderate reversal of seasonal flows. Cease to flow events observed. Aggradation of the channel and moderate woody habitat instream. Four native fish species expected (incl. past distribution of Silver perch). Drought refuge provided by Loddon Weir pool.	Reach currently dry. Becoming increasing terrestrialised with siltation of pools and colonisation of riparian and semi-aquatic plant species in bottom of channel. History of blackwater events and recent evidence of acid sulphate soils/acid water	Lake Leaghur first priority to receive small volume of environmental water
Environmental Water Flexibility	600ML of Loddon System Withheld Flows Account available (allocated to G-MW to run river) Deficit and Reimbursement Account unavailable Wetland Entitlement unavailable 300ML available for use in Tullaroop Creek					
Reach Operations	System disconnected	Transfer of water from Cairn Curran to Laanecoorie via Reach 1	River operated between Laanecoorie Reservoir and Bridgewater Weir (no water below Bridgewater) to September/October	No river operation and therefore no flow	No river operation and therefore no flow	None available
Environmental Water Use	Refer to Section 5(b) part (ii)	No environmental water available	No environmental water available	No environmental water available	Reach to be kept dry (divert any unregulated flows to Boort District Wetlands)	

ii. Scenario 2 – Extremely dry (delivery of carryover)

This scenario is based on receiving slightly more inflows into the Loddon storages than we recorded in 2006-07.

As in the previous scenario, there will be no irrigation allocation made in the Loddon system, however there will be delivery of private carryover water from the 3% allocation made in 2009-10.

As in the previous scenario, the river operation through the season will not explicitly target environmental values through Reaches 1, 3a and 3b. It will however, provide sufficient water to maintain condition of the large, deep pools such as Bridgewater Weir pool, and flow through the remainder of the river (excluding Reach 3b and Reach 4). Reaches 3a and 3b will receive minor flushes from rainfall at best during winter/spring.

At this stage, the river will be running though to Serpentine Weir for the whole of the season to meet stock, domestic and carryover demands. The river operations only through to Serpentine Weir mean that there is some difficulty in using the 600ML of environmental water due to a disconnected river. The priority uses of this water are therefore:

- deliver approximately 300ML through Reach 3b (Serpentine Weir to Loddon Weir) with the aim of diverting from Loddon Weir to provide a spring top-up to Lake Leaghur (potentially passing the water through the reach on top of a winter/spring rainfall event)
- reserve remaining water to respond to water quality issues through the season.

Reach 4 of the Loddon River (Loddon Weir to Kerang Weir) will again remain dry under this scenario (as per the revised environmental flow recommendations described in Section 4c).

Table 11 shows the river system operations and environmental water use expected under Scenario 1 while Table 18 shows overall system operations (under all scenarios).

Table 11. Loddon System operations under Scenario 2 – Extremely Dry

Loddon System Reach	REACH 2: Tullaroop to Laanecoorie Reservoir	REACH 1: Cairn Curran to Laanecoorie Reservoir	REACH 3a: Laanecoorie Reservoir to Serpentine Weir	REACH 3b: Serpentine Weir to Loddon Weir	REACH 4: Loddon Weir to Kerang Weir	Boort District Wetlands
Key Reach Characteristics	Complex morphology present in reach with high levels of instream woody habitat. Four native fish species expected (incl. River blackfish)	Channel in-filled, lack of pools and some bank notching. Little instream woody habitat and five native fish species expected (incl. historical records of River blackfish)	Channel unstable and high levels of instream woody habitat. Four native fish species expected (incl. past distribution of Silver perch). Drought refuge provided by Bridgewater and Serpentine Weir pools.	Moderate reversal of seasonal flows. Cease to flow events observed. Aggradation of the channel and moderate woody habitat instream. Four native fish species expected (incl. past distribution of Silver perch). Drought refuge provided by Loddon Weir pool.	Reach currently dry. Becoming increasing terrestrialised with siltation of pools and colonisation of riparian and semi-aquatic plant species in bottom of channel. History of blackwater events and recent evidence of acid sulphate soils/acid water.	Lake Leaghur first priority to receive small volume of environmental water
Environmental Water Flexibility	600ML of Loddon System Withheld Flows Account available Deficit and Reimbursement Account unavailable Wetland Entitlement unavailable 300ML available for use in Tullaroop Creek					
Reach Operations	System disconnected	Steady low flows provided throughout season	Steady low flows provided throughout season	Steady very low flows provided throughout season	No river operation and therefore no flow	Some water transferred from LSWFA to Wetland Entitlement and unregulated flows diverted to wetlands if required
Environmental Water Use	Refer to Section 5(b) part (ii)	No environmental water allocated to reach	Hold water to respond to water quality issues	No environmental water allocated to reach	Reach to be kept dry (divert any unregulated flows to Boort District Wetlands)	

iii. Scenario 3 – Very dry (1% irrigation allocation)

The main difference between this scenario and Scenario 2 is that there is slightly more water available in the system for use by towns, irrigators and the environment, and assumes that a 1% allocation is available in the Loddon System. At a 1% HRWS allocation in the Loddon system, the unused volume of the Loddon System Withheld Flows Account (LSWFA) from 2009-10 becomes available for use for environmental purposes (projected to be approximately 3,200ML in total).

There will be a low, steady flow through Reaches 1 and 3a (Cairn Curran to Serpentine Weir) throughout the season to meet stock, domestic and irrigation demand. This will provide water to both Bridgwater and Serpentine Weir pools, increasing the available habitat for flora and fauna species.

Reach 3b (Serpentine Weir to Loddon Weir) will also receive an intermittent flow through the whole reach to provide water between Serpentine Weir and Loddon Weir, as in the previous scenario.

At this stage there will be river flow from Cairn Curran Reservoir to Loddon Weir. Reach 4 (Loddon Weir to Kerang Weir) will still remain dry under this scenario. There will be a need to manage any unregulated flows resulting from rainfall events to ensure Reach 4 remains dry, and these flows will likely be directed to the Boort District Wetlands.

There is an option under the Qualification of Rights which will allow up to 2,000ML of water to be transferred from the LSWFA into the Wetland Entitlement account. This means that up to 2,000ML (plus any unregulated flows) could be available for use in any of the Boort District Wetlands over the season (according to wetland prioritisation, volume of water available, timing and existing hydrological status of each wetland). This clause has been included in the current Qualification of Rights due to the need to keep Reach 4 dry under this scenario, and the ongoing priority of providing water to the Boort District Wetlands.

In addition, when an allocation occurs on the Loddon System, water becomes available for use from the Wetland Entitlement. A total of 2,000ML is contained in this entitlement which becomes available at 100% allocation. At a 1% allocation 20ML is available for use.

Figure 30 (pg 74) shows the prioritisation for the Boort District Wetlands according to the availability of unregulated flows, and the need to divert these.

With some baseflow being provided from Cairn Curran to Loddon Weir, the next environmental objectives are to maintain water quality and provide a September/October fresh in Reach 3a to clean accumulated sediment from the bed and improve macroinvertebrate habitat. Water from the LSWFA can be used to provide a fresh through these reaches of at least 52ML/day for 13 days (plus flows rising and falling) which would require approximately 650ML. Some of this water would continue to flow through to Loddon Weir and could be used to for a wetland watering event.

If this water delivery is undertaken, there would be approximately 1,500ML remaining in the LSWFA which would be used to manage any water quality issues in the river during summer, and another 1,000ML will be available to transfer to the Wetland Entitlement in order to water Boort District Wetlands. The first priority wetland to receive water will be Lake Leaghur and it is expected that 300ML will be required to provide a spring top-up to follow on from the autumn 2010 watering event. The second priority wetland to receive water under this scenario is Little Lake Meran (with an approximate requirement of up to 2,000ML).

Management of water held in the LSWFA will be dependent on the timing of inflows into the Loddon System, and therefore, dependent on when the 1% allocation is made. Freshes and wetland watering events would ideally be made in winter/spring of the 2010-11 season (but may be made later in the season e.g. autumn) and any water remaining in the LSWFA at the end of the 2010-11 season would be reserved for use in 2011-12.

Table 12 shows river system operations and environmental water use expected under Scenario 3 while Table 18 shows overall system operations (under all scenarios).

Table 12. Loddon System operations under Scenario 3 – Very Dry

Loddon System Reach	**REACH 2:** Tullaroop to Laanecoorie Reservoir	**REACH 1:** Cairn Curran to Laanecoorie Reservoir	**REACH 3a:** Laanecoorie Reservoir to Serpentine Weir	**REACH 3b:** Serpentine Weir to Loddon Weir	**REACH 4:** Loddon Weir to Kerang Weir	**Boort District Wetlands**
Key Reach Characteristics	Complex morphology present in reach with high levels of instream woody habitat. Four native fish species expected (incl. River blackfish)	Channel in-filled, lack of pools and some bank notching. Little instream woody habitat and five native fish species expected (incl. historical records of River blackfish)	Channel unstable and high levels of instream woody habitat. Four native fish species expected (incl. past distribution of Silver perch). Drought refuge provided by Bridgewater and Serpentine Weir pools.	Moderate reversal of seasonal flows and unnatural cease to flow periods. Aggradation of the channel and moderate woody habitat instream. Four native fish species expected (incl. past distribution of Silver perch). Drought refuge provided by Loddon Weir pool.	Reach currently dry. Becoming increasing terrestrialised with siltation of pools and colonisation of riparian and semi-aquatic plant species in bottom of channel. History of blackwater events and recent evidence of acid sulphate soils/acid water.	Lake Leaghur first priority to receive environmental water. Lake Meran, Little Lake Meran, Lake Boort, Lake Yando or other priority wetlands in this region as opted by the Environmental Water Manager
Environmental Water Flexibility	3,200ML of Loddon System Withheld Flows Account available (able to transfer up to 2,000ML into Wetland Entitlement) Deficit and Reimbursement Account unavailable 20ML (1%) of Wetland Entitlement available Minor unregulated flows at Loddon Weir 875ML available for use in Tullaroop Creek					
Reach Operations	System disconnected	Steady low flows provided throughout season	Steady low flows provided throughout season	Steady very low flows provided throughout season	No river operation and therefore no flow	Some water transferred from LSWFA to Wetland Entitlement, unregulated flows diverted to wetlands if required, environmental flows from reach 3a to be diverted to wetland/s
Environmental Water Use	Refer to Section 5(b) part (ii)	No environmental water allocated to reach	Provide fresh(es) and hold water to respond to water quality issues – water flows into reach 3b	No environmental water allocated specifically to reach (however water from Reach 3a and wetland water flow through reach)	Reach to be kept dry (divert any unregulated flows to Boort District Wetlands)	

iv. Scenario 4 – Dry (5% irrigation allocation)

Under this scenario there is a 5% HRWS allocation for the Loddon System. The total volume of the LSWFA is available for use in the system. This includes water carried over from 2009-10 (approximately 3,200ML), plus 2010-11 flows withheld (projected to be 5,000ML). The total estimated volume is 8,200ML.

As in Scenario 3, there will be uninterrupted flows between Cairn Curran Reservoir and Loddon Weir. The priority for environmental water once the whole of this river length contains a baseflow will be to add freshes to Reach 3a (Laanecoorie Reservoir to Serpentine Weir). The target of these freshes will be to remove accumulated sediments and biofilms in order to improve the habitat and abundance of macroinvertebrates in this reach. The reason for targeting this component of the reach habitat is to ensure that adequate food is available for fish populations, with an attempt to improve the survival and condition of individuals in the reach.

With the additional water available for use in the system, the next priority will be to provide freshes to Reach 3b (Serpentine Weir to Loddon Weir) with a similar objective to that described in Reach 3a (Laanecoorie Reservoir to Serpentine Weir).

Once again, as overall inflows to the system are relatively low, there will be a need to maintain the dry condition of Reach 4 (Loddon Weir to Kerang Weir) under this scenario and divert any unregulate flows to Boort District Wetlands. Additionally, with increasing irrigation allocation, there will be an increase in the water available for use from the wetland entitlement. Under a 5% irrigation allocation, 100ML becomes available and up to 2,000ML will again be able to be transferred from the LSWFA into the Wetland Entitlement. However, it is unlikely that the full amount will be transferred as there will be freshes provided in Reach 3a and 3b, with water provided for these events also originating from the LSWFA.

Figure 30 shows the prioritisation for the Boort District Wetlands according to the availability of unregulated flows, and the need to divert these.

Depending on the timing of the 5% allocation being made in winter/spring, at least one fresh would be provided in Reach 3a at this time (~650ML) which may be increased to provide a reasonable flow rate through Reach 3b. An additional two freshes may be made through season which will be adaptively managed to meet objectives of both Reach 3a and Reach 3b according to conditions observed in the reaches.

Cottingham et. al (2010) recognise the importance of having sufficient water available for a fresh to both commence the desired ecosystem response, to maintain that ecosystem response, and to minimise potential adverse outcomes. Cottingham et. al (2010) state that freshes should generally be delivered in September-October, and should avoid the summer-autumn periods to be inline with climatic conditions including air pressure, temperature and humidity as well as avoiding potential risks such as blackwater.

Approximately 1,000ML would be reserved to manage any water quality problems with another 1,000ML available for transfer into the Wetland Entitlement and use in the Boort District Wetlands (with the first priority being delivery to Lake Leaghur, followed by Little Lake Meran). The remaining LSWFA water will be reserved for 2011-12.

Table 13 shows river system operations and environmental water use expected under Scenario 4 while Table 18 shows overall system operations (under all scenarios).

Table 13. Loddon System operations under Scenario 4 – Dry

Loddon System Reach	REACH 2: Tullaroop to Laanecoorie Reservoir	REACH 1: Cairn Curran to Laanecoorie Reservoir	REACH 3a: Laanecoorie Reservoir to Serpentine Weir	REACH 3b: Serpentine Weir to Loddon Weir	REACH 4: Loddon Weir to Kerang Weir	Boort District Wetlands
Key Reach Characteristics	Complex morphology present in reach with high levels of instream woody habitat. Four native fish species expected (incl. River blackfish)	Channel in-filled, lack of pools and some bank notching. Little instream woody habitat and five native fish species expected (incl. historical records of River blackfish)	Channel unstable and high levels of instream woody habitat. Four native fish species expected (incl. past distribution of Silver perch). Drought refuge provided by Bridgewater and Serpentine Weir pools.	Moderate reversal of seasonal flows and unnatural cease to flow periods. Aggradation of the channel and moderate woody habitat instream. Four native fish species expected (incl. past distribution of Silver perch). Drought refuge provided by Loddon Weir pool.	Reach currently dry. Becoming increasing terrestrialised with siltation of pools and colonisation of riparian and semi-aquatic plant species in bottom of channel. History of blackwater events and recent evidence of acid sulphate soils/acid water.	Lake Leaghur first priority to receive environmental water. Lake Meran, Little Lake Meran, Lake Boort, Lake Yando or other priority wetlands in this region as opted by the Environmental Water Manager
Environmental Water Flexibility	8.200ML Loddon System Withheld Flows Account available (able to transfer up to 2,000ML into Wetland Entitlement) Deficit and Reimbursement Account unavailable 100ML (5%) of Wetland Entitlement available Small unregulated flows at Loddon Weir 875ML available for use in Tullaroop Creek					
Reach Operations	System disconnected	Steady low flows provided throughout season including some domestic and stock and irrigation flows provided for in spring, summer and autumn	Steady low flows provided throughout season including some domestic and stock and irrigation flows provided for in spring, summer and autumn	Intermittent flows provided throughout season	No river operation	Some water transferred from LSWFA to Wetland Entitlement, unregulated flows diverted to wetlands if required, environmental flows from reach 3a to be diverted to wetland/s
Environmental Water Use	Refer to Section 5(b) part (ii)	No environmental water allocated to reach	Use of environmental water to provide freshes to reach - water flows into reach 3b	Use some environmental water to provide freshes	Reach to be kept dry (divert any unregulated flows to Boort District Wetlands)	

v. Scenario 5 – Moderate (50% irrigation allocation)

This scenario will occur where there are good inflows into the Loddon storages and a 50% irrigation allocation can be made.

There will be larger flows through the whole Loddon System (excluding Reach 4) for the whole season. During spring, summer and autumn the flows through Reaches 1 and 3a will be higher than Reach 3b to meet irrigation demand. However there will still be small continuous flows through Reach 3b both from irrigation requirements, and flow through from Reach 3a.

Under this scenario there will be more unregulated flows through the system in winter/spring, however these will likely still be manageable in the sense that they could still be harvested for use elsewhere in the system. The river will be operated in a similar manner to the previous scenario, but with overall more water moving through the system to meet irrigation demand.

The unregulated flows entering the Loddon System can be broken into two parts. Firstly, due to current low levels in the storages (Cairn Curran in particular), unregulated flows in the upper catchments will be harvested and held in storage without any difficulty. Secondly, unregulated flows below Laanecoorie will end up at Loddon Weir. Once again, Reach 4 will be actively managed to keep dry, and flows will need to be diverted from Loddon Weir to the Boort District Wetlands. The ability to manage the flows at the weir, and stop water flowing into Reach 4 will therefore be dictated by the capacity of Loddon Weir pool to hold the flow (most likely a limited volume of airspace), and the capacity of channels and wetlands to take the river flow rates and volumes.

These unregulated flows will be higher under this scenario, and therefore a wetland with larger capacity is required to take the flow volumes. Hence, it is under this scenario that the priority for unregulated flows shifts to Lake Boort which has a capacity to receive water than other wetlands in the Boort Area.

If volumes of water passing through Bridgewater and Serpentine Weir are in excess of what can be delivered to the small wetlands in the Boort area (~60ML/day into Lake Leaghur), these peaks will be diverted to Lake Boort and may require additional environmental water from the Loddon sources of environmental water. The delivery to Lake Boort could either be done by through flow via Little Lake Boort and into Lake Boort, or by delivery directly to Lake Boort, or both. Through using both methods, maximum capacity for deliver could be up to 160ML/day (LEWAG 2010). Figure 30 shows the prioritisation for the Boort District Wetlands according to the availability of unregulated flows.

8,200ML of LSWFA water is available under this scenario, and a total of 1,000ML of water from the Wetland Entitlement will be available for use (a total of 3,000ML could therefore be used for wetland watering). The target for this water will be Lake Leaghur, Little Lake Meran and potentially supporting Lake Boort depending on unregulated flows.

Between 3,000 and 4,000ML would be available to potentially to carryover to 2011-12

Table 14 shows river system operations and environmental water use expected under Scenario 5 while Table 18 shows overall system operations (under all scenarios).

Table 14. Loddon System operations under Scenario 5 – Moderate

Loddon System Reach	REACH 2: Tullaroop to Laanecoorie Reservoir	REACH 1: Cairn Curran to Laanecoorie Reservoir	REACH 3a: Laanecoorie Reservoir to Serpentine Weir	REACH 3b: Serpentine Weir to Loddon Weir	REACH 4: Loddon Weir to Kerang Weir	Boort District Wetlands
Key Reach Characteristics	Complex morphology present in reach with high levels of instream woody habitat. Four native fish species expected (incl. River blackfish)	Channel in-filled, lack of pools and some bank notching. Little instream woody habitat and five native fish species expected (incl. historical records of River blackfish)	Channel unstable and high levels of instream woody habitat. Four native fish species expected (incl. past distribution of Silver perch). Drought refuge provided by Bridgewater and Serpentine Weir pools.	Moderate reversal of seasonal flows and unnatural cease to flow periods. Aggradation of the channel and moderate woody habitat instream. Four native fish species expected (incl. past distribution of Silver perch). Drought refuge provided by Loddon Weir pool.	Reach currently dry. Becoming increasing terrestrialised with siltation of pools and colonisation of riparian and semi-aquatic plant species in bottom of channel. History of blackwater events and recent evidence of acid sulphate soils/acid water.	Lake Meran, Little Lake Meran, Lake Boort, Lake Yando, Lake Leaghur or other priority wetlands in this region as opted by the Environmental Water Manager
Environmental Water Flexibility	8.200ML Loddon System Withheld Flows Account available (able to transfer up to 2,000ML into Wetland Entitlement) Deficit and Reimbursement Account unavailable 1,000ML (50%) of Wetland Entitlement available Larger unregulated flows at Loddon Weir 1,875ML available for use in Tullaroop Creek					
Reach Operations	System connected	Steady larger flows provided to meet irrigation, stock and domestic demand in spring, summer and autumn	Steady larger flows provided to meet irrigation, stock and domestic demand in spring, summer and autumn	Steady larger flows provided to meet irrigation, stock and domestic demand in spring, summer and autumn	No river operation however potential for unregulated flows to enter reach	1. Divert small unregulated flows/or wetland entitlement to meet wetland priorities (Lake Leaghur, Little Lake Meran). 2. Divert medium unregulated flows to Lake Boort to meet diversion requirements from Reach 4. 3. If Lake Boort holds water, use environmental flows to maintain ecological condition
Environmental Water Use	Refer to Section 5(b) part (ii)	No environmental water allocated to reach	Use of environmental water to provide freshes to reach	Use some environmental water to provide freshes	Reach to be kept dry divert unregulated flows to Boort District Wetlands	

vi. Scenario 6 – Average (100% irrigation allocation)

This scenario begins where good inflows are recorded in the system. Under this scenario there will be a HRWS irrigation allocation of 100% however it would still be a much drier year than a 'historically average year'.

6,000ML of water from the Deficit and Reimbursement Account becomes available for use under this scenario (when irrigation allocation reaches 100%). This water can be carried over for use in 2011-12. There would be significant inflows into the Loddon System, including significant unregulated flows at Loddon Weir.

Minimum passing flows and some river freshening flows may be reinstated for the river between Cairn Curran and Loddon Weir under this scenario after the 100% allocation has been declared, in accordance with those described in the Loddon System Bulk Entitlement. Under the Qualification of Rights there is no obligation for these flows to be reinstated rather than held in the LSWFA. Therefore, the decision as to the restarting of these flows through the river (excluding Reach 4) will be determined according to the condition of the river, likely flows through the system, and in consultation with the storage operator (G-MW).

The LSWFA will hold 3.200ML from the 2009-10 season, plus any passing flows which were not released until the 100% allocation was made, and the decision to release these flows was made (assuming an opening allocation of 100% is not able to be made). In essence, while environmental flows (minimum flows and passing flows) will be reinstated by G-MW, there will be less environmental water held in storage for use through the season (3,200ML plus approximately 1,600ML).

Significant summer/autumn flows will occur in order to deliver irrigation entitlements and these would be adequate to meet environmental needs through Reach 1, 3a, and 3b (Cairn Curran Reservoir through to Loddon Weir), and there would be some winter/spring freshes. However, these freshes may not be large, and a release of LSWFA water may be required to provide desired fresh characteristics to target macroinvertebrate habitat.

In Reach 4 (Loddon Weir to Kerang Weir), the management objective at the start of the year will be to keep the reach dry. However, unregulated flows may exceed the ability to divert them, and some flow into Reach 4 could occur. Under this scenario, the management objective for Reach 4 changes from actively keeping it dry, to providing a high flow through the reach (as per revised environmental flow recommendations [SKM 2010]). It is noted that there is a large amount of instream vegetation growth through this reach of the Loddon River which may change the expected inundation area of this flow (as provided through flow modelling). In addition to water quality monitoring, flows through this reach should be monitored to gain information about how, where and how long the water moves through the reach.

If significant flows occur over Loddon Weir (i.e. enough to wet significant part of the reach), some or all of the 10,800ML of environmental water (6,000ML from the Deficit and Reimbursement Account plus 4,800ML from the LSWFA) would be used in Reach 4 to give the flow through this reach persistence in volume and duration. Once the target peak flow has been provided, there will be a need to cease flows below Loddon Weir again to avoid a persistent low flow through the reach.

The revised environmental flow recommendations for the lower Loddon will dictate the required volume and flow pattern to follow in restarting this reach (SKM 2010). Once Loddon Weir spill occurs and significant water is flowing over the weir, diversions of unregulated flows to the wetlands will cease in preference of this water going down Reach 4. The diversion to the Boort Wetlands may start up again after the required flow to Reach 4 is provided.

At 100% irrigation allocation, 100% of the Wetland Entitlement will become available for use in the Boort District Wetlands (2,000ML). The priorities for use of this water are again Lake Leaghur and Little Lake Meran, with a potential to provide additional water to Lake Boort is if has been started with unregulated flows. There is also potential to flow the Lake Boort water through to Lake Lyndger, providing additional environmental benefit from the water.

This entitlement can also be carried over for use in 2011-12, but the carryover volume is not available until the 2011-12 allocation also reaches 100%. Some small unregulated flows at Loddon Weir would be diverted before the 100% allocation was reached, and transfer of LSWFA water into the Wetland Entitlement would again be available if there is no requirement to target Reach 4 with this water. Hence, the watering of several wetlands, potentially including Lake Boort (as per the previous scenario) would occur under this scenario. There is then possibility to flow water from Lake Boort into Lake Lyndger to provide some water to both wetlands. Figure 30 shows the prioritisation for the Boort District Wetlands according to the availability of unregulated flows.

Table 15 shows river system operations and environmental water use expected under Scenario 6 while Table 18 shows overall system operations (under all scenarios).

Table 15. Loddon System operations under Scenario 6 – Average

Loddon System Reach	REACH 2: Tullaroop to Laanecoorie Reservoir	REACH 1: Cairn Curran to Laanecoorie Reservoir	REACH 3a: Laanecoorie Reservoir to Serpentine Weir	REACH 3b: Serpentine Weir to Loddon Weir	REACH 4: Loddon Weir to Kerang Weir	Boort District Wetlands
Key Reach Characteristics	Complex morphology present in reach with high levels of instream woody habitat. Four native fish species expected (incl. River blackfish)	Channel in-filled, lack of pools and some bank notching. Little instream woody habitat and five native fish species expected (incl. historical records of River blackfish)	Channel unstable and high levels of instream woody habitat. Four native fish species expected (incl. past distribution of Silver perch). Drought refuge provided by Bridgewater and Serpentine Weir pools.	Moderate reversal of seasonal flows and unnatural cease to flow periods. Aggradation of the channel and moderate woody habitat instream. Four native fish species expected (incl. past distribution of Silver perch). Drought refuge provided by Loddon Weir pool.	Reach currently dry. Becoming increasing terrestrialised with siltation of pools and colonisation of riparian and semi-aquatic plant species in bottom of channel. History of blackwater events and recent evidence of acid sulphate soils/acid water.	Lake Meran, Little Lake Meran, Lake Boort, Lake Yando, Lake Leaghur or iother priority wetlands in this region as opted by the Environmental Water Manager
Environmental Water Flexibility	BE flows restored and Loddon System Withheld flows account available (4,800ML)					
	6,000ML of Deficit and Reimbursement Account available					
	2,000ML (100%) of Wetland Entitlement available					
	Significant unregulated flows at Loddon Weir					
	1,875ML available for use in Tullaroop Creek					
Reach Operations	System connected	Significant irrigation flows	Significant irrigation flows	Some domestic and stock and irrigation flows	No river operation however potential for unregulated flows to entre reach	1. Divert small flows to meet wetland priorities (Lake Leaghur). 2. Divert medium unregulated flows to Lake Boort to meet diversion requirements from reach 4. 3. Combination of both
Environmental Water Use	Minimum passing flows and river freshening flows restored - refer to Section 5(b) part (ii)	Potential for minimum passing flows and river freshening flows to be restored	Potential for minimum passing flows and river freshening flows to be restored (may also need to provide winter/spring fresh from LSWFA)	Potential for minimum passing flows and river freshening flows to be restored (may also need to provide winter/spring fresh from LSWFA)	Reach to be kept dry under small - medium unregulated flows (divert to Boort District Wetlands up to ~200ML/day). Use environmental water to maintain peak and duration of flows if spill into reach occurs	

vii. Scenario 7 – Wet (100% irrigation allocation and 80GL held in storage)

Under this scenario there are more inflows into the storages, resulting in a 100% allocation being made, along with 80,000ML of water being held in the combination of Cairn Curran Reservoir and Tullaroop Reservoir.

Under the Environmental BE and Qualification of Rights, once the volume in storage reaches 80,000ML, the environment receives the next 25,000ML to be captured. Once the volume held in storage drops below 80,000ML again, access to the water ceases. Hence, it is likely that this environmental water would primarily be available for use in winter/spring before irrigation releases in spring/summer lower the storage again.

From an operational perspective, this scenario will be similar to the previous scenario but with a greater volume of water moving through the landscape, both in response to irrigation demand and unregulated flows.

There will be more sizeable unregulated flows through the system below Cairn Curran and Tullaroop Reservoir and it will be more difficult to control the peaks of these flows, resulting in greater volumes requiring diversion/management than under the previous scenario.

Environmental water availability will increase under this scenario. Up to 4,800ML of the LSWFA will be available (with the potential to transfer 2,000ML into the wetland entitlement). In addition, 2,000ML of water in the Wetland Entitlement will be available meaning that a maximum of 4,000ML could be used in the Boort District Wetland complex.

As in the previous scenario, the wetland entitlement should be used to water Lake Ieaghur and Little Lake Meran. At this stage some unregulated flows would have been diverted to Lake Boort before committing to Reach 4. Therefore, there will be a requirement to provide environmental water from the wetland entitlement to Lake Boort to maintain and manage the wetland through its wet cycle.

There is also a greater potential for through flows from Lake Boort to be used in Lake Lyndger, generating multiple outcomes for this water. Figure 30 shows the prioritisation for the Boort District Wetlands according to the availability of unregulated flows.

The total volume of water available in the Deficit and Reimbursement Account in this scenario increases from 6,000ML to up to 25,000ML (total capped volume). The primary target of this water will be to provide recommended flows through Reach 4 of the Loddon River in winter/spring. Ideally this should tie in with natural unregulated flows over Loddon Weir to maximise the use of environmental water. There is an expectation that some of this water will flow through the whole reach, some will leave the river through distributary channels and flood-runners, and some will get to Kerang Weir for use in Reach 5. The flow recommendations for Reach 4 target an improvement in riparian vegetation condition and as such, a high bankfull flow is required. In Reach 4 overall, the commitment will be made to the reach using un-divertible unregulated flows, and there will be a requirement to follow through with that commitment using water from the Deficit and Reimbursement Account depending on the timing and volumes of flows.

The remainder of the river will have sufficient flows through it though the provision of irrigation and unregulated flows to cover-off on the environmental requirements.

It is likely that there will be sufficient water held in the Loddon storages to guarantee an allocation of close to 100% in the 2011-12 season, and any remaining environmental water will be carried over for use in 2011-12.

Table 16 shows river system operations and environmental water use expected under Scenario 7 while Table 18 shows overall system operations (under all scenarios).

Table 16. Loddon System operations under Scenario 7 – Wet

Loddon System Reach	**REACH 2:** Tullaroop to Laanecoorie Reservoir	**REACH 1:** Cairn Curran to Laanecoorie Reservoir	**REACH 3a:** Laanecoorie Reservoir to Serpentine Weir	**REACH 3b:** Serpentine Weir to Loddon Weir	**REACH 4:** Loddon Weir to Kerang Weir	**Boort District Wetlands**
Key Reach Characteristics	Complex morphology present in reach with high levels of instream woody habitat. Four native fish species expected (incl. River blackfish)	Channel in-filled, lack of pools and some bank notching. Little instream woody habitat and five native fish species expected (incl. historical records of River blackfish)	Channel unstable and high levels of instream woody habitat. Four native fish species expected (incl. past distribution of Silver perch). Drought refuge provided by Bridgewater and Serpentine Weir pools.	Moderate reversal of seasonal flows and unnatural cease to flow periods. Aggradation of the channel and moderate woody habitat instream. Four native fish species expected (incl. past distribution of Silver perch). Drought refuge provided by Loddon Weir pool.	Reach currently dry. Becoming increasing terrestrialised with siltation of pools and colonisation of riparian and semi-aquatic plant species in bottom of channel. History of blackwater events and recent evidence of acid sulphate soils/acid water.	Lake Meran, Little Lake Meran, Lake Boort, Lake Yando, Lake Leaghur or iother priority wetlands in this region as opted by the Environmental Water Manager.
Environmental Water Flexibility	BE flows restored					
	Loddon System Withheld flows account available (4,800ML)					
	25,000ML of Deficit and Reimbursement account available					
	2,000ML (100%) of Wetland Entitlement available					
	Unregulated flows at Loddon Weir					
	1,875ML available for use in Tullaroop Creek					
Reach Operations	System connected	High domestic and stock and irrigation flows	High domestic and stock and irrigation flows	High domestic and stock and irrigation flows.	River not operated for consumptive purposes. High volumes of unregulated flows	Wetlands to receive captured unregulated flows, plus wetland entitlement and LSWFA transfer (up to 4,000ML plus unregulated flows). Target under high flows will be Lake Boort
Environmental Water Use	Minimum passing flows and river freshening flows restored - refer to Section 5(b) part (ii)	Potential for minimum passing flows and river freshening flows as per BE	Potential for minimum passing flows and river freshening flows as per BE	Potential for minimum passing flows and river freshening flows as per BE	High bankfull flow/s provided as per environmental flow recommendations	

viii. Scenario 8 – Very wet (storages spill)

With very high rainfalls over winter/spring there is potential for the Loddon storages to spill. The result of this will be that bigger unregulated flows occur, and there will be little ability to control them. Whereas previous scenarios considered only unregulated flows below Laanecoorie would not be captured, this scenario is where flows above the storages can not be fully captured.

From a system operation perspective, G-MW will be operating the system similar to previous scenarios, but potentially with more water moving to the Boort area during summer to meet Boort irrigation demand (taking over supply from the Goulburn system and reliance on Lake Eildon). There will be a large amount of unregulated flows through the whole system. There is potential for high winter flows resulting in flooding through the system.

When the storages spill, both the environmental Deficit and Reimbursement Account and the water held in the LSWFA will spill with water exiting Cairn Curran Reservoir. This is considered a progressive spill with the balance of the environmental entitlements and allocations (Deficit and Reimbursement Account and LSWFA) reducing according to the volume of water spilling from the reservoir. As such, under this scenario there is potential for the environment to be holding anything from 0ML to slightly less than 25,000ML at the end of the spilling event (i.e. anything between a minimal spilling event and a large event could occur).

The Wetland Entitlement is not considered in the spillage account, and as such, there will be 2,000ML remaining for use in the Boort District Wetlands irrespective of the spilling of Cairn Curran. The target for this water is to provide a filling or top up to wetland/s in the Boort area that are not already flooded. Some wetlands (such as Lake Meran and Lake Leaghur) may receive flood waters from the Loddon River via creeks and flood runners. Therefore, the priority for use of this water will be for watering wetlands disconnected from the floodplain (Little Lake Meran, Lake Boort and Lake Lyndger), and provide top up (if required) to wetlands receiving flood waters.

Under this scenario there will be a large volume of water moving through the whole of the Loddon system, with bankfull and/or overbank flows occurring. This scenario is when the big flows of the past return to the Loddon and from an environmental perspective, the need to pass environmental water through the river system diminishes under this scenario. The target for water remaining in the Deficit and Reimbursement Account will be carryover for 2011-12 to maintain flows in the subsequent year/s.

Table 17 shows river system operations and environmental water use expected under Scenario 8 while Table 18 shows overall system operations (under all scenarios).

Figure 30 shows the prioritisation for the Boort District Wetlands according to the availability of unregulated flows.

Table 17. Loddon System operations under Scenario 8 – Very wet

Loddon System Reach	**REACH 2:** Tullaroop to Laanecoorie Reservoir	**REACH 1:** Cairn Curran to Laanecoorie Reservoir	**REACH 3a:** Laanecoorie Reservoir to Serpentine Weir	**REACH 3b:** Serpentine Weir to Loddon Weir	**REACH 4:** Loddon Weir to Kerang Weir	**Boort District Wetlands**
Key Reach Characteristics	Complex morphology present in reach with high levels of instream woody habitat. Four native fish species expected (incl. River blackfish)	Channel in-filled, lack of pools and some bank notching. Little instream woody habitat and five native fish species expected (incl. historical records of River blackfish)	Channel unstable and high levels of instream woody habitat. Four native fish species expected (incl. past distribution of Silver perch). Drought refuge provided by Bridgewater and Serpentine Weir pools.	Moderate reversal of seasonal flows and unnatural cease to flow periods. Aggradation of the channel and moderate woody habitat instream. Four native fish species expected (incl. past distribution of Silver perch). Drought refuge provided by Loddon Weir pool.	Reach currently dry. Becoming increasing terrestrialised with siltation of pools and colonisation of riparian and semi-aquatic plant species in bottom of channel. History of blackwater events and recent evidence of acid sulphate soils/acid water.	Lake Meran, Little Lake Meran, Lake Boort, Lake Yando, Lake Leaghur or iother priority wetlands in this region as opted by the Environmental Water Manager
Environmental Water Flexibility	BE flows restored Some of 25,000ML of Deficit and Reimbursement account unavailable (volume has spilled) 4,800ML of LSWFA unavailable (volume has spilled) 2,000ML (100%) of Wetland Entitlement available Unregulated flows at Loddon Weir 1,875ML available for use in Tullaroop Creek					
Reach Operations	Minimum passing flows and river freshening flows restored - refer to Section 5(b) part (ii)	High domestic and stock and irrigation flows. Cairn Curran spills	High domestic and stock and irrigation flows. Laanecoorie spills	High domestic and stock and irrigation flows. High unregulated flows over Serpentine Weir	High volume of unregulated flows	Un-full wetlands receive flood flows and 2,000ML of wetland entitlement
Environmental Water Use	Refer to Section 5(b) part (ii)	High flows through reach meet environmental requirements	High flows through reach meet environmental requirements	High flows through reach meet environmental requirements	High bankfull flow/s provided as per environmental flow recommendations	

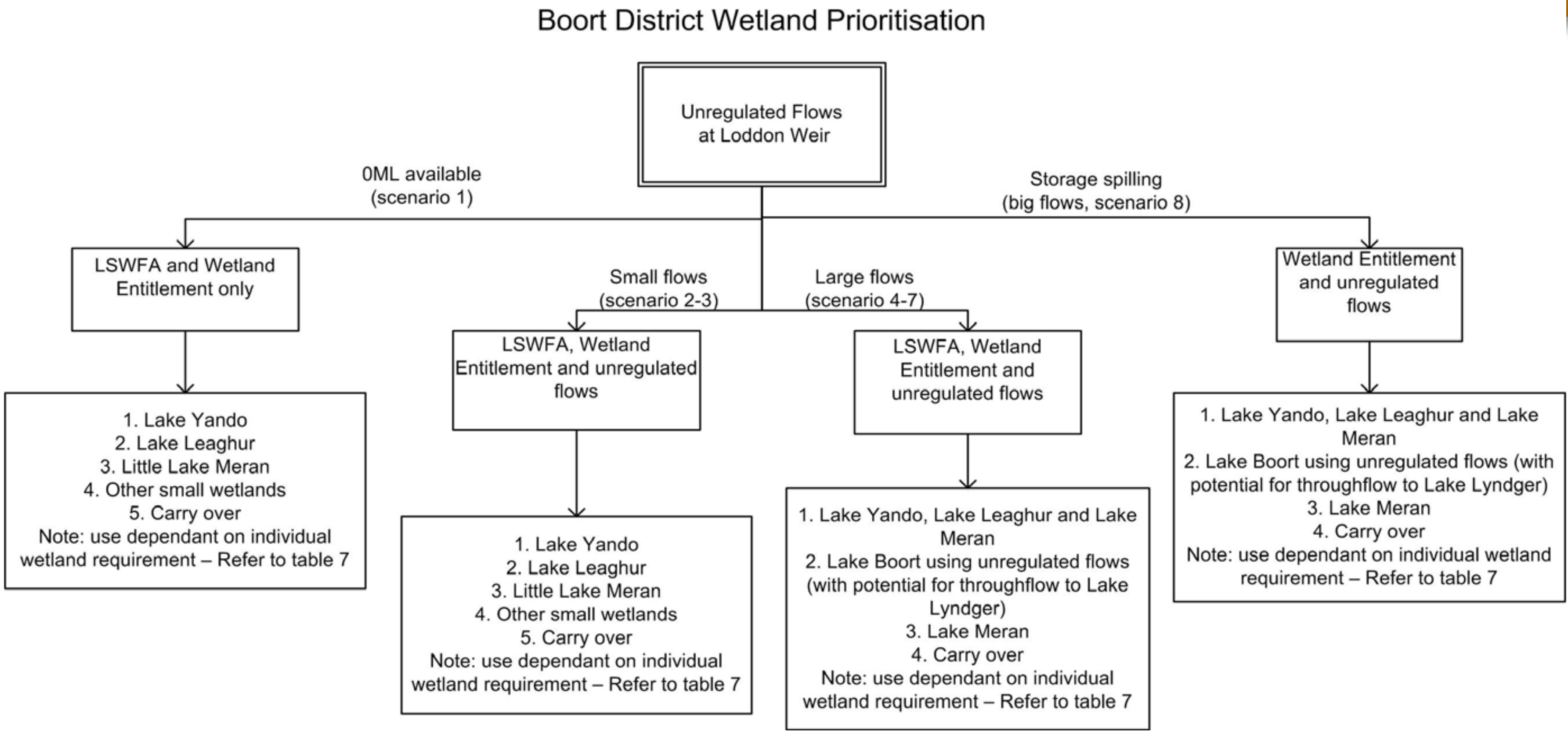

Figure 30. Boort District prioritisation flow chart, according to unregulated flow availability and scenarios

Table 18. Scenario description according to reach.

LODDON RIVER REACH Irrigation Allocation (Assumed Trigger)	SCENARIO 1 WORST DROUGHT 0% HRWS allocation	SCENARIO 2 EXTREMELY DRY Delivery of carryover water	SCENARIO 3 VERY DRY 1% HRWS allocation	SCENARIO 4 DRY 5% HRWS allocation	SCENARIO 5 MODERATE 50% HRWS allocation	SCENARIO 6 AVERAGE 100% allocation	SCENARIO 7 Wet 100% allocation and 80GL held in storage	SCENARIO 8 VERY WET Storages Spilling
Environmental Water Flexibility	No BE flows provided	No BE flows provided	No BE flows provided	No BE flows provided	No BE flows provided	BE flows restored	BE flows restored	BE flows restored
	Deficit and Reimbursement Account unavailable	Deficit and Reimbursement Account unavailable	Deficit and Reimbursement Account unavailable	Deficit and Reimbursement Account unavailable	Deficit and Reimbursement Account unavailable	6,000ML of Deficit and Reimbursement Account available	25,000ML of Deficit and Reimbursement account available	Some of 25,000ML of Deficit and Reimbursement account unavailable (volume has spilled)
	600ML of LSWFA available (allocated to G-MW to run river	600ML of LSWFA available	3,200ML of LSWFA available	8,200ML LSWFA available	8,200ML of LSWFA available	4,800ML of LSWFA available	4,800ML of LSWFA available	4,800ML of LSWFA unavailable (volume has spilled)
	Wetland Entitlement unavailable	Wetland Entitlement unavailable	20ML of Wetland Entitlement available	100ML of Wetland Entitlement available	1,000ML of Wetland Entitlement available	2,000ML (100%) of Wetland Entitlement available	2,000ML (100%) of Wetland Entitlement available	2,000ML (100%) of Wetland Entitlement available
	No unregulated flows at Loddon Weir	No unregulated flows at Loddon Weir	Minor unregulated flows at Loddon Weir	Small unregulated flows at Loddon Weir	Larger unregulated flows at Loddon Weir	Significant unregulated flows at Loddon Weir	Unregulated flows at Loddon Weir	Unregulated flows at Loddon Weir
	300ML available for use in Tullaroop Creek	300ML available for use in Tullaroop Creek	875ML available for use in Tullaroop Creek	875ML available for use in Tullaroop Creek	1,875ML available for use in Tullaroop Creek	1,875ML available for use in Tullaroop Creek	1,875Ml available for use in Tullaroop Creek	
REACH 2: Tullaroop to Laanecoorie Reservoir	System disconnected	System disconnected	System disconnected	System disconnected	System connected	System connected	System connected	System connected
	Refer to Section 5(b) part (ii)	Refer to Section 5(b) part (ii)	Refer to Section 5(b) part (ii)	Refer to Section 5(b) part (ii)	Refer to Section 5(b) part (ii)	Minimum passing flows and river freshening flows restored - refer to Section 5(b) part (ii)	Minimum passing flows and river freshening flows restored - refer to Section 5(b) part (ii)	Minimum passing flows and river freshening flows restored - refer to Section 5(b) part (ii)
REACH 1: Cairn Curran to Laanecoorie Reservoir	Transfer of water from Cairn Curran to Laanecoorie via Reach 1	Steady low flows throughout season	Steady low flows throughout season	Steady low flows provided throughout season including some domestic and stock and irrigation flows provided for in spring, summer and autumn	Steady low flows provided throughout season including some domestic and stock and irrigation flows provided for in spring, summer and autumn	Significant irrigation flows	High domestic and stock and irrigation flows. Cairn Curran spills	High domestic and stock and irrigation flows. Cairn Curran spills
	No environmental water available	No environmental water allocated to reach	No environmental water allocated to reach	No environmental water allocated to reach	No environmental water allocated to reach	Potential for minimum passing flows and river freshening flows to be restored	Potential for minimum passing flows and river freshening flows as per BE	High flows through reach meet environmental requirements
REACH 3a: Laanecoorie Reservoir to Serpentine Weir	River operated between Laanecoorie Reservoir and Bridgewater Weir (no water below Bridgewater) to September/October	Steady low flows throughout season	Steady low flows throughout season	Steady low flows provided throughout season including some domestic and stock and irrigation flows provided for in spring, summer and autumn	Steady low flows provided throughout season including some domestic and stock and irrigation flows provided for in spring, summer and autumn	Significant irrigation flows	High domestic and stock and irrigation flows. Cairn Curran spills	High domestic and stock and irrigation flows. Laanecoorie spills
	No environmental water available	Hold water to respond to water quality issues	Provide fresh(es) and hold water to respond to water quality issues – water flows through reach 3b	Use of environmental water to provide freshes to reach – water flows into reach 3b	Use environmental water to provide freshes to reach	Potential for minimum passing flows and river freshening flows to be restored (may also need to provide winter/spring fresh from LSWFA)	Potential for minimum passing flows and river freshening flows as per BE	High flows through reach meet environmental requirements
REACH 3b: Serpentine Weir to Loddon Weir	No river operation and therefore no flow	Steady low flows throughout season	Steady low flows throughout season	Intermittent flows provided throughout season	Steady low flows provided throughout season including some domestic and stock and irrigation flows provided for in spring, summer and autumn	Some domestic and stock and irrigation flows	High domestic and stock and irrigation flows. Cairn Curran spills	High domestic and stock and irrigation flows. High unregulated flows over Serpentine Weir
	No environmental water available	No environmental water allocated to reach	No environmental water allocated specifically to reach (however water from reach 3s and wetland water flow through reach)	Use some environmental water to provide freshes	Use some environmental water to provide freshes	Potential for minimum passing flows and river freshening flows to be restored (may also need to provide winter/spring fresh from LSWFA)	Potential for minimum passing flows and river freshening flows as per BE	High flows through reach meet environmental requirements

Cont.

LODDON RIVER REACH Irrigation Allocation (Assumed Trigger)	SCENARIO 1 WORST DROUGHT 0% HRWS allocation	SCENARIO 2 EXTREMELY DRY Delivery of carryover water	SCENARIO 3 VERY DRY 1% HRWS allocation	SCENARIO 4 DRY 5% HRWS allocation	SCENARIO 5 MODERATE 50% HRWS allocation	SCENARIO 6 AVERAGE 100% allocation	SCENARIO 7 Wet 100% allocation and 80GL held in storage	SCENARIO 8 VERY WET Storages Spilling
Environmental Water Flexibility	No BE flows provided	No BE flows provided	No BE flows provided	No BE flows provided	No BE flows provided	BE flows restored	BE flows restored	BE flows restored
	Deficit and Reimbursement Account unavailable	Deficit and Reimbursement Account unavailable	Deficit and Reimbursement Account unavailable	Deficit and Reimbursement Account unavailable	Deficit and Reimbursement Account unavailable	6,000ML of Deficit and Reimbursement Account available	25,000ML of Deficit and Reimbursement account available	Some of 25,000ML of Deficit and Reimbursement account unavailable (volume has spilled)
	600ML of LSWFA available (allocated to G-MW to run river	600ML of LSWFA available	3,200ML of LSWFA available	8,200ML LSWFA available	8,200ML of LSWFA available	4,800ML of LSWFA available	4,800ML of LSWFA available	4,800ML of LSWFA unavailable (volume has spilled)
	Wetland Entitlement unavailable	Wetland Entitlement unavailable	20ML of Wetland Entitlement available	100ML of Wetland Entitlement available	1,000ML of Wetland Entitlement available	2,000ML (100%) of Wetland Entitlement available	2,000ML (100%) of Wetland Entitlement available	2,000ML (100%) of Wetland Entitlement available
	No unregulated flows at Loddon Weir	No unregulated flows at Loddon Weir	Minor unregulated flows at Loddon Weir	Small unregulated flows at Loddon Weir	Larger unregulated flows at Loddon Weir	Significant unregulated flows at Loddon Weir	Unregulated flows at Loddon Weir	Unregulated flows at Loddon Weir
	300ML available for use in Tullaroop Creek	300ML available for use in Tullaroop Creek	875ML available for use in Tullaroop Creek	875ML available for use in Tullaroop Creek	1,875ML available for use in Tullaroop Creek	1,875ML available for use in Tullaroop Creek	1,875Ml available for use in Tullaroop Creek	
REACH 4: Loddon Weir to Kerang Weir	No river operation and therefore no flow	No river operation and therefore no flow	No river operation and therefore no flow	No river operation	No river operation however potential for unregulated flows to enter reach	No river operation however potential for unregulated flows through entire reach	River not operated for consumptive purposes. High volumes of unregulated flows	High volume of unregulated flows
	Reach to be kept dry (divert any unregulated flows to Boort District Wetlands)	Reach to be kept dry (divert any unregulated flows to Boort District Wetlands)	Reach to be kept dry (divert any unregulated flows to Boort District Wetlands)	Reach to be kept dry (divert any unregulated flows to Boort District Wetlands)	Reach to be kept dry divert unregulated flows to Boort District Wetlands	Reach to be kept dry under small-medium unregulated flows (divert to Boort District Wetlands up to ~200ML/day). Use environmental water to maintain peak and duration of flows if spill into reach occurs	High bankfull flow/s provided as per environmental flow recommendations	High bankfull flow/s provided as per environmental flow recommendations
Boort District Wetlands	No environmental water available.	Provide water to Lake Leaghur	Some water transferred from LSWFA to Wetland Entitlement, unregulated flows diverted to wetlands if required, environmental flows from reach 3a to be diverted to wetland/s. Lake Leaghur is priority wetland to receive water	Some water transferred from LSWFA to Wetland Entitlement, unregulated flows diverted to wetlands if required, environmental flows from reach 3a to be diverted to wetland/s. Lake Leaghur is priority wetland to receive water	1. Divert small unregulated flows/or wetland entitlement to meet wetland priorities (Lake Leaghur, Little Lake Meran). 2. Divert medium unregulated flows to Lake Boort to meet diversion requirements from Reach 4. 3. If Lake Boort holds water, use environmental flows to maintain ecological condition	1. Divert small unregulated flows/or wetland entitlement to meet wetland priorities (Lake Leaghur, Little Lake Meran). 2. Divert medium unregulated flows to Lake Boort to meet diversion requirements from Reach 4. 3. If Lake Boort holds water, use environmental flows to maintain ecological condition	Wetlands to receive captured unregulated flows, plus wetland entitlemnt and LSWFA transfer (up to 4,000ML plus unregulated flows). Target under high flows will be Lake Boort	Un-full wetlands receive unregulated flows and 2,000ML of wetland entitlement

6. Plans for other sources of water

As discussed in Section 3a, there is potential for additional water to become available on the Loddon system during 2009-10. While the volumes and operation requirements of these water sources are yet to be finalised, the potential use of the water is considered in this section should it become available for use.

Wimmera-Mallee Pipeline water (available for use at Loddon Weir):

- 2,000ML entitlement to become available for environmental use from the water savings
- 300ML of this has been earmarked for Little Lake Boort and should this water come to the CMA, North Central CMA will work with Committee of Management in the delivery of this water
- The additional 1,700ML of this water will be considered as a wetland water delivery, according to scenario and wetland priorities up to Scenario 6 (when significant unregulated flows at Loddon Weir occur) where it should be used to fulfil requirements of Reach 4 as a first priority
- Into the future this water should be used as a first priority to provide recommended flows to the high priority small wetlands in the Boort Area (Lake Yando, Lake Leaghur and Little Lake Meran) to maintain their required watering regime every year (irrespective of irrigation allocation).

Commonwealth water (available for use at Loddon Weir depending on irrigation allocation):

- To date, 1,029ML of HRWS have been purchased by the Commonwealth in the Loddon System. Should this water become available for use in 2010-11, it is recommended that it be used in accordance with the scenario priorities described.

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- The volume of environmental water available under the mitigation water requirement is currently unclear.

Overall there may be up to 3,000ML-4,000ML of environmental water entitlement available for use in the Loddon River System and it is assumed that the water in these entitlements will be subject to Loddon irrigation allocations (in some cases as a surrogate for Goulburn allocations).

Under Scenario 1 to Scenario 4, the water described above would be allocated as per the scenario description (i.e. the volume of water would not change recommended management actions described).

Under Scenario 5 (50% irrigation allocation) the additional volumes of water described would be in the order of 1,500ML-2,000ML and would add to the management actions undertaken by increasing the volume of water being delivered to Lake Boort, and increasing the potential for some of this water to be delivered to Lake Lyndger via through-flow from Lake Boort.

Under Scenario 6 (100% irrigation allocation) up to 3,000ML-4,000ML of additional water would be available and according to the scenario priorities, this water would be used to increase the flows in Reach 4 (downstream of Loddon Weir).

Under Scenario 7, the priority will again be environmental flows in Reach 4, with the view of providing the best possible flow as per the environmental flow recommendations (SKM 2010). If this water is already available and this flow has been secured, the priority for use of the water will be as a wetland delivery to Lake Boort and Lake Lyndger.

Under Scenario 8 there will be significant unregulated flows through the whole system, including some flooding so there will be minimal ability to provide additional environmental flows through the system. The recommendation under this scenario will therefore be to carryover the water for use in 2011-12.

7. Delivering the Environmental Water Reserve

7a. Managing Environmental Water through the Season

In the Tullaroop Creek system, the key driver between the scenarios described in Section 5d relates to inflows received in Tullaroop Reservoir. This will directly impact the volumes available to the environment after October 2010 to maintain creek flows through the 2011-12 season. Prior to this, the 300ML of environmental water from 2009-10 is to be used to maintain the river through to November 2010 when the new allocation will be made.

In the Loddon River system, the 2010-11 season will probably start under extremely dry conditions, with only 600ML of water from the LSWFA available and no river flow. As such, there are likely to be no environmental flow management decisions able to be made during the first one to two months of the season. Any unregulated flows arriving at Loddon Weir should be diverted to the first Boort District wetland on the priority list, to keep the Loddon River below Loddon Weir dry (Reach 4).

Initially, inflows to the system will determine whether some of the minimum 600ML of environmental water from the LSWFA can be transferred to the Wetland Entitlement for use in Boort District Wetlands. Again, the destination of this water will follow the wetland prioritisation.

The commencement of allocations increases the available water for environmental use, and allows water to be delivered for spring (and later) flushes in Reach 3a.

If significant unregulated flows occur at Loddon Weir through the 2010-11 season, these flows are to be diverted to Lake Boort (to keep Reach 4 dry), allowing other environmental water entitlements to be delivered to other wetlands in the Boort area.

If unregulated flows are large enough (greater than ~200ML/day), flows into Reach 4 below Loddon Weir are triggered. This will cease diversions of unregulated flows (for certain amount of time) and shift the delivery of most of the available environmental water to maximising the size of the Reach 4 flow event. Allocations of 100% and the combined storage volumes reaching more than 80GL increases the water resources available to be provided to Reach 4.

When the storages spill, there will be a reduction of available water for environmental use. Therefore, as storages approach full capacity, management decisions will be required regarding whether to release water for a specific environmental gain, or allow the spill to occur to provide some more general environmental gain.

By September/October 2010, inflows received in the Loddon System and the seasonal outlook will allow better planning for the remainder of the season. Importantly, the timing of resource availability (particularly if allocation increases occur late in the spring) may preclude some planned watering options.

7b. Costs

The Environmental Water Manager does not have to make any payment for headworks costs relating to the Environmental Reserve BE. However, any additional delivery costs relating to the supply of the wetland entitlement where it is delivered through channel infrastructure will require payment.

7c. Notice Required

A notice period of 4 - 7 days is the agreed notice required for environmental water orders from Loddon storages to the Loddon River and the Boort District Wetlands.

If channel capacity and maintenance constraints are foreseen G-MW in making environmental water available, the Environmental Water Manager will be advised accordingly.

7d. Travel Time and Channel Capacity

Release from Cairn Curran and Tullaroop Reservoirs on the Loddon System may take up to 5-6 days to reach Loddon Weir, however this will be influenced by existing conditions in the channel and seasonal conditions.

The Environmental Reserve Bulk Entitlement (Schedule 3, clause 3.1) states that the wetland entitlement "*shall be supplied only when there is spare channel capacity available after meeting all the consumptive demands supplied from the system waterway*". Therefore the intended delivery times to wetlands in this AWP may change subject to consumptive demand.

Delivery to any wetland in the Boort District will vary depending on channel capacity and irrigator demand. As such, it is recommended that ability to deliver, and therefore delivery time be organised with the storage operator (G-MW) prior to commencement of delivery.

8. Risks of Environmental Water Delivery

While it is widely acknowledged that the delivery of environmental water to the Loddon River System provides a major benefit to the health of the environment and ecosystems supported in the river system, there are a number of risks that need to be considered in the delivery of environmental water.

Some of the risks posed by environmental water to the Loddon River System, along with recommended mitigating actions are described below:

Blackwater:

Blackwater events are characterised by a dark discolouration of the water column which is usually associated with a low dissolved oxygen concentration as a result of a high organic matter load (SKM 2008). In the Loddon River, blackwater events may occur through many mechanisms, however the accumulation of external organic matter (e.g. leaf litter) entering the river during summer freshes and the subsequent processing of this organic matter can cause a decline in dissolved oxygen concentrations and the release of tannins which cause the water to turn black (SKM 2008).

The major risk these events pose is to aquatic fauna species residing in the river as the dissolved oxygen declines, temperature increases, pH decreases and tannins increase, and can result in fish movement out of the area and/or fish deaths. While these events occur naturally in some ecosystems (SKM 2008), the risk in recent years has been heightened by the delivery of environmental flows to stressed, and drying river reaches.

Cottingham et. al (2010) note that freshes occurring in late summer-autumn carry an increased risk of triggering a blackwater event. Spring freshes carry a lot less risk due to lower temperatures, slower decomposition of organic matter and less severe oxygen depletion, and these should be releases in preference of summer-autumn freshes (Cottingham et. al 2010).

The freshes described in this Plan generally focus on a spring delivery and therefore avoid the risk period of summer/autumn. These freshes are priorities for Reaches 3a (Laanecoorie Reservoir to Serpentine Weir) and 3b (Serpentine Weir to Loddon Weir) with the aim of increasing habitat quality and improvement in food resources for invertebrates through the disruption of biofilms and exposure of organic matter (Cottingham et. al 2010). In turn, this should improve fish populations as their food source will be improved (Cottingham et. al 2010).

Any fresh delivered through the river will need to be monitored closely for a number of parameters (e.g. dissolved oxygen, colour, electrical conductivity, pH, temperature etc.). Should blackwater begin to present itself (generally characterised by dissoloved oxygen and colour), additional water may be required to increase the flow duration of the event, and provide sufficient water volume to dilute the blackwater, as well as increased velocity to mix the water and provide aeration.

Reach 4 of the Loddon River (Loddon River to Kerang Weir) is currently dry and holds a large amount of organic matter. This reach will not be restarted until a large volume of water (above ~2,000ML) can be delivered to the reach (through unregulated flows and/or environmental water) to provide a high bank-full flow. As the reach has been dry for a number of years, and depending on the timing of this flow, there may be potential to trigger a blackwater event. From an environmental perspective the consequence of a blackwater event occurring in this reach at this stage will not be high as there are currently no aquatic species residing in the reach (due to it being dry). The only consequence of an event of this nature will occur if the blackwater reaches the downstream section of the reach (at Kerang) where there is water in the weir pool. It is expected that the flow volume and duration will be sufficient to dissipate/recover the water quality along the length of the river.

Acid Water in Reach 4:

The development of acid water through Reach 4 of the Loddon River (below Loddon Weir) is considered to occur when the system is dry, but presents itself when the system is re-wet, through the exposure of large amounts of sulfidic sediments to the air for a considerable amount of time (SKM 2010). This acid water is characterised by a low pH and deoxygenating of the water, causing harm to aquatic organisms unable to leave the poor conditions. The development of this acid water may be as a result of Acid Sulphate Soils (ASS) in the reach, however there is currently some conjecture as to whether there is actually wide-spread ASS, or whether other mechanisms have are presenting themselves as ASS. For example, it has been noted that acid groundwater under the Parilla sands in the Mallee can contribute to acid water, however this is only is a small area of the Loddon River, and as such probably do not contribute a significant amount of acid (if at all).

Recommendations for the management of the potential risk of ASS and/or acid water involve ensuring that the recommended high bank-full flows through this section of the river are large and sustained (SKM 2010). It is expected that theses flows will be enough to wash any sulphides from the sediment, and to dilute any acid that may form (SKM 2010). Should a rainfall event cause a small unregulated flow over Loddon Weir and into this reach, there is greater potential for acid to be formed at some locations due to small volumes of water wetting the channel but not passing through with enough water to dilute the water (SKM 2010). As such, the proposals developed through the scenarios of this Plan ensure that water is diverted from Loddon Weir at these low flow conditions, with the switch to allowing a spill at Loddon Weir occurring only when there is sufficient unregulated flows and/or enough environmental water available to follow through with a large flow event.

It is recommended that any flows through Reach 4 of the Loddon River be monitored for pH, dissolved oxygen levels, metals and sulphides during and after flow events (SKM 2010).

High bank-full flows:

As discussed throughout this Plan, the first priority flow through Reach 4 of the Loddon River (between Loddon Weir and Kerang Weir) will be a high bank-full flow lasting at least six days. The environmental flow recommendations stipulate that a 3,500ML per day flow over Loddon Weir will inundate high benches downstream of Loddon Weir, and will reach the top of the river bank when the flow reaches the Loddon River immediately upstream of the Twelve Mile Creek regulator (due to the smaller channel capacity) (SKM 2010). Additionally it is expected that this flow will engage both Venebles and Kinypanial Creeks with reasonable flows (SKM 2010).

While modelling suggests that a flow of this magnitude will remain contained in the river and creek channels, there is potential that additional water may be added to this flow (via a rainfall event) which may result in some localised flooding outside of the river and creek channels.

Initial discussions with community representatives indicate that both the risk of promoting an over-bank flow, as well as the consequences to property of a flow of this nature are low, the issue requires some consideration (LEWAG 2010).

It is acknowledged that providing an environmental flow of this nature (high bank-full) is North Central CMA's plan only, and it does not infer that this action will be able to be undertaken during 2010-11. Prior to providing an environmental flow of this nature, North Central CMA will ensure that appropriate advice has been obtained to ensure all real risks have been identified and will be adequately managed.

During this flow event, monitoring of water movement through the system will also need to be undertaken. This information will be fed back into the model used for this reach of the Loddon River to provide refinement to the outputs generated.

9. Monitoring

A major component of environmental water management and delivery involves monitoring, and using this information to inform future management decisions. There are a number of monitoring activities currently undertaken in the Loddon River System which are outlined in Table 19.

Table 19. Current monitoring undertaken in the Loddon River System

Monitoring program	Objectives	Parameters targeted	Comment
Victorian Environmental Flows Monitoring Program (VEFMAP)	*"Evaluate ecosystem responses to environmental flows in six to eight regulated rivers that are to receive enhancements (to various degrees) to their flow regime." Cottingham et. al 2005 pg. 1*	▪ Flow ▪ Channel features ▪ Habitat survey ▪ Macroinvertibrate survey ▪ Vegetation survey ▪ Fish survey ▪ Water quality	Long-term monitoring program which aims to generate information about long-term ecosystem responses at a 5-10 year timeframe, rather than in real-time
VEFMAP	As above	Continuous water quality monitoring probes (dissolved oxygen, electrical conductivity and temperature)	Real-time data provided at five sites through the system
G-MW Drought Response Water Quality Monitoring Program	To monitor potential impacts to G-MW customers and the environment due to changed operations of the rivers brought about through the Qualification of Rights implementation	▪ Dissolved oxygen ▪ Electrical conductivity ▪ pH ▪ Temperature ▪ Turbidity	14 sites are monitored on the Loddon River, and two on Tullaroop Creek. Monitoring is undertaken on a fortnightly/monthly basis
CHW drought response monitoring program	To monitor potential impacts to the environment due to changed operations of the rivers brought about through the Qualification of Rights implementation	▪ Dissolved oxygen ▪ Electrical conductivity ▪ pH ▪ Temperature ▪ Turbidity	Seven sites are monitored on Tullaroop Creek on a fortnightly basis

In addition to the monitoring described above, there are a number of other monitoring activities that should be undertaken during 2010-11 to generate continuing knowledge about the Loddon River System. Some of these activities are detailed in Table 20 and should be considered in the development of a monitoring evaluation, reporting and improvement (MERI) plan.

Table 20. Additional monitoring that should be undertaken during 2010-11 in the Loddon River System

Monitoring Type	Location	Comment
Aquatic fauna (fish)	Tullaroop Creek	Monitoring should specifically target River Blackfish populations and include information on population structure. This will provided important information about the Blackfish community in Tullaroop creek, being targeted by environmental flow releases, and will follow on from a 2005 study undertaken by ARI (Pitman and Tinkler 2005).
Waterbird monitoring	Boort District Wetlands	Monitoring should be undertaken after environmental water has been delivered to wetlands to show change due to watering events.
Vegetation monitoring	Boort District Wetlands	Monitoring should be undertaken after environmental water has been delivered to wetlands to show change due to watering events.
Additional water quality monitoring	Reach 4 of Loddon River	Monitoring probes should be established through reach 4 of the Loddon River in prior to any flows entering the reach, and should specifically target water quality parameters associated with acid sulphate soils/acid water (e.g. pH, dissolved oxygen, metals and sulphides).

9. Communication

It is important that the North Central CMA, as the manager of the Environmental Water Reserve, ensure all stakeholders are kept informed of its operational activities in relation to the release of water for environmental purposes through factual and prompt information.

The following primary and secondary audiences have been identified as requiring factual and prompt communication engagement.

- Primary audience - Bulk Entitlement holders and storage operators (Goulburn-Murray Water and Central Highlands Water) are to be informed of the North Central CMA's management of the Environmental Water Reserve and to ensure that consistent messages are delivered to the target audiences.
- Primary audience - Loddon Environmental Water Advisory Group. Members of this group assisted in the development of the Annual Watering Plan and are key community representatives in the Loddon System. They will be informed of the North Central CMA's management of the Environmental Water Reserve.
- Primary audience - diversion licence holders, farmers, irrigators, landholders etc. Individuals within this group have an entitlement to water to carry out their business activities and need to be informed of the North Central CMA's management of water for the river.
- Primary audience - the general community who use the water for recreational and social purposes. It is important this group are made aware of the role and functions of the North Central CMA as manager of the Environmental Water Reserve.
- Secondary audience – other stakeholders (DSE and DPI etc). Although already informed, they are an important group because the North Central CMA's activities require their input and support. They require continuing engagement with up to date information.

9a. Communication delivery channels

The delivery of our key messages will be via:

- Media releases - wherever practical these are to be joint releases with input from the North Central CMA and Goulburn-Murray Water. A media release should precede any environmental flow release.
- Advertising - to minimise the potential for key messages to be lost when media outlets editorialise media releases, paid advertisements are to be considered to supplement the release. This ensures balance is provided in the North Central CMA's community engagement of any environmental flow release.
- North Central CMA Website - all current and future proposed environmental flows will be displayed on the website and updated on a fortnightly basis. All media releases are also to be displayed.
- Community consultation – a copy of any media release is to be provided to any interested Loddon Environmental Water Advisory Group members to ensure they are informed and have up to date information that can be passed on to their local networks.

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11. Appendix 1: Environmental Reserve Bulk Entitlement

Environmental Flow Schedule – Environmental Reserve BE

Reach	River Section	Clause	Storage Volume	ML/day	Type	Notes	Timing	Duration (days)	Frequency (per year)
1	**Loddon River** Cairn Curran Reservoir to Laanecoorie Reservoir	1.1 (a)	Not applicable	20ML or natural	Minimum flow	Whichever is less	Nov to April	Continuous	-
		1.1 (b) (i)	>60,000ML combined storage volume of Cairn Curran and Tullaroop	35ML or natural	Minimum flow	Whichever is less	May to Oct	Continuous	-
		1.1 (b) (ii)	< or = 60,000ML combined storage volume of Cairn Curran and Tullaroop	20ML or natural	Minimum flow	Whichever is less	May to Oct	Continuous	-
		1.2	Not applicable	35ML	Fresh	Inclusive of minimum flows and only if inflows are sufficient	Nov to April	7	3
2	**Tullaroop Creek** Tullaroop Reservoir to Laanecoorie Reservoir	2.1	Not applicable	10ML or natural	Minimum flow	Whichever is less	All year	Continuous	
		2.2		13.5ML	Fresh	Inclusive of minimum flows and only if inflows are sufficient	Nov to April	7	4
3a	**Loddon River** Laanecoorie Reservoir to Serpentine Weir	3.1 (a)	Not applicable	15ML or natural	Minimum flow	Whichever is less	Nov to July	Continuous	-
		3.1 (b) (i)	>60,000ML combined storage volume of Cairn Curran and Tullaroop	52ML or natural	Minimum flow	Whichever is less	Aug to Oct	Continuous	-
		3.1 (b) (ii)	< or = 60,000ML combined storage volume of Cairn Curran and Tullaroop	15ML or natural	Minimum flow	Whichever is less	Aug to Oct	Continuous	-
		3.2	Not applicable	52ML	Fresh	Inclusive of minimum flows and only if inflows are sufficient	Nov to April	13	3

Cont.

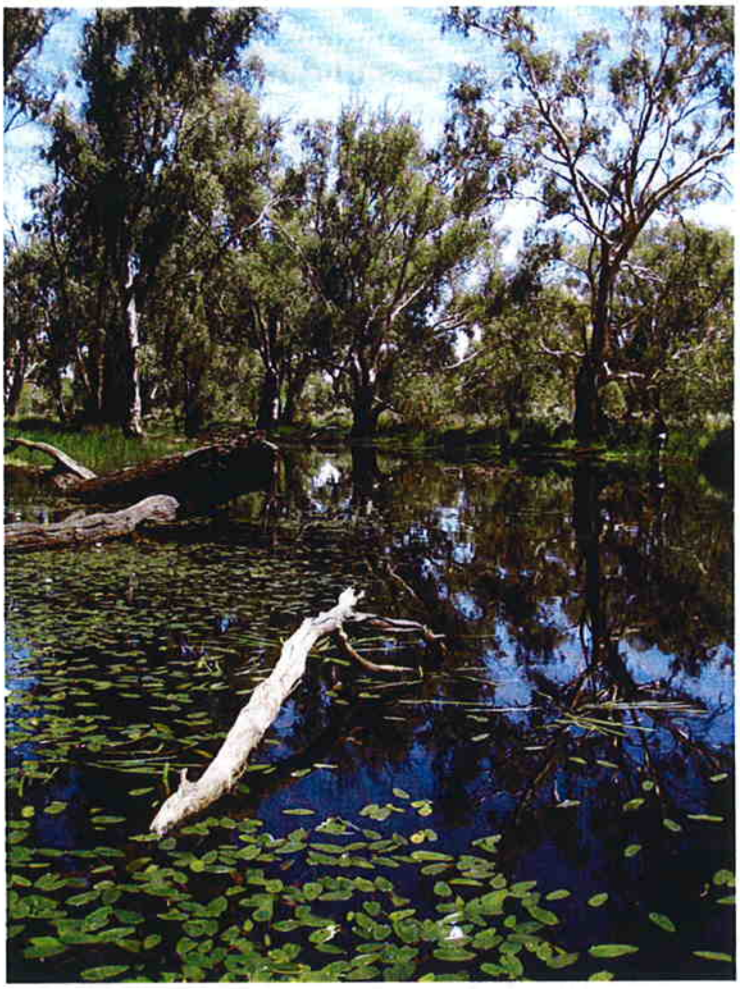
Reach	River Section	Clause	Storage Volume	ML/day	Type	Notes	Timing	Duration (days)	Frequency (per year)
3b	**Loddon River** Serpentine Weir to Loddon Weir	4.1 (a)	Not applicable	19ML or natural	Minimum flow	Whichever is less	Nov to April	Continuous	-
		4.1 (b) (i)	>60,000ML combined storage volume of Cairn Curran and Tullaroop	61ML or natural	Minimum flow	Whichever is less	May to Oct	Continuous	-
		4.1 (b) (ii)	< or = 60,000ML combined storage volume of Cairn Curran and Tullaroop	19ML or natural	Minimum flow	Whichever is less	May to Oct	Continuous	-
		4.2	Not applicable	61ML	Fresh	Inclusive of minimum flows and only if inflows are sufficient	Nov to April	11	3
4	**Loddon River** Loddon Weir to Kerang Weir	5.1 (a)	Not applicable	7-12ML	Minimum flow	Varied as slow rise and fall where possible	Nov to April	Continuous	-
		5.1 (b) (i)	>60,000ML combined storage volume of Cairn Curran and Tullaroop	61ML	Minimum flow	Inclusive of minimum flows and only if inflows are sufficient, plus loss	May to Oct	Continuous	-
		5.1 (b) (ii)	< or = 60,000ML combined storage volume of Cairn Curran and Tullaroop	10ML	Minimum flow	Inclusive of minimum flows and only if inflows are sufficient, plus loss	May to Oct	Continuous	-
		5.2	Not applicable	50ML	Fresh	nclusive of minimum flows and only if inflows are sufficient, plus loss	Jan to Feb	14	1

12. Appendix 2: Boort District Wetlands Flooding History

Wetland	1990 (Jul-Dec)	1991 (Jan-Jun)	1991 (Jul-Dec)	1992 (Jan-Jun)	1992 (Jul-Dec)	1993 (Jan-Jun)	1993 (Jul-Dec)	1994 (Jan-Jun)	1994 (Jul-Dec)	1995 (Jan-Jun)	1995 (Jul-Dec)	1996 (Jan-Jun)	1996 (Jul-Dec)	1997 (Jan-Jun)	1997 (Jul-Dec)	1998 (Jan-Jun)	1998 (Jul-Dec)	1999 (Jan-Jun)	1999 (Jul-Dec)
Boort District Wetlands (Listed in Environmental BE)																			
Lake Boort	Wetland full	Wetland half full	Wetland full	Wetland full	Wetland flooded	Wetland full	Wetland flooded	Wetland full	Wetland full	Wetland full	Wetland flooded	Wetland half full	Wetland flooded	Wetland half full	Wetland half full	Wetland less than half full	Wetland dry	Wetland dry	Wetland dry
Lake Yando	Wetland half full	Wetland dry	Wetland half full	Wetland half full	Wetland flooded	Wetland half full	Wetland flooded	Wetland half full	Wetland full	Wetland half full	Wetland flooded	Wetland full	Wetland flooded	Wetland half full	Wetland less than half full	Wetland dry	Wetland dry	Wetland dry	Wetland dry
Lake Leaghur	Wetland full	Wetland full	Wetland full	Wetland full	Wetland full	Wetland full	Wetland flooded	Wetland full	Wetland full	Wetland half full	Wetland flooded	Wetland full	Wetland flooded	Wetland half full	Wetland half full	Wetland less than half full	Wetland less than half full	Wetland less than half full	Wetland less than half full
Lake Meran	Wetland full	Wetland full	Wetland flooded	Wetland full	Wetland flooded	Wetland full	Wetland full	Wetland full	Wetland full	Wetland half full	Wetland full	Wetland full	Wetland flooded	Wetland full	Wetland half full	Wetland half full	Wetland half full	Wetland less than half full	Wetland less than half full
Little Lake Meran	Wetland full	Wetland full	Wetland flooded	Wetland full	Wetland full	Wetland flooded	Wetland full	Wetland full	Wetland full	Wetland flooded	Wetland full	Wetland full	Wetland flooded	Wetland full	Wetland full	Wetland half full	Wetland half full	Wetland less than half full	Wetland dry
Other sites																			
Little Lake Boort	Wetland full	Wetland full	Wetland full	Wetland full	Wetland full	Wetland full	Wetland half full	Wetland full	Wetland full	Wetland full	Wetland full	Wetland half full	Wetland full	Wetland full	Wetland full	Wetland full	Wetland full	Wetland full	Wetland full

Wetland	2000 (Jan-Jun)	2000 (Jul-Dec)	2001 (Jan-Jun)	2001 (Jul-Dec)	2002 (Jan-Jun)	2002 (Jul-Dec)	2003 (Jan-Jun)	2003 (Jul-Dec)	2004 (Jan-Jun)	2004 (Jul-Dec)	2005 (Jan-Jun)	2005 (Jul-Dec)	2006 (Jan-Jun)	2006 (Jul-Dec)	2007 (Jan-Jun)	2007 (Jul-Dec)	2008 (Jan-Jun)	2008 (Jul-Dec)	2009 (Jan-Jun)	2009 (Jul-Dec)	2010 (Jan-Jun)
Boort District Wetlands (Listed in Environmental BE)																					
Lake Boort	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry
Lake Yando	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland full	Wetland less than half full
Lake Leaghur	Wetland less than half full	Wetland less than half full	Wetland less than half full	Wetland less than half full	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland half full
Lake Meran	Wetland less than half full	Wetland less than half full	Wetland less than half full	Wetland less than half full	Wetland less than half full	Wetland less than half full	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry
Little Lake Meran	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry	Wetland dry
Other sites																					
Little Lake Boort	Wetland full	Wetland full	Wetland full	Wetland half full	Wetland less than half full	Wetland less than half full	Wetland less than half full	Wetland less than half full	Wetland less than half full	Wetland less than half full	Wetland less than half full	Wetland less than half full	Wetland full	Wetland half full	Wetland full	Wetland half full	Wetland half full	Wetland less than half full	Wetland less than half full	Wetland less than half full	Wetland less than half full

Environment, Climate Change & Water



Adaptive Environmental Water Plan for the Murray Valley

2010/11

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List of Abbreviations

AEW - Adaptive Environmental Water
ASS – Acid Sulphate Soils
CEWH –Commonwealth Environmental Water Holdings
CMA - Catchment Management Authority
DECCW - Department of Environment, Climate Change and Water
DEWHA – Department of Environment, Water, Heritage and the Arts
EC – Electrical Conductivity
GL - Gigalitre
LMD - Lower Murray Darling
MDBA –Murray Darling Basin Authority
MIL – Murray Irrigation Limited
ML- Megalitre
NOW – NSW Office of Water
NRC - Natural Resource Council
NRC – Natural Resource Council
NSW I & I – NSW Industry and Investment
RMW - River Murray Water
RRG - River Red Gum
SBF - Southern Bell Frog
SWC - State Water Corporation
TLM -The Living Murray
WAL – Water Access Licence

1.0 Background

The Adaptive Environmental Water Plan for the Murray Valley 2010/11, hereafter refer to as 'the Plan', outlines the proposed use of Adaptive Environmental Water (AEW) in the NSW Murray Valley for the 2010-2011 season. The Plan identifies a number of wetland sites, or assets, (private and public) that would benefit through receiving an allocation of AEW. Volumes of AEW required for each asset has been estimated and included in the Plan.

The Department of Environment, Climate Change and Water (DECCW) currently manages up to 32,027 megalitres (ML) of Adaptive Environmental Water within the Murray Valley on behalf of the Minister for Environment and Climate Change. The water is held in two AEW licences – a conveyance licence which has a maximum share of 30,000 ML and a high security licence which has a maximum share of 2,027 ML (Table 1). In addition to the AEW licences DECCW also facilitates the management of Commonwealth Environmental Water Holdings (CEWH) on behalf of the federal Department of Environment, Water, Heritage and the Arts (DEWHA), water allocated for The Living Murray (TLM) icon sites and any water donations made by the public.

Table 1. Summary of Adaptive Environmental Water licences held in the NSW Murray Valley and managed by DECCW.

Licence Type	Licence Number	Maximum Capacity (ML)
AEW Conveyance	WAL 9422 / 50AL503537	30,000
AEW High Security	WAL 9423 / 50AL503538	2,027

Several wetland assets located in NSW State Forests (currently managed by Forests NSW) are watered using a combination of TLM water allocations and AEW. These assets are monitored by DECCW in conjunction with Forests NSW.

This Plan has been developed in conjunction with, and is supported by, the Murray Lower Darling Environmental Water Advisory Group.

1.1 Primary Objectives for AEW Use

The primary objectives for the provision of AEW to wetland habitats within the NSW Murray Valley are:

1. *To improve and/or maintain the condition of a diversity of wetland types within the NSW Murray Valley;*
2. *To prevent the further decline in stressed wetland vegetation communities, in particular River Red Gum, Black Box and Lignum communities;*
3. *To increase and/or maintain the abundance and diversity of understorey wetland vegetation communities (in both wet and dry phases);*
4. *To reinstate a wetting/drying cycle for natural ephemeral floodplain wetlands that have been negatively impacted by river regulation and/or severe drought conditions, and*
5. *To provide habitat for wetland-dependant fauna including endangered species such as the Southern Bell Frog (Litoria raniformis) and Regent Parrot (Polytelis anthopeplus).*

1.2 Wetland asset selection

All wetland sites, or assets, are assessed prior to being listed to receive AEW in the NSW Murray Valley. The site selection process looks at a number of aspects under four main headings – Ecological Considerations, Management of Wetland, Landholder Interest / Community Values and Logistics/Feasibility.

i. Ecological Considerations:
   - Site condition (current) – vegetation, fauna, groundwater issues, adjacent land practices, hydrological regime, impacts;
   - Vegetation – overall community diversity, abundance and structure; presence of any rare, threatened or endangered species;
   - Fauna - overall community diversity, abundance; presence of any rare, threatened or endangered species;
   - Hydrology – natural hydrological regime, past watering/flooding history, last inundation event (artificial/natural), connectivity to main water source/other wetlands, volume of water required;
   - Ecological or conservation values – at local and/or regional scales, includes national or international agreements, and
   - Impacts / Risks- that may be encountered if watering was to proceed, or not proceed.

ii. Management of Wetland:
   - Stock management – stock are typically excluded during watering projects and for specified period after surface waters have dried, by agreement with landholders, to maximise ecological response;
   - Management plans – desirable but not essential;
   - Long-term management aims of site.

iii. Landholder Interest / Community Values:
   - Landholders are to be supportive of the watering activities and permission granted for watering to proceed;
   - Aim to develop a collaborative approach with landholders, in particular private landholders, to provide a sense of ownership to the watering projects;
   - Significance of wetland to the local community.

iv. Logistics / Feasibility:
   - Approvals – includes required licences and/or work approvals from relevant state authority(ies);
   - Preparatory works;
   - Feasibility – water delivery method, distance from main water source and infrastructure required;
   - Cost effectiveness.

2.0 Summary of AEW Use in 2009/2010

In 2009/10 a total of 28,828.1 ML of environmental water was available for use in the NSW Murray Valley. General security allocations peaked at 27% (01/04/10) which resulted in 18,145 ML available in the AEW conveyance licence. High security allocations peaked at 97% (01/04/10) equating to 1,966.2 ML available in the AEW high security licence (Figure 1).

Carry-over volumes equalled 960.8 ML[1] of AEW. In addition to these volumes DECCW managed 7,745 ML of Commonwealth Environmental Water Holdings (CEWH) and 11.1 ML of donated water, both of which were transferred onto the AEW conveyance licence (Figure 1, Table 2).

Throughout the 2009/10 season the Murray and Lower Darling Water Sharing Plan continued to be suspended.

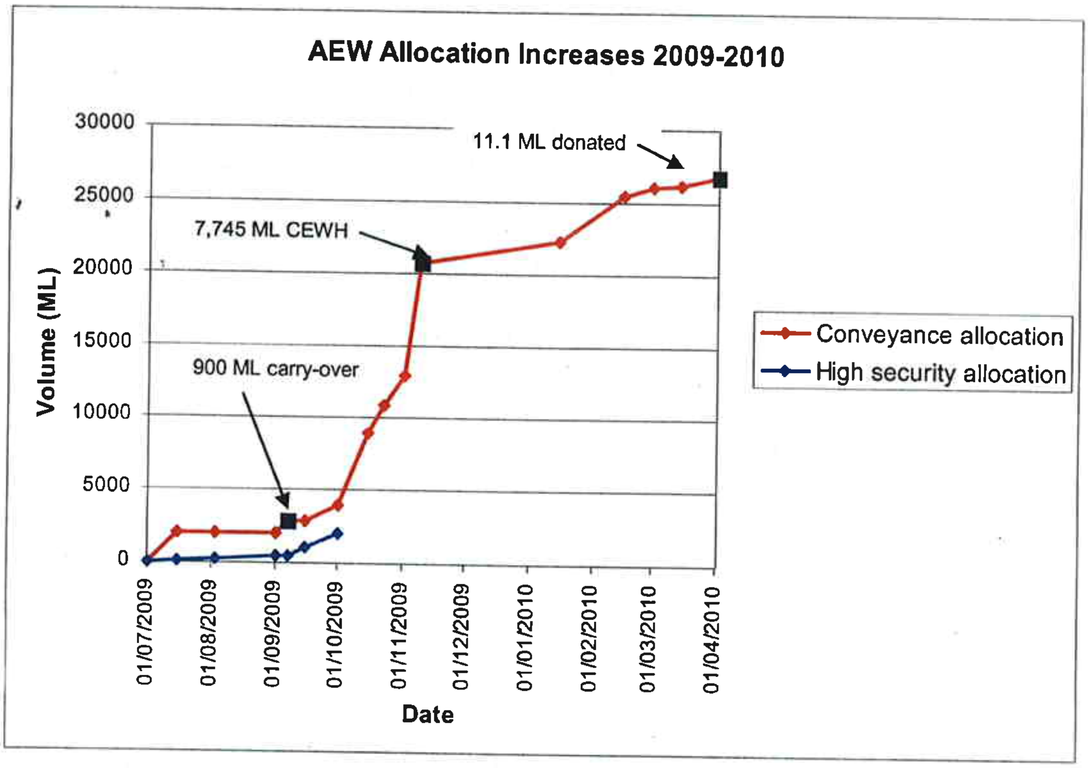


Figure 1. Allocation increases for the AEW conveyance and high security licences during the 2009/2010 season.

Table 2. Summary of environmental water allocations in the NSW Murray Valley during 2009/2010.

Water Source	Volume Available (ML)
AEW Conveyance (WAL 9422 / 50AL503537)	19,070 (includes 925 ML carry-over)
AEW High Security (WAL 9423 / 50AL503538)	2,002 (includes 35.8 ML carry-over)
CEWH (general security)	7,745
Donated water	11.1
TOTAL	**28,828.1**

[1] Due to the suspension of the Murray and Lower Darling Water Sharing Plan, carryover from 2008/2009 was allowed for both AEW licences. Carryover volumes were comprised of 925 ML (600 ML of which was directly transferred to the Wee Wee Ck and Andruco Lagoon projects) on the AEW conveyance licence, whilst the AEW high security licence carried over 35.8 ML which was transferred from a TLM licence.

Of the 28,828.1 ML of environmental water available a total of 15,561.6 ML was diverted into 56 wetlands covering approximately 1,487 Ha (Table 3). All CEWH and donated water was used, in addition to 7,816.6 ML[2] of AEW (conveyance and high security allocations). The remaining, or unallocated, 13,266.5 ML of AEW will be carried into the 2010/11 season on the AEW conveyance licence.

Monitoring of watered sites was conducted by DECCW staff, with the exception of some State Forest areas which were monitored by Forests NSW staff on behalf of DECCW. Only one site (Werai State Forest) required additional monitoring assistance from a contractor.

Overall, sites showed a positive response to the environmental water illustrated through:

- Increased foliage cover on riparian trees;
- Presence of wetland understorey species, dominated by natives;
- Presence of up to 7 different frog species, with some species recruiting, including the endangered Southern Bell Frog (*Litoria raniformis*);
- Three wetlands within the LMD region recorded the presence and recruitment of Southern Bell Frogs. It was estimated that at least 30 individuals were present at each of the three sites;
- Presence of various bird species, with some species breeding, including cormorants, grebes, ibis, ducks, swans;
- Water quality readings stayed within ANZECC guidelines for the majority of sites.

These results suggest that the objectives for the provision of environmental water had been met.

Further details on individual sites watered and monitoring results will be incorporated in the Murray Lower Darling AEW Annual Report 2009/2010 (in preparation).

[2] Includes 368 ML, used for Pollack Swamp, which was carried-over on the Bringnan Irrigation Trust's licence.

Table 3. List of Murray Valley wetlands watered during the 2009/2010 season with AEW and/or CEWH allocations.

Wetland	Location	AEW volume diverted (ML)	CEWH volume diverted (ML)	Area inundated (Ha)~	No. of landholders/ Public/Private
^Normans Lagoon	upper Murray	80		15	public
^Picanniny Lake	mid-Murray	87		13.5	1 / private
^Toupna Creek	mid - Murray	456	1,500	tbc	SF
^Boomanoomana Swamp	mid - Murray	504		68	SF
Pollack Swamp	mid - Murray	368*		158.5	SF
^St. Helena Swamp	mid - Murray	250		40	SF
Werai SF	mid - Murray	-	4,500	346	SF
Brechin	mid - Murray	150		26	1 / private
Kennaugh	mid - Murray	15		0.5	1 / private
^MIL wetlands	mid - Murray	1,517		490	17 / private
Bingara & Bungaree Cks	lower Murray	340		45	1 / private
^Wee Wee Creek	lower Murray	975	1,000	80	1 / private
Boeill Ck Floodplain	lower Murray	21	7.5	5	3 / private
^Andruco Lagoon	lower Darling	100	129	20	1 / private
^Thegoa Lagoon	lower Murray	2,045.1**		80	public
Grand Junction	lower Murray	442.5	357.5	45	1 / private
Lucerne Day	lower Murray	116		8	1 / private
Nampoo	lower Murray	220	166	15.5	1 / private
Cliffhouse	lower Murray	85	85	11	1 / private
TOTAL		**7,816.6**	**7,745**	**1,467**	

^ denotes water which was accessed from the AEW conveyance licence. All other projects used water from the AEW high security licence and/or CEWH.
* 368 ML carried-over on Bringnan Irrigation Trust's licence. ** includes 11.1 ML of donated water.

3.0 2010/2011 Adaptive Environmental Water Plan

3.1 Predicted Rainfall for 2010/2011 (May to July)

Weather conditions across the River Murray system from February to April 2010, in general, were warm and dry. In late March light to moderate rain fell, especially in the upper Murray catchments, however this made little change to the inflows (excluding Snowy River releases and Menindee Lakes inflows) which averaged 3.5 GL/day (Figure 2). Inflows during the first 9 days of June, averaged 7 GL/day, compared to a June long term average of approximately 23 GL/day (River Murray Weekly Report, MDBA, 09/06/2010).

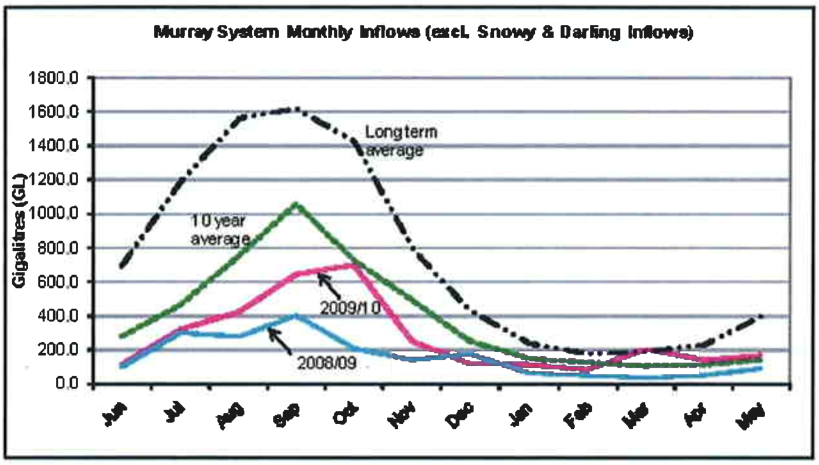


Figure 2. Monthly inflows for the River Murray system from June 2009 to May 2010 (*Source:* River Murray Weekly report, MDBA, 09-06-2010).

Rainfall predictions for June to August 2010 show that there is a 40% chance of exceeding the median rainfall along the majority of the River Murray (Australian Bureau of Meteorology website, http://bom.gov.au, June 2010) (Figure 3).

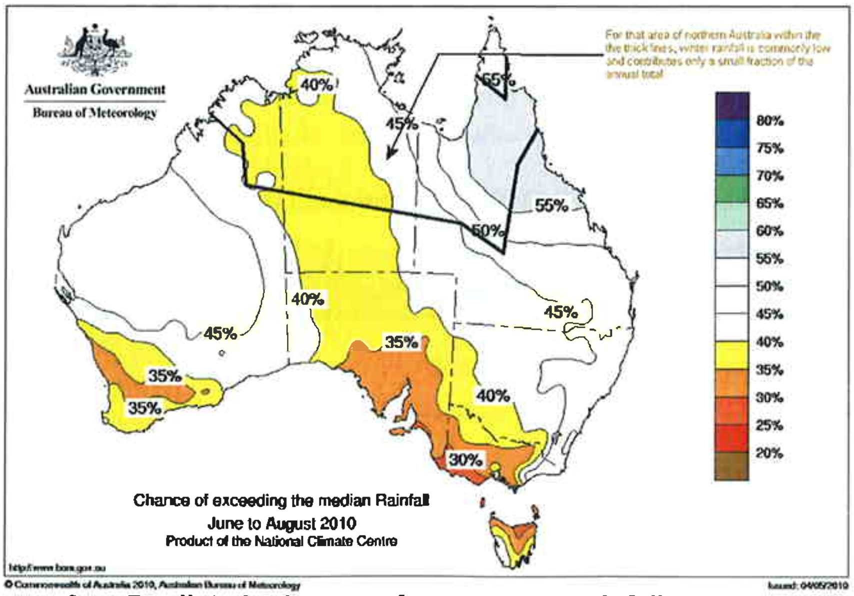


Figure 3. Predicted chance of exceeding rainfall averages across Australia for June to August 2010 (*Source:* Australian Bureau of Meteorology, http:// www.bom.gov.au 15/06/2010).

3.2 *Predicted Volumes of Environmental Water Available in the Murray Valley 2010/11*

As of the 16/06/10 storage capacities along the Murray and Lower Darling Rivers are as follows: Hume Dam had 24% storage capacity (719 GL), Dartmouth Dam had 32% capacity (1,251 GL), Menindee Lakes had approximately 86% capacity (1,494 GL) and Lake Victoria was at approximately 55% capacity (375 GL).

The NSW Office of Water (NOW) has released predictions of achieving differing percentages for high and general security allocations in the NSW Murray Valley by 1 July and 1 October, 2010 (Table 4; Critical water planning for the Murray Valley and Lower Darling, NOW, Issue 34).

Table 4. Chances of achieving high and general security allocations by 1 July and 1 October, 2010 in the Murray Valley.

Allocations	Probability of achieving by 1 July 2010	Probability of achieving by 1 October 2010
50% high security	1 chance in 4	19 chances in 20
97% high security	1 chance in 6	9 chances in 10
5% general security	1 chance in 10	5 chance in 6
25% general security	negligible	1 chance in 3

All critical human needs and carryover water in the NSW Murray Valley will be available on 1 July 2010. Therefore the 13,266.5 ML of AEW carried over will be available for use on 1 July 2010 (Table 5). Other sources of water which DECCW could potentially facilitate the management of include: a portion of CEWH (on behalf of DEWHA) and the NSW Murray Adaptive Environment Allocation (Murray AEA) – details on volumes available and sites for use are still to be confirmed.

The NSW Office of Water has indicated that it is unlikely that the Murray and Lower Darling Water Sharing Plan (WSP) will recommence in the immediate future. The WSP will remain suspended until such time that sufficient water is available for full urban, stock and domestic and high security use through the worst drought conditions over a two year period (Critical water planning for the Murray Valley and Lower Darling, NOW, Issue 34).

Table 5. Summary of adaptive environmental water availability in the Murray Valley as of 10/05/10.

Account	Maximum Capacity (ML)	Available Volume as of 01/07/10 (ML)
Conveyance (WAL 9422 / 50AL503537)	30,000	13,266.5 (carryover)
High security (WAL 9423 / 50AL503538)	2,027	Currently unknown
Barmah-Millewa Forest Allocation	700,000	37,000 (available, VIC) (94,000 - loaned VIC 181,000 - loaned NSW)

The Commonwealth Environmental Water Holder (CEWH) currently has holdings equal to 203.3 ML of high security and 161,349 ML of general security from NSW. A portion of this volume is likely to be available for use within the NSW Murray Valley during the 2010-2011 season.

The combination of below average to average rainfall experienced across the Murray Valley from February to May 2010, a prediction of below average rainfall for June to August and the likelihood of achieving 5% general security being a 1 in 10 chance, it is therefore anticipated that the 2010/2011 season will commence under 'Dry' conditions. However due to the availability of carryover volumes this will provide a good starting point for the commencement of the 2010/2011 watering season.

3.3 Wetland Site Identification and Prioritisation

A total of 41 wetland sites along the Murray Valley have been identified and prioritised to receive AEW during the 2010/11 season (Appendix 1).

To assist with AEW planning and prioritising of use, three condition scenarios i.e. Dry, Moderate and Wet have been used. These are defined in Table 6.

Table 6. Condition scenarios used to assist with prioritising of wetland sites.

Condition Scenario	AEW volume available (ML)	General Security availability (%)[3]
Dry	0 – 10,000	0
Moderate	10,001 – 25,000	0- 75
Wet	25,001 – 32,027	>75

Sites have been listed into the three scenarios based primarily on ecological needs. However other aspects such as logistical ease, approvals in place, works required etc. have also been used in prioritising.

It should be noted that due to the unpredictable nature of water allocations there is a need for a flexible and adaptive approach for watering of the wetlands. The order in which wetlands have been listed in the Plan is to be used as a guide rather than being rigidly adhered to.

[3] When the Murray and Lower Darling Water Sharing Plan is in operation, general security allocation availability has a bearing on the volume of AEW available in the conveyance licence i.e. when general security is 1% a total of 15.12 GL of AEW is available. Availability is scaled until the full 30,000 ML is reached at 100% general security.

A. **Dry Scenario (< 10,000 ML of AEW available)**

Under the Dry Scenario thirteen sites (see Appendix 1 for site information) have been given priority for environmental watering and include:

- Wee Wee Creek
- Bingara and Bungaree Creeks
- Grand Junction
- Speewa Creek
- Bengallow Creek
- Brechin
- Billa Downs
- Koondrook-Perricoota State Forest sites - Horseshoe Lagoon, Swan Lagoon, Blackbox Lagoon, 390 Mile Lagoon, Thule Creek and Unnamed Creek (near Clarkes Lagoon Road junction).

Reason:

The use of AEW for the above listed sites will fulfil all five of the AEW Objectives (see Section 1.1). All of these sites are dominated by River Red Gums which have dramatically declined in condition due to the severe drought conditions experienced over the past decade. Consequently their condition is considered to range from critical to poor.

All sites, with exception of Speewa Creek, Bengallow Creek system and the Koondrook-Perricoota State Forest sites received some environmental water in 2009/2010 and therefore have the required approvals in place. To maximise on the biological response observed to-date it is recommended that these sites receive a follow-up watering in 2010/2011. It is recommended that these projects not start until mid-late August to be in keeping with natural flooding times and therefore maximise on the capacity of faunal and floral responses.

Speewa Creek, located ~ 30 Km north of Swan Hill, is a 15 km creek line that connects with the Murray River. The creek is fringed by River Red Gums which are showing signs of stress due to the lack of flooding within the creek since 2001. The vegetation is considered to be in a poor to moderate condition and would benefit from an environmental watering. The project would be looking to inundate 10 Km of the creek and traverses over 5 properties. The local landholders are very supportive of the proposal, and are willing to provide in-kind contributions by managing the delivery of the AEW using their private pumping infrastructure as well as conduct required preparatory works. It is recommended that once works are completed and if required volumes (1,000 ML) are available that the project be conducted in mid-late August.

Bengallow Creek, located ~ 30 km north of Euston, is an extensive network of creeks, floodrunners and oxbow wetlands that cover approximately 100 km. The creek is part of the soon to be formed Kemendoc National Park and is of significant importance to a number of protected and threatened flora and fauna species, including the Regent Parrot (*Polytelis anthopeplus*. The importance of this system to local fish populations is currently unknown and poorly documented. Many of the deep-waterholes throughout the system are considered near to permanent by local landholders. The system received environmental water in 2005 as part of the 'Red Gum Rescue Project' conducted by the then NSW Department of Natural Resources. However since then, due to low river flows and water allocations the system has not been inundated since. It is therefore recommended that appropriate watering approvals be sought and the site be given a high priority for watering in the 2010/2011 season.

Billa Downs is located south-west of the Euston Lakes. River Red Gums dominate the vegetation of two wetlands that cover ~ 50 Ha. The condition of the vegetation is considered to in poor health due to the lack of over bank flooding since 1995. All approvals are in place to enable the pumping of an AEW allocation into the wetland. The landholder is strongly supportive of the project. It is recommended that if the appropriate volume (600 ML) of AEW is available that the project be conducted.

The Koondrook-Perricoota State Forest sites are semi-permanent wetlands that are dominated by River Red Gums. For the lagoons (Horseshoe, Blackbox, Swan and 390 Mile) the objective of the watering is to maintain basic wetland function and improve the ecological health of approximately 80% of the floodplain and wetland. For Thule and Unnamed Creek the objective is to avoid irretrievable loss of key environmental assets within the forest and improve the condition of up to 30% of River Red Gums and 80% of the floodplain and wetlands. These sites have also been listed to receive TLM allocations in 2010/2011 under the TLM Environmental Watering Plan, approved by the Murray Darling Basin Ministerial Council. The listing in the AEW Plan is to ensure that these sites receive some environmental allocation if TLM process has insufficient volumes of water.

B. <u>Moderate Scenario (10,000 – 25,000 ML of AEW available)</u>

Under the Moderate Scenario (includes dry/moderate) 29 wetland assets have been given priority for environmental watering (see Appendix 1 for site information). The sites include:

- MIL wetlands*
- Werai Forest *
- Thegoa Lagoon *
- Boomanoomana *
- Boeill Creek Floodplain *
- Lucerne Day *
- Hooper
- Billamein
- Hume to Yarrawonga*
- Duck Lagoon (via Warrick Creek)
- Toupna Creek *
- Walthours Swamp / Deadwood *
- Douglas Swamp *
- St. Helena Swamp *
- Black Swamp
- Clay Island
- Cars, Cappitts and Bunberoo Creeks
- Billa Downs
- Maine Creek
- Norman's Lagoon
- Banyena
- Lower Wakool wetlands
- Puckawidgee
- Koondrook-Perricoota State Forest sites (see Dry Conditions scenario)

* indicates sites which received an environmental allocation and/or regulated water in 2009/2010.

<u>Reason:</u>
Sites listed under the 'Moderate Conditions' scenario range in condition from poor to moderate and in some instances require larger volumes of water or higher regulated river flow rates to be conducted.

Eleven of the above listed sites (indicated by *) received an environmental allocation and/or regulated water in 2009/2010 and therefore have appropriate approvals in place. As for the Dry scenario sites, it is recommended that follow-up watering events be conducted in 2010/2011 to maximise on the biological response of the wetlands.

Collectively, the sites will fulfil all five AEW Objectives. Some sites are known to be important breeding and/or foraging habitat for threatened and vulnerable fauna species (Appendix 1, Watering Objective column for more information) including the Bush Stone-Curlew (*Burhinus grallarius)* Southern Pygmy Perch (*Nannoperca australis*), Southern Bell Frog (*Litoria raniformis*) and Brolga (*Grus rubicundus*).

Murray Irrigation Limited (MIL) Wetlands is a project which was postponed from 2005 until late 2009/2010 due to insufficient volumes of AEW being available. Only a small number of sites (19) were watered artificially during the 2009/2010 season. All wetlands are located on private properties distributed over the MIL Area of Operation. The dominant vegetation communities are Black Box, Lignum and River Red Gum. The wetlands provide critical habitat for a wide variety of flora and fauna species including threatened and vulnerable species such as Bush Stone-Curlews and Brolgas (respectively). The project is strongly supported by landholders, many of which have expressed their interest to participate in the 2010/2011 season. Due to past successes, the project has been recognised as one of Australasia's Top 25 Ecological Restoration Projects by the Global Restoration Network. It is anticipated that 30+ sites could be watered during the 2010/2011 season. The project is a resource and cost-effective way of watering a large number of sites simultaneously. It is recommended that this project be conducted if the required volume of water (~6,000 ML) is available and appropriate triggers are met.

Werai Forest received an environmental allocation (CEWH) of 4,500ML in 2009/2010 and inundated 360 Ha. The forest is part of the Ramsar-listed Central Murray Forests and is dominated by River Red Gum. Remnant stands of *Phragmites* are also present which provide important habitat for a variety of species. The watering in 2009/2010 initiated the growth of many native wetland plant species, the breeding of a number of bird, fish and frog species, improved the condition of River Red Gums (which were in the vicinity of the watering) and attracted a number of waterbirds to the forest (Webster, 2010). It is therefore recommended that this project be repeated in 2010/2011 if the required volume of water (5,000 ML) is available and appropriate triggers are met to maximise on the biological response recorded during the 2009/2010 watering event.

Between Hume to Yarrawonga on the Murray River there are approximately 771 wetlands. With a flow rate of 25,000 ML/day up to 62% of mapped wetland area (244 wetlands) in this reach can be inundated. Due to low rainfall and river flows, such flow rates have not been possible resulting in a large number of wetlands not being inundated since March 2006. Consequently the vegetation communities within these wetlands are showing signs of drought stress. The Hume to Yarrawonga project looks at piggy-backing onto higher regulated flows to enable the watering of lower benched wetlands within the reach. In 2009/2010 flows peaked at 15,400 ML/day at Doctor's Point resulting in approximately 170 wetlands (with commence-to-flow levels of less than 15,000 ML/day) being inundated. The ability to piggy-back onto higher regulated flows makes this a resource and cost-effective approach to watering a large number of wetlands. The use of AEW (6,000+ ML) would be to cover additional river losses if peaked releases are varied and last for 3-4 days. It is therefore recommended that this project be conducted if the likelihood of getting regulated flows of 18,000 – 25,000 ML/day is small, if appropriate triggers are met and the required volumes of water (6,000+ ML) are available.

Fifteen of the former State Forest sites listed (Duck Lagoon, Toupna Creek, Walthours Swamp/Deadwood, Douglas Swamp, St. Helena Swamp, Black Swamp, Clay Island and

Koondrook-Perricoota sites) have also been listed to receive TLM allocations in 2010/2011 under the TLM Environmental Watering Plan. If sufficient volumes are available the following sites should be watered and managed as one unit to maximise on ecological responses: Toupna Creek, Walthours Swamp/Deadwood and Douglas Swamp. If sufficient volumes are available the allocations for the Koondrook-Perricoota sites will be increased on the Dry Scenario volumes.

Maine Creek is an ephemeral, narrow flood runner creek system located ~ 20 Km west of the Murrumbidgee and Murray Rivers junction. The system includes examples of healthy mature River Red Gums as well as Black Box and Lignum country. Approximately a third of this system is drought stressed from lack of over bank flows. The system was last flooded in 1993, with several deeper remnant pools drying up 3 - 5 years ago. There is approximately ~40 Ha or ~15 Km of wetlands that would greatly benefit from an AEW allocation. The significance of this system to local fish populations is poorly documented but is thought to be a site of importance acting as a corridor for populations between the Murrumbidgee and Murray systems during times of flood flows. Approvals would be required to pump into the system. The project has strong landholder support. It is recommended that the project be considered once approvals are in place and the required volume (500 ML) is available.

Norman's Lagoon, located near Albury is a permanent to semi-permanent wetland which typically receives higher regulated flows. Due to low rainfall and low river flows, limited water volumes have entered the wetland since 2006. The wetland supports a community of Watershield (*Brasenia schreberi*) a native wetland plant that is listed as threatened in NSW. Historically the site also supported populations of Southern Pygmy Perch and Flatheaded Galaxia (*Galaxias rostratus*); however recent fish sampling (January 2010 – April, 2010) did not record either of these species (L. Beesley. *pers comms*.). The site received 80 ML of AEW in 2009/2010 and should be considered to receive an environmental allocation (~ 80 ML) in 2010/2011, via pumping, to maintain appropriate conditions to support the Watershield population if higher regulated flows are unlikely and/or the Hume to Yarrawonga project cannot be conducted.

Lower Wakool wetlands have been not been inundated for a number of years and as a consequence their vegetation communities are showing signs of stress. However, prior to a final decision being made on which wetlands should receive an allocation of AEW (if any) a field-based risk assessment is required, in particular to consider logistical information (what wetlands can be watered under different flow scenarios), the occurrence of high salinities within the Wakool River, and the presence of Acid Sulphate Soils (ASS) in some areas. Watering of wetlands with AEW should not occur during periods of high salinity (>1,500 EC) within the Wakool River or where ASS are detected.

C. <u>Wet Scenario (> 25,000 ML of AEW available)</u>

Under the Wet Scenario (includes moderate/wet) thirteen sites (see Appendix 1 for site information) have been given priority for environmental watering and include:

- Pollacks Swamp
- Kennaugh
- Boeill Creek Lands Reserve
- Lake Victoria Station
- Murray Eden
- Wanganella
- Cliffhouse
- Koondrook-Perricoota State Forest sites (see Dry Conditions scenario)

Pollack Swamp is part of the Koondrook State Forest and is dominated by River Red Gums (RRG). The wetland received environmental water in 2008/09 and 2009/2010 to improve fringing vegetation but to also drown out RRG regeneration which has grown in open-water areas during dry periods. Historically the site was a pied cormorant breeding area, the encroachment of RRG into the open-water areas will discourage pied cormorants from using this site for breeding in the future. If sufficient volumes of water are available this site should be allocated 1,500 ML to help drown out the RRG regeneration and restore open-water habitat.

In the 2008/09 the Kennaugh wetland supported a pair of breeding Brolgas that successfully fledged their chick. Water was provided in 2009/2010 for the Brolgas, however they failed to breed. It is recommended that if the Brolgas are present during the early part of the 2010/2011 season, an allocation (~20 ML) should be made available for the wetland.

The Boeill Creek Lands Reserve and Lake Victoria Station wetland are two sites within the Lower Murray Darling catchment. Both sites support lignum communities which are in very poor condition due to lack of flooding for more than 10 - 15 years. If sufficient volumes of AEW are available (~ 400 ML) it is recommended that these sites receive an allocation of AEW to help improve the condition of the lignum communities. It should be noted, however, that it is uncertain as to how well these communities will respond to a watering.

The Murray Eden wetland, a RRG dominated floodrunner, was listed to receive AEW in 2006, however because of limited water resource availability, the watering of this site has been postponed. This site has not been watered since the 1990's. The floodrunner traverses at least two properties. It would therefore be preferable to water the entire system rather than isolated sections of the wetland. The RRG are considered to be in moderate to good condition, but would benefit from a watering to prevent a decline in the community and maintain the integrity of the wetland.

Wanganella Swamp, located near Deniliquin, is a site of national importance as listed in the Directory of Important Wetlands of Australia. It is a known breeding site for various species of ibis as well as other wetland bird species such as the NSW vulnerable listed Brolga and Australasian Bittern (*Botaurus poiciloptilus*) and migratory species such as Latham's Snipe (*Gallinago hardwickii*) and Sharp-tailed Sandpipers (*Calidris acuminata*). The wetland is connected to the Forest Creek system which receives water from both the Murray and Murrumbidgee Rivers. The site was last watered in 2005. It is recommended that the site be watered if sufficient volumes of AEW are available (2,200 ML).

The two Cliffhouse wetlands support Southern Bell Frog (SBF) populations. The wetlands, combined with the Murray River, provide a larger scale habitat and connectivity for the SBF's to move across the landscape. These sites have been watered in 2005/2006, 2008/09 and 2009/2010. Wetland plant species have responded strongly in the past two watering events, with new species being recorded in 2009/2010. The Cliffhouse wetlands would benefit from a follow-up watering to ensure the replenishment of the seedbank.

If sufficient volumes are available the allocations for the Koondrook-Perricoota sites will be increased on the Moderate Scenario volumes.

3.4 Supplementary Water, Contingency Allocations and Unallocated Volumes

NSW Office of Water (NOW) is responsible for declaring supplementary access within the Murray Valley. As required under the Water Sharing Plan (WSP) NOW is to consider wetland/ecological needs prior to the declaration of supplementary access, in the event of this occurring NOW could use this Plan to help guide their decision-making process. Other wetlands that are not listed in the Plan should be assessed using the same selection criteria (see Section 1.2) as used for listed sites.

In the event that a bird (or other fauna species) breeding event is triggered, consideration for the provision of AEW and/or additional AEW should be made to ensure that the breeding event is successfully completed.

If in the event that there are unallocated volumes of AEW, considerations for the management of the water should include:

- potential use in complimenting other watering events, including events not considered in this Plan, and /or
- trading on the temporary water market to generate funds that can support future implementation and on-ground delivery of environmental watering projects.

4.0 Risk and Mitigating Strategies

Using the Risk Assessment matrix (see Appendix 2) a number of risks have been identified in association with the proposed management of AEW (Table 7). Responses on how best to manage the potential risk have also been listed.

Table 7. Identified risks associated with the management of AEW.

Risk	Rating	Response
Unpredictable weather – turns drier than expected.	High (likely & major)	Review asset condition and future priorities for watering. Consult with EWAG.
Unpredictable weather – turns wetter than expected.	Medium (unlikely & major)	Additional wetting options possible – continually assess volumes available. Consult with EWAG.
Unpredictable weather – turns hotter than expected early.	High (likely & major)	Review timing for watering. Consult with EWAG.
Flow management is uncoordinated	Medium (possible & moderate)	Early communication with State Water and River Murray Water.
Water use and works approvals not in place and/or linked to licences.	High (possible & major)	Confirm status with NOW and SWC. Seek discretionary one-off approval if necessary.
Estimated allocation volumes are substantially wrong.	Medium (unlikely & moderate)	Monitor flow delivery and area of inundation closely. Seek adjustments; revise targets for future attempts
Unforeseen physical impediments to flow delivery e.g. low river levels which prohibit pumping activities.	Medium (rare & major)	Early communication with River Murray Water (RMW), Landholders and State Water, where appropriate. Alert NOW if illegal obstructions identified.

Insufficient water available to complete colonial waterbird breeding, if initiated.	Medium (unlikely & severe)	Liaise with DEWHA for possibility of acquiring additional water. Liaise with RMW and State Water to look at flow delivery options.
Water delivery infrastructure (i.e. pump or regulator) faulty or not adequate.	Medium (possible & moderate)	Liaise with contractor, landholder to resolve issue.
Poor water quality in the main water source (e.g. high salinities, black water, low dissolved oxygen etc.) or from wetlands flowing back into main creeks/rivers.	High (possible & major)	Monitor water quality closely.
Poor water quality threatening aquatic fauna.	High (possible & major)	Liaise with NSW I & I in relation to timing of water delivery and cooperation on monitoring response.

5.0 Monitoring

All wetland sites will have some level of monitoring conducted. Some sites will have more intensive monitoring determined by the site's watering objectives. The majority of monitoring will be conducted by DECCW project officers. In National Park and Indigenous Protected Areas monitoring responsibilities will be shared with NSW Parks and Wildlife staff (where possible). The services of contractors may be engaged for larger-scaled projects eg: Werai Forest and/or where DECCW staff resources are limited.

Methods used are consistent with Natural Resource Council (NRC) and state-wide standards. The ecological and environmental monitoring that will be conducted at each site is listed in Table 8.

Table 8. Proposed monitoring for identified sites.

	Wetland Site	Ecological monitoring	Environmental monitoring
1	• MIL • Boeill Ck Floodplain • Hoopers • Billamein • Duck Lagoon • St.Helena Swamp • Black Swamp • Clay Island • Puckawidgee • Pollacks Swamp • Normans Lagoon • Murray Eden	• Understorey vegetation response • River Red Gum /Black Box/Lignum response	• Volume of AEW delivered (ML) • Timing of water delivery (days) • Duration of inundation (days) • Area and extent of inundation mapped using GIS (Ha) • Photo-points
2	• Wee Wee Creek • Lucerne Day • Brechin • Bingara & Bungaree Cks • Grand Junction • Speewa Ck • Bengallow Ck system • Billa Downs • Maine Creek • Banyandah • Boeill Ck Lands Reserve • Lake Victoria Station • Cliffhouse	• As above (1) • Frog diversity	• As above (1)
3	• Thegoa Lagoon	• As above (2) • Birds^ • *Typha* mapping	• As above (1) • Water Quality • Groundwater
4	• Boomanoomana • Kennaugh	• As above (1) • Brolgas	• As above (1)
5	• Lower Wakool wetlands	• As above (1)	• As above (1) • Water Quality
6	• Werai Forest	• As above (2) • Birds* • Fish#	• As above (1) • Area of inundation mapping – via satellite imagery/ground truthing* • Water Quality
7	• Walthours Swamp/Deadwood • Douglas Swamp • Carrs, Cappitts, Bunberoo Cks • Koondrook Perricoota State Forests sites	• As above (1)	• As above (6)
8	• Toupna Ck	• As above (1) • Fish*	• As above (6)
9	• Wanganella	• As above (1) • Birds*	• As above (6)

^ monitoring by Sunraysia Bird Observers (volunteers)
# potential monitoring partnership with Murray CMA
* monitoring to be contracted out

Fish maybe monitored at other sites where specific benefits are targeted or risks are evident. For such projects DECCW would liaise with and seek cooperation from NSW I & I in relation to any watering specifically targeted for fish and conduct appropriate monitoring.

6.0 Approvals, Access Licences and Associated Works

All wetland sites require appropriate approvals and licences to be in place prior to the watering event commencing. Water use and work approvals are granted by the NSW Office of Water (NOW). Table 9 shows which listed sites have approvals in place and which require approvals to be sought.

Preparatory works required to compliment the environmental watering in some instances also require permits and/or approvals which are sought from NOW (Table 9).

Table 9. Approvals status for identified wetland sites.

Wetland Asset	Work & Use Approvals in place.
• Wee Wee Ck • Grand Junction • Brechin • Thegoa Lagoon • Boeill Ck Floodplain • Lucerne Day • Cliffhouse • Billa Downs	Yes (10 year approval)
• Bingara & Bungaree Cks • Speewa Ck • Werai Forest • Boomanoomana • Duck Lagoon • Toupna Ck • Walthours Swamp/Deadwood • Douglas Swamp • St. Helena Swamp • Black Swamp • Clay Island • Pollacks Swamp • Kennaugh	Yes
• MIL • Hume to Yarrawonga	None required
• Carrs, Capitts, Bunberoo • Lower Wakool wetlands • Koondrook-Perricoota SF sites	Unsure – need clarification

• Bengallow Ck system • Hooper • Billamein • Banyandah • Puckawidgee • Normans Lagoon • Boeill Ck Lands Reserve • Lake Victoria Station • Murray Eden • Wanganella Swamp • Maine Creek	No – to be sought

7.0 Reporting

Reporting to:

- Director, Waters, Wetlands and Coast, DECCW – monthly update on conditions (climate, available environmental water) and weekly update during flow delivery events.

This plan is to be **revised** when conditions dictate. Good communication with MLD EWAG, State Water, NOW, Forests NSW and landholders will help clarify the timing and scale of revision.

Prepared by: Paula D'Santos
Position: Senior Wetlands and Rivers Conservation Officer, Waters, Wetlands and Coast Division
Date: 13 July, 2010

Approved by: Derek Rutherford

Position: Director, Waters, Wetlands and Coast

Sign:

Date: 13/7/10

Appendix 1: List of identified and prioritised wetland sites for the Murray Valley 2010 – 2011.

Refer to attached spreadsheet.

Appendix 2: Risk assessment matrix (adopted from Environmental Water Management Manual 2009-2010, DECCW).

Risk is a measure of the likelihood that some external factor will reduce the ability to achieve a desired outcome. In natural resource management risk can be associated with, for example, biophysical, socio-economic, institutional, technical, financial, temporal and cultural factors. Risks associated with occupational health and safety need also be considered at the appropriate time (as part of operational planning for flow delivery).

Impacts are the positive and negative consequences of management actions and may be environmental, economic, social and/or cultural.

It is important to assess risk properly and manage it appropriately. High risk does not necessarily preclude an action but rather dictates the need for a management strategy and appropriately focused monitoring and evaluation.

Possible steps to achieve this outcome include:

- Determine key environmental, economic, social, cultural and institutional risk
- Assess all risks on the basis of potential scale, probability, severity and frequency of identified impacts
- Develop prevention and management strategies for risks of all types commensurate with the significance of investment
- Be aware of all potential impacts and manage or mitigate their effects
- Regularly review risk management strategies and update when necessary
- Incorporate the consideration of risks and impacts and any relevant management strategies into monitoring and evaluation activities.

POSSIBLE APPROACH

The following standard risk assessment matrix could be used to produce a risk rating for each risk, summarised in a table (e.g. below).

		LIKELIHOOD				
		Rare	**Unlikely**	**Possible**	**Likely**	**Almost certain**
CONSEQUENCE	**Severe**	Medium	High	High	V High	V High
	Major	Medium	Medium	High	High	V High
	Moderate	Low	Medium	Medium	High	High
	Minor	Low	Low	Medium	Medium	High
	Negligible	Low	Low	Medium	Medium	High

Where:

Risk level	***Response***
Very high risk	*Emergency action necessary. Very high risks have the potential to stop the programme or project.*
High risk	*Immediate action necessary.*
Medium risk	*Action necessary as soon as practicable.*
Low risk	*Business as usual. No need to take action to address / manage / mitigate these risks.*

Environmental Watering Plan for the Macquarie Valley 2011/12

Environmental water releases in 2010/11

There were several episodic environmental water releases in 2010/11 managed in conjunction with significant tributary flows and flood mitigation releases from Burrendong Dam which resulted in extensive flooding in the Macquarie Marshes, the middle and lower reaches of the Macquarie River and associated effluent creek systems. At the commencement of the water year there was no water available in the environmental account. A total of 100% Available Water Determination (AWD) was made between July 26th and October 17th and accounts were reset to 100% when all carryover was spilled from storage on the 1st November, providing 265,157 megalitres of environmental account water; made up of 160,000 ML of environmental water allowance (EWA) and 47,766 ML of NSW adaptive environmental water (AEW) and 57,391 ML of Commonwealth Environmental Water Holdings.

	AWD (%)	carryover	EWA	Usage	EWA account	AEW	AEW usage	AEW account	CEWH	CEWH usaage	CEWH account
Jul-10	6	0	9,600	0	9,600	2,866	0	2,866	3,443	0	3,443
Aug-10	41		65,600	0	75,200	19,584	0	22,450	23,530	0	26,974
Sep-10	100		84,800	2,200	157,800	25,316	0	47,766	30,417	0	57,391
Oct-10	0		0	58,176	99,624	0	0	47,766	0	0	57,391
Nov-10	reset		60,374	0	159,998	0	0	47,766	0	0	57,391
Dec-10	0		0	0	159,998	0	0	47,766	0	0	57,391
Jan-11	0		0	0	159,998	0	0	47,766	0	0	57,391
Feb-11	0		0	78,725	81,273	0	20,665	27,101	0	0	57,391
Mar-11	0		0	0	81,273	0	11,205	15,896	0	21,920	35,471
Apr-11	0		0	0	81,273	0	0	15,896	0	3,080	32,391
May-11	0		0	0	81,273	0	0	15,896	0	0	32,391
Jun-11	0		0	0	81,273	0	0	15,896	0	0	32,391
total	**100**	**0**	**160,000**	**139,101**		**47,766**	**31,870**		**57,391**	**25,000**	

Total environmental water usage in the Macquarie in 2010/11 was 195,971 ML made up of 25,000 ML from the CEWH; 31,870 ML from NSW AEW accounts and 139,101 ML from EWA (60,376 ML of which was re-credited to the account following spillage of carryover account water from Burrendong Dam).

Total inflows to the Macquarie Marshes during the year totalled in excess of 951,000 ML with the bulk of water supplied from tributary flows and flood mitigation zone releases. The total inflow makes it the third highest inflow year recorded since river gauging commenced at Marebone in 1980.

Current condition of water dependent assets

Asset areas[∞]	Area of SPW[1] (ha)	% of SPW wet in Oct	% of SPW wet in Jan	Last watering[2]	Condition[3]
South Macquarie	4846	28	86	March 2011	Riparian vegetation in this zone is generally in good condition. There are large areas of floodplain vegetation in very poor condition, which appears to be related to flood protection works associated with cultivation in some areas, this is evident from the relatively low percentage of semi-permanent wetland (SPW) vegetation flooded in January, despite significant flood flows.
Bulgeraga Floodplain	2683	43	97	March 2011	Woody vegetation in this zone is generally restricted to the riparian zone. There is an area of floodplain woodland in the middle reaches of the zone that is in moderate to good condition. Approximately half of this area of SPW, largely red gum, was flooded from October, while the remainder was flooded through December and January.
The Jungle & Back Swamp	5447	21	96	March 2011	The woody vegetation in this zone is in quite good condition with only small patches of stressed vegetation, possibly related to flood protection works associated with cultivated areas. Approximately one-fifth of this area of SPW, largely red gum, was flooded from October, while the remainder was flooded through December and January.
Old Macquarie	446	48	59	March 2011	Riparian vegetation retains some vigour; floodplain vegetation is in very poor condition with a majority of dead trees. Approximately

[∞] see map at Appendix A for location of asset areas
[1] Semi-Permanent Wetland area - Based on vegetation mapped in 2008: includes water couch, mixed marsh, common reed, cumbungi and river red gum.
[2] Estimated from on-ground and aerial observation, final mapping should confirm.
[3] These descriptions are based on 2008/2009 vegetation mapping and provide a comparison with mapping from 1991.

					half the SPW (mostly red gum) in this area was flooded for a substantial period through October-January. Substantial areas adjacent and downstream of the Breakaway were flooded extensively from October-January, these areas no longer support semi-permanent wetland species and are generally mapped as chenopod shrub land though there appears to have been some re-establishment of SPW species where flooding persisted for several months.
Central Southern Nature Reserve	58	72	95	March 2011	The central section of the NR was mapped as being heavily impacted by invasive chenopod species in 2008. Remaining SPW species included riparian red gum and remnant reed areas. This asset area includes the lagoon systems of the south marsh, which were also completely infested with black roly poly. The majority of the area received good flooding in 2010/11 from early Spring through to late summer. SPW responded very well, with observed increases in the area of phragmites and positive signs of change in the lagoon systems, with roly poly removed and modest areas of aquatic plant establishment including areas of water couch, cumbungi and mixed marsh species. Lagoon areas were particularly noted for their high degree of productivity as frog habitat in 2010/11 and were also well used as waterbird foraging areas.
North Marsh	14,931	85	99	May 2011	The condition of the north marsh varies from very good in wetter areas of reed and red gum woodland to large areas of dead red gum woodland and locally extinct reed bed in the driest areas. Large areas of the northern reserve have been mapped as being impacted by chenopod invasion in 2008. A large percentage of the north marsh asset area was flooded in 2010/11 for an extended period. The main reed bed has recovered from the wildfire that completely burned through it in December 2009. Aerial observation during 2010/11 indicates a degree of recovery in canopy densities in all parts of the red gum woodland except those areas where dead trees are dominant. The understorey also appears to have benefited from prolonged flooding with areas of rolypoly diminished. The area supported two very large egret colonies and several smaller egret and ibis colonies during 2010/11.

Gum Cowal & Terrigal	6482	33	100	May 2011	Extensive areas of couch have been replaced by chenopod dominated grasslands. The red gum forest and woodland appears to be in good condition, though 2008 mapping shows chenopods in the understorey. This area was extensively flooded in 2010/11 through spring and summer and provided valuable foraging habitat for frog recruitment and waterbird foraging. Observations indicated a strong response in water couch and mixed marsh species and an improvement in canopy density in river red gum. The system supported several good sized egret colonies and small ibis colonies in 2010/11.
Monkey Swamp*	2132	74	97	April 2011	There has been a critical reduction in the extent and condition of water couch and common reed in this asset area according to mapping in 2008. Large areas of remnant SPW, including red gum areas, are dominated by invading chenopods. Remnant areas of SPW benefited from prolonged spring and summer flooding in 2010/11, while areas no longer supporting semi-permanent wetland vegetation were also flooded for a substantial period. On-ground observation by OEH of this area has not been possible, however, aerial observations suggest modest potential recovery in water couch and mixed marsh species and a good improvement in red gum canopy density in most areas.
Monkeygar Wetlands	1272	89	97	May 2011	Mapping in 2008 confirmed a marked decrease in the area of common reed and a contraction of the water couch area and chenopod invasion of surrounding grasslands. Environmental water delivery in 2008 and 2009/10 improved the condition of the couch fields and reed bed. Prolonged flooding of this site has resulted in considerable expansion of reeds and cumbungi and vigorous growth (and likely expansion) of water couch and mixed marsh areas. This area supported a very large ibis colony in 2010/11 and provided important waterbird foraging areas for a broad range of waterbirds including threatened species such as freckled duck, brolga, magpie geese (including nesting sites) and shorebirds.
Mole Marsh	696	85	92	May 2011	2008 mapping indicates there has been a major reduction in the area of mixed marsh on Mole Marsh and invasion of chenopods into previously wet areas and under red gum forests. 2009/10

					watering improved the condition of couch fields and the small area of reed bed. The extensive flooding in this asset area in 2010/11 persisted from late winter into late summer and has resulted in vigorous growth (and likely expansion) of water couch, mixed marsh and reedbed areas. Flooding has also benefited red gum areas with an observable increase in canopy density. This site has also been highly productive for frogs and has supported small ibis colonies and magpie geese nesting in 2010/11, as well as providing well-used waterbird foraging habitat for a broad range of species.
Buckiinguy Swamp	1749	71	92	May 2011	2008 vegetation mapping indicated that extensive areas of water couch have been replaced by mixed marsh and chenopods, while the central reed bed has contracted in area and height. 2009/10 environmental water improved the condition (and likely expansion) of couch fields, mixed marsh and reed bed. The prolonged flooding of this asset during 2010/11 has resulted in considerable expansion of reeds and cumbungi and vigorous growth (and likely expansion) of water couch and mixed marsh areas.
Long Plain Cowal*	4141	10	100	March 2011	This asset area has undergone an extensive increase in chenopod dominance in grassland areas as well as areas previously mapped as wetland vegetation. Significant areas of red gum in this asset area were in very poor condition prior to the flooding of 2010/11. Flooding in this part of the marsh is likely to have been of the least duration. However flows within the cowal itself were observed to persist for several months. Over bank and floodplain flooding most likely persisted for 4-6 weeks.
Gunningbar Creek	Not mapped	Not assessed	All	Permanent	This asset is adversely impacted by persistent low flows. Riparian and instream areas are the main areas occupied by semi-permanent wetland-type vegetation, particularly river red gum. The channel is overgrown and choked with cumbungi and woody regrowth. Instream pools have been badly affected by sedimentation. In particular the absence of a diverse age structure within remnant riparian woodlands is of concern.
Duck Creek	Not mapped	Not assessed	all	Permanent	This asset is adversely impacted by persistent low flows. Riparian and instream areas are the main areas occupied by semi-permanent wetland-type vegetation, particularly river red gum. The

					channel has been overgrown and choked with cumbungi and woody regrowth. The recent flood has cleared cumbungi from some reaches. Instream pools have been badly affected by sedimentation. In particular the absence of a diverse age structure within remnant riparian woodlands is of concern.
Crooked Creek	Not mapped	Not assessed	All	Permanent	This asset is adversely impacted by persistent low flows. Riparian and instream areas are the main areas occupied by semi-permanent wetland-type vegetation, particularly river red gum. The channel is overgrown and choked with cumbungi and woody regrowth. The recent flood has cleared cumbungi from some reaches. Instream pools have been badly affected by sedimentation. In particular the absence of a diverse age structure within remnant riparian woodlands is of concern.
Lower Macquarie	Not mapped	Not assessed	All	June 2011	The Lower Macquarie has been adversely affected during the extended drought conditions between 2001 and 2010. This area is particularly important for connections and pathways between the Macquarie, Barwon, Castlereagh and Marthaguy. The river red gum has been reported to be in a poor condition prior to the flooding of 2010/11. In particular the absence of a diverse age structure within remnant riparian woodlands is of concern.
Marra Creek	Not mapped	Not assessed	All	March 2011	Marra Creek is in relatively good condition, without the problems of instream choking vegetation or sedimentation of the other effluent systems. The Marra serves as an important link between the Macquarie and Barwon systems and provides good refuge habitat.
Lower Crooked Creek	Not mapped	Not assessed	all	March 2011	Riparian and floodplain vegetation was assessed as being in poor condition in 2008. A substantial area (~2500 ha) of semi-permanent floodplain wetland at Talga and Half Moon was also reported to be in very poor condition as a result of reduction in flooding frequency. Riparian woodland was noted to be at significant risk due to a lack of flood flows required for germination and recruitment.

Water Management Arrangements for 2011/12

The section 60 suspension of the Water Sharing Plan (WSP) will be lifted on the 1st July 2011. On the 1st July 2011 the Minister for Water is expected to announce a 28% Available Water Determination (AWD) and 100% access to carryover water in 2011/12.

The reactivation of the WSP will mean that all environmental water can no longer be managed under the rules of the active sub-allowance. All carryover water will remain in the active account, while water made available under Available Water Determination through the 2011/12 year must be distributed between the translucent and active sub-allowances in accordance with WSP provisions and the Environmental Flows Reference Group (EFRG) recommendation on the proportional distribution between those accounts. Previous advice from the EFRG has set the distribution at 60:40 in favour of the active account; this remains unchanged for 2012/13. This distribution applies only to Planned Environmental Water; environmental water accrued to water licences held by either the State or Commonwealth Environmental Water Holder has similar characteristics to the active sub-allowance.

Volume of environmental water available

The balance of the environmental water account is 138,665 ML; made up of 118,275 ML of environmental water allowance and 20,390 ML of adaptive environmental water. The environment is entitled to a share of tributary flows in excess of that required to meet stock and domestic and town water supply requirements. The water levels in the supply dams at the beginning of July 2011 are:

Windamere = ~45% or 167,000 ML
Burrendong = ~90% or 1,100,000 ML

Account	Maximum	Available 01/07/12
Planned Environmental Water (PEW)	160,000 ML	44,800 ML (28% AWD)
Carryover of PEW	-	81,275 ML
Adaptive Environmental Water (AEW)	48,154 ML	13,483 ML (28% AWD)
Carryover of AEW	-	15,896 ML
Supplementary Access*	1,442 ML	1,442 ML

In addition to Planned Environmental Water and state-owned AEW the Commonwealth Environmental Water Holder (CEWH) will have up to 71,145 ML♦ of general security entitlement in 2011/12 as well as access to 32,391 ML from carryover accounts and 1888.4 ML in Supplementary

* Availability depends on declaration of a Supplementary event.
♦ Information on water purchases made by the Commonwealth is available from http://www.environment.gov.au/water/policy-programs/cewh/holdings.html

Access licences. Water purchased for the environment by New South Wales will be managed in conjunction with planned environmental water. NSW runs a collaborative program of environmental water management with the CEWH and it is anticipated that where the objectives of environmental watering are consistent, the State and Commonwealth will undertake joint watering activities in 2011/12. The CEWH has advised that additional holdings are expected to accrue in the short term, with up to 97 GL by July and up to approximately 100 GL by August – the following calculations are based on current CEWH holdings of 71 GL.

Likely environmental watering conditions

Estimated water availability for 2011/12

The following resource assessment scenarios provided by State Water (May assessment) are based on historical statistical inflows to Burrendong and Windamere Dams.

1. **Under drought conditions:** the 2011/12 allocation is likely to be at 28% until the end of October and remain at 28% by the end of January. With the addition of carryover, under the drought scenario a volume of 207,764 ML will be available.

		EWA		State AEW		CEWH		Carryover	TOTAL	
drought	probability	Oct	Jan	Oct	Jan	Oct	Jan	(all accounts)	Oct	Jan
[28,28]	100%	44,800	44,800	13,483	13,483	19,921	19,921	129,560	207,764	207,764

2. **Under dry conditions:** the 2011/12 allocation is likely to be at 28% until the end of October and at 28% by the end of January. With the addition of carryover, available water under the dry scenario a volume of 207,764 ML will be available.

		EWA		State AEW		CEWH		Carryover	TOTAL	
Dry	probability	Oct	Jan	Oct	Jan	Oct	Jan	(all accounts)	Oct	Jan
[28,28]	80%	44,800	44,800	13,483	13,483	19,921	19,921	129,560	207,764	207,764

3. **Under median conditions:** the 2011/12 allocation is likely to be at 53% until the end of October and at 67% by the end of January. With the addition of carryover, available water under the median scenario will increase to 277,589 ML in October and 316,690 ML in January.

		EWA		State AEW		CEWH		Carryover	TOTAL	
median	probability	Oct	Jan	Oct	Jan	Oct	Jan	(all accounts)	Oct	Jan
[53,67]	50%	84,800	107,200	25,522	32,263	37,707	47,667	129,560	277,589	316.690

4. **Under wet conditions:** the 2011/12 allocation is likely to be at 100% at the end of October and at 100% by the end of January. With the addition of carryover, available water under the wet scenario will increase to 408,859 ML in October. However, under the wet conditions forecast in this scenario it is more likely that Burrendong will spill and by the end of October all carryover is likely to have been debited from accounts, bringing account balances back to 279,299 ML.

		EWA		State AEW		CEWH		Carryover	TOTAL	
wet	probability	Oct	Jan	Oct	Jan	Oct	Jan	(all accounts)	Oct	Jan
[100,100]	20%	160,000	160,000	48,154	48,154	71,145	71,145	129,560	408,859	408,859

* * *

Conditions in the Macquarie catchment have been dry since December, while Bureau of Meteorology climate indicators forecast a 55-60% chance of accumulating higher than median rainfall during the period June-August suggesting that a dry to median scenario may be anticipated at the beginning of the new water year.

Objectives for environmental water use for 2011/12

The following table links water availability scenarios and ecological objectives with management objectives, actions and targets.

scenario[♦]	ecological objective	management objective WSP	management action[♥]	estimated wetland target[♠]	estimated in-channel target
drought [28,28] 100%	Avoid damage	maintenance of critical habitat and high frequency watering dependent semi-permanent wetland	inundation of priority, good condition semi-permanent wetland and refugia	9,000 hectares of SPW over 3 months	<1000 ML/d at Marebone Weir
dry [28,28] 80%	ensure capacity for recovery	habitat maintenance of semi-permanent wetland; small-scale recruitment of fish or waterbirds; fish dispersal	inundation of priority, good condition semi-permanent wetland and refugia; increased duration; connectivity	19,000 hectares of SPW over 3 months	1000-1500 ML/d at Marebone Weir
median [53,67] 50%	maintain ecological health and resilience	habitat maintenance of semi-permanent wetland; small-scale recruitment of fish or waterbirds; fish dispersal	inundation of priority, good and fair condition semi-permanent wetland; connectivity	20,000-30,000 hectares of SPW over 3-4 months; consider refreshment flows to non-marsh assets	1000-2000 ML/d at Marebone Weir
wet [100, 100] 20%	improve and extend healthy and resilient ecosystems	habitat maintenance of semi-permanent wetland; medium-scale recruitment of fish or waterbirds; fish dispersal	inundation of priority, good and fair condition, semi-permanent wetland; increased duration; connectivity and in-channel targets	40,000-50,000 hectares of SPW over 3-5 months; refreshment flows to non-marsh assets	2000-3000 ML/d at Marebone Weir
v.wet [100, 100] 10%	improve and extend healthy and resilient ecosystems	habitat maintenance of semi-permanent wetland; large-scale recruitment of fish or waterbirds; fish dispersal	inundation of priority, good, fair and poor condition, semi-permanent wetland; connectivity and in-channel targets	>80,000 hectares over 4-5 months; refreshment flows to non-marsh assets	2000-4500 ML/d at Marebone Weir

♦ scenario name (drought, dry etc); likely allocation at October and January respectively [x,y]; statistical probability of condition occurring

♥ good, fair and poor condition wetland is generally defined as: good quality wetland has vegetation in good condition relative to the 1990 mapping; fair quality wetland has experienced a reduction in vegetation health relative to the 1990 mapping but has not undergone major change; poor quality wetland has experienced a major change in vegetation health, type or extent relative to 1990 mapping. NB: the definition of semi-permanent wetland is given in the Water Sharing Plan as River red gum, water couch and common reed communities.

♠ Estimated areas of wetland in the given health category. These estimates are based on mapped areas of vegetation changes and the inundation frequency over 30 years. These are coarse estimates made for environmental water management purposes. Additional work will be undertaken to determine these areas with greater accuracy.

Macquarie Marshes Objectives

The Environmental Flows Reference Group (EFRG) considered the available water scenarios and climate indicators and agreed that environmental water management in the Macquarie in 2011/12 would focus on improving resilience of ecosystems and promoting recovery of degraded wetland systems, particularly focussing on up to 50,000 hectares of semi-permanent wetland vegetation, including river red gums woodlands. In addition the EFRG agreed to manage a substantial carryover to ensure water availability to sustain highly water-dependent species (such as common reed and water couch) in future years.

With an initial starting volume of 210 GL considered for planning purposes the EFRG recommends a minimum of 150GL be committed to watering in 2011/12 to target red gum areas and re-water common reed and water couch areas throughout the marshes (north, south and east) to build on the benefits accrued during the flooding and environmental watering of 2010/11. As degraded areas typically take longer to respond, the longer inundation can be maintained in degraded systems the better the ecological response. Therefore if conditions allow, the EFRG will target an event lasting at least 4 months and perhaps longer, consistent with effective use of environmental water and consideration of likely future watering requirements.

Watering in successive years appears to be a sound strategy for promoting recovery in degraded areas while maintaining and/or improving resilience of wetland areas in good condition. Therefore the EFRG recommends carrying forward sufficient water to re-water reed and couch areas in 2012/13 and 2014/15. With an initial commitment of 150 GL to red gum watering this leaves a balance of 60 GL that will be set aside for future years.

The watering for 2011/12 will be scheduled to commence in late winter (August) to build on the benefits accrued during the flooding and environmental watering of 2010/11, though the release may be brought forward should a suitable triggering event occur.

Should water availability alter markedly during the year release recommendations will be reviewed in accordance with this watering plan, however it is envisaged that the availability of increased volumes of water will generally not alter the primary management objective to improve resilience in semi-permanent wetland vegetation communities.

This scale of watering is likely to result in breeding of fish, frogs, waterbirds and colonial waterbirds. The requirements of these communities will be taken into account in the determination of specific operational parameters as conditions become known. Should it be required the EFRG will consider utilising some part of the 60GL set aside for future years, to support recruitment of dependent fauna. This requirement will be assessed adaptively during the course of the year.

The proposed watering action assumes generally dry conditions persisting through winter and spring. The emergence of wetter conditions during this period may delay or negate the need for delivery of environmental water to achieve the sought ecological outcomes for semi-permanent wetland vegetation. Under such conditions, the likelihood of large scale recruitment of fish, frogs and waterbirds may increase and the focus of environmental water delivery will be on the successful completion of such recruitment events. Consideration will also be given to the health of flood-dependent floodplain vegetation, and opportunities to deliver environmental water to improve the health of endangered ecological communities such as myall and coolibah/black box will also be examined.

The EFRG and the Office of Environment and Heritage will continue to collaborate with the Commonwealth Environmental Water Holder to ensure that environmental watering opportunities are enhanced.

Riverine and Floodplain assets outside the area of the Macquarie Marshes

The EFRG has considered how best to accommodate the needs of non-marsh river and wetland systems for environmental water. Given the substantial volume of water available in various environmental accounts in 2011/12, it is considered that opportunities to deliver environmental water to these assets may be realised.

Generally speaking, sufficient environmental water could be made available to provide substantial 'freshes' to the effluent creeks and the Lower Macquarie, which may provide some beneficial flooding in some zones. It is not expected sufficient water will be available to flood significant areas of floodplain vegetation, rather the objective of watering in these systems would be to improve nutrient-cycling, provide opportunities for fish movement and water riparian zone semi-permanent wetland vegetation types. The introduction of such freshes may also have benefits in relation to sediment transport and suppression of invasive instream vegetation (such as cumbungi and red gum).

The OEH will determine the most appropriate use of environmental water on a case by case basis, according to the principles developed for assessing effluent creek flow requirements in collaboration with the EFRG and State Water, who will advise on operational opportunities for delivery of environmental water to the effluent creeks. Close collaboration will also be required with landholders to ensure that unintended outcomes can be avoided. As environmental water deliveries of this nature have not been attempted in the effluent creeks before, it is critical that they be considered experimental in nature and that real-time adaptive decision-making is used to realise potential benefits. Given the novelty of delivery of water to the effluent creeks for environmental benefit it is proposed to limit options for 2011/12 to ensure maximum learning and capacity to monitor specific outcomes and impacts of operational decisions.

Freshes into the effluent creeks are likely to have occurred at any time of the year under natural conditions. The range of species likely to benefit from proposed environmental flows to the effluent creeks is similar to that targeted in the Macquarie Marshes, therefore refreshment during spring and early summer is likely to have the greatest benefit, however, delivery will also need to consider the needs of competing uses and this will be determined in consultation with State Water.

The following deliveries are proposed as potential recipients of environmental account water in 2011/12:

	reach	target	Source of water	peak	duration	volume
Lower Crooked Creek	Downstream of Mumblebone to Talga Wetlands	Germination event, sediment flushing from pools, native fish movement	Supplementary, Planned & Held; operational surplus	250-500 (ML)	Moderate (10-20 days)	5000 ML (might be partially accounted as stock and domestic replenishment)

Sources of Water

Tributary flows

Additional water for the environment arises from tributary flows in response to rainfall events. Tributary flows are divided into two categories:

1. Flows less than 5000 ML/d in excess of requirements at Warren and
2. Flows greater than 5000 ML/d in excess of requirements at Warren.

State Water typically use tributary flows to satisfy extractive needs where possible. Dam releases augment tributary flows to deliver stock, domestic, town water and irrigation supplies. Tributary flows in excess of extractive needs are generally available to the environment. Under the Water Sharing Plan tributary events that exceed 5000 ML/d at Warren are declared Supplementary events and water is made available to holders of Supplementary Water Access Licences.

Water from the tributaries in excess of requirements flow through to the Macquarie Marshes or if the peak of the event is large enough into floodplain creeks or onto the floodplain itself. State Water can exert some control over where excess tributary flows are directed.

As government holds supplementary water licences on behalf of the environment, some consideration has been given to the management of such licences when supplementary events are declared. In 2011/12 it is recommended that the environmental water manager consider placing an order for the environment's share of all such events with a view to directing such water to one or more of the effluent creeks.

Planned Environmental Water and Held Environmental Water

Planned Environmental Water (referred to above as EWA) and Adaptive Environmental Water (referred to above as NSW AEW and CEWH) may also be directed into the effluent creeks in accordance with the rules of the WSP and in the case of the Adaptive Environmental Water in accordance with the Water Use Plan. OEH will collaborate with NSW Office of Water, State Water and the

Commonwealth Environmental Water Holder to determine opportunities to deliver Planned Environmental Water and Adaptive Environmental Water to the effluent creeks.

Cudgegong

Windamere is now storing over 110,000 ML (33%) and environmental releases are now possible under the rules of the water sharing plan. The EFRG has previously agreed that the arrangements for environmental releases from Windamere should ensure that releases are made as frequently as possible. The default position described by the Water Sharing Plan imposes a target range of 150-1500 ML/d, which may be made at any time of year. The EFRG has proposed no alteration to the default position for the 2011/2012 water year.

The EFRG notes that make up releases as a result of temporary suspension of environmental releases in the Cudgegong last year are still required, when release triggers are met. This requirement will increase the maximum possible environmental releases from Windamere to total 15,500 ML in 2011/2012 rather than the default 10,000 ML/annum allowed by the WSP.

Risks and mitigating strategies

Risk	Rating	Response
Decision-making phase		
Priority-setting overlooks critical ecological needs	High (unlikely and major) Severe environmental damage	EMP and priority setting frameworks developed by OEH and EFRG used to systematically examine priorities
Water requirements to meet ecological objectives are under/over-estimated	Moderate (possible and moderate) Contained environmental impact	Document outcomes to inform future decision-making; liaise with SWC to ensure real-time management can be responsive to unintended outcomes
Future watering opportunities compromised	Moderate (possible and minor) Some environmental impact	Document trade-offs associated with decisions
Water delivery phase		
Further damage and erosion in the northern reed bed in the vicinity of the North Marsh Bypass Channel	High (possible and major) Severe environmental damage	OEH and State Water have agreed to assess the site and undertake stabilisation works prior to watering; the requirements for works may influence the timing of the commencement of watering and/or the rate of water delivery so that the risk of lasting damage is minimised.
Unforeseen physical impediments to water delivery	Moderate (rare and major) severe environmental impact	Early communication with State Water; alert NOW compliance if obstructions identified; targeted surveillance is planned
Unforeseen operational impediments to water delivery (channel capacity/valve capacity sharing)	Moderate (rare and major) severe environmental damage	Early communication with State Water; request NOW ruling with respect to channel capacity sharing arrangements
Estimated flow target volumes or rates are substantially inaccurate	Moderate (possible and moderate) Contained environmental impact	Monitor flow delivery daily and seek adjustments; revise targets accordingly
Gauging station failure or inaccuracy	Moderate (possible and moderate) Contained environmental impact	Forewarn hydrometric suppliers of likely release and request confirmation that stations are active and accurate (particularly if access during release may be difficult); negotiate alternate accounting procedures with State Water and DWE as required
Errors or omissions in accounting methods	Low (unlikely and minor) Some environmental impact	Regular audit of accounts compared to delivery strategy in consultation with State Water and NOW
Unintended ecological outcomes (eg. insufficient water available to complete colonial waterbird breeding, if initiated; germination and spread of weeds; germination of dense eucalypts)	High (possible and major) Severe environmental damage	Early identification of water requirements and assessment of likely outcomes; reconsider flow rates and targets to improve likelihood of success; consider the purchase of temporary water allocations to complete event/avoid negative outcome; manage expectations with comprehensive and regular communication

Monitoring, reporting and revising

Monitoring will be conducted as per the RiverBank monitoring strategy for adaptive environmental water.

Minimum monitoring includes satellite imagery analysis to measure extent of inundation; analysis of available hydrographic data at Marebone, Gum Cowal, Oxley, Pillicawarrina and Miltara and Bell's Bridge; Gunningbar, Duck and Crooked Creeks, and Marra Creek; airborne surveillance to check water delivery and diversions and activity at colonial bird breeding sites; fortnightly or monthly on-ground inspection of wetland areas to ground-truth inundation areas, duration of inundation and photographic evidence of response. Additional monitoring tailored to the specific objectives of the release may be required, eg. Inspection of the progress of waterbird breeding.

Because of the novelty of providing water into the effluent creeks, a specific monitoring program to determine the benefits and constraints within those systems will be necessary if environmental water is to be delivered into those systems. Observation/measurement of area wetted in target areas in effluent creek systems, duration of connectivity, drown-out levels of in-stream structures and monitoring of fish movement have been identified as issues of interest, but will ultimately be dependent on objectives of the release and the availability of resources.

Reporting to

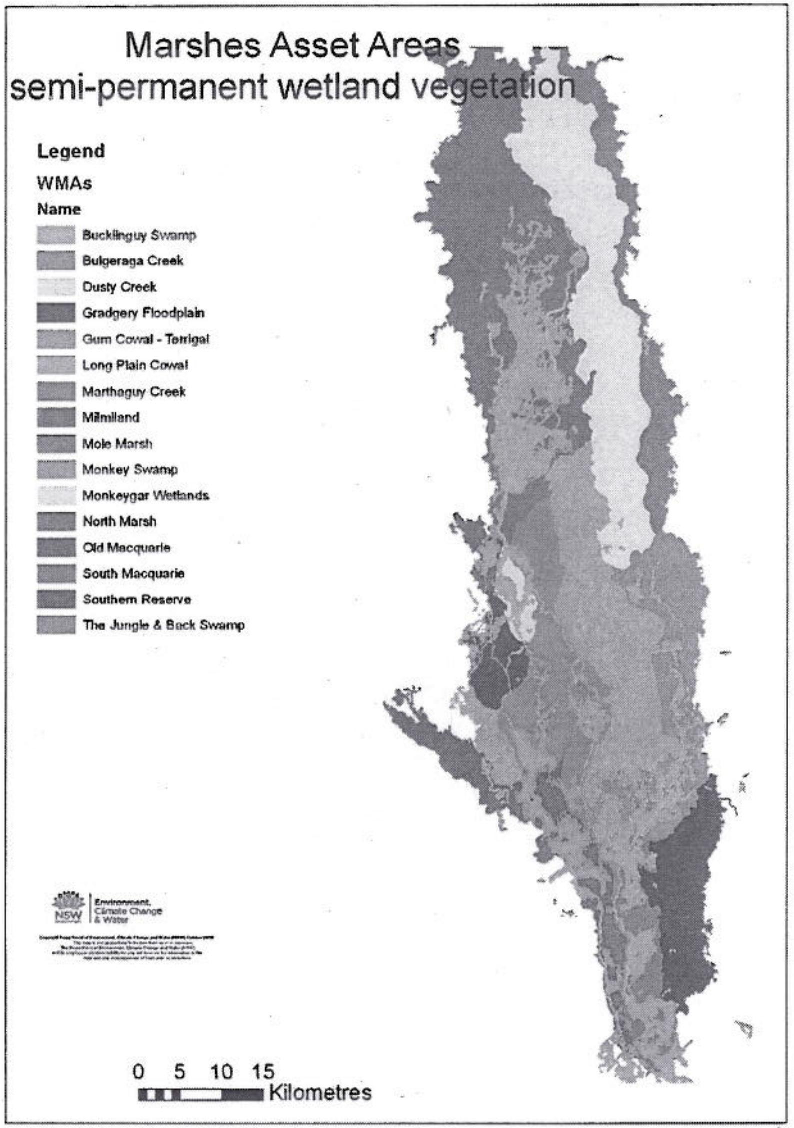
- Director, Water for the Environment, OEH: monthly update on conditions (climate, available environmental water) and weekly update during flow delivery events.
- EFRG: weekly/fortnightly update on conditions and flow delivery details. EFRG to be consulted if triggers for changes to this plan occur.
- Central West CMA: through EFRG representatives
- State Water Corporation's Macquarie Customer Services Committee: regular update at meetings.
- Broader community: update in E-water newsletter; press releases.

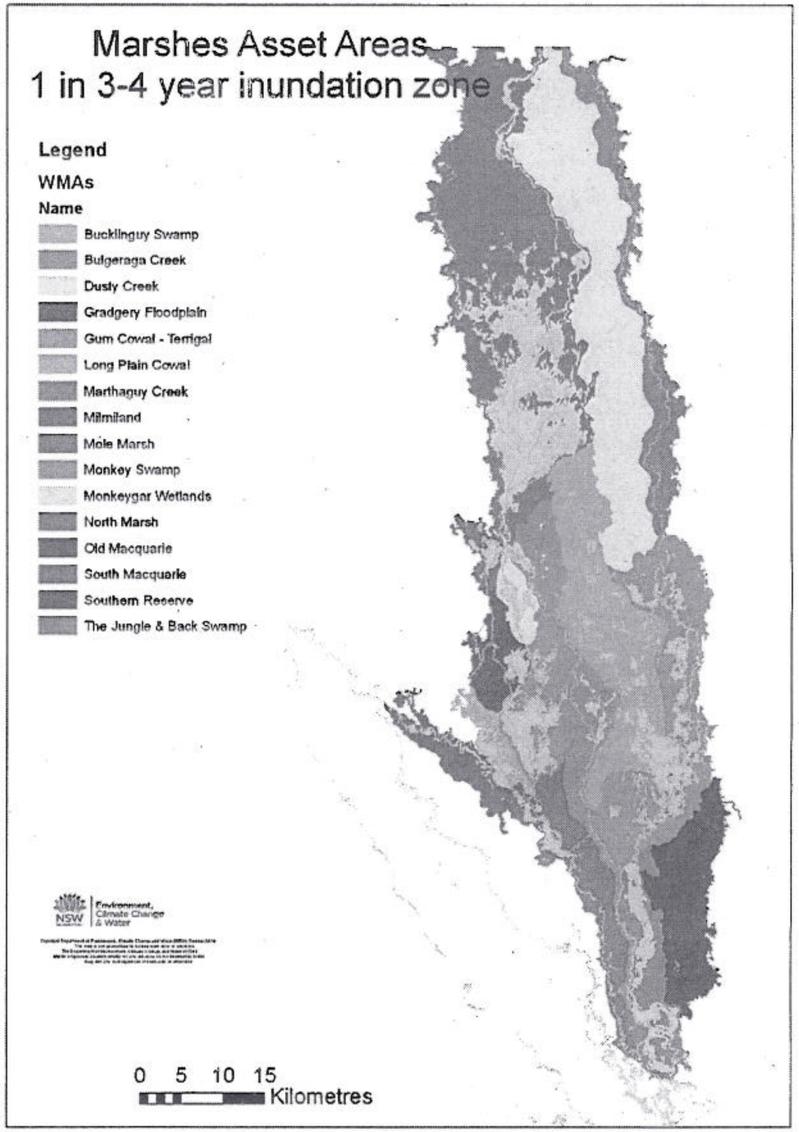
This plan is to be **revised** when conditions dictate. Triggers for revision will be sustained catchment or localised rainfall that produces significant flows in tributaries. Good communication with State Water and local community representatives will help clarify the timing and scale of revision.

Primary responsibility for identifying and reporting opportunities for revisions to this plan rests with DECC Senior Wetlands and Rivers Conservation Officer.

Prepared by:	Debbie Love in consultation with the Environmental Flows Reference Group
Position:	SWaRCO North-West Branch, NSW Office of Environment and Heritage
Date:	

Approved by:	Derek Rutherford
Signature:	
Position:	Director, Water, Wetlands and Coasts, NSW Office of Environment and Heritage
Date:	28/7/11


Marshes Asset Areas
semi-permanent wetland vegetation
Legend
WMAs
Name
Buckilnguy Swamp
Bulgeraga Creek
Dusty Creek
Gradgery Floodplain
Gum Cowal - Terrigal
Long Plain Cowal
Marthaguy Creek
Milmiland
Mole Marsh
Monkey Swamp
Monkeygar Wetlands
North Marsh
Old Macquarie
South Macquarie
Southern Reserve
The Jungle & Back Swamp
NSW
Environment, Climate Change & Water
0 5 10 15
Kilometres


Marshes Asset Areas
1 in 3-4 year inundation zone
Legend
WMAs
Name
Buckilnguy Swamp
Bulgeraga Creek
Dusty Creek
Gradgery Floodplain
Gum Cowal - Terrigal
Long Plain Cowal
Marthaguy Creek
Milmiland
Mole Marsh
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0 5 10 15
Kilometres

Interim Environmental Watering (AEW) Plan for the Murray Valley 2009/10[1]

Background

This plan outlines the wetland assets and water volumes required to enable Adaptive Environmental Water (AEW) to be delivered to wetlands within the Murray Valley of NSW in 2009/10. Up to 32,027 Megalitres (ML) of AEW allocation is currently managed by the Department of Environment, Climate Change and Water (DECCW) on behalf of the Minister for Climate Change and the Environment. NSW is also involved in the delivery of environmental water recovered under The Living Murray (TLM) initiative and cooperates with the Commonwealth Environmental Water Holder (CEWH) in the delivery of environmental water recovered by the CEWH.

Several wetland assets located in NSW State Forest (managed by Forests NSW) have been watered recently using a combination of The Living Murray (TLM) water and AEW. These assets are monitored in conjunction by DECCW and Forests NSW and include Pollack's Swamp and Reed Beds Swamp (Gulpa Creek).

Summary of AEW releases in 2008/09

The Water Sharing Plan for the Murray and Lower Darling Regulated River Water Sources remained suspended for the whole of 2008/09. Allocations continued to accrue to AEW licences, however, in accordance with available water determinations made by the Office of Water (then Department of Water and Energy) and 11,027 ML of AEW was available for use in the Murray Valley as of May 2008.

Thirteen wetlands (private, Forests NSW) were watered mainly between September 2008 and December 2008, with Andruco Lagoon and Wee Wee Creek watered in May and June 2009 respectively. In total, approximately 5,000 ML of AEW was used to inundate 610 hectares of wetland area within the Murray Valley of NSW. 6,000 ML was traded on the temporary water market, with revenue from this transaction proposed to be used to fund further water savings works in 2009/10.

Reed Beds Swamp (Gulpa Creek) has received AEW on several occasions (2003, 2004 and 2008) and is listed as part of the Barmah-Millewa TLM Significant Ecological Asset. The project partners of Reed Beds Swamp (Gulpa Creek) include: Forests NSW (project managers), State Water, River Murray Water, Murray Darling Basin Authority and DECCW. 1,600 ML was allocated to Reed Beds Swamp (Gulpa Creek) from The Living Murray (TLM) and from AEW in 2008/09 (approximately 800ML each) with the delivery of water managed by DECCW and monitored by Forests NSW and DECCW. Water was allocated because key water bird roosting sites were at risk due to the collapse of Giant rushes (*Juncus* ingens) in response to prolonged drying. The AEW allocation has previously facilitated bird breeding events at Reed Beds Swamp and the 2008/09 AEW has allowed vegetation to complete its reproductive cycle and subsequently maintain the health of these important water bird breeding habitats.

Several species of water birds have also been observed at Pollack's Swamp, although no breeding has been observed. Pollack's Swamp received 1,000ML of TLM water in the 2008/09 water season and is to receive a top up of 500ML of AEW in 2009/10 water season. If the top up triggers a water bird breeding event, further water will be prioritised from TLM

[1] DECCW intends convening a Murray and Lower Darling Environmental Water Advisory Group during 2009 to advise on the management of adaptive environmental water in the Murray and Lower Darling valleys. It is expected that this group will review and may revise this interim Plan.

and/or AEW allocation to assist and maintain a water bird breeding event in order to minimise the risk of nest abandonment.

In general, all wetland assets responded positively to AEW allocations. The results from monitoring indicated an increase in plant diversity and the recruitment of wetland flora. New growth, denser crowns and improved canopy extent was observed in River Red Gums and frog breeding habitat was enhanced, evidenced by breeding activities such as male calling, the presence of egg masses, tadpoles and metamorphs. The ongoing monitoring of sites will determine how well the primary objectives have been satisfied.

Primary Objectives include:

1. *To prevent the further decline in stressed wetland vegetation communities, in particular, River Red Gums, Black Box and Lignum communities;*
2. *To improve the condition of a broad and representative selection of indigenous wetland vegetation types including River Red Gum, Black Box, River Cooba, Lignum, Common Reed (Phragmites australis) and Spike rush (Eleocharis sp);*
3. *To increase (maintain) the abundance and diversity of understorey wetland vegetation communities;*
4. *To reinstate a wetting/drying cycle for natural ephemeral floodplain wetlands that have been negatively impacted by river regulation and/or severe drought conditions; and*
5. *To provide habitat for the endangered and Southern Bell Frog (Litoria raniformis) and other wetland dependant fauna and flora and to improve River Red Gum habitat for the endangered Regent Parrot (Polytelis anthopeplus)* (LMD).

Wetland Asset	Required AEW (ML)	Area Watered (ha)	Last time watered	Asset Condition
Andruco Lagoon	250	20	~2000 (natural event) AEW May 2009	Critical
Grand Junction	1000	40	AEW Feb 2006	Critical
Nampoo Station	240	15.5	AEW Sept 2006 AEW Oct 2008	Good
Boeill Ck Floodplain	100	10	~1995 (natural event) AEW October 2008	Poor
Wee Wee Creek	1000 - 1500	140	~1998 (natural event) AEW June 2009	Critical
Thegoa Lagoon	1280	80	AEW Sept 2005 AEW Sept 2008	Poor - Good
Lucerne Day	150	8.1	AEW Sept 2005 AEW Sept 2008	Good
Cliffhouse	50	5.13	AEW Sept 2006 AEW Sept 2008	Good
Cliffhouse	50	5.5	AEW May 2005 AEW Sept 2008	Good
Speewa Creek	1000-1500	185ha	2001	Poor
Toroga Wetland	72	12	2000	Poor
Reed Beds Swamp (Gulpa Ck)	800	300	AEW summer 2005/06 AEW summer 2008/09	Good
Kennaugh’s	10 - 50	2	AEW summer 2008/09	n/a

Wetland				
Pollack's Swamp	500	75	AEW Nov 2006 AEW May 2009	Good
Brechin	170	30	~1990's AEW Oct 2008	Good
MIL sites	7500	1065	various	Poor

Volumes of Environmental Water Available in the Murray Valley

Account	Maximum Capacity (ML)	Available 01/08/09 (ML)
Conveyance (WAL 9422/50AL503537) (conveyance)	**32,000**	**900 (carryover*)**
High Security (WAL 9423/50AI503538) (high security)	**2,027**	**198**
Commonwealth Environmental Water Holder	**12,000**	**TBC**
Barmah-Millawa Allocation	**100,000**	**TBC**

*** carried over on Murrumbidgee licences and to be transferred back to the Murray.**

Likely environmental watering scenario

- As at 13 July 2009 Hume Dam was at approximately 14% capacity (416 GL), Dartmouth Dam was at approximately 22% capacity (860 GL), Menindee Lakes was at approximately 14% capacity (239 GL) and Lake Victoria was at approximately 38% capacity (255 GL).
- A small volume of carryover (900ML) is fully available but currently 'parked' on TLM licences (with the agreement of the MDBA) and will require a transfer at the first available opportunity.
- Rainfall for the up coming months has been predicted to be average or below average, with the potential for an El Nino developing.
- High security allocations currently stand at 8% availability, general security allocations currently stand at zero percent availability.

Objectives for environmental water use for 2009/10

A. <u>Under dry conditions</u>

1. Wetland assets including Wee Wee Creek, Andruco Lagoon and Grand Junction should receive priority as they are considered critical in terms of requiring drought relief and fulfilling primary objectives 1,2,3,4 and potentially 5. Nampoo Station, a Cliffhouse site and Kennaugh's Wetland, should be considered as they provide breeding habitat for endangered and vulnerable fauna (respectively), fulfilling primary objective 5. In the event that a bird breeding event is triggered by the 500 ML of AEW top up at Pollack's Swamp, a contingency of extra allocation sourced from TLM and or AEW may be necessary to ensure a successful, uninterrupted breeding event.

<u>Reason:</u>

The AEW is intended to provide drought relief and improve wetland environments within the NSW Murray Valley. Both Wee Wee Creek and Andruco lagoon were watered in winter 2009 and would greatly benefit from a spring top up using up to 1,750 ML of AEW (1000-1500 ML and 100-250 ML respectively). The RRG's that surround both wetland assets were displaying severe drought stress, thus greater ecological outcomes could be achieved by providing extended inundation duration, thus a longer opportunity for wetland fauna and flora to recruit. It is widely recognised that multiple watering events can also greatly benefit vegetation communities. Additionally, significant landholder involvement (via pump maintenance, refuelling and temporary block bank construction) has made these AEW projects achievable.

It has been recommended that the Grand Junction wetland assets, which are currently exhibiting severe drought stress, be watered one in every four years, thus should receive AEW this water season (up to 1,000 ML with appropriate approvals processed and in place in a timely fashion). Nampoo Station wetland(s) and a Cliffhouse wetland(s) require small amounts of water (up to 240 ML and 50 ML respectively) and are close to the river, thus are logistically easy to wet via pumping. The locality of these wetlands to the river (which is used as refuge habitat by the Southern Bell Frog (SBF) (*Litoria raniformis*)), also enables this species to use the wetlands (when inundated) to breed and maintain populations. SBF have been recorded at these wetland assets since 2006. In the 2008/09 water season, Kennaugh's Wetland asset supported a pair of breeding Brolgas (*Grus rubicunda)* that successfully fledged their chick. This asset also requires a small amount of AEW (10-50 ML) and will provide habitat for another Brolga breeding event if the birds return. The above mentioned wetland assets combined, require the delivery of between 2,400 ML and 2,940 ML and would achieve the highest ecological benefits and outcomes this 2009/10 water season.

2. If further allocation announcements are made by NOW, it is recommended that other wetland assets be selected based on the above stated primary objectives and the condition of the wetland asset**.**

Both Cliffhouse and Nampoo Station wetland assets (four wetlands in total) support SBF populations and exist within approximately 10 kilometres of each other. The wetlands, combined with the Murray River, provide a larger scale habitat which provides a level of connectivity for the SBF's to move across the landscape between sites. In total, these SBF sites use only up to 340 ML of AEW and used only 325 ML in the 2008/09 water season.

3. The Brechin wetland asset requires approximately 170 ML and was watered in October 2008. The wetland displayed positive responses in terms of vegetation and the occurrence of the migratory bird, the Latham's Snipe (*Gallinago hardwickii*). As the Brechin wetland asset meets the outlined primary objectives, and was historically SBF habitat (though none have been recorded in the 2008/09 water season), it should be prioritized to receive an AEW allocation if the relevant approvals associated with the Grand Junction wetland assets are not processed in a timely fashion for the 2009/10 water season. Reed Beds Swamp (Gulpa Creek) has 1,600 ML allocated to the project. The Giant Rush in the Gulpa Creek wetlands positively responded to the 2008/09 AEW event. AEW and TLM allocations at Reed Beds Swamp (Gulpa Creek) has previously facilitated bird breeding events and allowed vegetation to complete its reproductive cycle. Several water birds have also been observed at Pollack's Swamp, although no breeding has been observed during the 2008/09 watering, water may be needed to ensure a successful, uninterrupted breeding event should nesting commence. This additional water should be prioritised over other watering events to minimise the risk of abandonment of nest sites if water levels drop. Ultimately, greater ecological outcomes could be achieved by providing extended inundation duration, thus a longer opportunity for wetland flora and fauna to recruit. It is widely recognised that multiple watering events can also greatly benefit vegetation communities.

The incorporation of these wetland assets will utilise approximately an additional 2,610 ML on top of the A1 wetland asset scenario presented (1,400 ML and 1,940 ML), thus up 5,550 ML of AEW in the 2009/10 water season.

B. <u>Under average to slightly wet conditions</u>

1. Consider capacity to support Wakool system environmental flow, in cooperation with NOW and CEWH

Reason:

To avoid critical loss of remnant fish communities from poor water quality that may be experienced over summer months under minimum flow conditions. In 2006/2007 a replenishment flow of approximately 30GL was supplemented with 6GL of TLM environmental water to assist in sustaining residual deep pools which provide refuge habitat for native fish. In 2009 a similar replenishment flow was provided but because of the prevailing hot weather conditions the flow resulted in poor water quality and subsequent fish kills. A management protocol to provide water to this system under current resource constraints is currently being developed by NOW.

2. Inundate other wetland assets including Thegoa Lagoon, Boeill Creek Floodplain, Lucerne Day, Speewa Creek and Toroga Wetland that meet the primary objectives outlined on above (page one).

Reason:

The AEW is intended to provide drought relief and improve wetland environments within the NSW Murray Valley. In 2008/09 Thegoa Lagoon received approximately 1,700 ML (and water is still present in the wetland). A top up of 1,280 ML has been recommended for Thegoa Lagoon in the 2009/10 water season. This wetland asset is logistically easy to deliver water into as it has regulator structure managed and operated by the Wentworth Shire Council in place (thus requires no pumping). This wetland supports a high diversity of water birds and has enabled the recruitment of several widespread frog species. The Thegoa Lagoon Management Plan (2003) recommends that the wetland be inundated seven out of every ten years, hence the AEW allocation would be in keeping with the plan.

Boeill Creek Floodplain and Lucerne Day were recent recipients of an AEW allocation (approximately 103 ML) in 2008/09. Speewa Creek hasn't received an overbank flow since 2001. The condition of these wetlands ranges between poor to good. These wetland assets cannot be watered naturally without high river levels, thus pumping would be required. All sites are logistically feasible. Flooding is essential to retain the ecological character, River Red Gum health and aquatic plant seed-bank production.

C. Under very wet conditions

1. Divert water into MIL Wetlands (7.5 GL)
Reason: Water has not been received for several years and Brolgas have been observed utilising several MIL sites in the past and as recently as 2008/09. Flooding is essential to retain the ecological character, tree health and aquatic plant seed-bank production.

2. Ensure the "Junction wetlands" are satisfactorily watered.

Reason**:** The condition of these wetlands is critical and this system cannot be watered without high rivers (ie no weirs for diversions). Flooding is essential to retain live River Red Gums, aquatic plant seed-bank and ecological character. Some sections have not filled for 12 years. Requires the delivery of approximately 5,000 ML/Day or greater @ d/s of Redbank Weir for several weeks plus a Murray River flow u/s of the junction of >10,000ML/day for the same period. *This would involve managing high Murrumbidgee flows to co-inside with high Murray Flows. This could require a period of reduced diversions into the Lowbidgee to create higher downstream river heights*.

3. Divert water into Billamein Wetland asset (126 ML).

Reason: Watering is essential to maintain and potentially improve the Black Box vegetation community of this wetland. This wetland has not received water since 2000.

4. Boomanoomana State Forest Wetlands (520 ML)

Reason: In spring 2004 Boomanoomana received an AEW allocation and demonstrated a positive response such as high wetland plant diversity. The site also provides foraging and breeding habitat for several water birds including the Brolga which was observed in the site during the 2004 flooding event.

5. Werai Forest Wetlands (3,200 ML)

Reason: To maintain vegetation health and diversity and maintain water bird rookery sites. This wetland last received an AEW allocation in 2001 and the wetland showed a positive response to the artificial flooding event.

D. Other potential opportunities

1. Divert water to Lake Gol Gol (9 GL) (LMD CMA initiative)
Reason: Previously recognised as JAMBA, CAMBA site. Hasn't been inundated since the early 1990's.

2. Divert water in to Lake Caringay (7 GL) a long term MWWG Flagship project
Reason: Hasn't been inundated since the 1960's.

3. Divert water into Murray Eden wetland (100 ML)
Reason: In 2006, The Murray Eden Wetland was recommended to receive water, however because of limited water resource availability, the watering of this site was suspended. This site has not been watered since the 1990's.

4. Tally's Lake (400 ML)
***Reason*:** Tally's Lake was historically used as a breeding site for water birds including Ibis. The lake typically filled annually, however due to the very low flows down the Wakool River System, Tally's Lake has not filled since 2003.

Risk and mitigating strategies:

Risk	Rating	Response
Unpredictable weather – turns drier than expected	High (likely & major)	Review asset condition and future priorities for watering.
Unpredictable weather – turns wetter than expected	Medium (unlikely & major)	Additional wetting options possible – continually assess volumes available
Flow management is uncoordinated	Medium (possible & moderate)	Establish EWAG; early communication with State Water and CSC
Water use and works approvals not linked to licences	High (possible & major)	Confirm status with NOW; seek discretionary one-off approval if necessary

Estimated flow target volumes are substantially wrong	Medium (unlikely & moderate)	Monitor flow delivery daily and seek adjustments; revise targets for future attempts
Unforeseen physical impediments to flow delivery e.g. low river levels which prohibit pumping activities.	Medium (rare & major)	Early communication with Landholders and State Water; alert NOW if illegal obstructions identified
Insufficient water available to complete colonial waterbird breeding, if initiated	Medium (unlikely & severe)	
River levels too low to pump (as may be the case for the Wakool and Murray Rivers in parts)		
Pump infrastructure faulty or not adequate		
Poor water quality in the Wakool System (e.g. high salts, black water and low dissolved oxygen	High (possible & major)	Monitor water quality

Monitoring:

The monitoring of all wetland asset sites will be conducted or overseen by DECCW project officers (and in the case of sites within State forest, in conjunction with Forests NSW) using methods that are consistent with Natural Resource Council (NRC) and state-wide standards.

Wetland Asset	**Ecological monitoring**	**Environmental monitoring**
Lucerne Day Cliffhouse (2 wetland assets)	• Vegetation response • River Red Gum response • Frog diversity • Fish #	• Water quality • Inundation area and extent • Inundation duration • Volumes used • Photo points
Nampoo Station (2 wetland assets) Andruco Lagoon Brechin	• Vegetation response • River Red Gum response • Frog diversity	• As above
Boeill Creek Floodplain Wee Wee Creek	• Vegetation response • River Red Gum response • Frog diversity • Macroinvertebrate diversity	• As above
Thegoa Lagoon	• Vegetation response • River Red Gum response • *Typha sp* mapping • Frog diversity • Bird diversity*	• As above • Ground water
Reedbeds Swamp (Gulpa Creek) Pollack's Swamp	• Vegetation response	• As above • Flow rates (no ground water)
Kennaugh's Wetland	• Brolga activity	• Inundation duration • Volumes used

monitoring conducted by Dr Leah Beasley from the Arthur Rylah Institute
* monitoring conducted by Sunraysia Bird Observers (volunteers)

Approvals, Access Licences and Associated Works:

All wetland sites require approvals and licences granted by NOW.

Wetland Asset	Work & Use Approvals in place.
Andruco Lagoon	Yes (up to 10 years)
Grand Junction	no
Nampoo Station	Yes (up to 10 years)
Boeill Ck Floodplain	Yes (up to 10 years)
Wee Wee Creek	Yes (temporary until the 31/10/09)
Thegoa Lagoon	Yes (up to 10 years)
Lucerne Day	Yes (up to 10 years)
Cliffhouse	Yes (up to 10 years)
Cliffhouse	Yes (up to 10 years)
Speewa Creek	no
Toroga Wetland	no
Reed Beds Swamp (Gulpa Ck)	Yes
Kennaugh's Wetland	Yes (up to 10 years)
Pollack's Swamp	Yes
Brechin	Yes (up to 10 years)
MIL sites	None required
Billamein Wetland	No

Reporting to:

- Director, Water for the Environment, DECCW – monthly update on conditions (climate, available environmental water) and weekly update during flow delivery events.

This plan is to be **revised** when conditions dictate. Good communication with PWG, State Water, DWE, Forests NSW and landholders will help clarify the timing and scale of revision.

List of Abbreviations

AEW - Adaptive Environmental Water
CAMBA - China-Australia Migratory Bird Agreement
DECCW - Department of Climate Change and Water
DWE - Department of Water and Energy (now NSW Office of Water)
EWAG - Environmental Water Advisory Group
GL - Gigalitre
JAMBA - Japan-Australia Migratory Bird Agreement
LMD - Lower Murray Darling
LMDCMA - Lower Murray Darling Catchment Management Authority
MIDMUR - Middle Murray
ML- Megalitre
MWWG - Murray Wetlands Working Group
NRC - Natural Resource Council
NOW - NSW Office of Water
PWG - Parks and Wildlife Group
RRG - River Red Gum
SBF - Southern Bell Frog

SWC - State Water Corporation
TLM -The Living Murray

Prepared by: Sascha Healy (in consultation with Trish Alexander and Emma Wilson)
Position: Project Officer Water, Water for the Environment, DECCW
Date: 13 August 2009

Approved by: Derek Rutherford

Position: Director, Water for the Environment, DECCW

Sign:

Date:

Interim Environmental Watering Plan for the Murrumbidgee Valley 2009/10[1]

Summary of Environmental water releases in 2008/09

The Murrumbidgee Regulated Water Sharing Plan remained suspended for the whole of 2008/09. Over spring and summer 2,500 ML of Environmental Water Allowance (EWA) was used to assist the endangered Southern Bell Frog (*Litoria raniformis*) populations in key "Lowbidgee" wetlands. The EWA was used in two separate events which were three months apart. The first diversion was just 500 ML and was due to a small surplus flow being identified by State Water which came from a catchment rainfall event. The second diversion was 2,000 ML and was made available following improvements in resources/allocations in the Murrumbidgee and Murray Valleys.

In between these events, 812 ML of Adaptive Environmental Water (AEW) was used for the same purpose in Yanga National Park wetlands. This was the first usage of AEW water in the Murrumbidgee Catchment and despite the small volume it was crucial to maintaining the necessary hydrology in the Yanga wetlands, when EWA was not available.

Overall the wetland watering project was successful in promoting the survival of the Southern Bell Frog. Significant recruitment was also detected at some sites, although carp appear to be having an effect on recruitment success.

> *"Carp control at Warwaegae Swamp appears to have been effective in increasing recruitment by L. raniformis. No tadpoles or metamorphs were recorded in 2007/2008 prior to carp control despite persistent calling activity, this increased to 118 tadpoles and metamorphs in 2008/2009". (Responses of frogs, fish & waterbirds to environmental flows in the Lowbidgee wetlands in 2008-09 -Wassens & Spencer, 2009)*

Monitoring of the Southern Bell frogs response to the flooding indicates that *"The long-term persistence of this species depends on regular flooding events to promote recruitment. At this stage annual flooding over a number of years may be required in order to re-establish population numbers"(Wassens et al, 2008 - draft).*

The EWA volume used for the wetland watering in 08/09 was deducted from the recognised 'loaned' volume of EWA (approximately 104 GL at the start of 2008/09) nominally held in Burrinjuck Dam.

In mid-January, as the final Southern Bell Frog diversions were coming to an end, the then Department of Water and Energy approved the repayment of 25 GL of the "loaned" EWA. An independent wetland watering prioritisation panel was assembled to advise the then Department of Environment and Climate Change on watering priorities in the Lowbidgee. The Panel advised that water be held over until the cooler months and agreed on a number of priority sites both on private property and within Yanga National Park.

In late May, June and early July the 25 GL was released into 4 wetland systems (Attachment A). A total of approximately 8,000 ha of floodplain wetlands have been inundated, with above average rainfall during the diversions aiding the spread of water significantly. The watering was completed on the 13th July and ongoing monitoring will determine how well it has achieved the following primary goals:-

[1] DECCW intends reactivating the Murrumbidgee Environmental Water Allowance Reference Group during 2009 and expects that this group will review, and may revise, this interim plan.

1.) Achieve large scale hydrological connectivity between Lowbidgee wetland complexes which contain a diversity of habitat types, including significant waterbird rookeries and can realistically be maintained into the future with minimal delivery losses.

2.) Improve the condition of a broad and representative selection of native wetland vegetation types eg red gum, black box, river cooba, lignum, phragmites (native reed) and spike rush.

3.) Increase habitat for threatened species including the threatened Fishing Bat (Myotis macropus) and the Southern Bell Frog (Litoria raniformis) along with a broad spectrum of more common waterbirds and other wetland dependant fauna.

Current condition of water dependent assets

Asset[1]	Last watering[2]	Condition
Core SBF wetlands - North Yanga	Summer 2009	Good
Core SBF wetlands – Nimmie-Caira	Summer 2009	Good
Remainder of North Yanga Redgum forest	Summer 2005	Good
South Yanga Red Gum forest	2000	Critical
Black Swamp	1993	Poor
Mid-Murrumbidgee Wetlands - DIWA	2000	Poor-Critical
Dams to Narrandera Wetlands	Spring 2005 or 2000	Good -Poor
Carrathool to Maude Weir Wetlands	1996 or 2000	Poor-Critical
Fivebough Swamp (Ramsar)	EWA 2005, other 2008	Poor
Tuckerbil Swamp (Ramsar)	EWA 2005 then dry	Good

[1] Identified in RiverBank Water Use Plan, Yanga National Park wetland management plan or Murrumbidgee Regulated Water Sharing Plan
[2] By any means – natural or managed

Volumes of environmental water available

Account	Maximum (ML)	Available 01/07/09 (ML)
EWA (payback of suspended account water)	Approx 75,000	Surplus flow dependant, until 20% GS is reached.
Translucency	26,328 (State Water Figure)	Nil, while WSP suspended
Other EWA *	SW to confirm	Nil, while WSP suspended
Adaptive Environmental Water held by DECCW (General Security)	6,634	1,214 ML**
Adaptive Environmental Water held by DECCW (Supplementary Access)	5,679	5,679 ML (availability is dependant on the declaration of a Supplementary event)
Commonwealth Environmental Water Holder	48GL GS; 21GL Supp	tba

*the volume of EWA accrued prior to the WSP being suspended and after the September 2006 DNR Resource Assessment quoted the “recognised volume” of 113GL.
** to be confirmed with State Water Corporation

Likely environmental watering context 2009/10

- Burrinjuck Dam was at approximately 38% capacity (390 GL) and Blowering Dam 36% (605,000 ML) as at 01/07/09.
- The repayment of "loaned EWA" to a storage account will occur once GS reaches 20% with storage inflows shared 1:1 with GS users until full repayment has occurred.
- The EWA substitution arrangements that applied in 2008/09 will continue, whereby the environment gets access to the first portion of any surplus flow with the volume accesed accounted as EWA payback. Until 20% GS is announced the availability of EWA is therefore dependant on rainfall/tributary flows and State Waters re-regulation capacity along the Murrumbidgee River.
- Presently all weir pools are partially or completely full and there is only approximately 10% of full re-regulation capacity. A significant rainfall event could therefore provide water for environmental use at short notice.
- Presently close to average rainfall conditions are predicted for the Murrumbidgee Catchment during August and September, however below average rainfall is forecast for October.
- Average rainfall for the next 2 months would most likely generate a number of surplus flow events increasing from small to moderate as the catchment becomes wetter.
- The WSP will not be turned back on until the EWA is repaid in full and all HS needs for the current and forward year are fully accounted for.
- The Murrumbidgee Environmental Water Allowance Reference Group (EWARG) has not met for 3 years. However, it is likely that DECC will re-convene this group in the next 6 months.
- In summary, for the 3 month period up to the 31st October 2009:
    - Low probability of WSP being switched back on
    - Low probability of GS allocation reaching the 20% payback trigger
    - High probability of EWA water (surplus flows) becoming available

Objectives for environmental water use for 2009/10

A. <u>Under dry conditions</u>

1. During late spring and summer, use limited surplus flows, as identified by State Water, to inundate Warwaegae Swamp on the property "Torry Plains", Mercedes Swamp in Yanga National Park (these 2 sites are the highest priority Southern Bell Frog (SBF) wetlands identified from the ongoing CSU frog monitoring) and other wetlands which are considered to be important for the population maintenance of this threatened species.

If surplus flows do not arise during this period or are insufficient, use Adaptive Environmental Water to inundate these and other identified key sites. At least one top-up flow will be required, to produce the necessary hydrology for the SBFs (minimum of four months inundation)

<u>Reason</u>: preserve the Southern Bell Frog population in their priority habitat areas and provide for limited recruitment. Requires the delivery of approximately 1-3 GL and could be achieved using small surpluses under EWA payback arrangements.

2. If surplus flows come about outside of the SBF breeding season it is recommended that sites are selected using criteria similar to goals 1-3 used in 2008/09 listed in the watering summary for 2008/09 (see page 1).

B. Under average to slightly wet conditions

1. **Flood larger SBF wetlands in the Lowbidgee (Maude and Redbank systems) to enable a significant distribution of the population**
   Eulimbah Swamp 6,000 ML and Twin Bridges 4,000 ML
   Reason: recent severe population decline of this endangered species. Flooding is essential to provide drought refuge and breeding habitat for the recovering population. Requires delivery of approximately 10 GL and could be achieved using small to moderate surpluses under EWA payback arrangements.

2a. To flood the southern section of red gum forest in Yanga National Park (South of Tala Lake) using the channel systems from Maude Weir for greatest efficiency.
Reason: forest condition currently critical and declining. Flooding is essential to retain some of the river red gums alive and provide best chance of preventing loss of ecological character. Requires delivery of approximately 50-60 GL and could be achieved using moderate surpluses under EWA payback arrangements

2b. To flood sections of privately owned red gum forest in the Lowbidgee from both Redbank and Maude Weirs. Target sites would be prioritised for watering using an independent wetland assessment process which would inform the Murrumbidgee EWARG and the DECC decision making process.
Reason: forest condition currently critical and declining. Flooding is essential to retain some of the river red gums alive and provide best chance of preventing loss of ecological character. Requires delivery of approximately 50-60 GL and could be achieved using moderate surpluses under EWA payback arrangements

3. To flood the Northern Section of red gum forest in Yanga National Park (above Tala Lake)
Reason: condition good (compared with the southern section). Flooding would allow for Southern Bell Frog dispersal into historical habitat, waterbird breeding in significant rookery and wetland areas including Piggery Lake and maintenance of red gum forest health. Requires delivery of approximately 60 GL and could be achieved using moderate surpluses under EWA payback arrangements.

4. To inundate the Nimmie-Caira system of Lowbidgee wetlands creating and sustaining a waterbird breeding event of a similar extent to that of 2005 (30,000 pairs, mainly Ibis and Cormorants)
Reason: condition good, but waterbird numbers are declining nationally and this would boost numbers of a variety of species affected by a series of very dry years. Requires delivery of approximately 60-70 GL and could be achieved using moderate surpluses under EWA payback arrangements or availability of Lowbidgee diversions under Water Sharing Plan arrangements.

5. **Use infrastructure to flood prioritised mid-catchment wetlands in the Murrumbidgee Irrigation Area eg. Coonancoocabil Swamps and MIA State Forest wetlands.**

Reason: condition varies from good to poor, up to 8 years since last flooding, create drought refuge and potential habitat for threatened waterbird species, could be achieved using small surpluses under EWA payback arrangements. Requires delivery of approximately 0.2-10 GL and could be achieved using small to moderate surpluses under EWA payback arrangement. This would be a substitute for filling river fed wetlands with large scale dam releases, and would be attempted if piggybacking opportunities (option C,1. below) did not arise or stand alone releases were not possible.

C. Under very wet conditions

1. Piggyback EWA releases onto significant tributary fresh/s inundating the majority of river fed wetlands from Gundagai to Maude Weir.

Reason: condition currently critical and declining (condition gets progressively worse downstream). Flooding is essential to retain live fringing river red gum, aquatic plant seed-bank and ecological character. Some sites have not filled in 12 years Requires delivery of approximately 45,000 ML/Day or greater @ Wagga for 2-3 days (See the Murrumbidgee Environmental Water Delivery Guidelines DNR 2006)

2. Maintain and complete any colonial waterbird breeding event initiated by natural flood event or environmental flows.

Reason: waterbird numbers are declining nationally and this would boost numbers of a variety of species whose numbers have been affected by a series of very dry years. This could require anything between 2-50 GL depending on a number of variables

3. Inundate the Lowbidgee wetlands and red gum forest north of Redbank Weir to Balranald.

Reason: condition currently poor and declining. Flooding is essential to retain live river red gum aquatic plant seed-bank and ecological character. Significant waterbird breeding sites are located in this system. Some sites have not filled in 8 years. Requires delivery of approximately 100 GL and would require access to sustained periods of surplus flows

4. Inundate extensive areas of the Yanga Nature Reserve and other significant wetlands located outside of the Lowbidgee Flood Control and Irrigation District (LFCID)

Reason: condition currently critical and declining. Flooding is essential to retain live river red gum, black box, river cooba, aquatic plant seed-bank and ecological character. Some sites have not filled in 12 years. Requires delivery of approximately 100 GL and would require access to sustained periods of surplus flows

D. Other potential opportunities (may be considered depending on circumstances)

1. Divert water to Fivebough and Tuckerbil Swamps. Under dry conditions in the catchment of Fivebough Swamp (MI drainage network around Leeton) there could be a need to provide environmental water to this site. Alternatively, under wet conditions if the site was partially flooded already, the complete flooding with environmental water could be requested to provide maximum inundation. The later also applies to Tuckerbil Swamp. (See Management Plans)

Reason: Ramsar sites, condition currently poor due to no major flood of entire swamp basin for many years, would provide habitat for JAMBA- CAMBA bird species and *preserve ecological character. Requires the delivery of approximately 0.5 GL for Fivebough and 0.4GL for Tuckerbil Swamp.*

2. Pump water into 1 to 3 high conservation value, nationally significant mid-Murrumbidgee wetlands (DIWA). These sites have been identified under the Integrated Monitoring of Environmental Flows (IMEF) Program eg. McKenna's, Sunshower and Yarradda Lagoons.
Reason: This would be primarily to preserve the highly diverse aquatic plant seed-bank at the targeted sites, which have not been inundated for 9 years. It would enable the later, natural or managed, dispersal of aquatic plants throughout the other Murrumbidgee wetlands. This would require between 1-3 GL of water depending on the number of sites

3. Divert water to Wanganella Swamp.
Reason: Wanganella Swamp is a nationally significant site (DIWA) and due to the drought and water savings measures has remained dry since 2007. Previously the site was watered annually in association with irrigation flows down the Billabong/Forest Creek system.
Up until 2007 the swamp was an annual Brolga breeding site and historically a breeding site for the Australasian Bittern. It provided habitat for a number of threatened waterbirds including the Freckled Duck, Blue Billed Duck, Australian Painted Snipe and other JAMBA - CAMBA bird species.

4. Pump water into selected Lower Murrumbidgee wetlands (below Balranald).
Reason: This would be primarily to preserve the aquatic plant seed-bank within a selection of these sites. Logistically only something in the range of 1-4 sites could be achieved using an estimated 1-2 GL

5. Ensure the "Junction wetlands" below the Lowbidgee are satisfactorily watered. This would involve managing high Murrumbidgee flows to coincide with high Murray Flows. This could require a period of reduced diversions into the Lowbidgee to create higher downstream river heights. Delivering TLM or Commonwealth Environmental Water Holder water from the Murrumbidgee system to target the lower Murray icon sites while the Murray river was already predicted to be above the 10,000ML/day for some period could assist in achieving this.
Reason: the condition of these wetlands is critical and this system cannot be watered without high rivers (ie no weirs for diversions) Flooding is essential to retain live river red gums, aquatic plant seed-bank and ecological character. Some sections have not filled for 12 years. Requires the delivery of approximately 5,000 ML/Day or greater @ d/s of Redbank Weir for several weeks plus a Murray River flow u/s of the junction of >10,000ML/day for the same period

Risks and mitigating strategies

Risk	Rating	Response
Unpredictable weather – turns drier than expected	High (likely & major)	Review asset condition and future priorities for watering.
Unpredictable weather – turns wetter than expected	Medium (unlikely & major)	Additional wetting options possible – continually assess volumes available
Flow management is uncoordinated	Medium (possible & moderate)	Establish EWARG; early communication with State Water and CSC
Water use and works approvals not linked to licences	High (possible & major)	Confirm status with NOW; seek discretionary one-off approval if necessary
Estimated flow target volumes are substantially wrong	Medium (unlikely & moderate)	Monitor flow delivery daily and seek adjustments; revise targets for future attempts

Unforeseen physical impediments to flow delivery	Medium (rare & major)	Early communication with Lowbidgee Landholders and State Water; alert NOW if illegal obstructions identified
Water use plan not amended in time to take advantage of other opportunities	Medium (possible & moderate)	Seek urgent approval from NOW
Insufficient water available to complete colonial waterbird breeding, if initiated	Medium (unlikely & severe)	"Borrow" of EWA 2 ahead of later accrual; purchase GS allocation
Murrumbidgee water resources used to supply traditional Murray requirements resulting in Murrumbidgee EWA reduction or loss of surplus flow arrangements etc	Medium (unlikely & major)	Review asset condition and future priorities for watering, arrange "payback' conditions

Monitoring, reporting and revising

Monitoring as per Rivers Environmental Restoration SPII, RiverBank monitoring plan for adaptive environmental water, and IMEF style wetland monitoring program for mid and lower murrumbidgee wetlands - DECCW.

Reporting to

- Director, Water for the Environment, DECCW – monthly update on conditions (climate, available environmental water) and weekly update during flow delivery events.
- Environmental Water Allowance Reference Group when formed – monthly update on conditions and weekly update during flow delivery events.
- Murrumbidgee Customer Services Committee – regular update at meetings.
- Broader community – updates in Riverbank Newsletter.

This plan is to be **revised** when conditions dictate. Triggers will be sustained catchment or localised rainfall that produces significant flows into storages or tributaries. Good communication with PWG, State Water, NOW, Murrumbidgee EWARG and Lowbidgee landholders will help clarify the timing and scale of revision.

DECCW intends reactivating the Murrumbidgee EWARG during 2009/10 and expects that this committee will review this interim plan.

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Position: Senior Wetlands and Rivers Conservation Officer, South; Principal Project Officer Water, Water for the Environment, DECCW
Date: 24th July 2009

Approved by: Derek Rutherford

Position: Director, Water for the Environment, DECCW

Sign:

Date: 19/08/2009

ATTACHMENT A – Summary Table of 2008-2009 Environmental watering.

Wetland Name	Current Status	Watering/Monitoring history	Volume Estimated/Used (ML)	Daily flow rate ML	Area (Ha) Inundated	Flow Timing	Ve
Nap Nap Rookery Swamp	Full	Last watered in 2005, one of the significant Maude system rookeries, with potentially the best vegetation diversity. Depth logger installed	3,000/**2,250 Rainfall assisted**	100-200	400	Start 22nd May	Red Gu Rive Lignu
Twin Bridges - Piggery Lake Complex, including Tarwillie Swamp - Yanga National Park	System is full with water slowly reaching Breer Swamp	Last filled in 2005, one of the largest and most significant wetlands on Yanga National Park. Historical Southern Bell Frog site and hydrologically connected to current sites as well as Fishing bat sites. Significant waterbird rookery site. DECC depth loggers installed in numerous wetland sites	12,000/**15,350 Under use at other sites allowed for addition watering in Yanga**	500-1000	4,000	15th June	River r with under lignu Naro
Shaws Swamp, Waugorah Lake complex	Full	Last filled in 2005, Waugorah Lake is ideal habitat for the threatened Fishing Bat (*Myotis macropus*) Depth logger installed	1500/**780 rainfall assisted**	50 - 100	150		F
Paika – Narwhie Complex (Steam engine Swamp Rookery)	Full	Significant Egret rookery site, (Steam Engine Swamp) last watered in 2005. Top up flow of approximately 500ML running currently to upper section of this complex	10,000/**7,000 rainfall assisted**	500	1,500	Start 1st June	Red g sp unde n Phra Eleo swan Steam
		Total ML	**25,380**				

Note : exact volumes are yet to be confirmed by State Water.

NSW GOVERNMENT
Environment, Climate Change & Water

Macquarie Marshes Adaptive Environmental Management Plan

Synthesis of information projects and actions

Australian Government
Water for the Future

Environment, Climate Change & Water

Macquarie Marshes Adaptive Environmental Management Plan

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Cover photographs (anticlockwise from main image):
Aerial of Macquarie Marshes (Grenville Turner); River red gum (W. Johnson); reed warbler (Grenville Turner); wavy marshwort (W. Johnson); green tree frog (W. Johnson).

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Summary

The Macquarie Marshes are a large, diverse wetland system on the lower Macquarie River in north-western New South Wales. The marshes have supported some of the largest waterbird breeding events in Australia and provide essential habitat for hundreds of species of animals and plants. They are an important refuge for wildlife during dry times. The values of the marshes are recognised at all levels of Australian government. The Macquarie catchment comprises some of the more agriculturally diverse rural landscapes of central NSW, and includes a wide range of intensively farmed and broad-acre crops. It also includes a relatively large range of urban centres as well as many smaller, traditional rural service centres.

In the Macquarie Marshes Adaptive Environmental Management Plan (MM AEMP or 'the plan') and its supporting documents, knowledge about the marshes has been gathered and analysed. The intention of the plan is to inform land and water management, and to guide strategies, projects and tasks for restoring and maintaining critical ecological functions and habitats in the Macquarie Marshes.

The marshes are described in terms of their assets and values, and on the basis of water supply, management and geomorphological boundaries. The water needed to maintain the values of semi-permanent wetlands has been identified. The extent of inundation has been calculated using water and vegetation signatures for October each year from 1979 to 2006. These maps have been used to produce an index of the frequency of inundation of different parts of the marshes. Since 1979, the area of the marshes that receives the flood frequency and duration necessary for maintaining the values of identified semi-permanent wetland assets has declined. This decline has accelerated during the very dry period since 2001 until the present time.

Much of the 72,000 hectares of semi-permanent wetland mapped in the marshes in the early 1990s no longer supports wetland vegetation. Less than half of this area is now in fair or better condition, and many areas are still in decline. According to CSIRO, it is likely that future rainfall will be less than that experienced during the 1970s, 80s and 90s. Four scenarios of water availability and area of wetland that can be sustained are outlined. While considerable uncertainty exists under each scenario – particularly in relation to the volume of unregulated flow that may benefit the marshes – the scenarios provide context for water planning, environmental water recovery and environmental water management.

Prioritising the delivery of environmental water will involve an annual planning process; the Macquarie–Cudgegong Environmental Flows Reference Group will be integral to this process. This plan includes information that will inform planning and management actions in the context of the actual climatic circumstances and environmental condition of the ecological assets at that time. The primary objective for the Macquarie Marshes for the duration of this plan is to support the ecological functions and processes necessary to sustain the diversity of type, and extent of, the ecological assets described within the plan. As further progress is made in recovering water for the environment, and depending on the climatic conditions experienced, enhanced ecological function and condition should begin to restore resilience to the marshes ecosystem. Objectives and priorities for restoring former wetlands areas that no longer support wetland values may then be possible.

Acronyms and abbreviations

AEMP	adaptive environmental management plan
AWD	available water determination
BMP	best management practice
CAP	catchment action plan
CHD	Cultural Heritage Division (of DECCW)
CW CMA	Central West Catchment Management Authority
DAA	Department of Aboriginal Affairs
DECC	Department of Environment and Climate Change
DECCW	Department of Environment, Climate Change and Water
DEWHA	Department of the Environment, Water, Heritage and the Arts
DLWC	Department of Land and Water Conservation
DPI	Department of Primary Industries
DWE	Department of Water and Energy
DWR	Department of Water Resources
EPRG	Environmental Protection and Regulation Group
I&I NSW	Industry and Investment NSW
LHPA	Livestock Health and Pest Authorities (formerly Rural Lands Protection Board)
LGA	local government area
LPMA	Land and Property Management Authority
MER	monitoring, evaluation and reporting
MM AEMP	Macquarie Marshes Adaptive Environmental Management Plan
MMNR	Macquarie Marshes Nature Reserve
NAP	national action plan
NMSF	national metering standard framework
NHT	Natural Heritage Trust
NOW	NSW Office of Water
NPWS	National Parks and Wildlife Service
NRC	Natural Resources Commission
NWQMS	National Water Quality Management Strategy
PWG	Parks and Wildlife Group (of DECCW)
RERP	Rivers Environmental Restoration Program
SLATS	Statewide Land and Tree Survey
UNE	University of New England
UNSW	University of New South Wales
WRC	Water Resources Commission
WRP	wetland recovery program
WSP	water sharing plan

1 Introduction

1.1 The purpose of the Macquarie Marshes Adaptive Environmental Management Plan

Compelling evidence exists that the resilience of the Macquarie Marshes – the capacity of its ecological and social systems to adapt to and shape change – is declining. In some parts it has already been lost. If this trend is not reversed, the marshes will almost certainly cease to exist as a large, diverse and complex wetland system. The challenges are both ecological and social. According to the information gathered and analysed for this plan, much of the knowledge needed to restore and maintain critical ecological functions and habitats of the marshes exists. There is a reasonable understanding of the ecological aspects of these problems, and their solutions, but understanding of the social aspects is not as strong. The over-arching challenge is to apply this knowledge to the complex and closely linked ecological and social systems of the marshes to protect this important wetland.

The plan describes the marshes and the conditions under which management decisions will be made. It aims to guide actions – strategies, projects and tasks – for restoring and maintaining critical ecological functions and habitats in the Macquarie Marshes. People are an integral part of the system that includes the Macquarie Marshes and the Macquarie River – the future of communities in the Macquarie Valley is tied to the health of the river and the marshes.

The Macquarie Marshes Adaptive Environmental Management Plan (MM AEMP or 'the plan') is *not* a guide to returning the marshes to some past and inevitably disputed condition *or* to managing them to maintain a fixed state. It is a guide to restoring ecological structure and function in agreed priority areas. In the broadest sense, the plan is a guide to restoring resilience. Before resilience can be restored, the trajectory of decline must be halted and the condition of the wetlands stabilised.

1.2 The context for the plan

A number of policies and Acts exist at the local, state, national and international levels which support and complement the AEMP. Internationally the Ramsar Convention provides an outline for the conservation and wise use of wetlands and their resources. The Convention on Wetlands of International Importance, generally known as the Ramsar Convention, refers to an intergovernmental treaty made during a wetlands convention held in Ramsar, Iran, in 1971. About 19,000 hectares of private and public land are collectively listed as the Macquarie Marshes Ramsar site and Australia is responsible for maintaining the ecological character of this site. Under the Ramsar Convention, Australia is also obliged to develop national water and land use policy to achieve wetland conservation. Nationally, the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides protection for matters of national environmental significance, including the ecological character of declared Ramsar wetlands. The EPBC Act also establishes a framework for managing Ramsar wetlands.

The Wetlands Policy of the Commonwealth Government of Australia was developed in 1997. The goal of the policy is 'to conserve, repair and manage wetlands wisely.' The NSW Wetlands Management Policy 2010 also identifies the 'active restoration' of degraded wetlands and their habitats as a key principle. The AEMP is consistent with both these policies as it highlights the current degradation of the marshes but at the same time identifies the continuing values and provides an objective baseline for restoration activities.

At a basin scale, the Commonwealth *Water Act 2007* provides for the Murray–Darling Basin Authority to develop a Basin Plan which will establish sustainable diversion limits for each of the basin's water sources, including the Macquarie River. The definition of assets and their watering needs within the AEMP will inform the Basin Plan. The Basin Plan will include an environmental watering plan to guide the management of environmental water.

The *Water Act 2007* also established the Commonwealth Environmental Water Holder to manage the Commonwealth's environmental water to protect or restore the environmental assets of the Basin so as to give affect to international agreements.

At a statewide scale, the Water Sharing Plan for the Macquarie-Cudgegong Regulated Rivers Water Source (2003) is the legal document made under the *Water Management Act 2000*, which provides for water for the environment and directs how the available water for extraction in the Macquarie–Cudgegong is to be shared. Other state legislation assists in the protection of elements of the marshes including the *Native Vegetation Act 2003* which signalled an end to broadscale clearing. This Act has importance in conserving vegetation throughout the greater marshes area, including the semi-permanent wetland vegetation listed within the AEMP.

The *Threatened Species Conservation Act 1995* (TSC Act) aims to protect threatened species, populations and ecological communities and their habitats. A number of threatened species are mentioned within the AEMP, including coolibah–black box woodlands and myall woodlands, and their protection under the TSC Act is outlined. The *Fisheries Management Act 1994* (FMA) has relevance to aquatic species, aiming to conserve threatened species, populations and ecological communities of fish and marine vegetation. Silver perch and the aquatic ecological community of the natural drainage system of the lowland catchment of the Darling River are listed under the FMA and are included as assets in the AEMP.

At a regional level, the Central West Catchment Management Authority's catchment action plan identifies 12 broad catchment targets for natural resource management. Actions within the AEMP complement these targets, and the Central West CMA will assist DECCW to review the implementation of the AEMP on an annual basis.

The NSW Wetland Recovery Program (NSW WRP) is funded by the NSW and Australian governments to deliver permanent benefits to the Macquarie Marshes and Gwydir Wetlands by restoring and protecting critical ecological functions and habitats. This AEMP for the Macquarie Marshes has been developed under this program and is complemented by the NSW RiverBank Program and the Rivers Environment Restoration Program (RERP) funded by the NSW and Australian governments. Collectively, NSW WRP, RiverBank and RERP include significant planning, water purchase, research, infrastructure development and land management projects.

The AEMP is not a statutory document, and will require support from the NSW and Australian governments, and local people, for its implementation. The Department of Environment, Climate Change and Water is the lead agency for implementing the plan within NSW. The Central West CMA's catchment action plan will be responsive to much of the information and many of the recommendations in the plan.

1.3 The plan: expectations and structure

The NSW and Australian governments have the following 10 clear expectations for the plan:

1. Define the ecological assets and values to be protected and establish condition benchmarks.
2. Define desired ecological outcomes.
3. Identify water requirements (volume, timing, duration, frequency and security) for meeting ecological outcomes.
4. Identify activities to address the effects of land- and water-management practices on the wetlands.
5. Identify methods to enable stakeholders to be included in managing the river and wetlands.
6. Recognise Aboriginal cultural values in managing and planning for the Macquarie Marshes and Macquarie River, and provide recommendations to enable Aboriginal people to reconnect with Country.
7. Integrate different disciplines of study and sources of knowledge to start developing an understanding of the entire system.
8. Provide advice about how to build community ownership of scientific research and knowledge.
9. Provide advice about monitoring, evaluating and reporting management activities and the system's condition.
10. Identify requirements for adaptive management.

The plan identifies ecological assets and values defined from a review of the ecological system, ecological outcomes and the water requirements to achieve them. It lists ecological and social issues, includes a brief description of water-management infrastructure, policies and procedures, refers to natural climatic variability and how climate change affects water availability, and provides details of Aboriginal cultural values. Finally, in providing implementation guidelines, it identifies who has to be informed and involved and who is responsible for administering and implementing the plan.

1.4 The Macquarie Marshes

The Macquarie River is a large, regulated river in the Murray–Darling Basin with a catchment of about 75,000 square kilometres. The river rises on the western side of the Great Dividing Range, south-east of Bathurst, and flows for about 500 kilometres north-west and north before joining the Barwon–Darling River in northern New South Wales, as shown in the map in Figure 1.1.

Figure 1.1 Location of the Macquarie catchment in the Murray–Darling Basin.

The Macquarie River's main tributaries enter the river upstream of Narromine, and most are upstream of Burrendong Dam, the river's largest water storage (DWR 1991). As the Macquarie River flows on to the Darling Riverine Plain, downstream of Narromine, it develops distributary streams and extensive floodplain wetlands (WRC undated). These streams flow north and north-west and join the Bogan and Barwon–Darling rivers. The main Macquarie River channel forms the Macquarie Marshes about 50 kilometres north of Warren. The marshes extend for about 120 kilometres to near Carinda, as shown in the map in Figure 1.2.

The Macquarie Marshes are a large and diverse wetland system that is the core of the traditional country of the Wailwan people. They marshes were an important location for traditional Aboriginal settlement in this dry region because they contained rich and reliable resources. The wetlands, and the specific places and the plants and animals that the wetlands supported, held an important place in the Aboriginal cultural world. Since European settlement, the marshes have continued to be important for Wailwan and other Aboriginal people.

In 1882, the NSW Government declared parts of the marshes a water reserve, and in 1900, the government gazetted a reserve for game preservation in the marshes (NSW Government 1900). In 1902, landholders on the lower Macquarie River formally expressed their concerns about the effects of development on the marshes (Royal Commission 1902; Sinclair Knight and Partners 1984). In the 1940s, the NSW Government established the Macquarie Marshes Investigation Committee to plan for the protection of the marshes after Burrendong Dam was built (Cooper 1949; MMIC 1951; Johnson 2005).

The values of the marshes are now recognised formally at all levels of government in Australia, including in the Coonamble Local Environmental Plan and the Ramsar Convention. Parts of the marshes are listed as a nature reserve under the *NSW National Parks and Wildlife Act 1974*. They are included in the *Directory of Important Wetlands in Australia* (Australian Nature Conservation Agency 1996) and as areas of conservation importance by the National Trust of Australia and the Australian Heritage Commission (NPWS 1993). The floodplain wetlands are recognised in the migratory bird agreements that Australia has made with Japan, China and Korea (Kingsford & Auld 2005).

For the purpose of this plan a wetland is defined as under the Ramsar Convention as:

> *'Areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres'*
> *(Ramsar Convention 1971).*

These marshes include a variety of wetland types, ranging from semi-permanent marshes and lagoons to ephemeral wetlands that are inundated by only the largest floods (Keyte & Johnson 1999). The core areas of semi-permanent wetland are typified by river red gum forest and woodland and large areas of common reed (reedbeds), tall grassland and water couch low-grassland, which are inundated by overbank and overland flooding from many small channels.

Ephemeral wetlands include coolibah and black box woodlands (Paijmans 1981; DLWC & NPWS 1996). The marshes have supported some of Australia's largest waterbird breeding events and provide essential habitat for hundreds of species of animals and plants (Kingsford & Johnson 1998; Jenkins & Wolfenden 2006). Their role in absorbing, recycling and releasing nutrients and in trapping sediment is especially valuable. The marshes are an important refuge for wildlife during dry times.

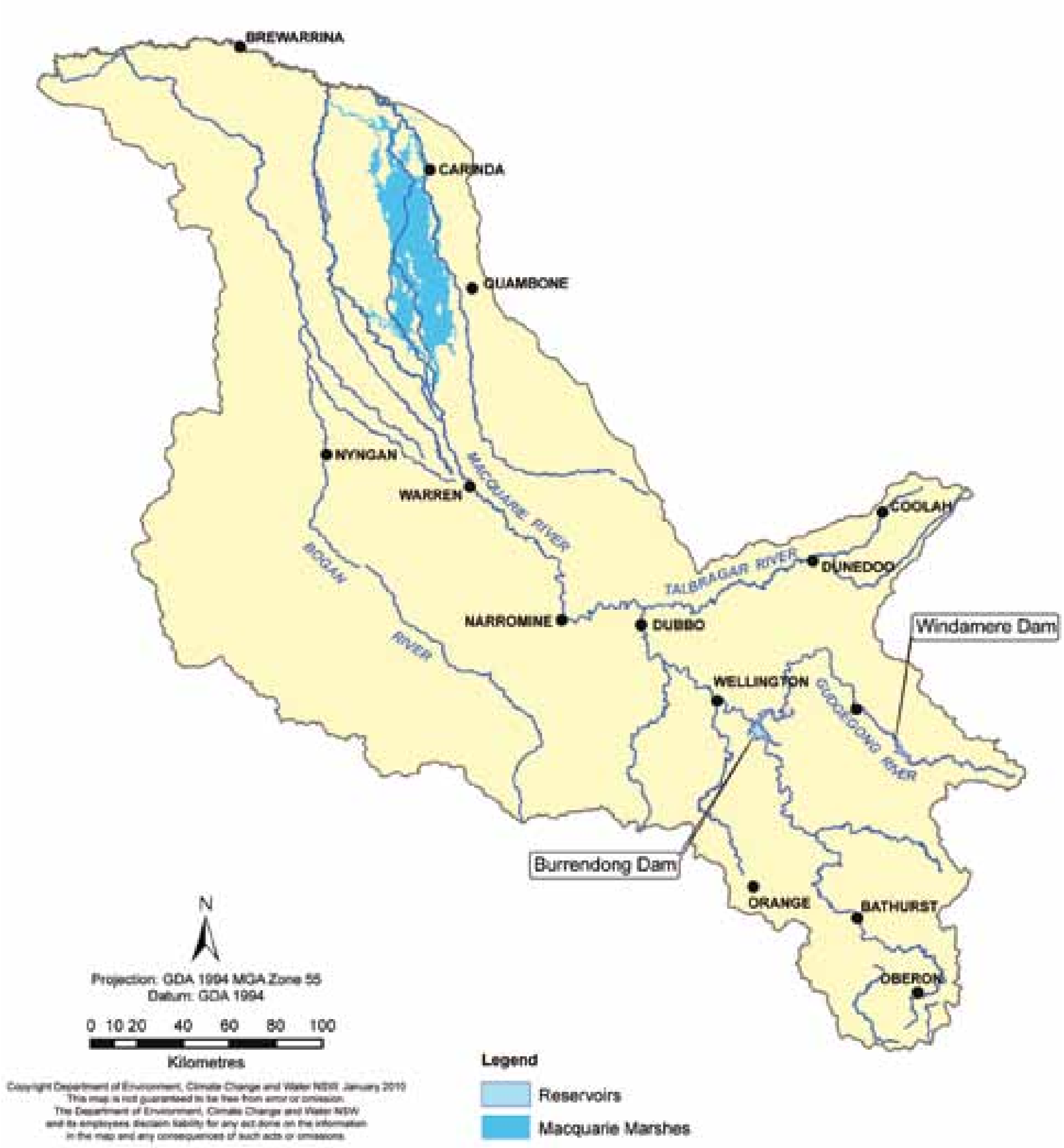

Figure 1.2 The Macquarie River catchment.

1.5 Ecological systems

An ecosystem is a basic functional unit of nature. It comprises both organisms and their non-living environment and is linked by a variety of biological, chemical and physical processes. A general definition of an ecological system, or ecosystem, is a dynamic system of local ecological relationships, including relationships between organisms and between organisms and their environment. An ecosystem includes humans if they are present in the system (Barnhart 1986; Meffe et al 2002).

The Macquarie Marshes ecosystems include the plants and animals, places, the processes or relationships between the different parts of the system, and functions such as flooding, drying and nutrient cycling that are the foundations of the marshes and contribute to their ecological character. The river system outside the marshes must also be considered. Managing the marshes requires consideration not only of the defined ecosystem but of the Macquarie catchment and the hydrology and geomorphology of the river and the floodplain.

Much is known about the key ecological components of the marshes, their structure, including their biological, physical and chemical make-up, what they look like, where they are and the nature of different parts of the overall system. However, there is much less detail about their ecological processes and functions, and how the different parts interact and change in time. Knowledge of both structure and function is necessary for adaptive management.

Like most other major rivers in the Murray–Darling Basin, the Macquarie has been highly regulated since the mid–20th century (Mussared 1997; Young 2001). The valley's social systems depend on the regulated river and the relatively reliable water supply it provides (DWR 1991). Managing the marshes and river requires sound information about their social systems and their ecosystems.

1.6 Aboriginal cultural values

Aboriginal cultural values are related to the history of Aboriginal interaction with the marshes, and to the values, interests and aspirations of contemporary Aboriginal communities that have a custodial relationship with the marshes. Aboriginal cultural values are related to specific places, plants and animals, and to the landscape as a whole. The Aboriginal ethos of 'caring for Country' can assist with sustainably managing wetlands through its emphasis on the connections between people and the natural world and the sense of responsibility of caring for the natural world.

The NSW Government is committed to protecting Aboriginal cultural values of wetlands and to working in partnership with Aboriginal communities in managing and conserving the environment (DAA 2003; DECC 2006). The three main elements of protecting and strengthening cultural values in the Macquarie Marshes are:

1. Acknowledging Aboriginal connection to Country.
2. Protecting Country by maintaining the health of the wetlands, protecting sites of Aboriginal cultural heritage, and protecting plants and animals that have cultural values.
3. Improving access to Country for cultural activities, facilitating working on Country, and increasing participation of Aboriginal people in managing the environment.

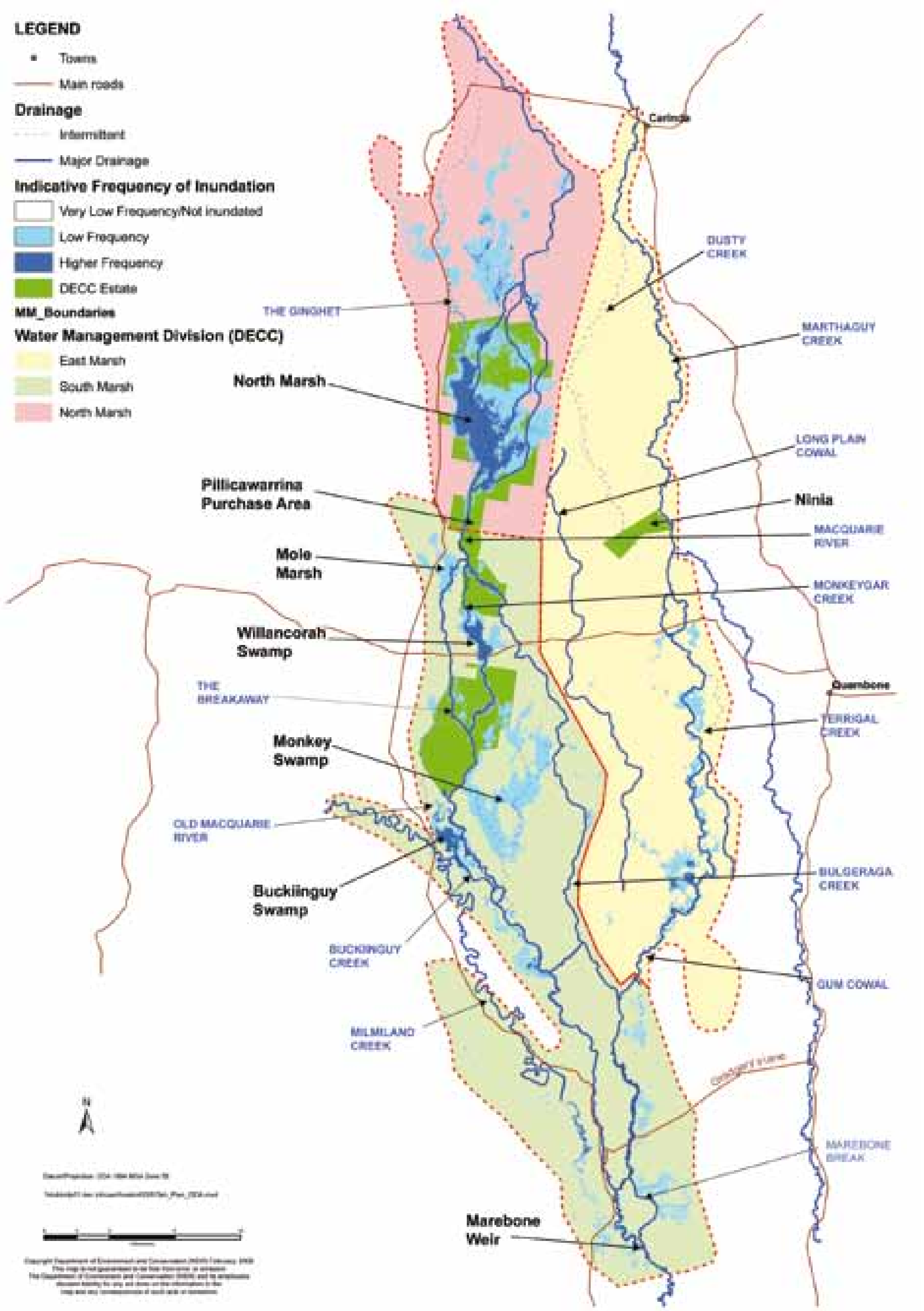

Figure 1.3 Streams, locations and water management divisions in the marshes.

1.7 Economic activity

The Macquarie catchment comprises some of the more agriculturally diverse rural landscapes in central NSW, and includes cultivation of a wide range of intensively farmed and broad-acre crops. The catchment also encompasses a relatively large range of urban centres as well as many smaller traditional rural service centres (Argent et al 2007).

Consistent with regional areas throughout Australia, the catchment has shown signs of demographic decline relative to the rest of NSW. Population has not grown at the same rate, and youth out-migration has led to a faster rate of ageing of the catchment's population. According to economic indicators, compared with NSW as a whole, the catchment has a stronger dependence on agriculture for employment, higher rates of unemployment and lower income levels (Hassall & Associates 2007a).

These trends are not uniform throughout the catchment. Compared with its more accessible communities in the higher rainfall areas to the east, its more remote communities have a much greater dependence on agriculture. Larger regional centres in more accessible areas tend to have a broader economic base that includes more people in professional and managerial occupations and fewer people in more vulnerable, less skilled occupations, so the larger centres are less dependent on agriculture. Also, compared with smaller, more remote settlements, larger centres have higher individual incomes and are less affected by youth out-migration (Argent et al 2007).

1.7.1 Agriculture and other industries

In 2005–06, the total agricultural output for the Macquarie catchment was worth $400 million, 57 per cent of which was attributable to crops and 43 per cent to livestock. In the same financial year, fruit and vegetables contributed an extra $17 million (ABS 2006a).[1] In 1996–1997, the manufacturing sector had a turnover of $355 million (based on figures reported for the Dubbo, Wellington and Mudgee LGAs). Tourism also made a significant contribution: in the June 2006 quarter, accommodation takings (for Dubbo, Narromine and Mid-Western Regional LGAs) were $8.5 million (Hassall & Associates 2007a).[2]

In relation to employment, in 2006 the retail trade sector was the largest employer, accounting for 12.3 per cent of total employment, followed by agriculture, forestry and fishing (12 per cent); health care and social assistance (11.4 per cent); education and training (8.4 per cent) and manufacturing (7.1 per cent). Over time, the importance of agriculture has declined both absolutely and relatively. Between 1996 and 2006, although the number of people employed in the catchment increased, the number of people employed in the agriculture, forestry and fishing sector declined. That sector's share of total employment also declined, from 15 to 12 per cent – the largest decline of any sector. The largest gains in the share of employment were in health care and social assistance (1.7 per cent), public administration and safety (1.4 per cent) and construction (1.2 per cent) (ABS 1996, 2006b).

1. This section of the Macquarie catchment comprises the Brewarrina, Dubbo, Mid-Western Regional, Narromine, Warren and Wellington LGAs, which essentially run down the centre of the catchment along the Macquarie River and include most of the area of irrigated agriculture. This area is smaller than the official Macquarie catchment area. Unfortunately, the LGA boundaries do not match the official catchment boundaries. Comparable statistics have been compiled for a larger area that comprises a number of other LGAs, which are only partially included in the official Macquarie catchment boundary.

2. Data for other LGAs was not available from ABS (2007) NSW Regional Statistics.

1.7.2 The irrigation industry

Cotton is the dominant irrigation enterprise in the lower catchment. Cereal, pulse and oilseed cropping also occurs. These crops can be watered on a limited scale, especially cereals (such as wheat) and chickpeas. However, there are few alternatives to irrigated cropping that generate the gross income associated with cotton (Hassall & Associates 2007b).

Irrigated enterprises are highly spatially concentrated in the catchment.[3] In 2000–01, irrigated agriculture was worth $255 million and accounted for slightly less than half the total value of agricultural production in the catchment (Hassall & Associates 2007a).

1.7.3 Cotton production

Although the irrigated cotton industry grew significantly during the 1980s and 1990s, the momentum of the growth has slowed as a result of recent dry climatic conditions and relatively more favourable price movements for other commodities. According to ABS figures for 1996–1997, almost 60,000 hectares were irrigated each year from all sources of water, that is, groundwater, regulated and unregulated supplies, farm dams and supplies of reticulated water.

In 2000–01, cotton accounted for 69 per cent of all irrigated agriculture in the catchment. By 2005–06, cotton's share of the irrigated area had declined to 38 per cent. This decline corresponded to a reduction in the area of cotton from 50,760 hectares in 2000–01 to 15,125 hectares by 2005–06 (ABS 2001, 2006a). Commensurate declines in water use by the cotton industry have also occurred since 2000, and reflect dry conditions and reduced irrigation allocations. Despite this, per-hectare yields have been increasing. Possible reasons for this increase include an increased emphasis on management when the industry is facing limited water availability and technological change in the industry (Hassall & Associates 2007b).

Cotton processing also contributes to the regional economy. Four cotton gins operate in the Macquarie catchment. Each is reported to employ 30 people on average during the cotton ginning season, which lasts three months a year (Australian Government 2007; Hassall & Associates 2007a). A fifth gin was built near Carinda, although it has not operated since the early 2000s.

Australia's cotton production is forecast to increase to 374,000 tonnes in 2009–2010, up from the low 2007–08 harvest of 132,000 tonnes, which was the smallest since 1982–1983. The world cotton indicator price (the Cotlook 'A' Index) continues its slight rising trend over the last five years with prices up from US41.8 cents per pound in 2001-2002 to a forecast price of US74 cents per pound in 2009–2010. (ABARE 2009).

Cotton could be substituted for other crops if prices change significantly. Recent dry times have led to other crops being identified as options during times of low water availability and high prices for feed grains. These options include the development of grain-based (sorghum or corn) ethanol production in Australia, which has lower per-hectare water requirements. Any shift would depend on factors such as commodity prices, management expertise, and infrastructure and equipment exchangeability (Hassall & Associates 2007b). To date, there has been little evidence that a long-term change will occur in the cropping patterns in the catchment.

3. For example, irrigated cotton is produced in only the Warren and Narromine LGAs.

1.7.4 The grazing industry

Agricultural land in the marsh region is also valuable for livestock grazing, especially in areas where pastures are more frequently flooded. The Dubbo, Brewarrina, Wellington and Mid-Western regional LGAs all differ from Warren and Narromine in that they have much less crop production and higher levels of livestock production.

In 2005–06, the catchment's livestock slaughterings and products were worth $173 million (ABS 2006a).[4] Compared with earnings from cropping – both irrigated and dryland, but especially compared with irrigated agriculture – these earnings are spread more evenly throughout the catchment. Cattle and calves provided the largest number of livestock slaughterings ($71 million), followed by sheep and lambs ($36 million). Wool provided by far the largest contribution to livestock products ($53 million).

1.8 The past and present condition of the marshes

Because the Macquarie Marshes are changeable, it is difficult to decide on a date for a baseline condition to compare with the existing condition. The marshes have been in their present location and maintained their general wetland state for the past 6000 to 8000 years, and evidence of landscape change is available for both pre-European and post-European periods (Yonge & Hesse 2007; Ralph 2008).

The Macquarie Marshes were an important focus of settlement for Aboriginal people in traditional times. The Wailwan people had a relatively small country compared to the larger nations that surrounded them – the richness of the marshes as a resource base might account for this. The marshes provided rich and reliable wetlands, floodplains with riverine forests and grasslands, and elevated sandy ridges. Given the richness offered by these resources, the Wailwan would have held an important place in the overall region, between the arid Darling river country to the north and west and the slopes and ranges to the south and east.

Grazing of domestic animals and establishment of cattle stations began in the 1830s. Although irrigated agriculture began in the South Marsh in the 1840s, it was not until Burrendong Dam was completed in 1967 that large-scale irrigation began. By the 1990s, irrigated agriculture on the lower Macquarie floodplain had reached its peak in both area and water use (MRAC 1994).

In 1986 the Macquarie Marshes Nature Reserve was listed as a Ramsar site. In passing the *Environment Protection and Biodiversity Conservation Act 1999*, the Australian Government established a framework for managing Ramsar wetlands. The framework includes an ecological character description and a report about the area's condition at the time of listing. For the period 1981–91, reliable information exists about waterbird breeding, vegetation, geomorphology and hydrology, from studies undertaken in the marshes (Paijmans 1981; Wilson 1992; Kingsford & Johnson 1998), and we can use the information to assess the baseline condition at the time of Ramsar listing of the nature reserve.

4. Again, this area comprises the Brewarrina, Dubbo, Mid-Western Regional, Narromine, Warren and Wellington LGAs, which essentially lie down the centre of the catchment along the Macquarie River and include most of the area of irrigated agriculture. This is a smaller area than the official Macquarie catchment area.

The Macquarie Marshes Water Management Plan (DLWC & NPWS 1996) uses flood patterns and vegetation types to define the marshes and included areas inundated by flows from the Macquarie River and its streams and anabranches, specifically the Macquarie River, Marebone Break, Bulgeraraga Creek, Buckiinguy Creek, Monkeygar Creek, the Old Macquarie River, the Bora Channel, the Ginghet, Mullins Swamp, the Gum Cowal–Terrigal Creek to its confluence with Marthaguy Creek, Long Plain Cowal and Dusty Swamp (DLWC & NPWS 1996). The water management plan gives a figure of approximately 150,000 hectares for the study area, consisting of 72,000 hectares of semi-permanent wetland, 59,000 hectares of ephemeral wetland and 23,000 hectares of dryland vegetation within the boundary (Wilson 1992).

The ecological condition of the marshes has declined since the Ramsar listing in 1986, and since 2000 the decline has been accelerating (Bacon 1996, 2004; Summerell 2004). Similarly, much of the semi-permanent wetland identified in the 1996 management plan is in poor condition, or no longer present (Bowen & Simpson 2010). The specific decline in condition at the Macquarie Marshes Ramsar site was acknowledged in July 2009 when the Australian Government submitted a notification of likely change in ecological character at the site in accordance with Article 3.2 of the Ramsar Convention. In order to stabilise the condition of the marshes under both existing and predicted climatic conditions, their existing condition must be used as the base to work from. This will need a precise and systematic approach to managing water, including improved delivery, measurement and reporting on managing environmental and extractive water. This plan, by identifying ecological values and assets and the water needs of those assets, will guide priority setting for managing water in the marshes. The plan will also provide the broader catchment scale context for the development of the Macquarie Marshes Ramsar site 3.2 Notification Response Strategy. When completed, the response strategy will set out actions aimed at responding to the change in ecological at the Ramsar site.

2 The ecological assets and values of the marshes

The ecological assets and values of the marshes are defined in this plan as the ecological components, processes, functions and sites of significance known to contribute to the essential character of the Macquarie Marshes. The assets selected serve as indicators for the health of the whole ecosystem. When semi-permanent wetlands and waterbirds are flourishing, it is because ecological functions and processes are in place. The animals, plants and wetland ecosystems noted here also hold important Aboriginal cultural values.

The ecological assets defined in the plan are as follows:

1. Waterbirds and waterbird habitat: the marshes are renowned for large-scale waterbird breeding with many tens of thousands of birds breeding throughout the whole system.
2. Semi-permanent wetland vegetation: this vegetation is typified by river red gum forest and woodland and by common reed and water couch grasslands.
3. Species and communities of special significance: these species and communities include threatened species; endangered ecological communities and species of conservation concern, including the aquatic ecological community; silver perch; coolibah, black box and myall woodlands; woodland birds and red-bellied black snakes.

Assets are described in each of these three categories. The marshes are then described in terms of the assets and values on the basis of their water supply and their geomorphological and management boundaries – the North Marsh, South Marsh and East Marsh, as shown in the maps in Figure 1.3.

Water is sometimes defined as an asset as well as the driver and supporter of other assets (Torrible et al 2008). In this plan water is treated separately as the unifying element of the Macquarie River's ecological and social systems. Water supports, organises and drives the functions and processes of the marshes, as well as the Macquarie Valley's agricultural and social systems. The frequency, duration, extent of inundation and quality of the water determine the character of the marshes (Poff et al 1997; Puckridge et al 1998).

Wetland processes and functions are not described specifically in this plan. Ecological processes are dynamic forces within ecosystems. They include all the changes or reactions that occur between organisms, and within and between populations and communities, including interactions with the non-living environment that shape ecosystems. They may be physical, chemical or biological (Ramsar Convention 1996; Australian Heritage Commission 2002). Ecological functions are activities or actions that occur naturally in wetlands as a product of the interactions between ecosystem structure and processes. Functions include flood control, connections between river channels and floodplains, nutrient, sediment and contaminant retention and dispersal, erosion control, habitat provision, food web support, water quality maintenance and improvement, erosion control and stabilisation of local climatic conditions, particularly rainfall and temperature (Ramsar Convention 1996).

Wetland functions and processes and their interactions are poorly understood. Expanding our understanding from knowledge of structure to knowledge of function and processes is important work. Research into carbon metabolism and nutrients is underway in the marshes and will be finalised in late 2010. It will help determine indicators and thresholds for functions and processes.

2.1 Waterbirds and waterbird habitat

The Macquarie Marshes are recognised as a refuge for waterbirds during dry times and for supporting some of Australia's largest recorded waterbird breeding colonies (MMIC 1951; Marchant & Higgins 1990; Kingsford & Auld 2005). Seventy-six waterbird species have been recorded in the marshes, and 44 of these species have been recorded breeding (Kingsford & Auld 2003). Included are species listed as being threatened both in NSW and nationally, and the only NSW breeding record for the pied heron.

The ecological requirements of breeding waterbirds in the marshes are known at a structural level. Information exists about the wetland vegetation and the materials required for most species' nesting sites. The flow size, timing and duration are known for different sized breeding events. Food required by breeding waterbirds is known, and there is some information about what happens to both adult and young birds after breeding (Kingsford & Auld 2005).

Of the waterbirds that breed in the marshes, colonial nesting species are prominent, and have been the most studied. Sixteen species have been recorded breeding, with the great egret, intermediate egret, little egret, nankeen night heron, glossy ibis, Australian white ibis, straw-necked ibis, little pied cormorant and little black cormorant occurring in the largest numbers (Kingsford & Thomas 1995; Kingsford & Auld 2005; Jones 2009).

Between 1986 and 2001, colonially nesting species bred in 10 years at 14 sites throughout the marshes (Kingsford & Auld 2003). By 2008 several of the known breeding locations were considered to be in poor condition due to both lack of water and grazing pressure. Since 2001, only one breeding event of colonially nesting waterbirds has occurred in the marshes. In 2008, a relatively small flood supported a successful nesting of about 2000 pairs of egrets in river red gum forest on the Bora Channel. This nesting was unpredicted because flows were lower than the threshold previously considered necessary to stimulate breeding, and it was the first record of colonially nesting waterbirds breeding at only one location in the marshes (Jones 2009). Environmental water was delivered to the site of this colony to ensure water levels were maintained at a sufficient level to sustain the breeding event.

The Macquarie Marshes were long known for providing waterbird habitat that served as a refuge during dry times (MMIC 1951). Waterbird habitat components include preferred locations and vegetation for shelter and nest sites, the water needed to flood breeding sites and feeding areas, and the availability of preferred food items. Most sites are located in semi-permanent wetland vegetation types, requiring regular, frequent and prolonged flooding (Kingsford & Auld 2005). Managed environmental flows will be critical for their maintenance and, in some cases, their restoration.

Photo 1 An intermediate egret steps onto a nest in a river red gum in the Bora Creek colony of the northern nature reserve (W. Johnson).

Large-scale waterbird breeding events in the marshes – more than 40,000 nests – indicate the whole ecological system is functioning. Numerous management issues are affecting the ecological system's ability to support large waterbird breeding events. Most of these issues are related to the flow regime, but others include the effects of grazing, clearing, fire, pests and a limited understanding of the complexity of a system such as the marshes.

The minimum requirement for colonially nesting waterbirds to breed successfully is flooding of a sufficient volume and duration for colony sites and feeding areas to be inundated for a minimum of four to five months between August and March (DECCW unpublished reports). These flows are also critical both for maintaining wetland vegetation and for completing the life cycles of aquatic invertebrates (Jenkins & Wolfenden 2006). Although smaller flows do not generally support successful colonially nesting waterbird breeding, they do enable other flood-dependent waterbird species to breed (Marchant & Higgins 1990; Jones 2009).

2.2 Semi-permanent wetland vegetation

Semi-permanent wetland vegetation in the marshes requires regular, frequent and prolonged flooding. Some species and communities have specific legislative protection, and some plants – such as river red gum, river cooba, cumbungi and nardoo – have iconic Aboriginal cultural values. The extent and condition of semi-permanent wetland vegetation in the Macquarie Marshes have been declining since the 1930s (Paijmans 1981; Brander 1987; Goodrick et al 1991; Bowen & Simpson 2010) with many communities recently being colonised by chenopod shrubs *Sclerolaena muricate* and *Salsola kali* (black roly poly and soft roly poly or buck bush).

2.2.1 River red gum forest and woodland

River red gum forests and woodlands are widespread in Australia and occur most commonly in narrow bands fringing watercourses. About 50 per cent of their pre-European extent remains in western NSW (Benson 2006). They support critical ecological functions and provide waterbird nesting sites and habitat for many animals, including woodland birds.

River red gum forest and woodland is a distinctive part of the character of the marshes. The river red gum forest community has a denser canopy and occurs mostly in the channel country of the North Marsh. It usually has a wetland understorey that includes aquatic species, reed, rushes and sedges; it is described as inland riverine forest (Paijmans 1981; Keith 2004). The river red gum woodland community is less dense in canopy and occurs between the main channels in less frequently flooded areas. It has mostly grass and forb species in the understorey (Paijmans 1981). About 40,000 hectares of river red gum forest and woodland were mapped in the marshes in 1991 (Wilson 1992). Some areas were under stress at the time, mainly due to lack of flooding (Bacon 1996).

Although the extent of river red gum forest and woodland has remained relatively constant since 1991 (38,428 hectares in 2008), the condition of large areas has changed due to insufficient flooding. Most areas of river red gum woodland now have an understorey dominated by the chenopod shrubs (Bowen & Simpson 2010). By 2004, up to 30 per cent of trees that had been listed as stressed in 1996 had died (Bacon 1996, 2004).

The general water requirements of river red gum forest and woodland are that they be inundated in winter, spring or summer every one to three years (Robertson et al 2001) and that inundation lasts for a minimum of four to seven months but for no longer than 24 months. The key requirement is cycles of flooding and drying that enable soil aeration and water penetration into the root zone.

Photo 2 River red gum woodland in Bora Creek, northern marsh nature reserve, including aquatic plants in the foreground and water couch, cumbungi and common reed in the background (W. Johnson).

Photo 3 River red gum in the northern marsh nature reserve (W. Johnson).

2.2.2 Common reed tall grassland

Extensive stands of common reed (reedbeds) are a distinctive part of the Macquarie Marshes' character. The area of common reed mapped in 1991 was 4780 hectares (Wilson 1992). By 2008 this area had declined to 2202 hectares (Bowen & Simpson 2010). Common reed tolerates a range of flood frequencies, from permanent to infrequent inundation. To maintain vigour, surface flooding is required every one to two years (Roberts & Marston 2000). Expansion and regeneration for common reed is more effective from rhizomes than from seed (Weisner et al 1993; Roberts & Marston 2000). Germination and seedling requirements for common reed in Australia are mostly unknown but seed germination is better in moist rather than waterlogged conditions. If large stands are lost they could be difficult to restore due to the relatively low success of recruitment from seed. In the marshes, common reed is a habitat for many waterbirds and provides nest platforms for large breeding colonies of ibis as well as for Australasian bitterns.

2.2.3 Water couch grassland

Extensive water couch grasslands have been mapped in the marshes (Paijmans 1981). Wilson (1992) mapped 5500 hectares. These marsh grasslands have declined in area and condition, such that some have been colonised by roly poly and buck bush or are now mapped as 'mixed marsh'. The area of water couch mapped in the marshes in 2008 covered 420 hectares with only 53 hectares (12 per cent) of this being in good condition. The remaining 367 hectares was invaded by chenopod shrubs (Bowen & Simpson 2010). Water couch is a prolific seeder but the success of seed germination is limited and it can regenerate more successfully from fragments or buried nodes (Middleton 1999). If this is the case, loss of water couch from large areas might lead to its failure to recover quickly, because its regeneration depends on the presence of mature, healthy plants that have trailing stems. Water couch marsh grassland is considered by Benson to be an endangered community (Benson 2006).

To maintain vigour, water couch generally needs flooding in spring or summer at least once a year (Bennett & Green 1993). Flooding can be continuous for four to six months or longer, or can come in two or three separate, shorter events (Blanch et al 1999). Water couch can recover from a one- to three-year dry spell but cannot tolerate extended or frequently repeated dry periods. Spring and summer flooding is important (Roberts & Marston 2000).

When water couch is water stressed – that is, when it is dry – it does not tolerate grazing well. When it is underwater, it does not tolerate persistent grazing. However, according to recent research, under suitable flow conditions, grazing can be a contributing factor in maintaining water couch's dominance in grassy wetland communities (Wilson et al 2008).

In the summer and autumn of 2007 and 2008, widespread rain and some flows into the marsh that maintained inundation for more than three months in the summer and autumn of 2007 and 2008 supported a rejuvenation of water couch grassland in Willancorah Swamp, River Paddock in the North Marsh, and parts of the Gum Cowal–Terrigal Creek system (R. Jones pers. comm.).

2.2.4 Lignum shrubland

Lignum occurs throughout the marshes as an understorey plant but exists as a shrubland in only a few areas. Lignum provides valuable habitat for waterbird breeding, especially for ibis. Approximately 2800 hectares of lignum shrubland were mapped in 1991 (Wilson 1992). About 1000 hectares of lignum shrubland were cleared between 1991 and 2008, with about 300 hectares remaining in the marsh in 2008 (Bowen & Simpson 2010). Lignum shrubland is considered by Benson to be vulnerable (Benson 2006).

Lignum shrubland occurs in areas flooded at frequencies of once in two to ten years for durations of three to 12 months. The optimal flood times for growth and recruitment are spring and summer so as to maintain soil moisture (Young et al 2003). Lignum responds rapidly to flooding by producing an abundance of shoots, leaves, flowers and seeds. Seeds ripen quickly, disperse on floodwaters and germinate under moist soil conditions. To maximise seed germination, seeds settle in moist, but not flooded, soil within approximately eight weeks of flower development (Chong & Walker 2005).

Photo 4 (Top to bottom): Common reed, river red gum forest and woodland, lignum shrubland, and coolibah woodland in the northern marsh nature reserve (W. Johnson).

2.2.5 River cooba

Little is known about the ecology of river cooba. In the marshes it is found in the Marebone area, parts of the North Marsh and along the Gum Cowal–Terrigal Creek, often in association with river red gum or lignum. It provides valuable nesting habitat, especially for colonially nesting species (Kingsford & Johnson 1998; Kingsford & Auld 2005). Most of the remaining river cooba community is in poor condition. In 2008, 2614 hectares of river cooba was mapped in the Macquarie Marshes and many areas were invaded by chenopod shrubs (Bowen & Simpson, 2010).

2.3 Species and communities of special significance

This category contains threatened species, endangered ecological communities and species of conservation concern, including the aquatic ecological community; silver perch; coolibah, black box and weeping myall woodlands; woodland birds; and red-bellied black snakes.

2.3.1 The aquatic ecological community

The aquatic ecological community of the Macquarie Marshes, which is part of the natural drainage system of the lowland catchment of the Darling River, is listed under the *NSW Fisheries Management Act 1994* as an endangered ecological community (NSW Government 2005). This community includes all the area's native fish and aquatic invertebrates as well as the natural rivers, creeks, lagoons, billabongs, wetlands, lakes, tributaries and anabranches in which they live. The need exists both ecologically and legislatively to protect and restore the community.

Under the *NSW Fisheries Management Act 1994*, the key threatening processes or issues listed that affect the Macquarie Marshes aquatic ecological community are in-stream structures and other factors that alter natural flow, degrade native riparian vegetation and favour exotic species.

Photo 5 Wavy marshwort (W. Johnson).

2.3.2 Silver perch

Silver perch is listed as a vulnerable species in NSW under the *NSW Fisheries Management Act 1994*. This species inhabits warm, sluggish, standing waters with cover provided by woody debris and reeds as well as fast-flowing, turbid waters (Koehn & O'Connor 1990). Little is known about silver perch's ecological requirements in the wild, although some information is available from breeding in captivity. Recruitment of silver perch seems to be localised and opportunistic (Morris et al 2001). Although spawning can occur during non-flood conditions, spawning activity and recruitment success can be significantly increased during floods and higher flows. The larvae and juveniles use floodplain habitats. The adults and juveniles feed on small aquatic insects, molluscs, earthworms and green algae, and the larvae feed on zooplankton (Merrick 1996). In a formal survey undertaken in 2008, silver perch was recorded in the marshes for the first time since 1989 (S. Davis pers. comm.).

All native fish species in the Macquarie Marshes and lower Macquarie River typically recruit during spring and early summer. During this critical time, appropriate flows are needed for spawning so that eggs can be protected and larval and juvenile fish survival can be promoted. For most species, warmer temperatures are important during this period. It is vital that flow conditions be suitable during these critical larvae rearing stages and that the summer irrigation flows which follow be reduced so that larvae and prey are not washed out from nursery habitats (Humphries et al 2002). If late winter and spring floods were restored, conditions would be optimal for adult fish to feed and grow before they spawned (Humphries et al 2002) and floodplain habitats would have a rich supply of food for larval and juvenile fish (Gehrke et al 1995).

Many changes to the condition of the river have contributed to the degradation of native fish habitat. River regulation has changed the flow conditions that many native fish depend on. Changing flow patterns and degraded riparian zones increase bank erosion, turbidity and sedimentation within channels, filling pools and smothering habitats that include macrophytes, woody debris and gravel substrates (MDBC 2003). Constant low flows reduce ecosystem productivity by removing the boom (wet) and bust (dry) cues that trigger and sustain aquatic cycles (Poff et al 1997; Ward 1998). Other threats include increased contaminant runoff, competition with introduced species and structures in the river that act as barriers to movement (MDBC 2003).

Some structures are a direct threat to fish. Fish larvae are usually poor swimmers, and they travel with currents. Larval and juvenile fish are directly extracted from the river when water is pumped for irrigation and town water supply. Collaborative research is being undertaken between NSW DPI, the Australian Cotton CRC and Murrumbidgee Irrigation to investigate this (DPI 2005). Marebone Weir has an undershot design that is now known to cause high mortality among larval and juvenile fish; for example, 95 per cent of larval and juvenile golden perch (Baumgartner et al 2006; DPI 2007). Releases of cold, poor-quality water from the bottom of Burrendong Dam affect aquatic habitat adversely for many kilometres downstream. Habitat degradation has to be tackled at the whole-of-river scale and controlling introduced fish, especially carp, also has to be attempted at this scale (Humphries et al 2002).

Many parts of the marshes are potential habitat for fish, as evidenced by the number of mussel shells found in various areas. Freshwater mussels spend their early life as a small obligate parasite on the gills of fish (Baker et al 2003). Australian smelt, catfish and silver perch have been documented as being native fish hosts for mussel larvae. Provided that some mussel larvae parasitise on fish successfully, patterns of genetic distribution of mussels and fish hosts are likely to be closely linked (S. Davis pers. comm.).

Because the marshes are located in the lower end of the catchment, the fish communities are a blend of those found in adjacent main channel habitats; that is, directly upstream and downstream, but also in systems such as Marthaguy Creek. During flow events, fish are likely to move from these areas into the marshes. More specifically, the composition – the richness, relative abundance and biomass of pest species – of a fish community found at one of the marshes' specific sites or specific creeks is likely to be regulated due to a combination of local habitat characteristics; recent and historical flows; and the extent of longitudinal and lateral connectivity to habitats, including the floodplain (Jenkins et al 2004; Rayner et al 2009).

Photo 6 Silver perch (I&I NSW).

Reversing the decline of native fish communities in the Macquarie River and Macquarie Marshes will require finely calculated delivery of environmental flows, as well as the protection of riparian and instream habitat, particularly refuge areas (Rayner et al 2009). This will need a high level of cooperation between environmental flow managers, researchers and land managers.

2.3.3 Red-bellied black snake

Photo 7 A red-bellied black snake swimming through ribbon weed (Grenville Turner).

The number of red-bellied black snakes in the Macquarie Marshes was once one of the highest in Australia, but over the past 20 years, both the number and the condition of the snakes have declined dramatically (Johnson 2005). Although the snakes are not listed as threatened, they are a significant feature of the Macquarie Marshes. Their diet includes fish, tadpoles, frogs, lizards, snakes, mammals and aquatic invertebrates. They feed both on land and underwater (Greer 2006).

The reason for the decline in the number and condition of red-bellied black snakes in the marshes is mostly unknown. However, frogs are a mainstay of this snake's diet (Cogger 1996) and declining frog populations are believed to be one of the major causes (Johnson 2005). The most important management issue for this species is to find out more about its needs.

2.3.4 Frogs

Photo 8 A green tree frog (W. Johnson).

There is little information about the current health and status of frog populations or about how flows might be managed to ensure the populations' survival. The most recent surveys of frogs in the marshes were undertaken in the early 1990s and in 2009 (Metcalfe et al 1993; T. Rayner pers. comm.). The 2009 surveys found 8 of 14 frog species expected to occur in the marshes (J. Ocock pers. comm. 2010). Research is underway to determine the abundance, composition, richness and diversity of frog communities and the factors that influence populations, such as the amount of time since the most recent flood, inundation frequency, the dependencies of different frog species on environmental flows, habitat structure, water quality and the presence of chytridiomycosis.

2.3.5 Coolibah, black box and myall woodlands

2.3.5.1 Coolibah woodland

Coolibah is found in association with river red gum in some of the wetter parts of the marshes, although it is more commonly found in areas that are less frequently flooded, where it forms coolibah and coolibah–black box woodlands. In the marshes, coolibah is found along a gradient of decreasing flood frequency and duration between river red gum and black box woodlands. This contrasts with the generally accepted view of the water requirements of coolibahs, which suggests black box requires wetter conditions than does coolibah (Roberts & Marston 2000).

Coolibah requires flooding for regeneration. Although its broad ecological requirements are not well known, according to experience in the marshes – especially in the northern nature reserve after the North Marsh Bypass Channel was constructed in the early 1970s and on Terrigal Creek between 1998 and 2000 – coolibahs will die if they are inundated for too long. It is recommended that inundation of coolibah woodland in the marshes last no longer than six to eight months.

Kidson found that since 1949 distribution of coolibah woodland has declined by at least 12 per cent (Kidson et al 2000). In 1991, Wilson mapped 7800 hectares of coolibah woodland (Wilson 1992). Bowen and Simpson found the area of coolibah woodland has changed little since then but the condition of these woodlands has changed, with most now mapped as coolibah woodland–chenopod shrubland (Bowen & Simpson 2010). Coolibah woodland is part of the coolibah–black box woodland endangered ecological community listed under the NSW *Threatened Species Conservation Act 1995*. Coolibah open woodland is considered by Benson to be an endangered community (Benson 2006).

The Wailwan people considered coolibah woodlands to be especially important because the floodplain trees were the source of materials for implements, such as coolamons, and for shelter. The remaining scarred trees are especially important because few of the wooden implements have survived (Biosis Research 2008).

2.3.5.2 Black box woodland

In the marshes, black box is found at the drier end of a gradient of decreasing flood frequency and duration from river red gum to black box woodlands, where it forms black box and coolibah–black box woodlands. Both these communities are part of the coolibah–black box woodland endangered ecological community that is listed under the NSW *Threatened*

Photo 9 Coolibah and river red gum woodland in the northern nature reserve (W. Johnson).

Species Conservation Act 1995. Since 1949, distribution of black box woodland has declined by at least 38 per cent (Kidson 2000) due mostly to clearing. Wilson (1992) mapped 16,600 hectares of black box. Bowen and Simpson (2010) found that the area of black box woodlands have remained fairly constant since then, however, the condition of black box woodlands has changed, and most is now mapped as black box woodland–chenopod shrubland. Black box requires summer flooding for regeneration. It occurs most commonly in the ephemeral wetland vegetation zone of the marshes.

2.3.5.3 Myall woodland

Myall, or weeping myall, woodland is listed as an endangered ecological community under the NSW *Threatened Species Conservation Act 1995*. Only 14 per cent of its original area remains in NSW (Benson 2006). Bowen and Simpson (2010) found there was 7997 hectares of weeping myall woodland in the marshes in 2008. Despite its endangered status, little is known about myall's ecological requirements. In the marshes, it occurs on the outer floodplain, on the edge of ephemeral wetland vegetation and is inundated in large floods. About 680 hectares of myall woodland was cleared in the Macquarie Marshes between 1991 and 2008.

Photo 10 Myall woodland inundated in a large flood on the property Stanley, East Marsh (W. Johnson).

2.3.6 Woodland birds

In south-eastern Australia, many woodland bird species that were once common are now declining. Of 20 woodland bird species whose numbers have declined significantly since the 1980s (Reid 1999), 18 are found in the marshes. Four species – the brown treecreeper, diamond firetail, hooded robin and grey-crowned babbler – are listed as vulnerable under the *NSW Threatened Species Conservation Act 1995*.

In the NSW central Murray catchment, woodland bird abundance and species richness were highest in woodlands with an area greater than 100 hectares that were located less than a kilometre from other patches of woodland that had high habitat complexity – canopy cover, shrubs, groundcover, litter and logs – and good tree health (Oliver & Parker 2006). When compared with woodlands and forests of white cypress pine, black box, yellow box, grey box, buloke and myall (boree) and with tree planting sites, river red gum woodlands and forests had the highest total bird abundance and species richness.

Photo 11 Diamond firetail (Nevil Lazarus).

The main reasons for a decline in woodland bird species are loss of habitat, fragmentation of woodland vegetation and simplification or degradation of the remaining woodland vegetation. In south-eastern Australia, large intact woodlands containing native shrubs and groundcover plants are now extremely rare, especially on fertile soils. The Macquarie Marshes are an important area where woodlands remain on fertile soils. In the marshes, river red gum woodlands and forests and coolibah and black box woodlands are important and extensive plant communities. More information is needed about the relationship between these plant communities and woodland birds.

2.4 Locations in the marshes, based on landform and water management boundaries

The values and assets identified are found throughout the marshes. In the following section, the North Marsh, South Marsh and East Marsh are described on the basis of their water source and location, as shown in Figure 1.3. This section includes descriptions of past and present condition, and change in condition.

2.4.1 The North Marsh

The North Marsh includes the Bora Channel, the Ginghet, the River Paddock, Pillicawarrina, the Zoo Paddock, Louden's Lagoon, Hunt's Woodland, the confluence of Monkeygar and Bulgeraga creeks, and the Macquarie Channel. It supports river red gum forest and woodland, extensive marshy grasslands of common reed and water couch, lignum shrubland, river cooba and cumbungi. The North Marsh contains relatively deep and protected open water lagoons. It provides habitat for important breeding colony sites and feeding habitat for colonially nesting species – egret, heron, cormorant, spoonbill, ibis and darter – and many other waterbird species. It provides habitat for threatened species – brolga, magpie goose, Australian painted snipe, Australasian bittern and blue-billed duck – and species included in migratory bird agreements between Australia and Japan, China and the Republic of Korea (JAMBA, CAMBA and ROKAMBA, respectively). The North Marsh includes the northern part of the Macquarie Marshes Nature Reserve portion of the Ramsar site.

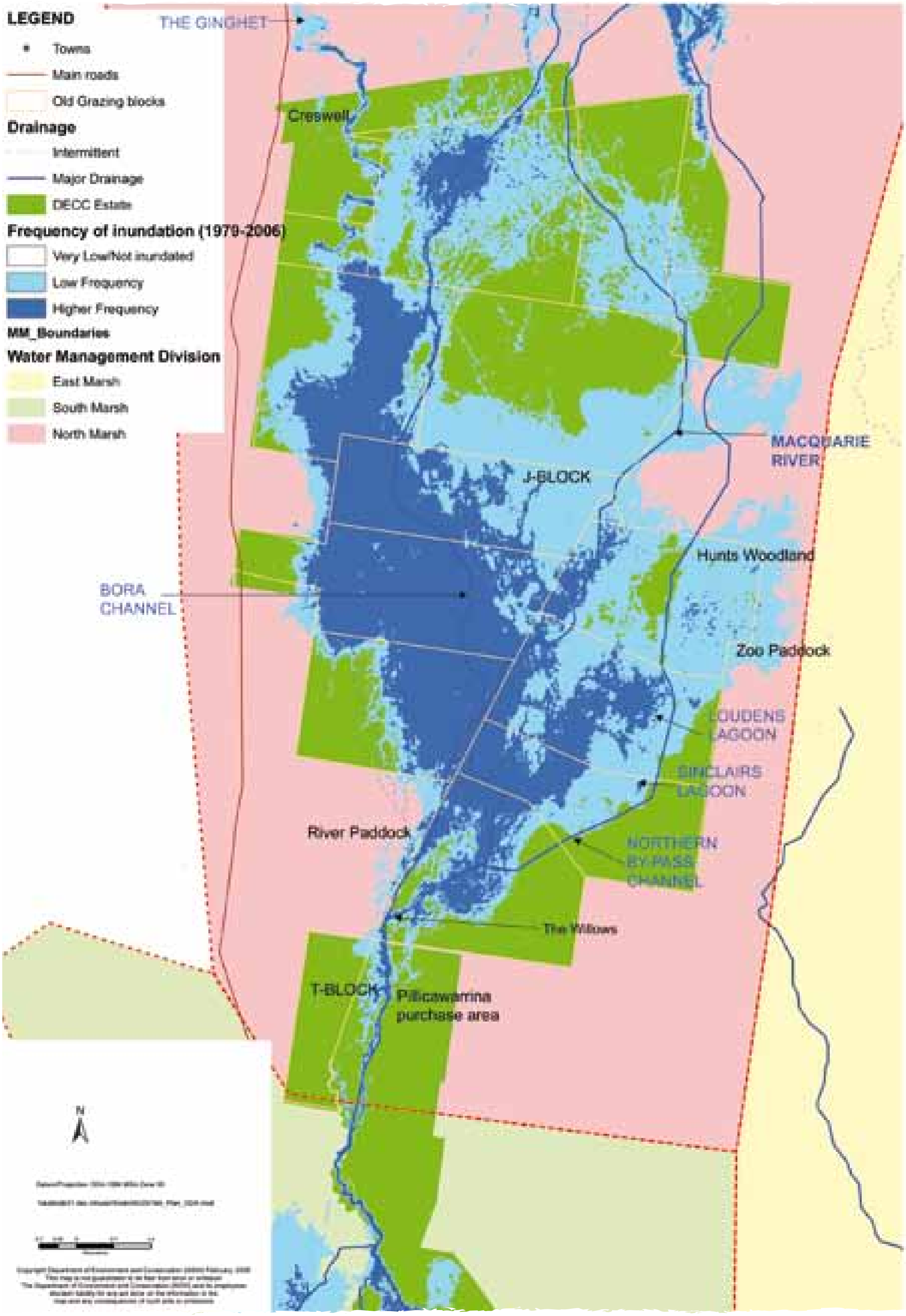

Figure 2.1 Localities within the North Marsh.

Photo 12 River red gum forest in the northern nature reserve (W. Johnson).

Colonially nesting waterbirds have been recorded breeding in eight locations in the North Marsh (Kingsford & Auld 2003). In 2000, when the most recent large flood and breeding event occurred, colonially nesting waterbirds used six locations. They did not use two known sites: Hunt's Woodland, a river red gum breeding site last used in 1990 and Louden's Lagoon, a common reed and marsh club-rush site last used in 1998 (Jones unpublished reports). Bowen and Simpson (2010) found that the river red gums in Hunts Woodland are showing signs of stress and demographic decline and that the understorey has been colonised by chenopod shrubs, (*S. muricata* and *S. kali*). It has been mapped as 'intermediate' condition (10–40 per cent dead trees). The vegetation in Louden's Lagoon is in poor condition probably due to lack of water and the presence of pigs and kangaroos (DNR 2007; Bowen & Simpson 2010). In 2008, an egret colony of 2000 pairs nested successfully in river red gum forest on the Bora Channel (R. Jones pers. comm.).

The North Marsh supports the most extensive area of river red gum forest and woodland in the Macquarie Marshes. Bowen and Simpson (2010) found that since 1991 the overall area of river red gum woodland has remained relatively stable, although the condition of red gum woodlands has declined in both overstorey condition – tree health (Bacon 1996; Nairn 2008), and understorey composition – species richness and type (Bowen & Simpson 2010). The river red gum woodland understorey is now dominated by chenopod shrub species that are more indicative of dryland communities. The area of river red gum forest that has a wetland understorey declined by 20 per cent in the period 1991–2008 (from 1860 hectares to 1486 hectares) (Bowen & Simpson 2010).

In the northern nature reserve in 2008, Bowen and Simpson (2010) found that 23 per cent of the 6130 hectares of river red gum communities were in 'good' condition (< 10 per cent dead canopy). All of this was river red gum forest occurring along the Bora channel. Of the remainder, 57 per cent was classed as 'poor' condition (80–100 per cent dead canopy), 19 per cent 'intermediate' (10–40 per cent dead canopy) and 1 per cent 'intermediate/poor' (40–80 per cent dead canopy).

In the northern nature reserve the majority of river red gum communities on the interfluves between the channels no longer receive adequate flooding and are composed of older trees which are stressed, dead or dying. There are often thickets of juvenile trees which are dead or dying, and the understorey is dominated by invasive chenopod shrubs or supported nothing at all in 2008 (Bowen & Simpson 2010).

Nairn (2008) surveyed tree health and population structure and found that 73 per cent of the sites surveyed in the northern nature reserve were under extreme water stress and that only 8 per cent of the sites had a profile that indicated 'fair' regenerative potential – none were found to be 'good'.

North of the nature reserve is a large area of river red gum forest and woodland (about 4000 hectares). The forest community is confined to narrow bands along channels and has an understorey of aquatic and semi-aquatic species when wet. River red gum woodland occurs between the main channels and was found to be stressed and dying, having a chenopod understorey (roly poly) that increases in density with distance from channels and on higher ground (Bowen & Simpson 2010). Of these river red gum communities, none is in good condition and 80 per cent are in intermediate condition (10–40 per cent dead canopy) (Bowen & Simpson 2010). The intermediate condition river red gums occur along the Bora and Ginghet in areas which receive some flooding.

Photo 13 Dead river red gum woodland in the northern nature reserve (W. Johnson).

Photo 14 *Foreground*: dead river red gum woodland; *top centre*: dry reedbeds; *top right background*: healthy river red gum forest and woodland, in the northern nature reserve (Grenville Turner).

The death of river red gums in the woodlands of the North Marsh has been attributed to lack of flooding (Bacon 2004). River red gums in the marshes need floods every one to two years, and Bacon found that trees receiving a flood in 2000 but not in 2003 were either under severe stress or dead. It is likely that in 2009 as much as 75 per cent of the woodlands had not been receiving the inundation frequency they needed in order to survive in the long term.

In the northern nature reserve there has been a 41 per cent reduction in the area of common reed, cumbungi and water couch marsh. In 1991 a total of 3314 hectares were mapped, of which 1946 hectares remained in 2008. Much of this area is in poor condition, and the area is continuing to contract. The area of common reed has declined by 17 per cent (2147 hectares were mapped in 1991, 1774 hectares remain in 2008), cumbungi has declined by 100 per cent (259 hectares were mapped in 1991, 0 hectares were mapped in 2008) and the area of water couch marsh has declined by 95 per cent (908 hectares were mapped in 1991, 49 hectares in 2008) (Wilson 1992; Bowen & Simpson 2009). Areas mapped as these communities in 1991 are now invaded by chenopod shrubs (*S. kali* and *S.muricata*) (328 hectares), or mapped as mixed marsh (123 hectares) (Bowen & Simpson 2010).

Widespread rain and some flows into the marsh maintained inundation for more than three months in the summer and autumn of 2007–2008, and supported an apparent rejuvenation of water couch grassland in the River Paddock. Even so, parts of the water couch grassland in the River Paddock are infested with black roly poly and soft roly poly (buck bush) (Bowen & Simpson 2010).

In 1986 and 1987, marsh club-rush was recorded in the North Marsh in Louden's Lagoon, where it provided nesting material for an ibis colony. Several stands have been recorded on the Bora Channel (R. Jones pers. comm.). Marsh club-rush sedgeland is considered by Benson to be critically endangered (Benson 2006) and is nominated as an endangered ecological community under the *Threatened Species Conservation Act 1995*.

Lignum occurs in many areas of the marshes as an understorey plant and occurs as shrublands in some areas of the North Marsh. According to the area of lignum shrubland mapped by Paijmans in 1981 and Wilson in 1991, there has been little change in the extent of lignum shrubland in the North Marsh other than in about 200 hectares near the confluence of Monkeygar and Bulgeraga creeks. Lignum shrubland in the Zoo Paddock, which is a critical nesting habitat for straw-necked ibis, is now in poor condition and is invaded by chenopod shrubs. Bowen and Simpson (2010) found that lignum shrubland had declined by 41 per cent from 17 to 10 hectares in the northern nature reserve and that 97 per cent of the 216 hectares of lignum mapped in the Pillicawarrina area had been cleared in the period 1991–2008.

Declining condition of wetland vegetation is the most significant ecological issue for the North Marsh, as shown in the maps in Figure 2.2. The 'hatching' pattern in the vegetation maps represents areas in which chenopods such as black roly poly and soft roly poly (buck bush) have colonised wetland areas in the North Marsh.

Photo 15 A narrow band of healthy river red gum forest and woodland located on the western side of the northern nature reserve, including the extent of green vegetation as an indication of the effect and boundary of inundation (W. Johnson).

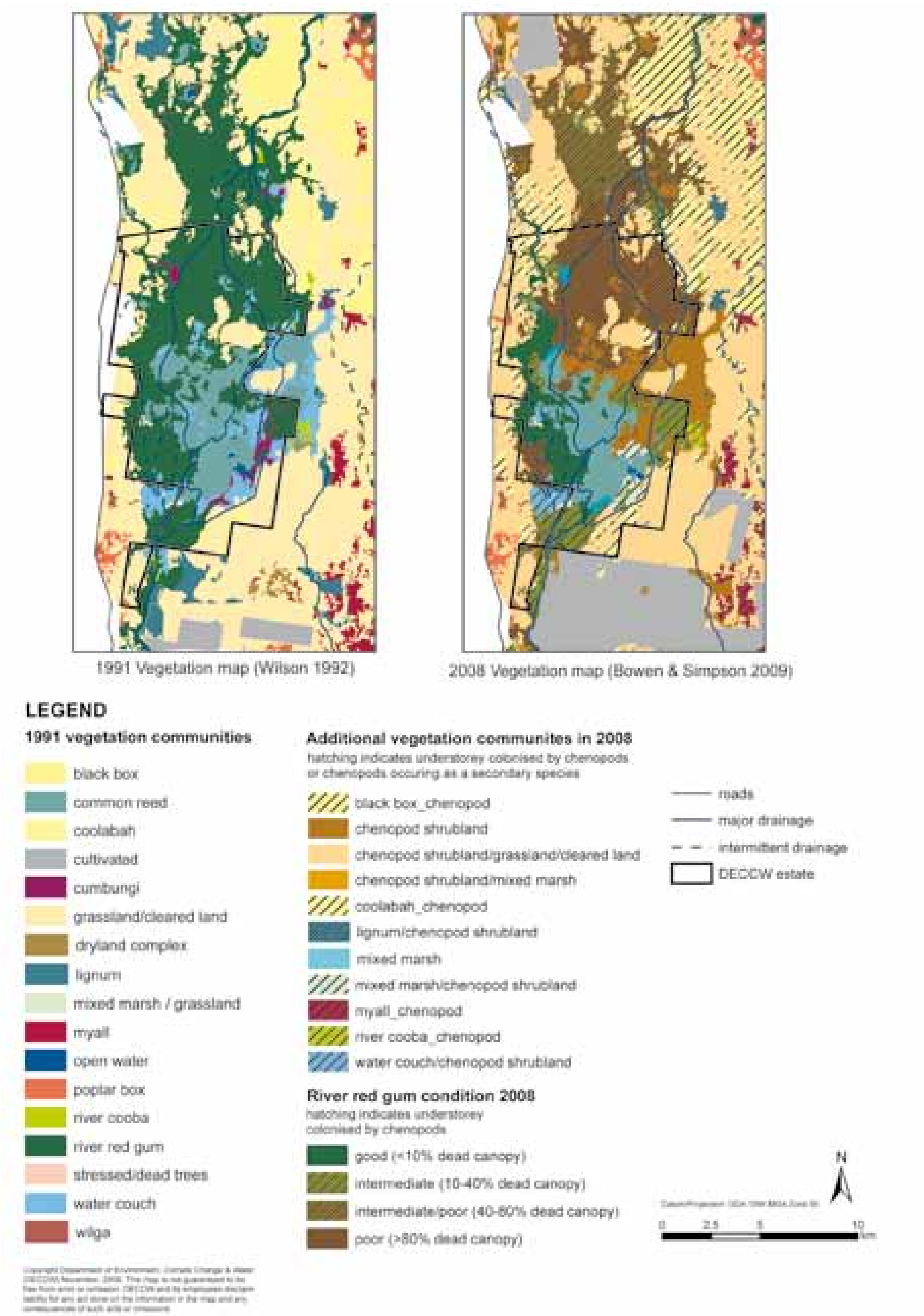

Figure 2.2 Changes in vegetation communities in the northern nature reserve and surrounding areas between 1991 and 2008 (Bowen & Simpson 2010).

2.4.2 The South Marsh

The South Marsh includes Mole Marsh, Willancorah Swamp, Monkey Swamp, the southern nature reserve, Buckiinguy Swamp and the Marebone area. It supports river red gum woodland, river cooba, water couch marsh and common reed, and contains large, relatively deep and protected open-water lagoons.

These communities provide important breeding and feeding habitat for colonially-nesting species, especially ibis and spoonbill. They support threatened species including the brolga, magpie goose, Australian painted snipe, Australasian bittern and blue-billed duck, as well as species included in the migratory bird agreements between Australia and Japan, China and the Republic of Korea (JAMBA, CAMBA and ROKAMBA, respectively). Willancorah Swamp provides important habitat for magpie geese.

The Macquarie River, Bulgeraga Creek and Monkeygar Creek provide important riparian habitats between Marebone Weir and the North Marsh, although the Old Macquarie River on the western side of the southern nature reserve is in very poor condition because of reduced flows. Bulgeraga Creek provides especially important fish habitat in the marshes. The lagoons in Buckiinguy Swamp and the eastern side of the southern nature reserve provide important wader habitat. The South Marsh includes the southern Macquarie Marshes Nature Reserve part of the Ramsar site.

Three breeding locations for colonially nesting waterbirds have been recorded in the South Marsh. Two of these locations have not been used since the 1960s. The only site used in the 2000 flood was Willancorah Swamp (R. Jones pers. comm.).

Evidence of change includes a significant reduction of common reed (reedbeds). Extensive stands of common reed are a distinctive part of the character of the Macquarie Marshes. Common reed provides habitat for many waterbirds and nest platforms for large breeding colonies of ibis. In 1981, Paijmans mapped about 2000 hectares of reedbeds in the South Marsh. In 1991 Wilson mapped a similar area (Wilson 1992). By 2006, areas of the South Marsh that had previously been mapped as having extensive reedbeds were supporting only a few clumps of reed remaining near channels (DNR 2007; Figure 2.3).

In the southern nature reserve, Bowen and Simpson found there has been a 96 per cent reduction in the area of semi–permanent wetland communities. The area went from 1446 hectares in 1991 to 63 hectares of intermediate condition wetland in 2008, which by then comprised 56 hectares of common reed/chenopod shrubland and 7 hectares of mixed marsh/chenopod shrubland. According to the same study, the area of common reed at Willancorah Swamp has been reduced by 40 per cent – from 571 hectares to 326 hectares. The remaining wetland in 2008 consisted of water couch/chenopod shrubland (100 hectares) and mixed marsh/chenopod shrubland (372 hectares) in poor condition. The area of mixed marsh and reed vegetation at Mole Marsh had been reduced by 98 per cent – from 1458 hectares to 17 hectares (Bowen & Simpson 2010; figures 2.3, 2.4, 2.5).

Although cumbungi was widespread in the marshes, it formed large stands or rushlands in only a few areas. In 1981, Paijmans mapped about 500 hectares of cumbungi rushland at several locations in the South Marsh, including the Mole Marsh, Willancorah Swamp, Monkey Swamp and Buckiinguy Swamp. He noted that at the Mole Marsh and Buckiinguy Swamp it seemed to be dying. In 1991, cumbungi rushland was mapped along Monkey Creek and in Buckiinguy Swamp only. In 2006, cumbungi was found in only one location in the South Marsh, at Buckiinguy Lagoon (DNR 2007).

Water couch forms extensive grasslands in the South Marsh and is an important understorey plant in woodland areas. In 1981, Paijmans mapped about 300 hectares of water couch in the Mole Marsh, 300 hectares in Willancorah Swamp, 2000 hectares in Monkey Swamp and Monkey Creek, and 200 hectares at Buckiinguy Swamp and Buckiinguy Lagoon. In 2006, the only water couch marsh remaining in the South Marsh was at Willancorah Swamp and Buckiinguy Lagoon, and the area of water couch in each area had been much reduced (DNR 2007). In 2008, in the southern nature reserve, no water couch grassland remained – a loss of 220 hectares from 1991–2008 (Bowen & Simpson 2010). The area of water couch grassland at Willancorah Swamp has been reduced by 65 per cent. As a result of widespread rain and some flows into the marsh, inundation was maintained for more than three months in the summer and autumn of 2007 and 2008 and supported a rejuvenation of water couch grassland in Willancorah Swamp.

The change in the southern nature reserve since 1991 is described as catastrophic (Bowen & Simpson 2010), with the loss of 96 per cent of semi-permanent wetland vegetation, a decline in the condition of river red gum, coolibah and black box communities and a 100 per cent loss of grassland communities. Eighty per cent of the southern nature reserve is now covered by chenopod shrubland. Extensive areas of Monkey Swamp and Buckiinguy Swamp are now covered by black and soft roly poly shrubland and are in very poor condition (Bowen & Simpson 2010).

Changes to vegetation in the southern nature reserve, Monkey Swamp, Buckiinguy Swamp, Willancorah Swamp and Mole Marsh are shown in the maps in figures 2.3 2.4 and 2.5. As is the case in other areas of the marshes, much of the area identified in the early 1990s as wetland or grassland has since been colonised by chenopods. This change has been due not only to lack of water but river regulation and major geomorphological changes in this part of the system.

The South Marsh is upstream of the North Marsh and therefore acts as a natural sediment filter for the lower Macquarie River. As a result, sediment accumulation is greater in and around the main distributary channels in the southern part of the system, causing channels in the South Marsh to evolve and shift across the floodplain more rapidly than those further downstream. In particular, the main channel running into the southern section of the nature reserve in the South Marsh – Monkeygar Creek – has become enlarged and incised since the 1960s, and excessively so since the 1990s. Another channel known as the Breakaway also formed through erosion in the early 1990s. Despite attempts at erosion control using rock-rubble structures since 2002, the Breakaway continues to allow water entering the nature reserve to flow through without flooding parts of the floodplain that were inundated at times before this channel formed.

As a result of the overall increase in the size of the channels in the South Marsh, larger inflows are needed to cause overbank flooding throughout the entire southern section of the nature reserve. It is believed that the great and apparently rapid increase in channel depth and width in the South Marsh, particularly that related to bed lowering and bank undercutting, has been exacerbated by the predominantly regulated flow conditions in the system since the late 1960s. It is unknown what effect grazing by native animals and domestic livestock has had on channels in the nature reserve, but bank erosion is typically exacerbated by animals gathering at water access points.

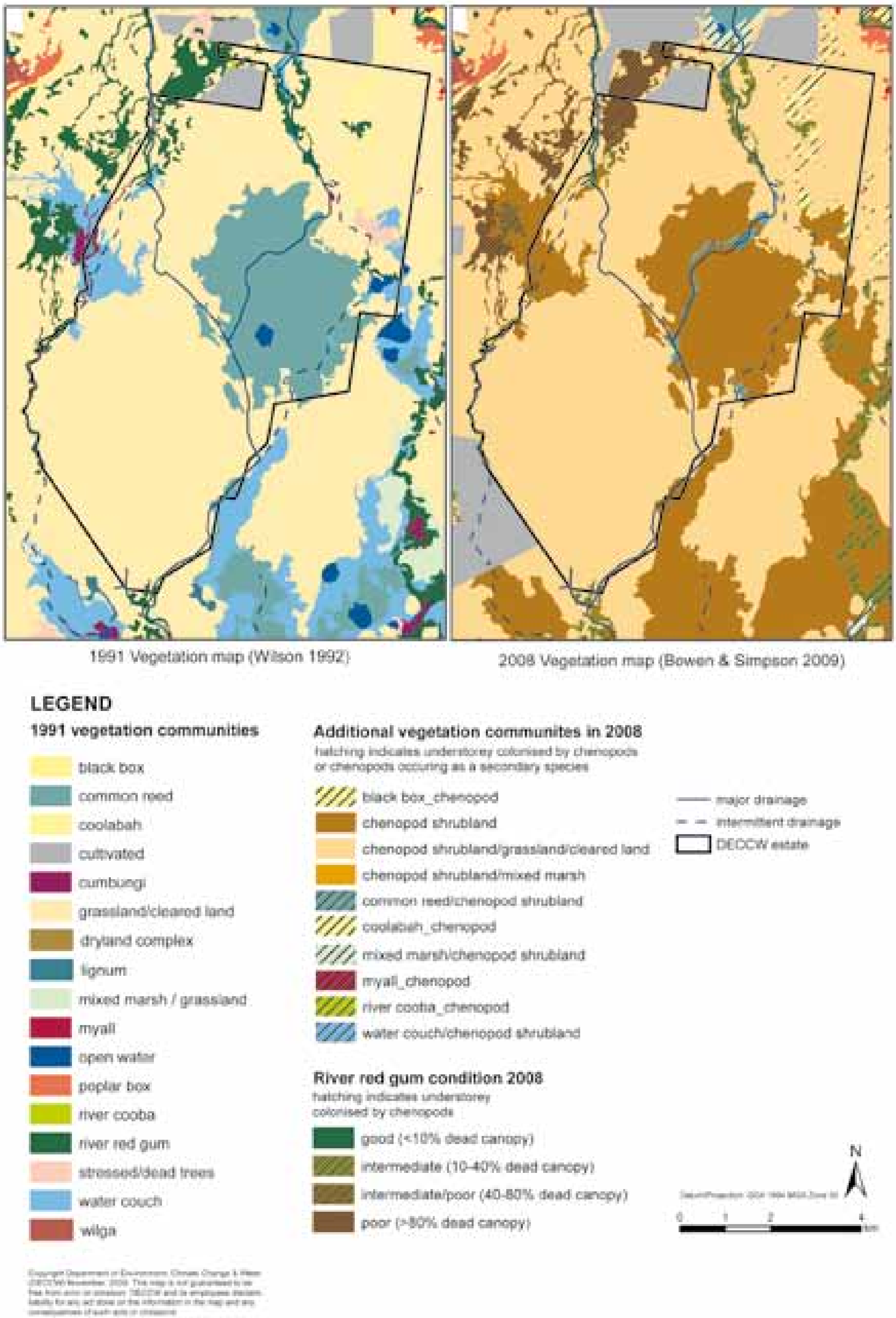

Figure 2.3 Changes in vegetation communities in the southern nature reserve and surrounding areas between 1991 and 2008 (Bowen & Simpson 2010).

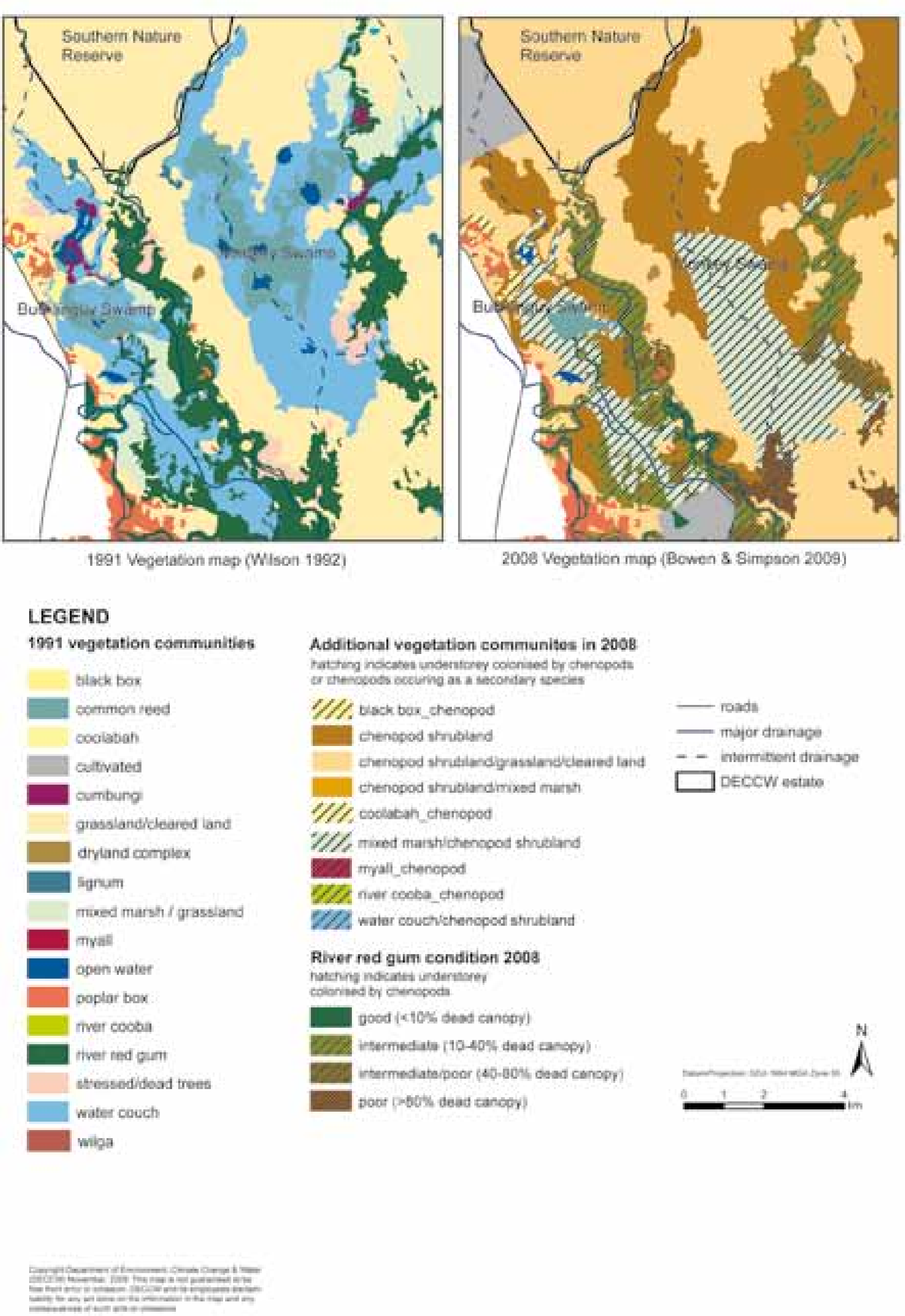

Figure 2.4 Changes in vegetation communities in Buckiinguy Swamp and Monkey Swamp in the South Marsh between 1991 and 2008 (Bowen & Simpson 2010).

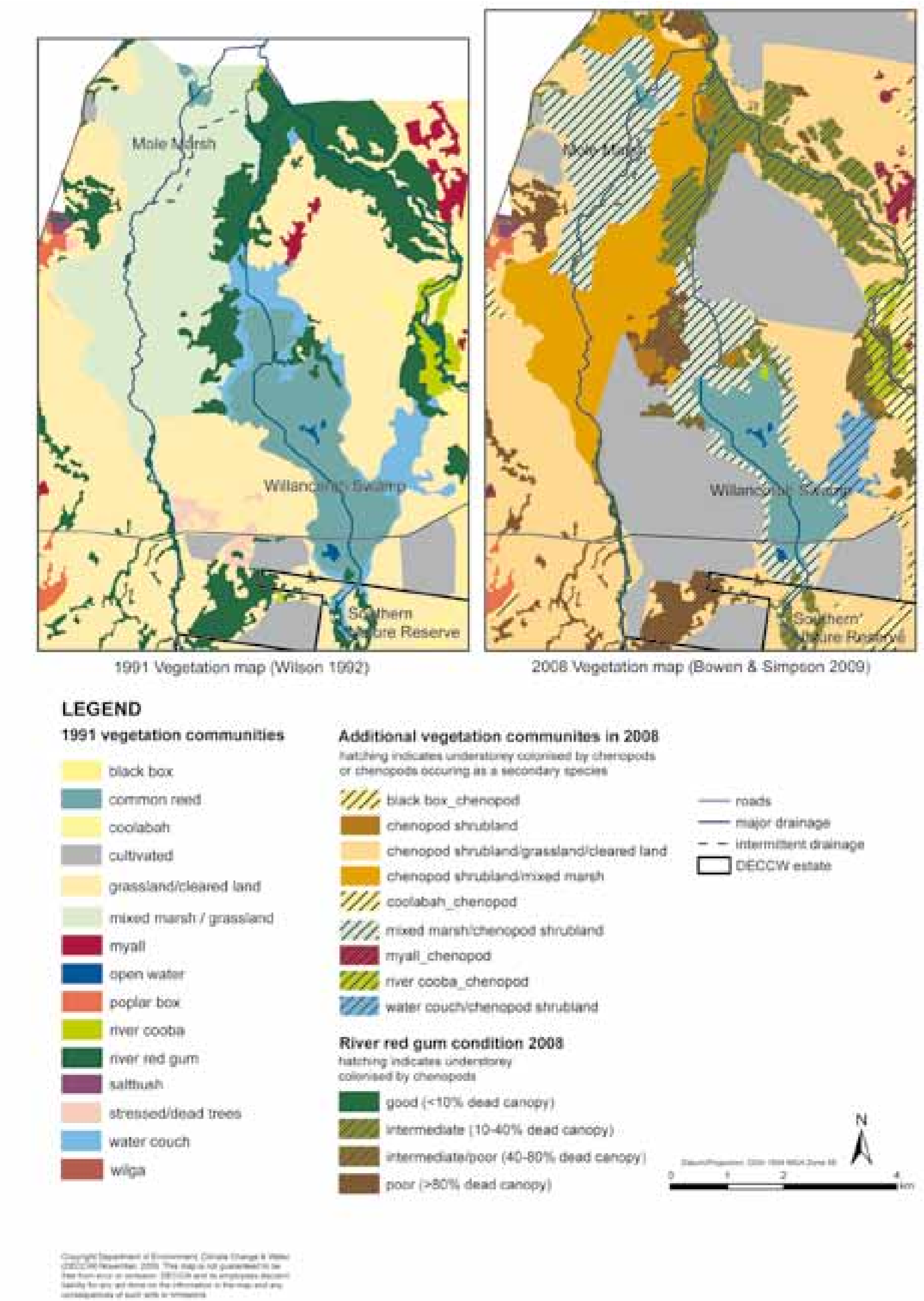

Figure 2.5 Changes in vegetation communities in Mole Marsh and Willancorah Swamp in the South Marsh between 1991 and 2008 (Bowen & Simpson 2010).

The North Marsh is currently shielded to a great extent from these severe sedimentation and erosion problems thanks to its position downstream of South Marsh. However, some indications of the adverse effects of these geomorphic processes is evident in discrete areas of the North Marsh, where sediments have begun to infill and block marsh channels, and where small erosion points have started to form in places where water can run from high points to low points on the floodplain or in channels. These recent observations in the North Marsh may be related to the increasingly poor infiltration role played by the much diminished and structurally altered South Marsh (Ralph 2008; T. Ralph pers. comm.).

Many areas of the South Marsh no longer support wetland vegetation. The remaining wetlands in this system are critical to the integrity of the system as a whole, including Back Swamp and the Jungle in the Marebone area. Most of the remaining wetlands in the South Marsh – including Mole Marsh, Willancorah, Buckiinguy Swamp, Monkey Swamp and wetlands on Mundooie – are there only because of banks and regulators designed to control erosion and stabilise these systems. Substantial structural work, including maintenance and modification of existing structures to control erosion, manage or respond to deposition, improve the capacity to distribute water, and restore fish passage, will be necessary for maintaining wetland values of the South Marsh. The swamps and marshes within the South Marsh depend on several streams, and are connected closely with one another. A strategic approach to restoration and maintenance work in the South Marsh and the marshes as a whole is essential.

2.4.3 The East Marsh

The East Marsh includes Gum Cowal–Terrigal Creek, Long Plain Cowal and Dusty Swamp. It supports river red gum forest and woodland, river cooba, water couch marsh and lignum shrubland. It has relatively deep and protected open water lagoons and supports important breeding colony sites and feeding habitat for colonially nesting species, including egret, heron, cormorant, spoonbill, ibis and darter. It supports threatened species including brolga, magpie goose, Australian painted snipe, Australasian bittern and blue-billed duck as well as species that are included in the migratory bird agreements between Australia and Japan, China and the Republic of Korea (JAMBA, CAMBA and ROKAMBA, respectively). The only recorded breeding of pied herons outside northern Australia occurred during the most recent major breeding event in 2000 (Jones unpublished reports). The East Marsh includes the Wilgara portion of the Macquarie Marshes Ramsar site.

According to vegetation mapping of the Wilgara portion of the Ramsar site, some change occurred in the extent of the vegetation communities between 1991 and 2008 and the condition of some vegetation types has declined (Bowen & Simpson 2010; Figure 2.6). Water couch marsh now has dryland chenopod shrubs occurring as a secondary species in the community. Widespread rain and some flows into the marsh maintained inundation for more than three months in the summer and autumn of 2007–2008 and supported a rejuvenation of water couch grassland in the Gum Cowal–Terrigal system in the East Marsh.

According to recent surveys of tree health in the river red gum community of Wilgara, condition ranged from 'fair' to 'stressed' and all trees were considered to be 'vulnerable' in terms of their regenerative potential. The largest – and probably therefore the oldest – trees tended to be relatively healthy; however, signs of stress were evident in some large trees and most of the younger ones. The understorey at these sites included water couch and lignum, indicating that Wilgara has not progressed as far towards the dryland state noted in some other parts of the marshes (L. Nairn pers. comm). The river red gum woodlands of the Wilgara portion of the Ramsar site were in 'intermediate' (10–40 per cent dead canopy) condition (Bowen & Simpson 2010). River cooba, a tree most often found in association with river red gum and lignum and often used by nesting waterbirds, including pied heron, is stressed and dying in parts of East Marsh. The reason for this has not been investigated but likely causes include lack of water, grazing of seedlings and old age accompanied by little or no recruitment. The areas of the Gum Cowal–Terrigal system that were mapped as mixed marsh and water couch in 1991 (Wilson 1992) have now been mostly replaced by chenopod shrubland of black and soft roly poly (buck bush) (Bowen & Simpson 2010).

Photo 16 Intermediate egret chicks in a nest in river red gum located in the Wilgara colony of Gum Cowal–Terrigal Creek (W. Johnson).

Long Plain Cowal and Dusty Swamp are inundated only in medium to large floods and under existing conditions providing such floods is beyond the scope of most managed environmental flows. They support river red gum woodland along channel margins, lignum shrubland, river cooba, coolibah, black box and myall woodlands, grassland and chenopods. When inundated, they support mixed semi-aquatic species. These areas provide important habitat for colonially nesting and other waterbird species, waders, and threatened species including brolga, magpie goose and Australasian bittern. In 1991 the Long Plain Cowal supported approximately 365 hectares of lignum shrubland, 1278 hectares of mixed marsh/grassland and 3961 hectares of river red gum in a mosaic of river red gum, river cooba, coolibah woodlands and myall woodland (Wilson 1992). In 2008, chenopod shrubland had replaced all areas of lignum and mixed marsh, and invasive chenopod shrubs had colonised understorey of the river red gum woodlands, river cooba shrublands and coolibah and myall woodlands (Bowen & Simpson 2010).

Because the Wilgara Wetland has Ramsar status, legal as well as ecological reasons exist for ensuring maintenance of the site's wetland value. According to the results of recent work, the condition of river red gum woodlands located on the property Wilgara is better than that of river red gum woodlands located in many other parts of the marshes (Nairn 2008 and pers. comm.; Bowen & Simpson 2010).

Photo 17 Coolibah woodland in Long Plain Cowal (W. Johnson).

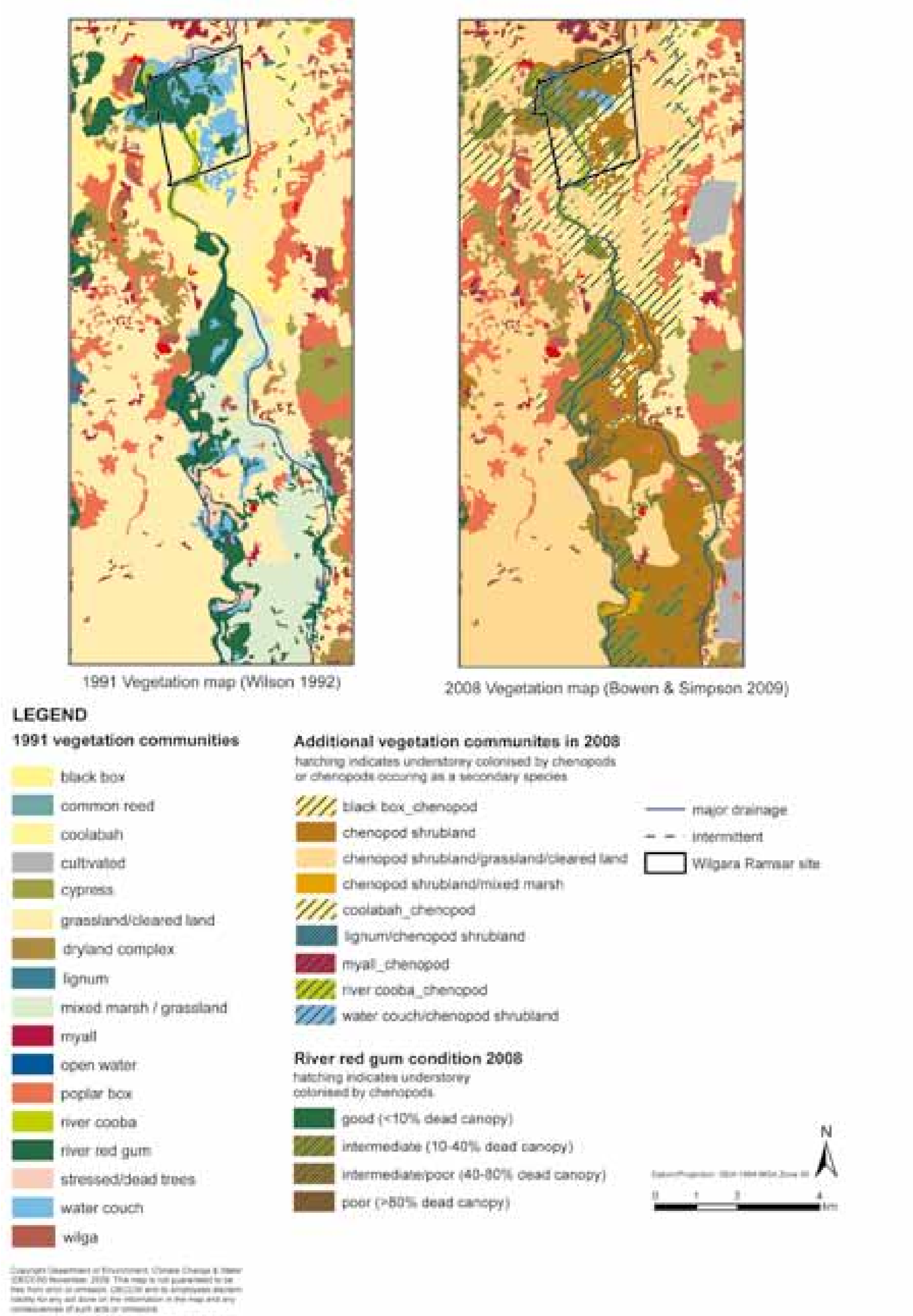

Figure 2.6 Changes in vegetation communities around the Gum Cowal–Terrigal Creek and the Wilgara portion of the Ramsar site in the East Marsh between 1991 and 2008 (Bowen & Simpson 2010).

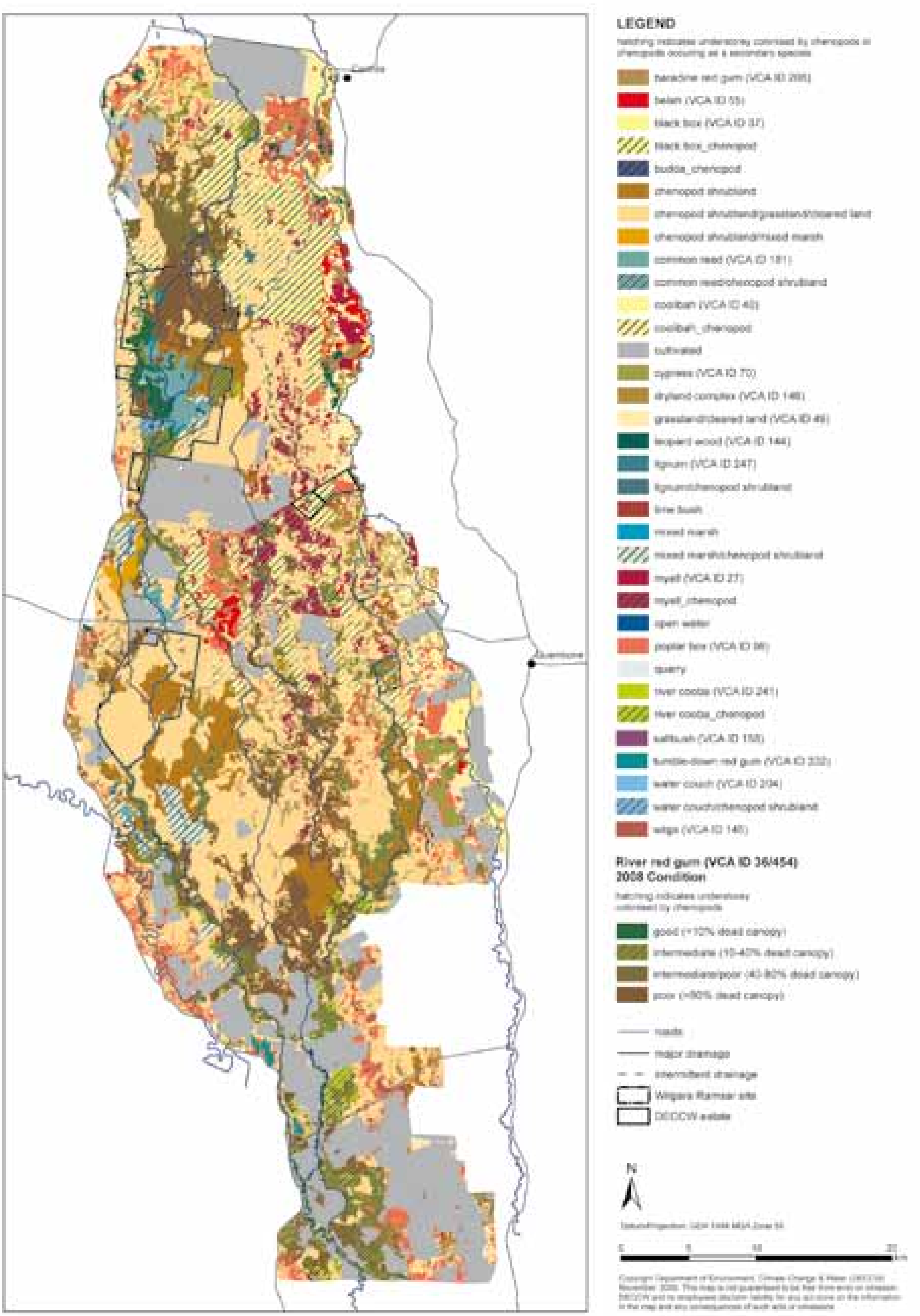

Figure 2.7 Vegetation communities in the Macquarie Marshes 2008 (Bowen & Simpson 2010).

2.5 Ecological objectives, priorities and targets

The desired ecological outcomes from managing the marshes are restoration and maintenance of critical ecological processes and functions, especially habitats.

The primary objective for the Macquarie Marshes for the duration of this plan is to support the ecological functions and processes necessary to sustain the diversity of type, and extent, of the ecological assets described within the plan. As further progress is made in recovering water for the environment, and depending on the climatic conditions experienced, enhanced ecological function and condition should begin to restore resilience to the marshes ecosystem. Objectives and priorities for restoring former wetlands areas that no longer support wetland values may then be possible.

The AEMP clarifies the broad management context within which water and land management decisions will be made. It also includes information that will inform actions in the context of the actual climatic circumstances and the environmental condition of the ecological assets at the time. Determining priorities for delivering environmental water will involve an annual planning process; the Macquarie–Cudgegong Environmental Flow Reference Group will be integral to this process. The Central West CMA will inform and facilitate land management investment and actions through its catchment action plan. Implementing the Macquarie Marshes Nature Reserve plan of management and on-ground actions within the Macquarie Marshes Ramsar site will be informed by the contents and objectives of this plan. I&I NSW (Fisheries) will lead the restoration of fish habitat.

The general water requirements of the ecological components contributing to the character and values of the marshes are already known. It is possible to give a reasonable assessment of the volume of water needed to maintain wetland functions and processes that support the assets identified in this plan, for a given area (tables 8.1, 8.2 and 8.3). It is also possible to assess the area and location of marsh that can be maintained with an available volume of water. Water availability and its implications for the marshes are discussed in the following sections of the plan.

3 Water

3.1 Flow regime

Flow regime organises, drives and defines the ecological systems of rivers and wetlands (Poff et al 1997; Puckridge et al 1998). A river's natural flow regime is driven by climate and runoff from the upstream catchment. The main components of flow regime are size, frequency, duration, timing and rate of change of flows (Poff et al 1997; Puckridge et al 1998). In the Macquarie Marshes, extent and duration of surface flows are crucial drivers of presence, type and vigour of wetland vegetation. The nature of flows depends on water from the river (the current flow), water stored in the soil (a result of recent years' flow history) and local rainfall. River regulation changes the hydrology, geomorphology and ecology of rivers by changing the size, duration, frequency and timing of flows. It often causes water quality to decline. These changes have a profound effect on riverine and wetland ecosystems (Johnson 2005).

According to several studies using both measured and modelled flow data, changes to flow regime in the Macquarie River have occurred, particularly since the construction of Burrendong Dam in 1967. They include:

- a significant reduction in moderate to high flows in the Macquarie River and end-of-system flows (CSIRO 2008)
- an increase in the average period between large flows and a reduction in the average volume of these events (CSIRO 2008)
- a reduction in the number of small flows likely to cause flooding passing the Oxley gauge (greater than 1000 megalitres per day) since construction of Burrendong Dam (Jenkins et al 2006)
- establishment of permanent low flows in previously intermittent streams (Grimes 2001)
- a significant reduction in frequency of floods in the marshes and the area inundated (Thomas et al in press).

3.2 Inundation mapping

The extent of inundation in the marshes, calculated using water and vegetation signatures, has been mapped for October each year from 1979 (the first year for which Landsat imagery is available) to 2006 using Landsat MSS and TM data (Thomas et al in press). Twenty-eight individual maps have been combined to produce an index of inundation frequency for different parts of the marshes, as shown in the map in Figure 3.1. The response of vegetation to recent inundation is included in the index because when only surface-water distribution is mapped, the effects of flow history are underestimated. There is a good relationship between the index of water distribution given for October each year and flows in the marshes during the six months before the date of the satellite image capture (Thomas et al in press).

The frequency and duration of inundation are indicators of the location of different wetland vegetation types (Figure 2.7). In the maps in figures 3.1, 3.2 and 3.3, areas of higher inundation frequency are coloured blue, mauve and pink, and represent areas that either sustain or have sustained semi-permanent wetland vegetation. This vegetation includes river red gum forest and woodland, water couch and common reed grasslands, cumbungi and lignum. Areas of lower inundation frequency are coloured pink, orange or yellow and represent larger floods that support ephemeral wetland vegetation. Coolibah, black box and myall woodland are more likely to occur in these areas.

In the three maps in Figure 3.2, inundation frequency is shown for three periods: 1979–87, 1988–97 and 1998–2006. During these periods, the area in the marshes that received high inundation frequency declined. This decline is closely related to water availability and flow

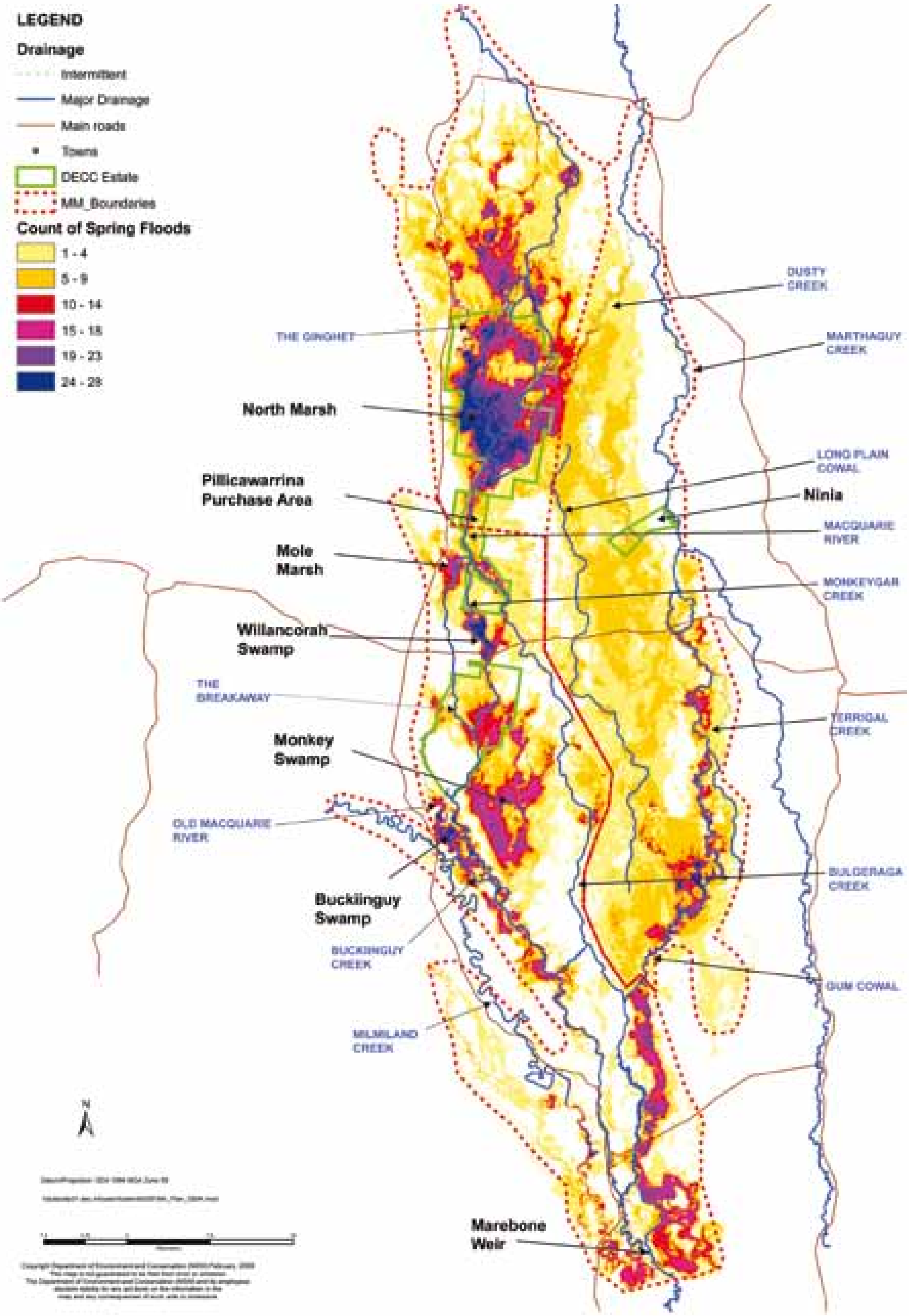

Figure 3.1 An index for the extent and frequency of inundation in the Macquarie Marshes from 1979–2006.

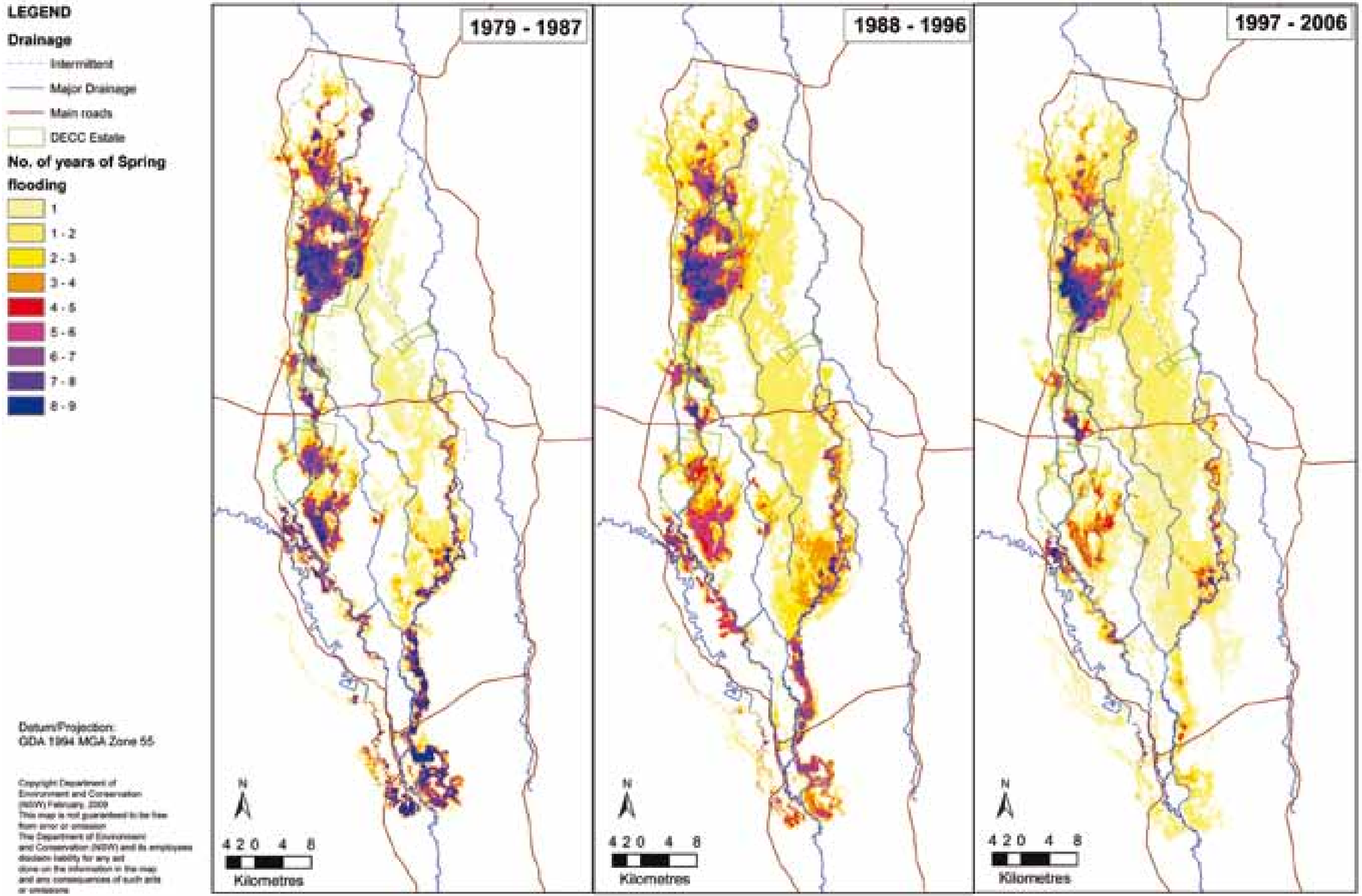

Figure 3.2 Changes in frequency and extent of Macquarie Marshes inundation. The area of low frequency inundation (yellow) increased in 1988–97 and again in 1998–2006 because of large floods that occurred in 1989, 1990, 1998 and 2000.

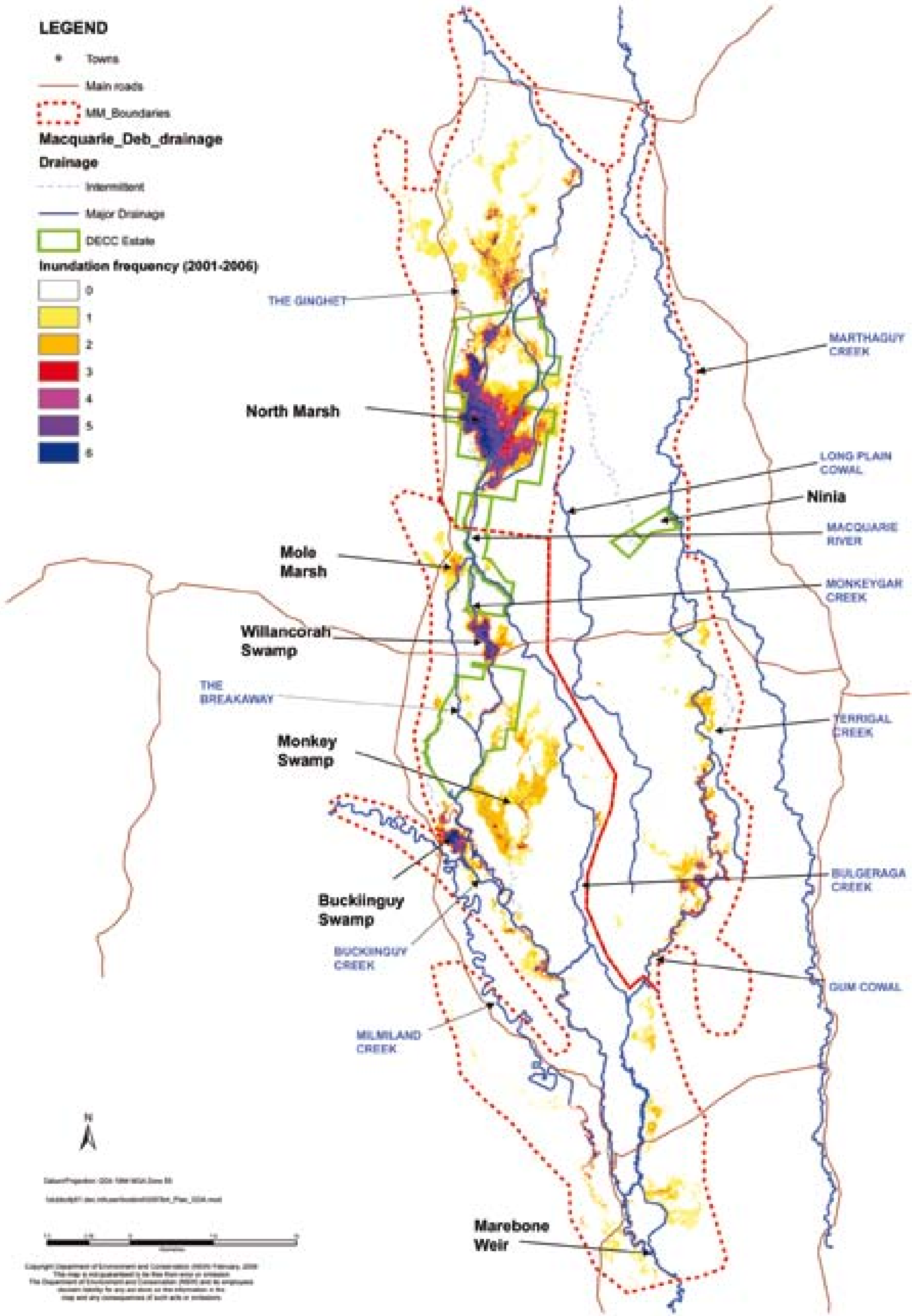

Figure 3.3 Extent and frequency of Macquarie Marshes inundation from 2001–06. Note the lack of large floods (yellow) and the small area of high inundation frequency (blue, mauve or pink).

size and is reflected in declining general security water allocations. Average allocations for comparable periods are:

- 1980–81 to 1987–88: 90 per cent
- 1988–89 to 1997–98: 83 per cent
- 1998–99 to 2006–07: 46.7 per cent.

There has been a decline in the area of the marshes that receives the flood frequency and duration necessary to maintain the values of identified semi-permanent wetland assets. In the maps, this area is represented in blue and mauve. The years from 1998–2007 (which had an average allocation of 47 per cent) began with three very wet years. Since 2001, conditions have been much drier and the average allocation between 2002–03 and 2008–09 was 12.7 per cent (figures 3.5, 3.6). It has been since 2001 that the decline of the marshes has been especially rapid.

3.3 Water allocation and availability

Until 1979, most irrigation in the Macquarie Valley was based on an individual entitlement to irrigate 162 hectares of land, although the volume of water that could be applied to the land was not specified (Sinclair Knight & Partners 1984). Entitlements to a set volume of water were introduced in 1979 (WRC 1979).

The Water Sharing Plan for the Macquarie–Cudgegong Regulated Water Source 2003 now provides the framework for water allocation in the regulated rivers of the Macquarie Valley. Under this water sharing plan, the total share component of access licences plus the environmental water allowance are now about 899,453 megalitres. This consists of 14,265 megalitres for domestic and stock access licences; 22,681 megalitres for local water utility access licences; 19,419 megalitres for regulated river (high security) access licences; 632,428 megalitres for regulated river (general security) access licences; 50,000 megalitres for regulated river (supplementary water) access' licences and 160,000 megalitres for the environment (NSW Government 2003). The accounting rules for the environmental water allowance are the same as for general security entitlement (NSW Government 2003; column graph in Figure 3.4). In 2007, an additional 660 megalitres was granted to Nyngan's town water supply. These volumes do not include extraction from groundwater, from the unregulated tributaries of the Macquarie River or access to be licensed under the NSW Floodplain Harvesting Policy.

The water sharing plan also allows access licences to be purchased and dedicated to environmental purposes. As at 30 April 2010, 46,275 megalitres of general security and 1,442 megalitres of supplementary access water entitlements had been purchased by the NSW Government to manage as environmental water. At 30 April 2010 the Commonwealth Environmental Water holder held 55,873 megalitres of general security and 1,888 megalitres of supplementary access water entitlements in the Macquarie-Cudgegong.

The available water determination and allocation of shares to general security access licences determines the amount of water available from regulated flows for the irrigation industry and the environment.

Measurements of water availability and use are often given as averages. For example, the average surface water availability in the Water Sharing Plan for the Macquarie–Cudgegong Regulated Rivers Water Source 2003 is 1,448,000 megalitres per year, and average total diversions are 391,900 megalitres per year (NSW Government 2003). The long-term average annual flow to the Macquarie Marshes is 440,000 megalitres per year (Macquarie–Cudgegong RMC 2001). However, long-term averages, especially in a highly variable system such as the

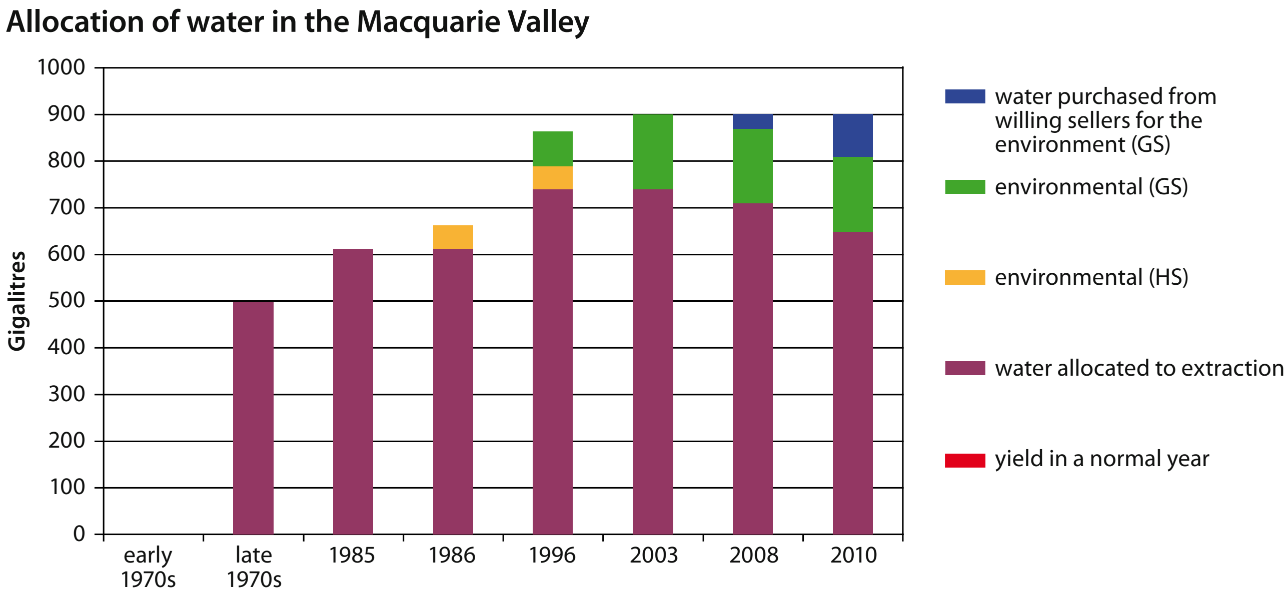

Figure 3.4 Distribution of the share components of access licences in the Macquarie River Regulated Water Source (NSW Government 2003).

Note: 'Total annual regulated yield of the Macquarie River in a normal year' was first calculated during the early 1970s by the Water Conservation and Irrigation Commission as being 406,000 megalitres (Sinclair Knight & Partners 1984) and was subsequently increased to 475,000 megalitres in 1979 by the Water Resources Commission. By that time, the estimated total requirement downstream of Burrendong Dam was 497,500 megalitres (WRC 1979, 1981, 1985).

Macquarie, can be misleading when managing at the shorter time scales relevant to agricultural and ecological systems.

The variability of the Macquarie River is demonstrated by the three measures of water distribution mentioned above:

1. Total system flows, calculated as surface water flow into storages and from tributaries downstream of Burrendong Dam.
2. Extractive use of licensed surface water shares in the regulated river.
3. Flows to the marshes at Marebone Weir, as shown in the column graph in Figure 3.5. A large proportion of total flow occurs in a relatively small number of years, and many years have extremely low flows. It is when low flows occur for several years in a row that the risk of managing according to long-term averages becomes evident.

Since 2001, the Macquarie's flows have been low by historical standards and surface runoff has been similar to that of the 1930s (State Water unpublished data). For the semi-permanent wetlands of the marshes, the sustained lack of flows has been especially damaging. However, between 1930 and 1950 at least seven moderate to large floods were recorded in the area now included in the northern nature reserve: in 1934, 1937, 1940, 1941, 1943 and 1948. More than half the area now included in the Macquarie Marshes Nature Reserve was classified as 'flooded channel country', 'swampy plain' or 'usually inundated' (Department of Lands 1941; circa 1950). The system is now under the additional pressure of Burrendong Dam harvesting flows from the largest and historically most reliable water supply in the catchment. Also, the river now supports a large irrigation industry as well as many other industries and larger urban populations. For the irrigation industry, which between 1980 and 2001 had an average of 88 per cent allocation to general security shares, a sudden shift to seven years of low flows and an average allocation of less than 13 per cent is equally serious.

Use of water in the Macquarie Valley

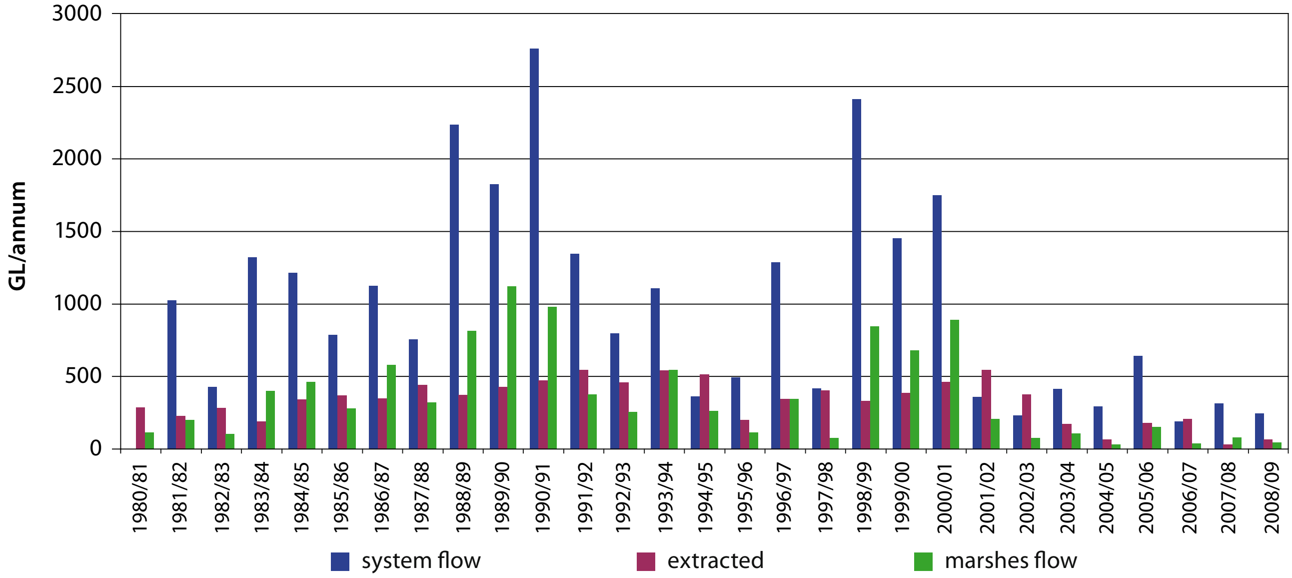

Figure 3.5 Assessed and estimated water distribution and use in the Macquarie Valley, 1980–2008 (State Water).

Note: Extractive use includes licensed surface water extraction from the regulated river. It does not include extractions from unregulated tributaries, groundwater extractions from aquifers linked directly to the river, or floodplain harvesting. Total system flows are greater than the combined total of extractions and flows to the marshes because of operational losses and extensive floodplain and distributary system flows during high flows.

3.4 Climate variability and climate change, and the Macquarie Valley

According to modelling by the CSIRO, the recent climate average (1997–2006) was similar to the long-term average conditions (CSIRO 2008). Also, future runoff in the Macquarie Valley is more likely to decrease than increase in response to climate change. CSIRO has considered climate scenarios for 2030 ranging from extreme wet to extreme dry, and a mid-range 'best estimate' are as follows:

- extreme wet: 25 per cent *increase* in surface water availability, 12 per cent increase in total diversions, and 41 per cent increase in end of system flows
- extreme dry: 25 per cent *decrease* in surface water availability, 16 per cent decrease in total diversions, and 28 per cent decrease in end of system flows
- best estimate: 8 per cent *decrease* in surface water availability, 4 per cent decrease in total diversions, and 9 per cent decrease in end of system flows

Water-resource development has already increased the average period between important inundation events for the Macquarie Marshes (200 gigalitres past Oxley between 1 June and 30 November), from 2.2 years to 4.7 years, and has reduced the average volume of these events from 328 gigalitres to 278 gigalitres per event (CSIRO 2008). Under the best estimate for climate in 2030, the average period between important inundation events in the Macquarie Marshes would increase by a further 10 per cent from the current level. The number of flood events would be 5 per cent smaller, and average annual flood volume would be reduced by 16 per cent. The scale of waterbird breeding events is expected to be reduced.

According to the 'extreme dry' estimate for climate in 2030, the average period between events would be increased by 24 per cent and the average annual flood volume would be reduced by 38 per cent. The changes that have already been experienced have had serious consequences for all aspects of wetland ecology. Under projected drier conditions, these consequences are expected to increase (CSIRO 2008).

3.4.1 Future water availability

Wetter or drier climatic conditions do not have the same relative effect on the availability of environmental water that they have on extractive water. Under wet conditions, the environment receives proportionally more of the available surface water than it does under dry conditions. Under dry conditions, the environment receives proportionally less water – a smaller proportion of a smaller total volume (CSIRO 2008) – due to reduced unregulated flows from tributaries and fewer dam spills (both of which benefit the environment). For the purposes of this plan, allocations to general security are used as a surrogate for general surface water availability. This probably underestimates the effects of a drying climate on the environment due to the greater proportional impact on the environment during dry periods described above.

In Figure 3.6, the annual allocation to general security since 1980 is shown, with averages calculated for decades as well as for the periods that correspond to the inundation maps at Figure 3.2. The graph also includes the average allocation since 2002–03, the beginning of the current dry period in terms of water allocations. Examining water availability for periods of a decade or less makes sense at both social and ecological scales: a period of water shortage such as the one experienced since 2002 is damaging for both river-dependent ecosystems and the irrigation industry.

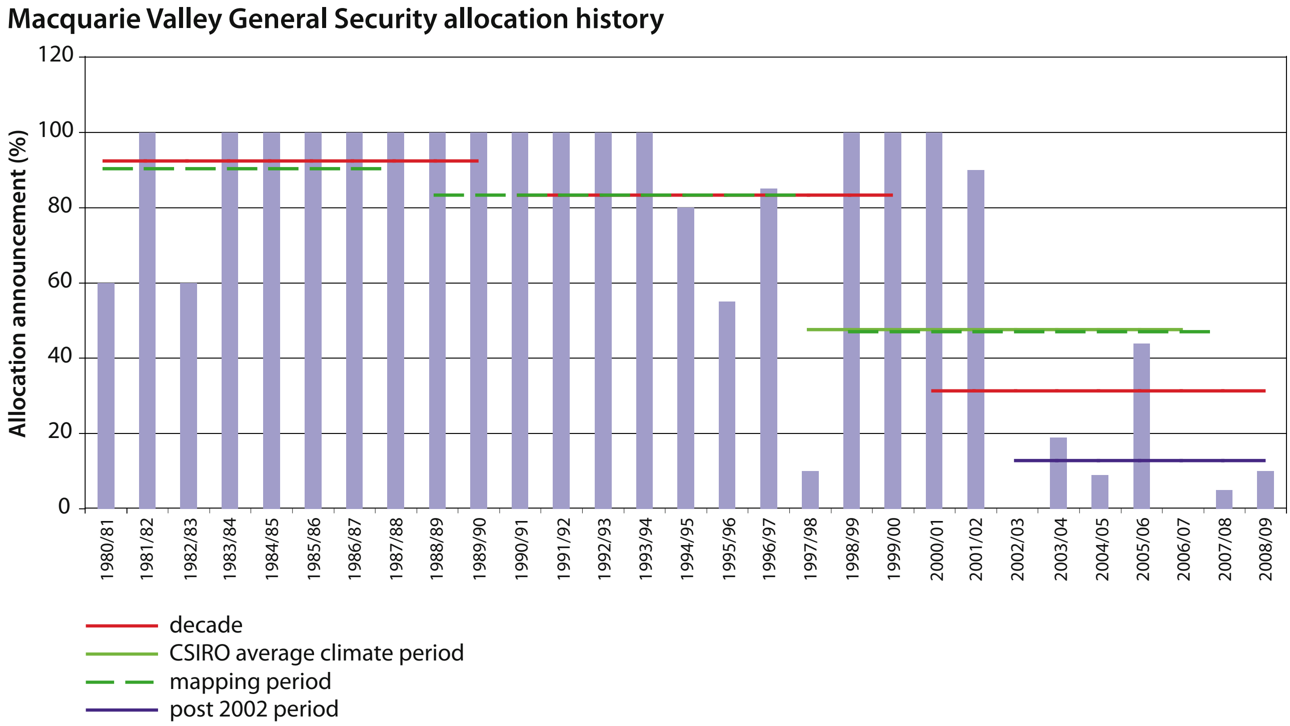

Figure 3.6 Allocations to general security shares expressed by decade, by inundation mapping periods and since 2002.

Climate change predictions for the Macquarie Valley

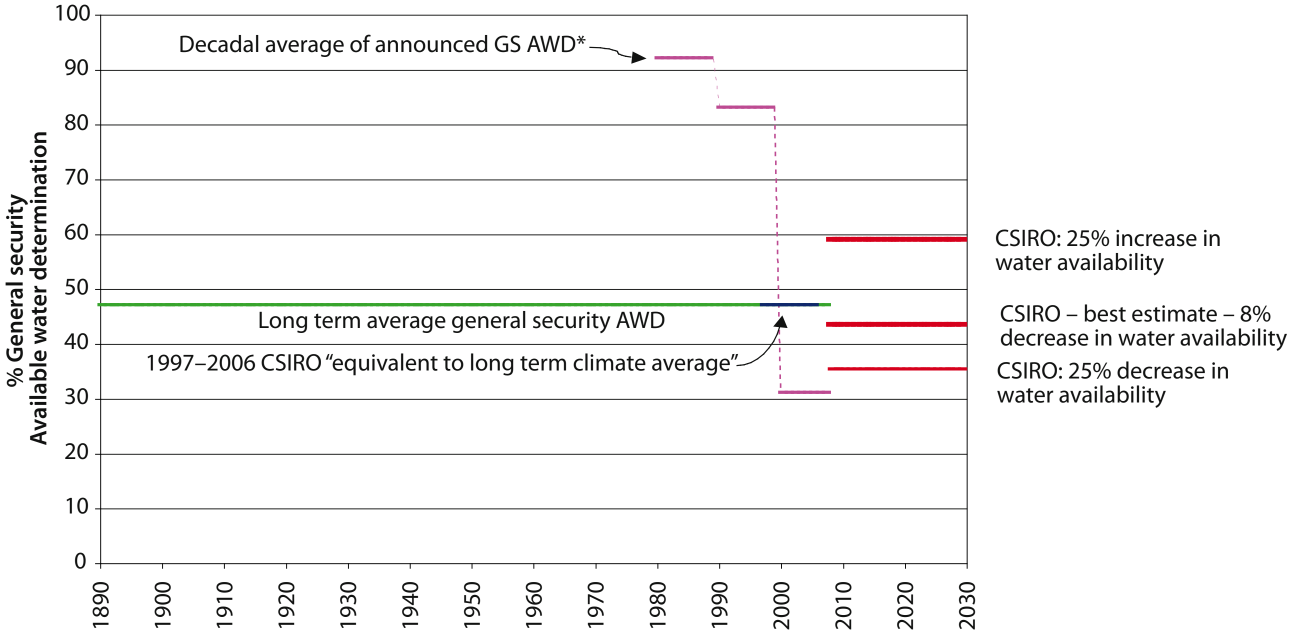

Figure 3.7 A comparison between the CSIRO forecasts for 2030 with surface water availability (represented by general security shares) in the Macquarie Valley since 1980. The variability experienced since 1980 exceeds the forecasts for 2030, on both the high side and the low side.

* GS AWDs = general security available water determinations

It is unlikely that rainfall conditions will return to the ones experienced during the 1970s, 1980s and 1990s (CSIRO 2008). Planning and management for the future of the Macquarie Marshes should take into account a range of possibilities, from a return to somewhat wetter conditions (which are nevertheless likely to be drier than the period from 1980–2000) to a continuation of existing or drier conditions. The scenarios provided by the CSIRO, represented in Figure 3.7, can inform water planning.

3.5 Water requirements of ecological assets

Scientific and technical studies now underway will help develop a better idea of the area of semi-permanent wetland that needs to be protected to maintain critical ecological functions and habitats in the marshes. Already, studies of vegetation extent, type and condition as well as waterbirds, native fish, microinvertebrates, soil nutrients, organic matter, flood patterns and groundwater levels show a declining trend and a major shift in the state of the system (Kingsford & Auld 2005; Jenkins et al 2004, 2009; Bacon 2004; Bowen & Simpson 2010; DECCW unpublished data). Large areas of semi-permanent wetland vegetation are being colonised, or have already been replaced, by dryland species (Bowen & Simpson 2010). This change in vegetation type indicates that most of the ecosystems of the marshes need more water, more regularly, than they have received since 2001.

Microinvertebrates underpin the food web, and their densities in recently inundated floodplain habitats in the marshes are among the highest in the world. They are eaten by all native fish species after hatching as well as by macroinvertebrates and some waterbirds, such as pink-eared ducks (Jenkins & Wolfenden 2006). Food availability both before and during nesting and egg laying is critical for successful waterbird breeding. The high densities of invertebrates and aquatic plants help to explain the ability of the marshes to support such large waterbird breeding events. Regular inundation is an important ecological requirement to maintain microinvertebrate diversity and density. Samples taken in 2005 demonstrate that the longer the period between flooding events, the greater the loss of organic matter and microinvertebrate diversity and density (Jenkins & Wolfenden 2006). Lack of regular inundation is a threat to maintenance of the high densities of microinvertebrates required to sustain large numbers of breeding waterbirds (Jenkins & Wolfenden 2006).

The locations and water requirements of the assets and values that contribute to the character of the marshes are known. The best knowledge available indicates that restoring and maintaining critical ecological functions and habitats of semi-permanent wetland assets identified in this plan will require inundation for a minimum of four months, and preferably six months, between July and April, at least seven and preferably eight years in 10 (Roberts & Marston 2000; Jenkins & Wolfenden 2006). Inundation every year would be beneficial for some parts of the system (Roberts & Marston 2000).

The volume of water from regulated sources needed to inundate a specific area of the marshes for a given time varies. It depends on many factors, including the location of the area receiving water, time of year, recent rainfall in the marshes, volume of unregulated flows, soil type, vegetation cover and flow history. Estimates of required volumes are based on the assumption that some flows to the marshes will be available as relatively high flows, for several consecutive months, to ensure that water is distributed to designated areas and to provide the required duration of inundation.

The soils of the marshes are estimated to have the capacity to hold at least 10 megalitres per hectare and up to 15 megalitres per hectare (P. Bacon pers. comm.). Once the soil profile in the marshes becomes very dry, a large volume of water is needed to replenish it before surface flows can be maintained.

The wetter areas of the marshes need a lower volume per area to maintain an appropriate wetland condition than the increasingly large, and increasingly dry, areas beyond them. For example, in 2008, an environmental flow release targeted a small area in the wetter part of the North Marsh, taking particular care to avoid spreading water over a large area of dry marsh and achieved a volume to area ratio of about 5 megalitres per hectare. The environmental release in 2005, made in combination with tributary flows, had generally higher inflow rates and targeted a larger area of dry marsh. Overall, this release achieved a volume to area ratio of about 9 megalitres per hectare. Figure 3.8 shows volume to area ratios up to 12 megalitres per hectare. During the 2009 environmental flow, almost 20 megalitres per hectare was required to inundate about 1000 hectares for three months. According to CSIRO forecasts, drying will probably increase (CSIRO 2008). It is likely that the drying will result in longer periods without water, drier conditions in the marshes and a higher volume-to-area ratio.

An important part of operational planning will be to obtain accurate information about the volumes required to provide suitable flow regimes in different parts of the marshes under a range of climatic conditions. Digital elevation and hydrodynamic models will assist environmental flow managers to narrow the range of volumes for any known set of antecedent conditions. These are currently being developed by DECCW.

Indicative inflow: inundation relationship

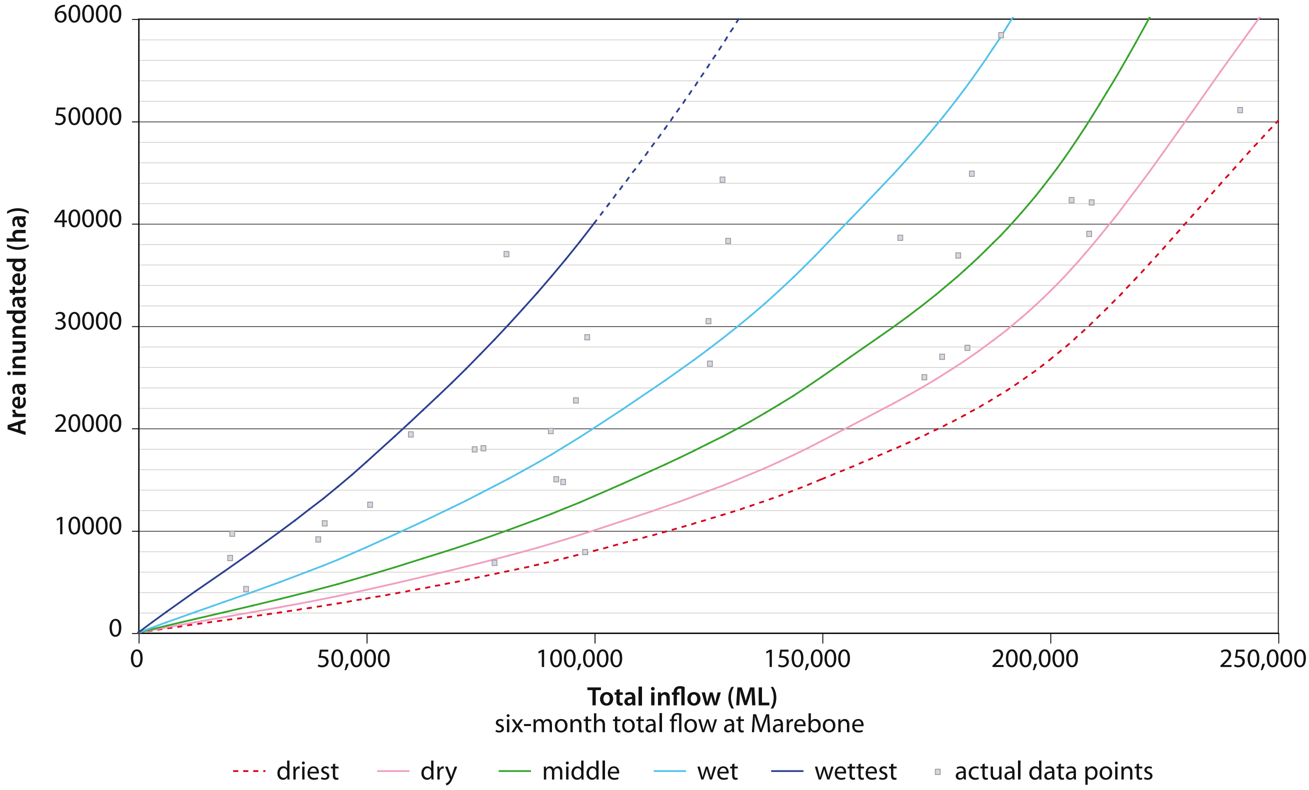

Figure 3.8 The relationship between inflows and area inundated. The volume is total flows for six months before the mapping of the inundated area.

3.6 Managing water in the marshes

One approach to managing water in the marshes is to identify an area to be maintained and calculate the volume needed to achieve it. Another approach is to calculate the amount of water likely to be available under different climate scenarios and identify how many hectares of wetland can be maintained for the given volume. In prioritising wetland areas for water delivery, consideration will be given to the ecological importance of each area and its importance for the character of the marshes, land management practices, legislative status, ease of water delivery and overall likelihood of achieving ecological outcomes and objectives.

3.6.1 Managing for an identified area of wetland (area based)

The area of semi-permanent wetland vegetation in the marshes in the early 1990s was mapped as about 72,000 hectares (Wilson 1992). The condition of most of this vegetation is declining (Nairn 2008; Bowen & Simpson 2010). It will be difficult to arrest this decline under the climatic conditions that have been experienced since 2000, or those predicted (CSIRO 2008). For example, restoring and maintaining functions and habitats in 30,000 hectares of semi-permanent wetland vegetation will require flows to the marshes of between 200,000–300,000 megalitres over six months, at least seven years out of 10. The marshes have not received this volume in a six-month period since early 2002.

3.6.2 Managing by availability of water (volume based)

The second approach is to calculate how many hectares of the identified assets and values of the marsh can be maintained to protect critical ecological functions and habitats, using a nominated amount of water. The amount of water available cannot be predicted accurately, although current trends and forecasts suggest that it will be less than the long-term average (CSIRO 2008).

The amount of water needed from regulated supply for the marshes will depend on climatic conditions. In the line graph in Figure 3.8, the broad relationship between inflows to the marshes and area inundated is shown. The wetter the climate, the less precise the relationship between inflows to the marshes and area inundated. During wet times, flows are higher; unregulated flows and rainfall in the wetlands provide more water; floods are longer and more extensive, and water flows through the marshes to the Barwon–Darling River. The relationship is more precise during drier climatic conditions, which are forecast for the Macquarie Valley. These are the conditions under which environmental flow management will be most significant.

3.7 Scenarios of water availability

Four scenarios of water availability have been selected to estimate the area of semi-permanent wetland that could be maintained under different conditions. The scenarios use allocation to general security and the environmental water allowance as an indicator of water availability, and are based on CSIRO's Murray–Darling Sustainable Yields Project, long-term average conditions, and allocations to general security shares since 2002. The total regulated environmental share at the time of publication of the plan is 262,148 megalitres, consisting of 160,000 megalitres provided in the water sharing plan. As at 30 April 2010, 46,275 megalitres of general security entitlement has been purchased by the NSW Government, and 55,873 megalitres of general security entitlement is held by the Commonwealth Environmental Water Holder.

Table 3.1 The area of semi-permanent wetland estimated to be supported under various scenarios for water availability.

Percentage allocated to general security shares	Megalitres per hectare	Regulated environmental share (ML)*	Number of hectares estimated to be maintained with no unregulated flow	Number of hectares estimated to be maintained with unregulated flow double (for scenario 1) or equal to the volume of regulated flow
60	7	157,289	22,470	44,940–67,410
40	8	104,859	13,107	26,215
25	9	65,537	7282	14,564
13	10	34,079	3408	6816

* assuming 262,148 ML total

The first three scenarios are for available water determinations allowing general security allocations of 60 per cent, 40 per cent and 25 per cent. The figure of 25 per cent strikes a middle line between the CSIRO driest case and allocations since 2001–02. This assumes that water availability will increase from recent low allocations. To account for the possibility that they will not, a fourth scenario – 13 per cent – using average general security allocations between 2001–02 and 2007–08 has been included. These scenarios assume a period of allocation at this level for 10 years, chosen as being a socially and ecologically relevant period. It is expected that some unregulated flows will also reach the marshes, although a great deal of uncertainty surrounds this figure. Estimates are provided for two unregulated flow scenarios: (1) volumes equal to the amount of regulated flow, and (2) no unregulated flow, as shown in Table 3.1.

3.7.1 Scenario 1: 60 per cent allocation to general security access licences and the environmental allowance

This percentage is near the upper estimate for water availability in the CSIRO forecasts. Under these conditions, the existing regulated environmental share of 262,148 megalitres will provide about 157,289 megalitres of available regulated water. Assuming that about 7 megalitres per hectare are needed under these conditions, and that no unregulated flows occur, it is possible that functions and habitats will be able to be maintained in an area of about 22,000 hectares of semi-permanent wetland vegetation. With the addition of twice the volume of unregulated flow, it is possible that functions and habitats will be able to be maintained in an area of about 67,000 hectares of semi-permanent wetland vegetation.

3.7.2 Scenario 2: 40 per cent allocation to general security access licences and the environmental allowance

Under these conditions, the existing regulated environmental share of 262,148 megalitres will provide about 104,859 megalitres of available regulated water. Assuming that about 8 megalitres per hectare are needed under these conditions, and that no unregulated flows occur, it is possible that functions and habitats will be able to be maintained in an area of about 13,000 hectares of semi-permanent wetland vegetation. With the addition of an equivalent volume of unregulated flow, it is possible that functions and habitats will be able to be maintained in an area of about 26,000 hectares of semi-permanent wetland vegetation.

3.7.3 Scenario 3: 25 per cent allocation to general security access licences and the environmental allowance

Under these conditions, the existing regulated environmental share of 262,148 megalitres will provide about 65,537 megalitres of available regulated water. Assuming that about 9 megalitres per hectare are needed under these conditions, and that no unregulated flows occur, it is possible that functions and habitats will be able to be maintained in an area of about 7000 hectares of semi-permanent wetland vegetation. With the addition of an equivalent volume of unregulated flow, it is possible that functions and habitats will be able to be maintained in an area of about 14,000 hectares of semi-permanent wetland vegetation.

3.7.4 Scenario 4: 13 per cent allocation to general security access licences and the environmental allowance (from 2001–02 to 2007–08)

If conditions continue as they have since 2001–02, with general security allocations of about 13 per cent, the current regulated environmental share of 262,148 megalitres will provide about 34,079 megalitres of environmental water. Assuming that about 10 megalitres per hectare are needed under these conditions, it is possible that functions and habitats will be able to be maintained in an area of about 3400 hectares of semi-permanent wetland vegetation. With the addition of an equivalent volume of unregulated flow it is possible that functions and habitats will be able to be maintained in an area of about 6800 hectares of semi-permanent wetland vegetation.

It is important to note that the four scenarios outlined above are indicative only, and are in the context of the regulated environmental water share at the time of writing of this plan. Additional water recovered under existing government initiatives will add to the environmental share, and increase the area able to be maintained under each scenario. The scenarios are also sensitive to the assumed volume of unregulated flow which may be much greater than the volume of regulated flow (and therefore greater than assumed in these scenarios), particularly in wetter years.

While the scenarios are indicative only, they demonstrate the necessity of prioritising assets for restoration, maintenance and protection. *Duration* and *frequency* are critical parts of the flow regime (Puckridge et al 1998). Long flows that are too infrequent are no more effective in maintaining important wetland values than frequent flows that are too short. Both duration and frequency can be important to ensure that seedbanks and eggbanks are maintained, which is critical to long term sustainability of wetland values.

Ephemeral wetland vegetation communities, except for areas on the fringes of semi-permanent wetlands, will rarely receive managed flows from allocated shares. In most cases, inundation of these communities will come from unregulated flows.

4 Water supply and management

4.1 Environmental water

The Macquarie–Cudgegong water sharing plan provides an environmental water allowance of 160,000 megalitres (NSW Government 2003). At the time of writing the plan, 102,148 megalitres of general security share and 3330 megalitres of supplementary share had been purchased and registered to the holdings of the NSW and Australian governments. Additional water may also be returned to the environment as a result of modernisation of the irrigation industry and river operations underway in some parts of the Macquarie Valley, although it is unclear how much water will be returned. The Basin Plan, in setting the new sustainable diversion limits for the basin and the Macquarie catchment, will influence the amount of water available for environmental purposes.

4.2 The available water determination

The process of allocating water for extraction and the environment is called the available water determination (AWD) and is undertaken by the NSW Office of Water (NOW) after a resource assessment. Under the process, the agency manages the system so that allocations of 100 per cent for domestic and stock, town water supplies and high-security shares are maintained throughout a repeat of the worst period of low inflows – 'drought of record' – in this water source. The 'drought of record' period is about two years in the Macquarie and seven years in the Cudgegong, based on 110 years of inflow records, from 1890–2000.

The available water resource is calculated by adding the volume of water stored in Burrendong and Windamere dams and the likely future minimum inflows, equal to the worst period of low inflows. From the available resources, NOW provides for essential requirements – which include basic rights; full allocations for stock and domestic, town water and high security shares; delivery and storage losses; and any water allocations remaining from previous available water determinations – before allocating to the environmental water allowance and general security shares.

Photo 18 Burrendong Dam, at less than 5 per cent capacity, in February 2007 (Grenville Turner).

This process differs from the available water determination that NOW undertakes in the Gwydir and Namoi valleys. There, the agency considers for allocation only water held in the dam at the time of the assessment, but is consistent with the resource assessment processes in southern NSW regulated rivers. Some anticipated future inflows are indirectly included in the assessment by discounting the budget for the essential requirements. This approach means that when inflows are less than or equal to the lowest on record (which has been the case in Burrendong Dam at times since 2002), essential requirements can be met, and often some general security water is available from new inflows. In 2007 the Macquarie–Cudgegong regulated rivers water sharing plan was suspended because insufficient reserves in storage meant that the ability to deliver full essential requirements was not assured. Access to the environmental and extractive carryover accounts was suspended, although later allowed as the resource availability improved, while high security users and town water supplies experienced restricted allocations.

Future reviews of the water sharing plan will need to consider the implications of the resource assessment method in dry-flow sequences not previously experienced and will need to be consistent with sustainable diversion limits to be established under the Basin Plan (Commonwealth *Water Act 2007*). The water sharing plan is to be reviewed in 2014.

4.3 Capacity of the Burrendong Dam outlet

Burrendong Dam has insufficient outlet valve capacity to meet high simultaneous demand for extractive and environmental water. The maximum rate of release from the dam is 8200 megalitres per day at full supply level, and peak summer extractive demand is typically between 4000 and 7000 megalitres per day. In the past, extractive requirements have been given priority for valve space (Keyte & Johnson 1997, 1998, 1999, 2000). Operational sharing of valve capacity might have to be specified in similar terms to channel capacity where this is constraining environmental or other operational releases, or the capacity of the valves might have to be increased.

Photo 19 A view downstream at the Burrendong Dam outlet (Grenville Turner).

4.4 Water quality, including cold water pollution

Although release of cold water low in oxygen from the bottom of Burrendong Dam does not affect the river's temperature as far downstream as the marshes, it has a significant effect on the aquatic ecological community for some distance downstream of Burrendong Dam. State Water is investigating options to manage this.

Water quality guidelines, objectives and targets are provided in the National Water Quality Management Strategy, the Natural Resources Commission Statewide Targets, and the Central West CMA's catchment action plan (CAP). Specific targets and objectives for the catchment within the CAP include having water temperature maintained or restored to within 2 degrees Celsius of median levels (ANZECC & ARMCANZ 2000), reducing the duration of blue-green algal blooms above high alert level, no detection of hazardous chemicals (ANZECC & ARMCANZ 2000) and reducing faecal coliforms to below primary contact levels at key sites located in the catchment (Central West CMA 2007). Meeting these targets is consistent with restoring critical ecological functions and habitats in the Macquarie Marshes.

4.5 The flood mitigation zone of Burrendong Dam

Burrendong Dam can store an additional 489,000 megalitres (42 per cent) of its capacity above the spillway. This is known as the flood mitigation zone (FMZ). The combined total of the conservation storage below the spillway (1,189,000 megalitres) and the FMZ storage is about 1,678,000 megalitres. The rules governing the FMZ are called *air space operations*. Using these rules, when the dam is between 100 and 120 per cent capacity, water releases are calculated to achieve a flow rate of 5000 megalitres per day at Warren. Between 120 and 130 per cent capacity, the target flow is 12,000 megalitres per day, and between 130 and 142 per cent capacity, the target flow is 18,000 megalitres per day, both at Gin Gin. If the dam is in the FMZ and is endangered as a result of more inflows that cannot be contained in the air space created by gate operation, then *flood operations* allow for the water to be released in a way that maintains the safety of the dam. The spillway's capacity is 1,200,000 megalitres per day.

Water stored in the FMZ cannot be allocated to extractive use, except for stock and domestic replenishment and opportunistic supplementary water extractions for irrigation. The water temporarily stored in the FMZ is for the environment. Historically, the storage has been returned to 100 per cent as soon as practicable and water from the FMZ has been released to the environment regardless of antecedent conditions, a practice that the agency developed during the 1980s after successive wet years. There is an opportunity to review management of the FMZ if increased flexibility of releases was considered to provide benefits to the environment.

4.6 The Marebone Choke

The Marebone Choke is a reference to impediments downstream of Marebone Weir that constrict flows in the river and on the floodplain. Prolonged flows of more than about 4000 megalitres per day at Marebone Weir cause flooding of Gradgery Lane (Johnson 2005). High priority is given to keeping environmental flow rates lower than would otherwise be the case in order to keep Gradgery Lane free of flooding, typically resulting in flows of less than 4000 megalitres per day at Marebone Weir. The range of flows that can be delivered to the Macquarie Marshes is thereby limited. The NSW Wetland Recovery Program has completed works to improve the hydraulic efficiency of the Macquarie River in the Marebone area by removing willows that block the channel. Gradgery Lane has also been upgraded under the program to allow regulated flows of up to 12,000 megalitres per day without impeding the road. A floodplain management plan made under the *Water Management Act 2000* now governs the regulation of structures within an identified floodway, allowing their impact on flood flows to be addressed.

4.7 The effects of weirs and pumps on fish

Reasons for the decline in native fish in the Macquarie River, as in other highly regulated rivers, include flow regulation; habitat degradation; reduced water quality; pest species; over-fishing; disease; loss of genetic integrity through stocking; and structures such as dams, weirs, culverts and river crossings forming barriers that prevent fish moving throughout the river (MDBC 2003). Fish attempting to migrate upstream become easy prey for birds as they gather downstream of barriers.

Weirs can also cause physical injury to fish attempting to migrate downstream. The weirs are of two designs: (1) overshot, whereby the water passes over a crest, and (2) undershot, whereby the water passes under a gate (DPI 2007). Fish can be injured as they pass over the crest and fall to the bottom of the weir, and by turbulence and pressure changes as water passes under the gate. Marebone Weir has an undershot design that is known to cause high mortality among larval and juvenile fish; for example, 95 per cent among golden perch (Baumgartner et al 2006). A fishway is currently being constructed on the Marebone Weir to deal with this issue.

Most irrigation occurs during the warmer months and coincides with spawning and migration, and it is highly likely that fish are being extracted from the river through channels or pumps. Even if the fish are not injured, it is very unlikely that they will be able to return to the river (MDBC undated). The NSW DPI, the Australian Cotton CRC and Murrumbidgee Irrigation are undertaking collaborative research in order to investigate this (DPI 2005).

Photo 20 A view downstream at Marebone Weir. Left: irrigation supply channel; centre: the Macquarie River; right: Marebone Break (Grenville Turner).

4.8 Structures for managing water in the marshes

Structures including banks, weirs, regulators and diversion channels in the marshes from Marebone Weir to North Marsh are a subject of much discussion and some controversy (Hogendyk 2008; Steinfeld & Kingsford 2008). These works are used for flood protection, erosion control, wetland stabilisation, and to provide stock and domestic and irrigation water. During 2008 and 2009, the NSW Office of Water led a strategic compliance project to assess the role, effectiveness and status of the structures and determine their effect on flows destined for the marshes. During the project, 119 structures were investigated and regulatory action was taken on 28 of them. A number of the structures identified and investigated had been constructed by, or on the advice of, the former Department of Land and Water Conservation to prevent erosion (NSW Office of Water 2009).

Photo 21 Banks located in South Marsh (W. Johnson).

Photo 22 Irrigation development in the Marebone area, showing the Macquarie River in the middle distance (Grenville Turner).

Photo 23 Development in the marshes located in the Marebone area. An identified floodway in centre has been cleared, and natural drainage patterns remain evident (W. Johnson).

4.9 Measurement of water extraction

Measurement of water extractions, including the reliability of meters, has been a matter of concern since volumetric allocations were introduced (Minister for Water Resources 1986; DLWC 1995). Measurement of all water extractions, including regulated river allocations, groundwater use, unregulated flows and floodplain harvesting, must be as accurate and reliable as possible. The Australian Government has developed a draft national metering standard framework (NMSF), and aims to provide an acceptable level of confidence whereby non-urban metering throughout Australia has a 'maximum permissible error' limit, in the field, of plus or minus five per cent.

The Australian Government has made an in-principle agreement to allocate $90 million to State Water under the Water for the Future program to replace existing customer-owned meters with State Water-owned meters, to be connected by telemetry. Water savings that the project may generate will accrue to a water access licence to be held by the Australian Government.

5 Land management

Within the context of sustainable development, the 'wise use' of wetlands encourages their beneficial use by people to provide services and benefits for present and future generations and maintain the wetlands' ecological character. However, some land management practices may not be sustainable and are causing damage to, or have the potential to cause damage to, the ecological value of the marshes. The causes of the damage can be diversion banks and channels, clearing, fire, cultivation, grazing and floodway obstruction.

5.1 Managing grazing

A grazing and landuse study of the Macquarie Marshes and Gwydir Wetlands investigated the ways grazing may be affecting the ecological processes in these systems. The study investigated vegetation composition, soil seed banks, soil chemistry, water quality and aquatic invertebrates (Wilson et al 2008).

Results indicated that the major driver of vegetation change is flow regime, and that grazing has a relatively small effect on wetland plant communities. Grazing by cattle appears to be important in maintaining the dominance of species such as water couch in grassy wetlands. The decline of water couch grassland in the nature reserve and its persistence on adjoining land grazed by domestic livestock lends support to this. By contrast, grazing disturbance appears to create openings for other species in marsh club-rush wetland, resulting in higher species diversity (Wilson et al 2008).

Photo 24 The boundary between the nature reserve and private land located in the North Marsh. Top left: river red gum, watered. Left foreground and centre: water couch, watered and grazed. Right foreground and centre: common reed, watered and ungrazed. Right background: chenopod shrubland, lack of water and ungrazed. Centre background and right centre: common reed, light brown and under stress from lack of water; ungrazed (W. Johnson).

There is evidence that river red gums germinate more successfully in grassy conditions but that tree establishment benefits from removal of grass by cattle grazing. Water couch tolerates neither sustained grazing when stressed from lack of water nor persistent grazing when underwater.

Common reed (reedbeds) can be damaged by grazing when it is dry or when new shoots are emerging. Lignum also seems to be damaged by sustained grazing when dry conditions are extended. Conditions of grazing leases that the Department of Lands issued for land that now lies within an area inside the nature reserve excluded livestock from *all reed regrowth until it has attained a height of not less than 3 feet* (Department of Lands no date).

Sustained, very dry conditions have led to increased grazing pressure from both domestic livestock and kangaroos. This is affecting lignum shrubland, common reed and water couch marsh in the North Marsh. A species-rich and abundant soil seed bank is vital if a wetland plant community is going to cope with variable environmental conditions and inundation patterns. It is important to balance the benefits to landholders of grazing cattle in the wetlands against the needs of plant species to reach maturity and set seed to allow species to maintain a long-term presence in the wetlands (Wilson et al 2008).

In consultation with marsh landholders, Industry and Investment NSW (I&I NSW) prepared guidelines for grazing (DPI 2009). Use of environmental water on wetland pasture, when grazed sensitively, can have both productive and ecological benefits.

Photo 25 Clearing and cultivation in the North Marsh. DECCW has since acquired this land on 'Pillicawarrina' for its estate. Foreground: the access road and bank. Left: the Macquarie River (W. Johnson).

5.2 Clearing

Clearing of floodplain and dryland vegetation communities has taken place in the marshes for many years, and the most affected species have been black box and coolibah woodland, river red gum woodland and lignum shrublands. Because the inundation frequency in the marshes has been reduced, pressure has been placed on the grazing industry, and landholders sometimes turn to cropping for an alternative income. The possibility of changing rainfall patterns (particularly higher summer rainfall) may make cropping more viable, and it is possible that clearing pressures will continue. DECCW and the CW CMA are undertaking regulatory activities, vegetation mapping, awareness campaigns and incentive programs.

5.3 Fire

For many years, it has been a normal part of grazing management to burn common reed, and this method is used by DECCW Parks and Wildlife Group (PWG) as a way to reduce fire hazard in the nature reserve (NPWS 1993). Fire is known to damage some wetland species and can kill river red gums. It is especially damaging when the marshes are dry, and any increased drying of the marshes will increase the threats from fire. PWG prepares fire management plans for the nature reserve and works closely with local bushfire brigades and the Rural Fire Service.

Photo 26 Fire in common reed in the northern nature reserve (W. Johnson).

5.4 Managing pests

Pest species in the marshes include pigs, foxes, feral fish and lippia. PWG, Livestock Health and Pest Authorities, and landholders have longstanding programs for controlling the numbers of pigs and foxes in the marshes. A carp-reduction strategy is being prepared for the Lower Macquarie region that will outline the current and future activities to stop the further spread of carp, control the size of the carp populations and increase the community's understanding and involvement in controlling carp.

Lippia, *Phyla canescens*, poses a considerable risk to the ecological and agricultural values of the marshes. Lippia was declared a target for biological control in November 2006 and in September 2009 was listed as a Class 4 Weed, requiring active management by councils for control. The Central West CMA is an active member of the National Lippia Working Group and has collaborated in the development of research work and the development of a best management guide for lippa.

The CMA's 'Warren to the Barwon' project is focusing on land management issues in floodplain and wetland areas along the Macquarie River and adjacent areas downstream of Warren. Trials of management practices to address issues of invasive plant species common to floodplains and wetlands of the area, such as lippia, black roly poly and bushy groundsell, are occurring.

5.5 Salinity

The Macquarie Marshes occupy a natural sump in the landscape where they have accumulated large amounts of salt over a long period of time. This salt is bound in saline clays and dissolved in saline groundwater in the quaternary aquifers and in the underlying regolith. Mapping of ground water shows a thin resistive layer only a few metres thick, with fresh pore water overlying this very large salt store throughout the marshes (BRS 2009).

Typically, the water table in these marshes rises and falls with floods and droughts (Brereton 1993). Salinity has been proposed as causing the loss of semi-permanent wetland in the North Marsh, particularly river red gum woodland and forest (Bacon 1996; Hogendyk 2007). The Australian Nuclear Science and Technology Organisation was commissioned to provide insight into groundwater–surface water interactions in the marshes and to identify sources of water used by riparian vegetation, to provide an improved understanding of wetland responses to water stresses (Hollis et al 2009). The report concluded that due to the high electrical conductivity (EC) values of the saline groundwater it is not likely to be a source of water for transpiration. The report goes on to say that:

> *The original hypothesis that trees may access groundwater during drought thereby lowering the water table would likely be untrue in those areas of the Macquarie Marshes where we have identified high salinity, shallow groundwater bodies – preliminary data suggest that in these areas, trees only access fresher soil waters from the unsaturated zone. When this source of water is less available (during periods of extended drought or when the extent of upstream diversions substantially reduces the frequency and degree of overbank flow) the trees become stressed. This is important to management considerations of which areas of the Macquarie Marshes to target with limited environmental flow allocations during periods of drought (Hollis et al 2009).*

On-ground works that increase the permanence of water bodies within the marsh are also likely to have local impacts on groundwater. Maintaining the marshes over the long term depends on providing enough fresh water to maintain a thin layer of freshwater for plants to utilise (BRS 2009).

6 Aboriginal cultural values of the Macquarie Marshes

6.1 Introduction

The Macquarie Marshes are an iconic natural area with significant Aboriginal cultural values. The marshes lie within the traditional country of the Wailwan people and are the core of Wailwan Country. Aboriginal cultural values are related to both the long history of Aboriginal interaction with the marshes and the interests and aspirations of contemporary Aboriginal communities that have a custodial relationship with the area. Wailwan and other Aboriginal communities maintain a custodial relationship with the marshes – a connectedness to the landscape and a sense of responsibility to care for this important part of their Country.

Over the past two centuries, however, white settlement has made it increasingly difficult, and sometimes impossible, for Aboriginal people to exercise their custodial duties. Enhancing Aboriginal cultural values involves strengthening Aboriginal communities' relationships with the marshes.

Protecting the wetlands' cultural and natural values is aligned, although differences exist, including differences in emphasis for on-ground protection. For example, the elevated sandy ridges in the marshes are an important part of the Aboriginal cultural landscape, because they contain culturally important vegetation communities and important cultural heritage sites. These areas are a conservation priority.

Photo 27 A grinding stone from Macquarie Marshes. These were used for grinding seed from grasses which grow around the wetlands (Damian Lucas/DECCW).

6.2 The history of Aboriginal settlement and occupation of the marshes

6.2.1 Traditional settlement of the marshes

In traditional times, the Macquarie Marshes' wetlands and river channels were an important focus of settlement for Aboriginal people. The Wailwan people had a relatively small country compared to the larger Aboriginal nations that surrounded them – the richness of the marshes as a resource base may account for this difference. The marshes provided a range of favourable conditions for settlement in this dry area: rich and reliable wetlands, floodplains covered with riverine forests and grasslands, and elevated sandy ridges. Mt Foster and Mt Harris were two of the region's only quarries for obtaining stone for manufacturing axes and flaked implements. Given the richness of resources in the marshes, the Wailwan would have held an important place in the overall region, between the arid and river country to the north and west, and the slopes and ranges to the south and east.

The marshes were not only a resource base for Aboriginal people; the wetlands landscape was at the centre of Aboriginal culture and spirituality. Aboriginal people were connected to the natural world through totem and kinship relationships, which established relationships of mutual care and responsibility. The landscape, specific places and specific plants and animals were all animated through events in the Dreamtime. The creation spirits continued to inhabit the landscape and often rested in large waterholes or in the form of animals, such as Mullian the eagle hawk, one of the Wailwan's totems (Masman & Johnstone 2000). The landscape of the marshes was a 'nourishing terrain' for the Wailwan traditional owners and other groups who had relationships with this place (Rose 1996).

When the wetlands were flooded, they would have been a larder in the floodplain country. During flood times, waterbirds would have been greatly abundant and the people living on the wetlands would have used both the birds and the birds' eggs. When the wetlands were not in flood, the large river channels and semi-permanent areas of water would also have been a major feature of the cultural landscape, as the source of water and associated resources. Aboriginal people harvested food, tools, shelter and medicinal items from plant and animal resources. The plants and animals were also a cultural and material contribution to the social and ceremonial aspects of the region's Aboriginal life. Aboriginal people adapted and developed sophisticated technologies in order to live in the wetland environment, such as using fire to modify the landscape and setting fish traps (Sturt 1833; Mitchell et al 1999).

A key aspect of living on the wetlands would have been moving between the 'red country' (elevated ridges) and the 'black country' (the floodplain and wetlands). During floods, the black country was uninhabitable, but as the flood waters dried up, people would have focused on the main river channels and core wetland areas (Witter 2004). Today, elevated red ridges contain the physical remains of many campsites and hearths. The black soil floodplains, characterised by self-mulching alluvial soils and periodic floods, have poor conditions for preserving stone artefacts (Biosis 2008).

Core wetland areas provided the important and iconic wetland plants, including cumbungi (bulrush) and nardoo. The riverine forests, woodlands and grasslands would have contained another suite of important plants, including river cooba, river red gum, coolibah, Mitchell grass and native millet. Today, scarred trees, typically coolibah, located throughout the marshes indicate that the people used floodplain trees for implements – such as coolamons – and shelter. These scarred trees have added importance because few of the actual wooden implements have survived. A large number of surviving grinding stones and mullers indicate the importance of grasses and seeds in the marshes (Biosis 2008).

The elevated ridges also provided important resources, and some of the important species were wilga; bumble, or wild orange; belah; leopardwood; quinine bush; nepine; quandong; and western boobialla.

The marshes were a focus for large ceremonies. The Bora (initiation) ceremonies recorded at a Macquarie Marshes site in 1893 and 1898 (Mathews 1901; Miller 1999) were modern examples of long-running Bora ceremonies at the site. The ecologically rich and dependable wetland environment of the marshes would have provided the reliable setting and quality of resources necessary for Bora ceremonies (Bowdler 2005). After almost 200 years of white settlement, most of the country has been radically changed, explaining the Aboriginal concern for the remnants that have survived in a relative natural condition.

6.2.2 Post-contact history

Colonisation of the Macquarie Marshes from the 1820s onwards caused radical changes for Aboriginal people in the marshes, and more broadly across western NSW. Aboriginal people were usurped from their lands, and their social, cultural and spiritual ways of being were severely disrupted.

However, even though invasion occurred, Aboriginal people were not dispossessed (Goodall 1996, 2001; Hope 2004). In the colonial situation, Aboriginal people maintained a connection with the wetland area. Although physical 'openings' into the landscape were constrained, Aboriginal people used a range of strategies in order to maintain a connection with the Macquarie Marshes under greatly changed circumstances (Byrne & Nugent 2004).

Throughout the nineteenth century and into the early twentieth century, Aboriginal people were valued workers on the region's pastoral properties and worked on stations that included Pillicawarrina, Wallumgambone, Buckiinguy, Sandy Camp, Oxley and Buttabone. Aboriginal people lived in communal camps on pastoral stations, in camps located on riverbanks, and on reserves created by the Aboriginal Protection Board (Masman & Johnstone 2000).

During the 1930s, scrutiny of Wailwan and other Aboriginal people living in the marshes radically increased. The Aborigines Protection Board actively instituted a policy of concentrating Aboriginal people on a small number of board-run reserves (Goodall 1996; Hope 2004). In 1935, people from Quambone were forcibly moved to the reserve at Brewarrina, and people were also moved to Pilliga and other missions (Goodall 1996). A key point is that this active removal from Country occurred only relatively recently, and for older people, within the period of living memory.

In order to escape the board's control and seek education for their children, Aboriginal people moved from the marshes to informal camps outside towns, which were located throughout the region. By the 1960s, few Aboriginal families were permanently living on properties located in the marshes. However, from the base of surrounding towns, many Aboriginal people continued to work in the marshes as shearers, stock workers and fencers. The movement to centralised reserves and town camps affected identification of all traditional Aboriginal groups but had especially negative implications for smaller groups such as the Wailwan.

By the late 1960s, a pattern of limited physical access to the marshes had developed, and this pattern has continued to today. Significant Aboriginal communities live in the towns surrounding the marshes: Quambone, Coonamble, Warren, Narromine, Walgett and Brewarrina; however, few Aboriginal people actually reside in the marshes area.

In this situation, physical access to the marshes depends on maintaining good relations with private landholders, but because the amount of work on marsh properties decreased, these relationships were more difficult to maintain. Many Aboriginal people have reported that in trying to access favoured areas of the marshes, for fishing or simply for visiting places, they encountered fences and locked gates. Since the 1970s, Aboriginal people have experienced the ecological decline of the marshes as another form of loss, not by way of barriers to physical access but because Country itself is rapidly declining.

Restriction of physical access has led to loss of detailed knowledge of areas of Country. However, Aboriginal people have sustained detailed knowledge of the areas of Country that they continued to be able to access in the colonial situation. For example, Aboriginal people have sustained knowledge of land surrounding the reserves they lived on, places they could access through work, or public land such as riverbanks. In this situation of restricted access, land continued to be at the centre of culture, identity and spirituality for the region's Aboriginal people. Although detailed knowledge of Country has been lost, Aboriginal people continue to have broad knowledge of Country and a distinctive set of cultural and ecological goals for Country (Goodall 2001).

Since the 1970s, Aboriginal rights in relation to land have been re-asserted and Aboriginal people have become increasingly confident in seeking access to land, protection of cultural heritage sites and involvement in managing the environment. The practice of managing the environment has also slowly changed, whereby Aboriginal people's involvement in conserving and managing the environment has increased incrementally, slowly creating new 'openings' into the landscape of the marshes.

6.3 Values, interests and aspirations of contemporary Aboriginal communities

The interests and priorities noted below were documented in community consultation activities conducted in 2007 and 2008, including 'back to Country' events held at the Macquarie Marshes. This section also draws on interviews conducted with community members (Peckham & Molsher 2005; Dykes et al 2006; Waters Consulting 2008).

6.3.1 Wailwan traditional descendants: key priorities

As traditional owners of Country, the Wailwan people have a special role in planning for Country. Wailwan traditional descendents have identified the following six key priorities for the Macquarie Marshes:

1. Cultural flows to Country.
2. Access to Country in order to conduct cultural activities.
3. Inclusion in management of Country.
4. Training and working for Country.
5. Cultural continuity and heritage protection on Country.
6. Caring for Country: enacting cultural and ecological responsibility for Country.

As first people, the Wailwan have inherent rights in Country. Wailwan people, along with other Aboriginal people, have never given up sovereignty over or connection to their lands and water. They have a specific interest in re-engaging with Country in order to enhance their spiritual connection to Country, and to revive their cultural practice and expressions on Country.

The Wailwan have a holistic view of land management and aspire to be involved in all aspects of processes for cultural, environmental, economic and social management. They hold a vision for a healthy, living river system that has natural flows and cycles. They share this vision with other Aboriginal peoples of the Macquarie Valley and the Barwon–Darling River. Today, Wailwan descendants and other Aboriginal people aspire to be equal participants in protecting and regenerating the Macquarie Marshes' ecology and in protecting Aboriginal culture and heritage. Also, the members of the contemporary Wailwan community want to ensure a sustainable economic base for current Wailwan and future generations.

Although the Wailwan have a special position as descendents of the area's traditional people, other Aboriginal communities have important associations with the Macquarie Marshes. Other Aboriginal groups that have a strong association with the marshes are:

- traditional owner groups from upstream and downstream of the marshes
- traditional owner groups who used to gather on Wailwan Country for ceremonial purposes
- Aboriginal people who have a historical connection with the marshes, especially through working in the pastoral and agricultural industry
- Aboriginal people who reside on Wailwan Country.

6.3.2 Values, interests and priorities: Wailwan and other Aboriginal people

During the community consultations conducted with community members from the Wailwan and other Aboriginal people, the following values, interests and priorities arose.

Photo 28 Ruby saltbush fruit, an important food plant, grows on the dry areas fringing the wetlands (Damian Lucas/DECCW).

6.3.2.1 Recognising custodianship

An overarching issue raised during the community consultations was the need to acknowledge and strengthen Aboriginal custodianship. Contemporary custodianship could be acknowledged by maintaining Aboriginal place names and renaming places so that they have Aboriginal place names, by welcoming people to Country at the beginning of events and by increasing Aboriginal people's participation in managing the environment.

6.3.2.2 Protecting Country

During the consultations, specific aspects of Country were considered to be especially important by members of the Aboriginal community and in need of conservation and protection. The priorities were as follows:

- to restore core wetlands
- to protect other areas and ecosystems, riverine forests, woodlands and grasslands, and elevated sandy ridges
- to institute a cultural allocation of water and take Aboriginal cultural values into account when managing environmental water
- to protect cultural heritage sites
- to take a holistic approach to managing Country
- to introduce additional land in conservation reserves.

6.3.2.3 Undertaking activities on Country

Aboriginal people described the activities they want to be able to undertake on Country:

- having access to Country in order to conduct cultural activities
- having work, training and economic opportunities on Country
- being involved in managing Country, especially in managing environmental water
- forming partnerships with the NPWS in managing conservation reserves
- establishing an Aboriginal cultural flow of water.

6.4 Identifying and protecting Aboriginal cultural values

6.4.1 Protecting Country

6.4.1.1 Aboriginal cultural values and ecological health

The Aboriginal cultural values of the wetlands are strongly associated with the wetlands' ecological health. Protecting the wetlands' natural values enhances their cultural values. However, there are differences of emphasis that exist. For example, Aboriginal communities have a strong interest in protecting wetland plants that have iconic cultural value, such as nardoo, cumbungi, river cooba, coolibah and river red gum. Also, Aboriginal people are strongly interested in being involved in managing and restoring their Country.

Along with the core wetland areas, other ecosystems and vegetation communities in the marshes are highly significant in relation to Aboriginal cultural values. Riverine forests, woodlands and grassland and the elevated ridge country ('red country', often associated with poplar box woodland) are the support systems for significant plants and animals that have cultural values and are important in the preservation of cultural heritage sites.

6.4.1.2 Aboriginal cultural values and management of environmental water: a cultural flow of water

Water is a key factor in sustaining wetland plants and animals that have cultural values and is important for sustaining the health of the cultural landscape in general. The Aboriginal community strongly aspires to having a dedicated cultural allocation of water for the Macquarie Marshes. Cultural flows are allocations of water that Aboriginal people control in order to improve the spiritual, cultural, environmental, social and economic conditions of Country (Morgan et al 2004). A cultural allocation of water is a way for Aboriginal community members to enact their custodial responsibilities for the Macquarie Marshes and to protect the health of the environment. The primary focus of these flows would be to provide water for important aspects of the cultural landscape – plants, animals, sites and the broader landscape – that depend on water. In practice, cultural flows could be used in conjunction with environmental flows.

Bringing about broader recognition of Aboriginal cultural values in managing environmental water involves other steps, including having Aboriginal representatives on committees that manage environmental flows and including Aboriginal cultural values as criteria in managing environmental water.

6.4.1.3 Aboriginal cultural heritage sites

The Macquarie Marshes contain a range of significant Aboriginal cultural heritage sites. More than 500 sites have been recorded in the wetland area (Biosis 2008). These places are important indicators of the long history of Aboriginal peoples' interaction with the Macquarie Marshes and show how Aboriginal people adapted to and used the wetlands' resources.

Cultural heritage sites in the Macquarie Marshes include:

- carved trees, and historically documented ceremonial and Dreaming sites and stone arrangements
- Aboriginal ancestral remains
- an assemblage of earth mounds that are the most northerly examples of a site type
- very large assemblages of grinding stones and scarred trees, which are evidence of how important plant foods and tree resources are in the wetland environment
- stone artefacts
- a range of places related to the region's post-contact (post 1788) history: sites of frontier violence, ceremonial sites, living places – missions, reserves and camps – and working places – pastoral properties (Biosis 2008).

According to predictive mapping of cultural heritage sites, important areas for potential sites include:

- within 250 metres of river channels and margins of inundation
- elevated sandy country within the marshes, which usually corresponds to box vegetation communities (Biosis 2008).

Cultural heritage sites are subject to a range of threats, which include land clearing, and tramping and erosion from livestock. In the marshes, cultural heritage sites occur across a range of tenures: private land, conservation reserves, travelling stock reserves and state forests.

6.4.2 Cultural activities on Country

6.4.2.1 Access to Country for cultural purposes

The ability to easily gain access to the wetlands for a range of cultural activities is a key interest for Aboriginal communities. Access to Country is a fundamental contributor to cultural renewal, creating opportunities for Aboriginal people to reconnect with their Country, conduct cultural practices and pass on their knowledge. Restoring access to Country addresses the long history of Aboriginal people's exclusion from the wetland area.

Activities that Aboriginal communities want to conduct on Country include:

- conducting family camps, back-to-Country camps and camps for conducting cultural practices
- undertaking education and cultural awareness activities
- collecting bush foods and wild resources – including sedges and reeds for weaving
- conducting men's and women's specific activities and specific activities for young people.

Public conservation reserves are a key focus for increased access to Country. Partnership arrangements with DECCW Parks and Wildlife Group are an important way to facilitate increased public access, as is expanding conservation reserves in the marshes. It is also important that Aboriginal communities have access to private land.

Photo 29 Fruit of the quandong tree, an important food plant that grows on the raised ridges surrounding Macquarie Marshes (Damian Lucas/DECCW).

Aboriginal cultural resources use is supported under the NSW Government's Aboriginal Cultural Resource Use Framework. The Central West CMA, as part of its cultural heritage activities, supports negotiated access to private lands located in the catchment. Furthermore, the NSW Government recognises that a key element in enhancing contemporary Aboriginal resilience is restoration of mechanisms for exercising connection with Country (DAA 2003; NSW Government 2006).

6.4.2.2 Working on Country: increasing employment, training and economic opportunities on the wetlands

Employment and training in conservation and management of natural resources are important ways for Aboriginal people to restore connections with Country (for the benefits of Working on Country programs in northern Australia, see Altman & Whitehead 2003, Garnett & Stilhole 2007). Opportunities for employment of Aboriginal people in the marshes could be created in a range of areas. This objective could be achieved by forming partnerships with the NPWS or undertaking activities for conserving and managing natural resources and the environment on private land in the marshes, supported by CMA projects. In the longer term, opportunities could be developed for Aboriginal-owned businesses or Aboriginal contractors to undertake contract work in conservation and management of natural resources.

6.4.3 Participation in managing the wetlands

It is important that environmental management agencies engage with Aboriginal communities early and on an ongoing basis so Aboriginal communities have the best opportunities to be involved in managing the Macquarie Marshes environment. Aboriginal communities would thereby be able to be involved in making decisions that affect them and to fully enact their custodial responsibilities to Country and its resources (DAA 2003; DECC 2006, 2007).

In the context of the marshes, which is a natural area with strong cultural values, it is important that Aboriginal communities participate in the overall environmental management of the marshes as well as in management of cultural heritage. Key forums for Aboriginal communities to participate in include the environmental flows reference group (EFRG) and management of the Macquarie Marshes Nature Reserve.

There are other important ways for Aboriginal people to be involved. Formation of an Aboriginal community reference group would be a key avenue for increasing Aboriginal people's engagement in managing the environment, especially in managing environmental water. The reference group would be a forum for Aboriginal communities to develop and advocate perspectives on managing the marshes environment. The Central West CMA and agencies could support the reference group by providing resources for the group to meet on Country a number of times a year.

Given that Aboriginal people's involvement in environmental management forums is relatively new, it is important that management agencies provide ongoing support and training for Aboriginal community representatives. In order to assist Aboriginal representatives on these forums, it is also important that cultural awareness training be available to non-Aboriginal committee members.

7 Integrating social and ecological systems

7.1 Adaptive management and adaptive governance

An aim of this plan is to guide adaptive management and adaptive governance of the Macquarie Marshes, to restore resilience and maintain critical ecological functions and habitats. Adaptive management provides structured links between science, policy and management, addressing two major concerns when managing social and ecological systems: (1) the need to have relevant knowledge of the systems and (2) ensuring that knowledge is included in decision making. Adaptive management uses available information to highlight management opportunities and choices, guide learning, and improve management (Holling 1978; Walters 1986, 1997).

An important definition of adaptive management is that it is *a structured process of 'learning by doing'* (Walters & Holling 1990; Walters 1997) that begins by applying existing knowledge, from different sources, to management. Management is adaptive when decision makers continuously monitor and integrate appropriate ecological, social and economic information into management and policy, and when uncertainty is acknowledged as always present (Berkes et al 2003; Johnson 2005).

Adaptive management includes social and technical processes. Objectives and actions must suit the time and place and must be at the right scale for it to be successful. Adaptive managers are aware that knowledge is always incomplete, that decisions are based on the values of the society they are made in, and that decision making is consequently a social and political responsibility (Johnson 2005; Resilience Alliance 2009). Adaptive governance goes beyond adaptive management to address the broad social contexts of management. It focuses on developing new institutional arrangements and organisational structures just as much as on scientific methods (Scholz & Stiftel 2005; Resilience Alliance 2009).

7.2 Resilience and adaptive capacity

Resilience is generally defined as the ability to recover from or adjust easily to misfortune or change. It applies to social and ecological systems and is a system's capacity to absorb disturbance and retain its basic structure and function. Resilience can also be defined as the distance from a threshold. A resilient ecosystem can withstand shocks or changed conditions and rebuild itself when necessary. Resilience in social systems includes the capacity of humans to anticipate and plan for the future (Walker & Salt 2006; Resilience Alliance 2009).

Adaptive capacity, or adaptability, is the ability to adapt to and shape change. It is the capacity of the parts of a system to influence resilience. In a social–ecological system, it is the capacity of humans to manage resilience. Systems that have a high adaptive capacity are able to adjust to changing conditions without undergoing significant declines in their crucial functions. A consequence of loss of resilience and therefore of adaptive capacity is loss of opportunity that limits choices for action during periods of change – an inability of parts of the system to do things differently, or to do different things (Resilience Alliance 2007, 2009).

7.3 Social systems

In this plan, social systems or social structures are defined as being the people, community groups or organisations that have some involvement in, interaction with or influence on, the Macquarie Marshes and its related ecological system. In this context, the term 'social' includes cultural, political and economic functions and structures. It also includes the organisational arrangements, needs, values and interests of various individuals and groups within a specific, distinct area. Area can be defined in terms of geography, issue or problem, or subject of interest.

This plan acknowledges the strong cultural and historical links that groups and individuals have with the marshes. These groups and individuals include government agencies, non-government organisations, rural industry organisations, environmental groups, individual landholders, and people who have cultural and historical connections and interests.

So that either the effects can be reduced or some of the costs associated with change can be negated, the following principles are proposed for guiding integration of community priorities, values, needs and interests into management and planning:

- negotiations will be held before actions are taken
- negotiated actions to reduce the stress associated with change must be possible and practical in terms of cost, personnel and time
- actions should be monitored and reported against specific ecological objectives and management responses
- actions should be valued by the parties for whom they are intended
- actions can draw on the experiences and skills of individuals and groups in the community as well as existing infrastructure and resources.

7.4 Research, monitoring, evaluation and reporting

Knowledge comes from different sources. Managers and researchers in many different fields have learnt from experience in the marshes, responding to the behaviour and condition of the systems they manage and study (Fazey et al 2006). An important part of managing the marshes adaptively will be effective use of different sources and types of information, including the knowledge of landholders and Aboriginal people. Community ownership of scientific research will be more likely if people are involved in the conception and implementation, and at the completion of research. Information is sometimes not available, and sometimes it is simply the case that science cannot answer the questions that managers and policy makers ask. Strong links and effective communication between researchers, managers and policy makers must be developed and fostered. A research plan will be developed as part of the plan's implementation.

Monitoring, evaluation and reporting of the effectiveness of policies and management are essential for adaptive management. The NSW Wetlands MER Rapid Assessment technique is just one example of a system for reporting wetland condition quickly. However, on its own, it is not comprehensive enough for monitoring and evaluating the success of management in the Macquarie Marshes. Water delivery must be monitored to ensure that it reaches identified assets, and the distribution of water in the assets must be measured. The effectiveness of environmental flow management in meeting specific objectives is of special interest, particularly in relation to:

- changes in the extent of semi-permanent wetland vegetation
- the proportions of healthy and stressed semi-permanent wetland vegetation
- the diversity and density of aquatic invertebrates
- the diversity and density of waterbird species.

Scientific research and monitoring activities themselves should also be evaluated for their contribution to a broader understanding of wetland processes and functions and the uptake of information into management actions.

DECCW is working with the University of New South Wales to develop a strategic adaptive management and research framework for the Macquarie Marshes Nature Reserve. A goal of this project is to address the perennial difficulty of linking management, policy and science (Walters & Holling 1990; Rogers 1998; Johnson 2005). This process will be reviewed and evaluated with a view to applying it to the whole of the marshes.

7.5 Regulation, enforcement and compliance

The objectives of plans or activities aimed at protecting and maintaining complex social-ecological systems such as the Macquarie River and the Macquarie Marshes will be achieved only if the legislation, policy and guidelines are regulated and enforced consistently, credibly and effectively (Scholz & Stiftel 2005).

There is no shortage of responsibility or legislation for regulation and enforcement; I&I NSW, NOW, State Water, DECCW and the Australian Government have responsibilities and powers under legislation. However, programs for strengthening and improving coordination of the approaches to implementation will have to continue if the full benefits of the legislation are to be realised.

7.6 Cooperation and community participation in management

The centrepiece of community participation in managing the marshes is the Macquarie–Cudgegong Environmental Flows Reference Group. This group has been operating since 2002 and has become very skilled, including the critical skill of operating effectively as a group. Its membership has grown in recent years and now includes representatives of the regional Aboriginal community and a representative of the Australian Government as an observer.

Nevertheless, for community participation in managing the Macquarie Marshes to remain effective, the following five key challenges should be kept in mind.

1. Striving for genuine representation by:
   (a) ensuring key people and groups are involved
   (b) creating an explicit statement of roles, responsibilities and expectations and
   (c) providing leadership and support so the stated roles can be undertaken effectively
2. Designing workable and useful processes.
3. Including scientific, expert and local knowledge in decision making.
4. Developing a common understanding of the system and the challenges that it faces.
5. Evaluating whether decisions are effective and whether they achieve management objectives (Scholz & Stiftel 2005).

Effective communication will be an essential part of undertaking the plan. Credible, trusted knowledge will not be developed without strong links and communication between relevant stakeholders.

8 Change and management in the Macquarie Marshes

Action is needed to arrest the decline of the marshes and ensure their ecological functions and processes are maintained. Most of the actions required for bringing about change are not new and many are already being implemented or planned under existing funding programs, policy or legislation.

DECCW and the Central West CMA will carry out an annual review of implementing the AEMP and ensure that other agencies, interest groups and individuals are involved both in the review and implementation of the AEMP. DEWHA, I&I NSW, NOW, State Water, Aboriginal communities and marshes landholders will be critical participants in this process.

8.1 Projects and actions identified in the plan

For the Macquarie Marshes to have a sustainable future, communities and government must establish a shared view of the condition and the trajectory of condition of the marshes, the causes, and useful management, research and policy responses. At the time of writing of the plan, agreement had been negotiated for many projects and actions. Most are uncontroversial, and some are already underway, as shown in tables 8.1-8.8 in section 8.4 of this plan. Examples include:

1. Modifying weirs and other barriers to improve conditions for native fish.
2. Increasing the release capacity of Burrendong Dam to increase the size range of managed flows.
3. Improving irrigation efficiency and purchasing water from willing sellers to return water to the environment.
4. Developing guidelines for grazing management to ensure the best outcomes from environmental water management.
5. Establishing processes for ensuring that community members participate effectively in river and wetland management.

For some issues, such as the regulation of floodplain harvesting, while policy directions have been generally agreed, specific actions to implement the policy are still to be developed or applied.

DECCW and the Central West CMA will review progress against the projects and actions in section 8.4 and the actions necessary for delivering them, in the context of the ongoing review and implementation of the AEMP.

8.2 Determining priorities for delivering water

Water from the Macquarie River drives the systems of the Macquarie Marshes and irrigated agriculture, and there is not enough to meet all existing needs. It is clear that much of the 72,000 hectares of semi-permanent wetland mapped in the marshes in the early 1990s no longer supports wetland vegetation and that most of the rest is in poor and declining condition.

The minimum duration and frequency of inundation identified as necessary to maintain the values of semi-permanent wetlands in the marshes is four months, in at least seven years out of ten, requiring about seven to 10 megalitres per hectare for the long term. Watering requirements for specific assets are defined in section 8.4. Delivering this duration and frequency of flooding to areas of wetland under both existing and forecast conditions of surface water availability will mean that a smaller area than has been historically mapped can be sustained in good condition. The policy, management and research implication is that some areas of the marshes will need to be given priority for water.

Determining priorities for watering environmental assets is an ongoing task undertaken at a regional level through an annual planning cycle in the context of the climatic circumstances, water availability and environmental conditions as they evolve. The Environmental Flows Reference Group (EFRG) is a key forum for this process.

Priorities may also be determined on a longer term basis if it becomes apparent that all areas of the marshes cannot be sustained in the long term. This will depend on the success of water recovery programs, the sustainable diversion limit established under the Basin Plan and medium-term climatic circumstances that are experienced.

Priorities for delivering environmental water are determined by DECCW taking into account the advice of the EFRG.

Establishing priorities for environmental watering on an annual and medium-term basis will include:

1. Considering the ecological assets and values of the marshes and their water needs as identified in this plan.
2. An annual review of the progress with the implementation of this plan (DECCW and the Central West CMA).
3. Reaching agreement on the condition and trajectory of condition of the marshes and appropriate management responses (DECCW, CW CMA and EFRG).
4. Identifying flow paths and means of delivering water to identified areas (EFRG).
5. Determining priority areas for water delivery to sustain the assets, values and character of the marshes (DECCW, CW CMA, EFRG and affected stakeholders).

Other factors that will influence medium-term priorities identified in water-management planning will include:

1. The ecological, social and cultural assets and values that are threatened as a result of recent and forecast climatic conditions.
2. The capacity to support complexity and diversity within the marshes, as well as within specific assets or areas.
3. Legislative and policy responsibilities.
4. The nature of land- and water-management activities within or along flow paths to ecological assets, including the number and role of banks, channels, regulators and other structures; management practices; and any formal management agreements.
5. The likelihood that identified management activities will lead to achievement of land and water management objectives.
6. The capacity to deliver water to different areas, including existing or potential works for directing, holding or otherwise managing water.

8.3 Delivering and managing water in the marshes

DECCW is responsible for managing environmental water allocations established under water sharing plans and water access licences held by the NSW Government for an environmental purpose. The EFRG established under the Water Sharing Plan for the regulated Macquarie and Cudgegong Rivers Water Source 2003 advises DECCW about managing this water and helps DECCW prepare an annual watering plan. NOW is responsible for developing and implementing water sharing plans and water licensing, including enforcement and compliance.

Under the *Commonwealth Water Act 2007*, the Australian Government has established a Commonwealth Environmental Water Holder (CEWH) to hold and manage water access licences for environmental purposes in accordance with the environmental watering plan which will be part of the Basin Plan to be prepared by the Murray–Darling Basin Authority (MDBA). The Basin Plan will also establish Sustainable Diversion Limits for water sources within the basin which are expected to be lower than existing diversion levels. The Commonwealth Environmental Water Holder is already a substantial and important holder of environmental water in the Macquarie Valley.

Governments, through the Murray–Darling Basin reform intergovernmental agreement, signed in 2008, have agreed to cooperate on environmental water management. In early 2009, DECC (now DECCW) and the CEWH signed a memorandum of understanding to ensure close cooperation on Commonwealth, state and territory environmental water planning and management.

Extensive public and private works have been built to manage water; to direct, control, harvest and store flows, and to control channel erosion, from Marebone Weir to the northern nature reserve (DNR 2006; Hogendyk 2008; Steinfeld & Kingsford 2008). Although many of these works are essential for managing the marshes, some are of either limited or of no benefit to the marshes and some may have to be modified or removed to protect assets. In some cases, new works will be needed.

An environmental allocation has existed in the Macquarie Valley since 1967 and has been actively delivered to the marshes since 1980. Many members of the Macquarie community have considerable expertise in managing environmental flows and will contribute to operational plans either at a site or on a broader wetland scale. Vegetation mapping and digital elevation and hydrodynamic models currently being developed will be especially useful when priorities for watering are being developed and annual watering plans are being prepared.

8.4 Tables of project and actions

The aim of this plan is to guide restoration of ecological structure and function of the Macquarie Marshes. In the plan, assets and their water needs are identified. It provides a broad context for a number of projects and actions that, when undertaken, will make an important contribution to a sustainable future for the Macquarie Marshes and the Macquarie River (see tables 8.1–8.9). This plan does not include directions for how the projects will be undertaken; it simply identifies them and explains why they are important. The projects and actions can be viewed as modules of the AEMP. Modules of particular importance, and necessary to achieve its objectives, include:

1. A review of the Macquarie Marshes Nature Reserve plan of management.
2. The Pillicawarrina restoration project.
3. An ecological character description of Ramsar site and review of the Ramsar information sheet.
4. Projects for managing water and land in the north, south and east marshes.
5. Guidelines for managing breeding of colonially nesting waterbirds.
6. Guidelines for grazing management.
7. A project for restoring fish habitat in the Macquarie River and Macquarie Marshes.
8. A strategic research plan for the Macquarie Marshes.
9. A monitoring and evaluation program for the Macquarie Marshes.
10. A strategic compliance project for the Macquarie Marshes.
11. A communication plan for the Macquarie Marshes.

Table 8.1 North Marsh wetland vegetation

Key to non-river red gum condition categories.
Good: species composition and structure representative of benchmark, 0–10% exotic (or invasive native) species.
Intermediate: 10–50% exotic (or invasive native) species in any stratum of community, reduced species and/or structural diversity from benchmark.
Poor: 50–100% exotic (or invasive native) species in any stratum of community, greatly reduced species and/or structural diversity from benchmark).

Ecological characteristic and objective	Location	Approximate area, in hectares, in 2008	Tenure	Current vegetation condition	Environmental water delivery potential under existing conditions	Existing wetland values
River red gum forest and woodland Provide water to inundate for at least 4 months of the year, between July and April, at least 7 years out of 10. Ensure that grazing is managed appropriately.	Bora Channel, Ginghet, Hunts Woodland, Macquarie Channel, Log Dam Channel	6150 in nature reserve 6000 on private land	Nature reserve, Ramsar site and private	Good (<10% dead canopy) on south-western side of North Marsh. Intermediate (10–40% dead canopy) to poor (80–100% dead canopy) elsewhere, including many dead trees.	Some areas good, some moderate, some poor	Very high
Lignum shrubland Provide water to inundate for at least 3 months of the year, between September and March, at least 5 years out of 10.	Zoo Paddock, Ginghet, Pillicawarrina, H Block, Halls Block	335	Nature reserve, Ramsar site and private	Most is poor, some good	Some areas good, some moderate, some poor	Very high
Common reed Provide water to inundate for at least 8 years out of 10. Timing is not critical.	Northern nature reserve	1820 as dominant species	Nature reserve and Ramsar site	Some good, some poor: stressed and dead	Some areas good, some moderate	Very high

Table 8.1 (continued) North Marsh wetland vegetation

Ecological characteristic and objective	Location	Approximate area, in hectares, in 2008	Tenure	Current vegetation condition	Environmental water delivery potential under existing conditions	Existing wetland values
Water couch marsh Provide water to inundate for at least 6 months of the year, 8 years out of 10.	River Paddock	250	Private	Good to intermediate. Some areas of invasive chenopod shrubland	Good	Very high
	Macquarie Channel	15	Nature reserve and Ramsar site	Poor: stressed and declining in area	Moderate	Very high
	Bora	25	Nature reserve and Ramsar site	Good	Good	Very high
Mixed marsh Provide water to inundate for at least 8 years out of 10. Timing is not critical.	Macquarie Channel	280	Nature reserve and Ramsar site	Poor	Good	Very high
	Bora	80	Nature reserve and Ramsar site	Good to poor	Good	Very high
	Ginghet	20	Nature reserve and Ramsar site	Good to poor	Good	Very high
Coolibah	North Marsh/ Halls Block, areas to the west of the northern nature reserve	4230	Nature reserve, Ramsar site and private	Good to intermediate	Mostly low, some areas on margins of semi-permanent wetlands receive environmental flows	Very high

Table 8.2 South Marsh wetland vegetation

Key to non-river red gum condition categories.
Good: species composition and structure representative of benchmark, 0–10% exotic (or invasive native) species.
Intermediate: 10–50% exotic (or invasive native) species in any stratum of community, reduced species and/or structural diversity from benchmark.
Poor: 50–100% exotic (or invasive native) species in any stratum of community, greatly reduced species and/or structural diversity from benchmark).

Ecological characteristic and objective	Location	Approximate area, in hectares, in 2008	Tenure	Current vegetation condition	Environmental water delivery potential under existing conditions	Existing wetland values
Common reed Provide water to inundate at least 8 years out of 10. Timing is not critical.	Willancorah Swamp	325	Private	Good	Good	Very high
	Buckiinguy Swamp	80	Private	Some good, some intermediate	Good	Very high
	Mole Marsh	20	Private	Some good, some intermediate, some poor	Good	Very high
	Southern nature reserve	55	Nature reserve and Ramsar site	Poor: now mostly chenopod shrubland	Mostly poor	Very high
Water couch marsh Provide water to inundate for at least 6 months of the year, 8 years out of 10.	Buckiinguy Swamp	5	Private	Poor to moderate: now invaded by chenopods and lippia	Good	Very high
	Willancorah Swamp	100	Private	Intermediate	Good	Very high
River red gum forest and woodland Provide water to inundate for at least 4 months of the year, between July and February, at least 7 years out of 10. Ensure grazing is managed appropriately. Ensure clearing is halted.	Marebone, along Monkeygar Creek in southern nature reserve, Buckiinguy and Mole Marsh	5765	Private	Some good (0–10% dead canopy, along Macquarie River), intermediate (10–40% dead canopy) at Monkeygar, Buckiinguy and Mole Marsh, some poor (80–100% dead canopy), some cleared	Good in parts	High, moderate, and low

Table 8.2 (continued) South Marsh wetland vegetation

Ecological characteristic and objective	Location	Approximate area, in hectares, in 2008	Tenure	Current vegetation condition	Environmental water delivery potential under existing conditions	Existing wetland values
Mixed marsh, water couch Provide water to inundate for at least 6 months of the year, 8 years out of 10.	Mole Marsh	1300	Private	Intermediate to poor: now invaded by chenopods	Moderate	High
Mixed marsh Provide water to inundate for at least 6 months of the year, 8 years out of 10.	Monkey Swamp	990	Private	Poor: now invaded by chenopods and lippia	Moderate	High
	Buckiinguy Swamp	670	Private	Intermediate to poor	Moderate	High
	Willancorah	380	Private	Intermediate to poor	Moderate	High
	Marebone area and Mundooie	245	Private	Intermediate to poor	Moderate	High

Table 8.3 East Marsh wetland vegetation

Key to non-river red gum condition categories.
Good: species composition and structure representative of benchmark, 0–10% exotic (or invasive native) species.
Intermediate: 10–50% exotic (or invasive native) species in any stratum of community, reduced species and/or structural diversity from benchmark.
Poor: 50–100% exotic (or invasive native) species in any stratum of community, greatly reduced species and/or structural diversity from benchmark).

Ecological characteristic and objective	Location	Approximate area, in hectares, in 2008	Tenure	Current vegetation condition	Environmental water delivery potential under existing conditions	Existing wetland values
River red gum forest and woodland Provide water to inundate for at least 4 months of the year, between July and February, at least 7 years out of 10.	Gum Cowal–Terrigal Creek.	5700	Private	Mostly intermediate (10-40% dead canopy). Some intermediate/poor (40-80% dead canopy) and some poor (80–100% dead canopy)	Good	Very high
	Wilgara portion of the Ramsar site	167	Private and Ramsar site	Intermediate (10–40% dead canopy)	Good	Very high
River red gum and coolibah woodland Provide water to inundate for at least 4 months of the year, between July and February, at least 5 years out of 10.	Long Plain Cowal	3010	Private	Mostly poor (80–100% dead canopy) or intermediate/poor (40–80% dead canopy). Some intermediate (10–40% dead canopy) and some good (>10% dead canopy)	Outside managed flows	Medium
	Dusty Swamp	30	Private	Intermediate (10–40% dead canopy). All have invasive chenopod shrubland in the understorey	Outside managed flows	Medium
	Stanley	330	Nature Conservation Trust	Intermediate (10–40% dead canopy). All have invasive chenopod shrubland in the understorey	Outside managed flows	Medium

Table 8.3 (continued) East Marsh wetland vegetation

Ecological characteristic and objective	Location	Approximate area, in hectares, in 2008	Tenure	Current vegetation condition	Environmental water delivery potential under existing conditions	Existing wetland values
Lignum Provide water to inundate for at least 3 months of the year, between September and March, at least 5 years out of 10.	Gum Cowal-Terrigal, Wilgara	70	Private and Ramsar site	Intermediate, all have invasive chenopod shrubland	Moderate	Very high
Water couch marsh	Gum Cowal-Terrigal Creek, Wilgara portion of the Ramsar site	30	Private and Ramsar site	Intermediate	Good	Very high
Mixed marsh Provide water to inundate for at least 6 months of the year, 8 years out of 10.	Gum Cowal-Terrigal Creek, Wilgara portion of the Ramsar site	25	Private, and Ramsar site	Intermediate	Good	Very high
Coolibah woodland	Gum Cowal-Terrigal Creek, Wilgara portion of the Ramsar site	800	Private, and Ramsar site	Some good, some intermediate	Some outside managed flows. Some areas on edge of semi-permanent wetlands receive environmental flows	Very high

Table 8.4 Management of water and land

Issue	Management response or action	Responsibility	Mechanism	Timing
Existing flow regime, including flow size, frequency, duration and timing	Buy water for the environment	DECCW and DEWHA	RERP – Sub-program 1 – Acquisition and management of water for environmental Australian Government's Water for the Future initiative: Restoring the Balance in the Murray-Darling Basin program	2006–11 2008–18
	Increase water efficiency through upgrading irrigation and water delivery systems and improved metering	State Water, DEWHA, irrigation industry and CW CMA	RERP Sub-program III – Ensuring better delivery of environmental water Australian Government's Water for the Future initiative Irrigation metering and national metering standard framework (NMSF)	2006–11 2008–18 2010
	Consider the implications of the resource assessment method in dry flow sequences not previously experienced	NOW, State Water, DECCW and CW CMA	Review of the Water Sharing Plan for the Macquarie-Cudgegong Regulated Rivers Water Source 2003 (WSP)	2014
	Review the way the flood mitigation zone is managed	NOW, State Water, DECCW, local government and CW CMA	Review of the WSP	2014
	Establish the environmental benefits of increasing the outlet valve capacity at Burrendong Dam to allow for both extractive and environmental flows	State Water, NOW, I&I NSW Fisheries and DECCW	To be determined	
	Clarify the role, effect and status of structures for managing water in the marshes	NOW, supported by DEWHA, I&I NSW, DECCW and CW CMA	Healthy Floodplain Project (funded under NSW Sustaining the Basin: Border Rivers–Gwydir Program)	2008–14
Planning	Review the Macquarie Marshes Nature Reserve plan of management	DECCW (PWG)	Core business	Underway
	Update the Ramsar information sheet, and review the Ramsar sites' boundaries	DECCW and private landholders	Ramsar program	2010

Table 8.4 (continued) Management of water and land

Issue	Management response or action	Responsibility	Mechanism	Timing
Planning	Review the Macquarie Marshes Nature Reserve plan of management	DECCW (PWG)	Core business	Underway
	An ecological character description of the Ramsar site and review of the Ramsar information sheet	DECCW and private landholders	Ramsar program	2010
The effects of grazing on wetland vegetation	Improve understanding of how grazing affects wetland vegetation, and determine grazing strategies required for protecting and restoring wetland vegetation	Individual landholders and floodplain graziers, CW CMA, I&I NSW, DECCW and LPMA	Implement grazing in wetlands guidelines developed under NSW WRP	Ongoing
	Provide incentives to improve management of wetlands on private land	CW CMA and DECCW	CW CMA incentives programs RERP – Sub-program IV – Boosting the Benefits of Environmental Water on Private Land	Ongoing 2008–10
Clearing	Implement the *Native Vegetation Act 2003*	DECCW and CW CMA	Legislative responsibility	Ongoing
Fire management	Improve understanding of the effects of fire on the marshes	DECCW	Macquarie Marshes Nature Reserve plan of management and fire management plan Additional research required	2010
Weed management	Minimise the effects of weeds on wetland values	DECCW, private landholders, LHPA, I&I NSW, CW CMA and LPMA	Implement lippia BMP developed under NSW WRP Noogoora burr bio-control using *Epiblemma* species moth	Ongoing Established and ongoing
Carp control	Minimise the impacts of carp on wetland values	I&I NSW Fisheries	Development of a carp-reduction strategy	Underway
Pig control	Minimise the effect of pigs on wetland values	LHPA, DECCW and private landholders	DECCW core business on the nature reserve	Underway
Wetland restoration	Undertake the Pillicawarrina restoration project	DECCW (PWG)	Pillicawarrina project team comprising members from DECCW and UNSW	Underway
Water Management	Implement an integrated plan for supplying and managing water in relation to North Marsh, South Marsh and East Marsh	DECCW, State Water, NOW, I&I NSW Fisheries and private landholders	Inter-agency project teams	2010 and ongoing

Table 8.5 Restoration and protection of fish habitat and the aquatic ecological community

Issue	Response or action for management	Responsibility	Mechanism	Timing
The effect of instream structures on native fish and the aquatic ecological community	Install fishways on all weirs and improve access through road culverts	I&I NSW Fisheries, State Water, local government and CW CMA	Marebone Weir fishway construction (funded under RERP Sub-program III) Investigation into requirements for fishways along Bulgeraga Creek (funded under RERP Sub-program III) Investigate installation of a fishway at Warren Investigate carp separation cages on Marebone, Warren and Gunningbar fishways	2010 2010
	Install screens on extraction points to prevent entrainment of fish	Local government and irrigation industry	Dubbo City Council has screens in place (otherwise unfunded)	Ongoing effort
Degradation of riparian zone and instream habitat	Identify and protect important refuge areas for fish in dry times	I&I NSW Fisheries, LPMA, UNSW, private landholders and CW CMA	Protection of riparian areas	Ongoing
Water quality	Apply the POEO Act	DECCW	Legislative responsibility	Ongoing
	Implement CW CMA CAP targets	CW CMA	Legislative responsibility	Ongoing
	Implement ANZECC 2000 guidelines	CW CMA and DECCW	Natural Resource Commission statewide targets Central West CMA catchment action plan	Ongoing
	Install mixing device to reduce cold-water pollution from Burrendong Dam	State Water	Assessment of performance of a suspended curtain (funded under RERP Sub-program III)	2010

Table 8.6 Application of scientific knowledge to management and policy

Issue	Response or action for management	Responsibility	Mechanism	Timing
Improve links between management, policy and science	Prepare a strategic research program	DECCW and partners	DECCW Water for the Environment Branch, DECCW Rivers and Wetland Unit	2010
	Prepare a manual for managing waterbird breeding	DECCW	Underway (funded under NSW WRP)	2010
	Map vegetation area and condition	DECCW and UNSW	DECCW Rivers and Wetlands Unit SLATS program	Ongoing
	Monitor ecological character of Ramsar site	DECCW	DECCW Water for the Environment Branch Landholders	Ongoing
	Prepare a monitoring, evaluating and reporting plan, and a report on wetland condition	DECCW, NOW, State Water, I&I NSW Fisheries, CW CMA and private landholders	The development of a strategic adaptive management (SAM) framework is being investigated for the nature reserve and may provide a mechanism to evaluate existing programs against objectives and direct the monitoring activities	Ongoing
	Develop a hydrodynamic model of the marshes	DECCW	Component of Decision Support System (funded by RERP Sub-program II)	2010
	Improve technical and scientific support for managers and decision makers	DECCW	DECCW Rivers and Wetlands Unit Other researchers	Ongoing
	Regularly conduct planning meetings between managers, scientists and policy makers	DECCW to lead	Inclusion of all units in key processes and functions including environmental flow reviews, MM AEMP implementation, ecosystem response modelling conferences	Ongoing
	Investigate sedimentation rates in different parts of the marshes	DECCW	Pilot project underway in Buckiinguy Swamp (funded by RERP)	2010

Table 8.7 Aboriginal cultural values

Short term: 2–3 years; **medium term:** 3–5 years

Issue	Response or action for management	Responsibility	Mechanism	Timing
Aboriginal cultural values and environmental water	Negotiate Aboriginal cultural values as criteria for managing environmental water	DECCW	EFRG Develop policies and guidelines on documenting places/sites with cultural values and methods for including these places/sites in the management of environmental flows.	Short term
	Negotiate an Aboriginal cultural flow	DECCW	Explore pathways for securing allocations of water and methods for managing these water allocations	Medium term
Aboriginal cultural heritage sites	Identify Aboriginal cultural heritage sites and take appropriate action to conserve them	DECCW, CW CMA and private landholders	NSW WRP (identification of sites), negotiated under CHD Aboriginal Heritage Conservation Program MMNR plan of management CW CMA Catchment Action Plan	Ongoing
Plants and animals that have Aboriginal cultural values	Identify and protect plants and animals that have Aboriginal cultural value	DECCW, CW CMA and private landholders	NSW WRP (identification of sites) Aboriginal Heritage Conservation Program MMNR plan of management CW CMA Catchment Action Plan Threatened Species Recovery Plans	Ongoing
Access to Country	Increase Aboriginal people's access to conservation reserves	DECCW (PWG) and LPMA	DECCW (PWG) Co-management Program MMNR plan of management	Short-medium term
	Increase negotiated access to private land in the marshes	CW CMA and private landholders	Catchment action plan: a guide to access agreements can be found at www.daa.nsw.gov.au/publications/DAA%20On%20Country.pdf	Short-medium term

Table 8.7 (continued) Aboriginal cultural values

Issue	Response or action for management	Responsibility	Mechanism	Timing
Working on Country	Increase employment, training and economic opportunities on the wetlands	DECCW (PWG) CW CMA	Caring for Our Country CW CMA Catchment Action Plan MMNR plan of management Aboriginal Land Management Framework Indigenous green teams Indigenous rangers	Medium term
Increased participation in managing the wetlands	Include Aboriginal representatives on the EFRG	DECCW	EFRG	In place
	Support formation of a reference group for both Aboriginal cultural heritage and land management in the marshes	Aboriginal community, DECCW, LPMA and CW CMA	To be determined	Medium term
	Make a partnership arrangement with managers of conservation reserves	DECCW (PWG)	DECCW (PWG) Co-management Program MMNR plan of management review Emergent indigenous protected areas program	Medium term
Acknowledgement of Aboriginal connection to Country	Include a welcome to Country and an acknowledgement of Country before major events occur in the marshes	DECCW and Aboriginal community	Event organisers to be advised of acknowledgement request; see guidelines at www.dpc.nsw.gov.au/publications/memos_and_circulars/circulars/2004/c2004-39	In place

Table 8.8 Adaptive governance: participatory processes and consultation

Issue	Response or action for management	Responsibility	Mechanism	Timing
Ensuring stakeholders are involved in managing the river and wetlands	Support the community's role in managing environmental flow	DECCW and CW CMA	Macquarie–Cudgegong Environmental Flows Reference Group, membership of which includes DECCW, CW CMA, NOW, State Water, I&I NSW Fisheries, DEWHA, the Aboriginal community and private landholders	Established and ongoing
	Ensure stakeholders participate in coordinating and reviewing the AEMP	DECCW and CW CMA	Undertake an annual review of the AEMP and identify priorities for watering assets in the marshes; the review to include DECCW, CW CMA, State Water, I&I NSW, DEWHA, EFRG and affected private landholders	Ongoing
	Develop a program for researching strategic adaptive management	DECCW, UNSW and CW CMA	Strategic Adaptive Management and Research Planning Group	Core of group established and ongoing
	Better understanding of legislation	DECCW, CW CMA	Central West CMA is running a *Native Vegetation Act 2003* information day in the marshes in 2010	2010
	Develop a communication strategy	DECCW and CW CMA	Continue communication mechanisms established under NSW WRP and RERP	Ongoing
	Opportunities for the community to access the marshes	DECCW	Discovery tours run by Parks and Wildlife Group in good seasons; a marsh observation platform is located on the Gibson Way	Ongoing

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Office of Environment & Heritage
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Murray and Lower Darling Valleys Annual Environmental Water Plan

2011-2012

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List of Abbreviations

AEW - Adaptive Environmental Water
ASS – Acid Sulphate Soils
ANZECC – Australian and New Zealand Environment and Conservation Council
c-t-f – commence to flow
CEWH –Commonwealth Environmental Water Holder
CMA - Catchment Management Authority
DAAMMP – Darling Anabranch Adaptive Management Monitoring Program
DPI Fisheries – Department of Primary Industries - Fisheries
EC – Electrical Conductivity
EWA – Environmental Water Allocation
GL - Gigalitre
LMD - Lower Murray Darling
MDBA –Murray Darling Basin Authority
MIL – Murray Irrigation Limited
ML- Megalitre
MDFRC – Murray-Darling Freshwater Research Centre
NOW – NSW Office of Water
NPWS – National Parks and Wildlife Service
NRC - Natural Resource Council
OEH – Office of Environment and Heritage
RMW - River Murray Water
RRG - River Red Gum
SBF - Southern Bell Frog
SEWPaC – Department of Sustainability, Environment, Water, Population and Communities
SWC - State Water Corporation
TLM -The Living Murray
WAL – Water Access Licence

Front cover image: Murray Darling Rivers junction, R. Smith, December 2010

1.0 Background

The Murray Valley Annual Environmental Water Plan for 2011-2012, hereafter referred to as 'the Plan', outlines the proposed use of Adaptive Environmental Water (AEW) and the Murray Regulated River Water Sources Additional Environmental Allowance (Murray AEA) in the NSW Murray Valley for the 2011-2012 season. The Plan identifies a number of wetland sites (private and public) that would benefit through receiving an allocation of AEW or AEA. Volumes of water required for each asset has been estimated and included in the Plan.

The Office of Environment and Heritage (OEH) currently manages up to 32,027 megalitres (ML) of Adaptive Environmental Water within the Murray Valley on behalf of the Minister for Environment. The water is held in two AEW licences – a river conveyance licence which has a maximum share of 30,000 ML and a high security licence which has a maximum share of 2,027 ML (Table 1). The OEH can also call upon the use of the Murray AEA, which is linked with high security licence allocations. In addition the OEH facilitates the management of water held by the Commonwealth Environmental Water Holder (CEWH) on behalf of the Commonwealth Department of Sustainability, Environment, Water, Populations and Communities (SEWPaC), water allocated for The Living Murray (TLM) icon sites located in NSW and any water donations made by the public.

Table 1. Summary of Adaptive Environmental Water licences held in the NSW Murray Valley and managed by OEH.

Licence Type	Licence Number	Maximum Capacity (ML)
AEW River Conveyance	WAL 9422 / 50AL503537	30,000
AEW High Security	WAL 9423 / 50AL503538	2,027

Several wetland sites located in NSW National Parks (currently managed by National Parks and Wildlife Service (NPWS)) are watered using a combination of TLM water allocations, Commonwealth allocations and/or AEW. These assets are monitored by NPWS staff and/or contractors commissioned by NPWS.

This Plan has been developed in conjunction with, and is supported by, the Murray Lower Darling Environmental Water Advisory Group.

1.1 Primary Objectives for AEW Use

The primary objectives for the provision of AEW to wetland habitats within the NSW Murray Valley are:

1. *To improve and/or maintain the condition of a diversity of wetland types within the NSW Murray Valley;*
2. *To prevent the further decline in stressed wetland vegetation communities, in particular River Red Gum, Black Box and Lignum communities;*
3. *To increase and/or maintain the abundance and diversity of understorey wetland vegetation communities (in both wet and dry phases);*
4. *To reinstate a wetting/drying cycle for natural ephemeral floodplain wetlands that have been negatively impacted by river regulation and/or severe drought conditions;*

5. *To provide habitat for wetland-dependant fauna including endangered species such as the Southern Bell Frog (Litoria raniformis) and Regent Parrot (Polytelis anthopeplus);*
6. *To compliment naturally occurring high river flows that provide a benefit to wetland/floodplain dependant fauna and flora communities by increasing duration and/or extent of inundation;*
7. *To minimise adverse impacts that highly fluctuating flow rates may have on naturally triggered breeding events, in particular for colonial nesting waterbirds and/or native fish populations, and;*
8. *To assist in furthering management understanding of biological processes and functions within wetland/riverine habitats that will inform future management of environmental water allocations.*

1.2 Wetland asset selection

All wetland sites are assessed prior to being listed to receive AEW in the NSW Murray Valley. The site selection process looks at a number of aspects under four main headings – Ecological Considerations, Management of Wetland, Landholder Interest / Community Values and Logistics/Feasibility.

i. Ecological Considerations:
   - Site condition (current) – vegetation, fauna, groundwater issues, adjacent land practices, hydrological regime, impacts;
   - Vegetation – overall community diversity, abundance and structure; presence of any rare, threatened or endangered species;
   - Fauna - overall community diversity, abundance; presence of any rare, threatened or endangered species;
   - Hydrology – natural hydrological regime, past watering/flooding history, last inundation event (artificial/natural), connectivity to main water source/other wetlands, volume of water required;
   - Ecological or conservation values – at local and/or regional scales, includes national or international agreements, and
   - Impacts / Risks- that may be encountered if watering was to proceed, or not proceed.

ii. Management of Wetland:
   - Stock management – stock are typically excluded during watering projects and for specified period after surface waters have dried, by agreement with landholders, to maximise ecological response;
   - Management plans – desirable but not essential;
   - Long-term management aims of site.

iii. Landholder Interest / Community Values:
   - Landholders are to be supportive of the watering activities and permission granted for watering to proceed;
   - Aim to develop a collaborative approach with landholders, in particular private landholders, to provide a sense of ownership to the watering projects;
   - Significance of wetland to the local community.

iv. Logistics / Feasibility:
   - Approvals – includes required licences and/or work approvals from relevant state authority(ies);
   - Preparatory works;

- Feasibility – water delivery method, distance from main water source and infrastructure required;
- Cost effectiveness.

2.0 Summary of AEW Use in 2010-2011

The 2010-2011 season in the Murray Valley was a record wet season far exceeding the long-term average for inflows (Figure 1). Summer valley inflows (excluding Snowy and Darling River inflows) totalled 6,400GL, nearly double the previous record summer. Inflows recorded during February 2011 totalled 2,170GL, approximately four times greater than the previous record February inflow of 508GL in 1911 (Murray Lower Darling Water Sharing communiqué, NOW, 16 March 2011).

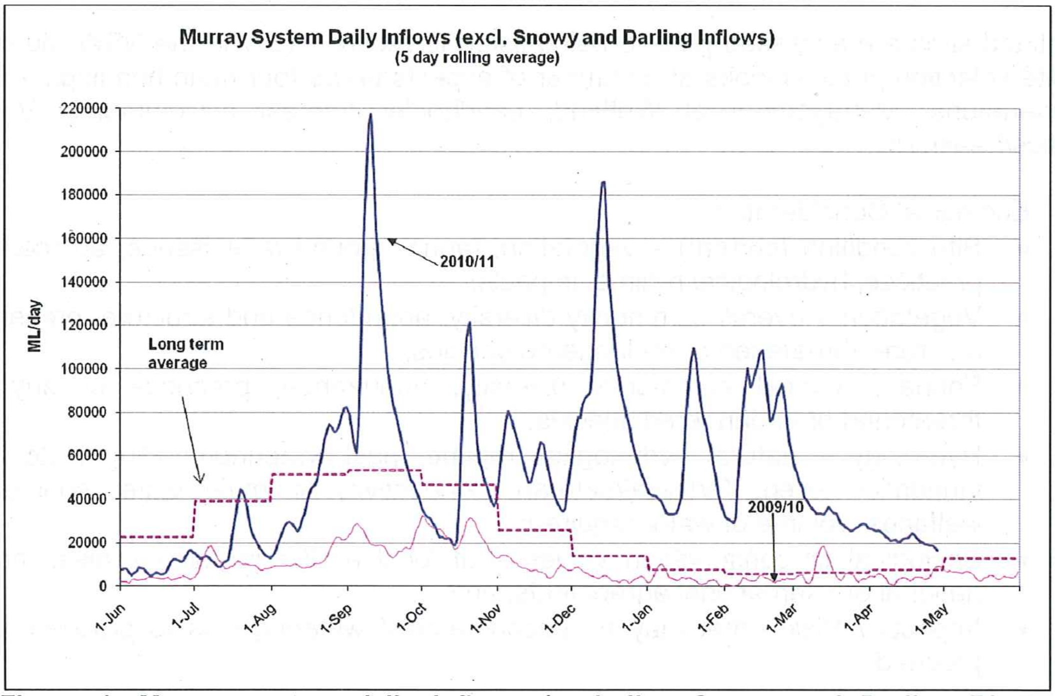

Figure 1: Murray system daily inflows (excluding Snowy and Darling Rivers inflows) for 2009-2010, 2010-2011 and the long term average from 1 June to May (Source: River Murray Weekly Report, MDBA, 11/05/11).

In 2010-2011 the maximum 32,027 ML of Adaptive Environmental Water was available for use in the NSW Murray Valley. Up to 13,563.3 ML was carried-over on the river conveyance licence and 9.7 ML on the high security licence from the 2009-2010 season, however these volumes were forfeited once the maximum share for each licence was reached during the season. As general security allocations increased the maximum share of the AEW river conveyance licence (i.e. 30,000 ML) was reached by mid-September 2010. General security allocations peaked at 100% by the 15th December 2010. High security allocations peaked at 100% by February 2011 equating to 2,027 ML available in the AEW high security licence (Figure 2).

In addition to the AEW volumes OEH managed a total of 19,767 ML of water held by the Commonwealth which was transferred onto the AEW river conveyance licence (Figure 2; Table 2).

Despite the announcement of 100% for all allocations in the valley the Murray and Lower Darling Water Sharing Plan continued to be suspended throughout the season.

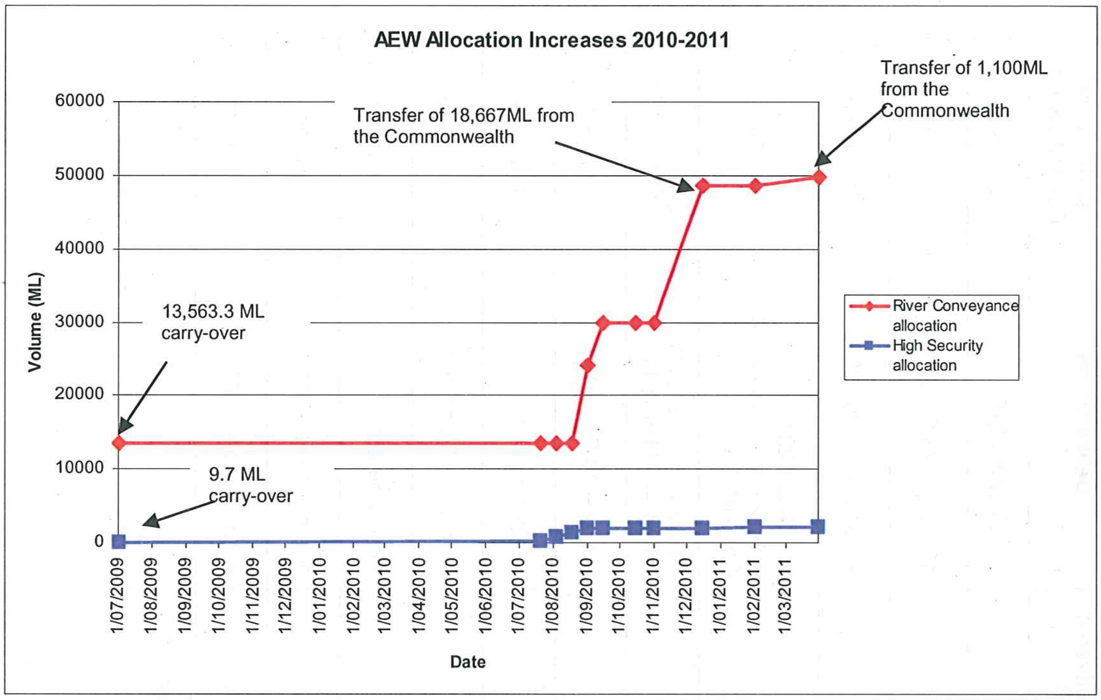

Figure 2: Allocation increases for the AEW river conveyance and high security licences during the 2010/2011 season.

Table 2. Summary of environmental water allocations in the NSW Murray Valley during 2010/2011.

Water Source	Volume Available (ML)
AEW Conveyance (WAL 9422 / 50AL503537)	30,000
AEW High Security (WAL 9423 / 50AL503538)	2,027
Commonwealth (general security)	19,767
TOTAL	**51,794**

Of the 51,794 ML of environmental water available a total of 51,299.5 ML was diverted into 11 project areas (Table 3). All of the Commonwealth water (19,767 ML) was used, in addition to 31,532.5[1] ML of AEW (conveyance and high security allocations). Twenty-one and 41 ML of AEW will be carried into the 2011-2012 season on the AEW high security and river conveyance licences (respectively).

Monitoring of watered sites was conducted by OEH staff, with the exception of the Barmah-Millewa Forest and Darling Anabranch projects. The Barmah-Millewa Forests were monitored using exisiting TLM arrangements. Monitoring conducted for the Darling Anabranch project was incorporated into the existing Darling Anabranch Adaptive Management Monitoring Program (DAAMMP) managed and funded through the Office of Environment and Heritage and conducted by the Murray Darling Freshwater Research Centre.

Further details on individual sites watered and monitoring results will be incorporated in the Murray Lower Darling AEW Final Report 2010-2011 (in preparation).

[1] 432.5 ML was transferred at the end of season to the Murrumbidgee valley for use.

Table 3. List of Murray Valley wetlands watered during the 2010-2011 season with AEW and/or Commonwealth allocations.

Wetland	Location	AEW volume delivered (ML)	Commonwealth volume delivered (ML)	Delivery time	No. of landholders/ Public/Private
^Grand Junction	lower Murray	357.5		11-20 Sept 2010	1 / private
Darling Anabranch	lower- Murray	5,000 (component of a 25.4 GL allocation)		13 Sept – 26 Oct 2010	public
^ Private Property Wetlands (ML)	mid-Murray	540		28 Sept – 24 Dec 2010	15/ private
Barmah-Millewa Forests	mid - Murray	10,000 (component of a 428 GL allocation)		22-24 Jan 2011 (whole event: Sept 2010 to Feb 2011)	public
^Wanganella Swamp	mid - Murray	12766		31 Jan – 11 Feb 2011, 9 April – 2 May 2011	Public/private
^Boeill Creek Floodplain	lower - Murray	12.5		9 Nov – 14 Dec 2010	3 / private
^Comersdale	mid - Murray	66		20-28 Nov 2010	1 / private
^Tueloga	mid - Murray	20		26 Nov – 10 Dec 2010	1 / private
^Bingerra Creek	lower- Murray	90		May-June 2011	1 / private
Yallakool-Wakool Fish Flow	mid - Murray	0	18,667	1 Jan – 3 Feb 2011	public
Jimaringle Cockran Ck	Mid-Murray	2,457	1,100	6 April – 2 May 2011	17/ private
TOTAL		**31,544.5**	**19,767**		

Water used from AEW river conveyance licence
Water used from AEW high security licence
Commonwealth environmental water delivered
^ denotes projects listed in the 2010-2011 Annual Environmental Water Plan

3.0 2011-2012 Annual Environmental Water Plan

3.1 Predicted Rainfall for 2011-2012 (May to July)

Rainfall predictions for June to August 2011 show that there is a 50% chance of exceeding the median rainfall along the River Murray catchment. For the Darling River system, it is predicted that there is a 60-55% chance of exceeding the median rainfall in southern Queensland and northern NSW. The moderate to wet forecast is mainly a result of warm conditions in the Indian Ocean, along with cool conditions in the central tropical Pacific Ocean associated with the current La Niña (Australian Bureau of Meteorology website, http://bom.gov.au, June 2011) (Figure 3).

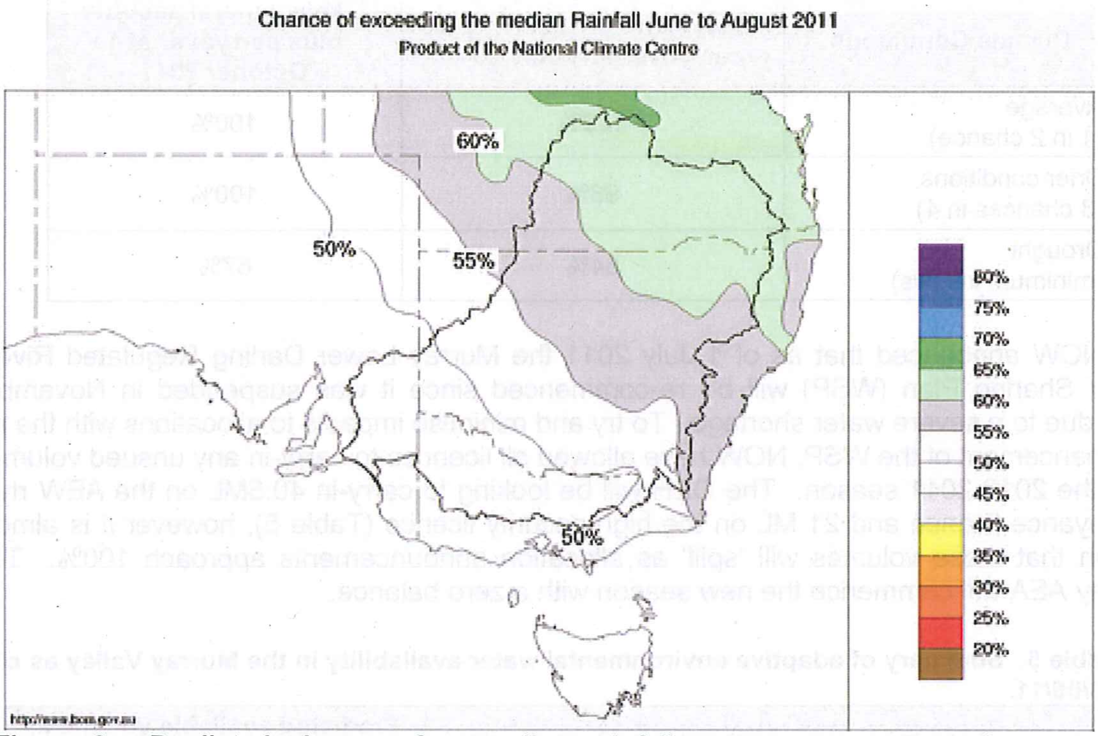

Figure 3. Predicted chance of exceeding rainfall averages across southeastern Australia for June to August 2011 (*Source:* Australian Bureau of Meteorology, http:// www.bom.gov.au 22/06/2011).

For the forthcoming winter and spring months the Australian Bureau of Meteorology are predicting drier conditions (compared to last season) to be experienced across parts of Australia, and in particular the south-east. This prediction is based on the La Niña event being declared officially over and moving into a neutral pattern, with cooler conditions being experienced in the central Pacific Ocean, in conjunction with warm conditions in the Indian Ocean (Australian Bureau of Meteorology website, http://bom.gov.au, June 2011).

3.2 *Predicted Volumes of Environmental Water Available in the Murray Valley 2011-2012*

On the 15 June 2011 storage capacities along the Murray and Lower Darling Rivers were as follows: Hume Dam had 93% storage capacity (2,798 GL), Dartmouth Dam had 64% capacity (2,457 GL), Menindee Lakes had approximately 113% capacity (1,957 GL) and Lake Victoria was at approximately 56% capacity (382 GL).

The NSW Office of Water (NOW) released probabilities of water availability for wet, average and dry conditions in the NSW Murray Valley by 1 July and 1 October 2011 (Table 4; Murray Lower Darling Water Sharing, NOW, 16/03/11).

Table 4. Probabilities of water becoming available (including carryover) for wet, average and dry conditions up to 1 July or 1 October 2011 in the Murray Valley.

Climate Conditions	Likely general security plus carryover at 1 July 2011	Likely general security plus carryover at 1 October 2011
Average (1 in 2 chance)	100%	100%
Drier conditions (3 chances in 4)	98%	100%
Drought (minimum inflows)	64%	67%

The NOW announced that as of 1 July 2011 the Murray Lower Darling Regulated Rivers Water Sharing Plan (WSP) will be re-commenced since it was suspended in November 2006 due to a severe water shortage. To try and minimise impacts to allocations with the re-commencement of the WSP, NOW have allowed all licences to carry-in any unsued volumes from the 2010-2011 season. The OEH will be looking to carry-in 40.5ML on the AEW river conveyance licence and 21 ML on the high security licence (Table 5), however it is almost certain that these volumes will 'spill' as allocation announcements approach 100%. The Murray AEA will commence the new season with a zero balance.

Table 5. Summary of adaptive environmental water availability in the Murray Valley as of 16/05/11.

Account	Maximum Capacity (ML)	Predicted available volume as of 01/07/11 (ML)
Conveyance (WAL 9422 / 50AL503537)	30,000	61.5 + 64% allocation = 22,829.5 (carryover)
High security (WAL 9423 / 50AL503538)	2,027	21 + 97% allocation = 1,987 (carryover)
Barmah-Millewa Environmental Water Allocation	700,000	~200,000
Murray AEA	28,740	0

At 7 June 2011 Commonwealth environmental water holdings for the southern connected basin equalled 587 GL (not including supplementary titles). This volume includes 195 GL of NSW Murray general security and 0.4 GL of NSW Murray high security. Forecasts for 2011-2012 indicate that between approximately 370 GL (dry scenario) and 680 GL (wet scenario) may be available for use in the southern connected basin.

3.3 *Wetland Site Identification and Prioritisation*

Thirty-one wetland sites along the Murray and Lower Darling valleys have been identified and prioritised to receive AEW during the 2011- 2012 season (Figure 4; Appendix 1).

To assist with AEW planning and prioritising of use, three condition scenarios i.e. Dry, Moderate and Wet have been used. These are defined in Table 6.

Table 6. Condition scenarios used to assist with prioritising of wetland sites.

Condition Scenario	AEW volume available (ML)	General Security availability (%)[2]
Dry	0 – 10,000	0
Moderate	10,001 – 25,000	0- 75
Wet	25,001 – 32,027	>75

Sites have been listed into the three scenarios based primarily on ecological needs. However other aspects such as logistical ease, approvals in place, works required etc. have also been used in prioritising.

The combination of moderate to high storage percentages within the Murray and lower Darling valleys at the commencement of the 2011-2012 season, as well as the prediction of a 50% chance of exceeding the median rainfall for June to August 2011 across the Murray catchment and general security allocations starting around 64%, suggests that the AEW allocations scenario will start under 'Moderate' conditions i.e approximately 24,000ML available.

Water usage under the Moderate and Wet Scenarios exceed the maximum that would be available from the two AEW licences i.e. 32,027ML. The sites listed therefore provide a range of options of how the AEW allocations can be best utilised under the different climate scenarios, and more than likely will be linked with usage from other environmental water licences eg: Barmah-Millewa Environmental Water Allocation, TLM allocations, Commonwealth holdings etc.

It should be noted that due to the unpredictable nature of water allocations there is a need for a flexible and adaptive approach for watering of the wetlands. The listing of wetlands in the Plan is to be used as a guide rather than being rigidly adhered to.

[2] When the Murray and Lower Darling Water Sharing Plan is in operation, general security allocation availability has a bearing on the volume of AEW available in the river conveyance licence i.e. when general security is 1% a total of 15.12 GL of AEW is available. Availability is scaled until the full 30,000 ML is reached when 100% general security is announced.

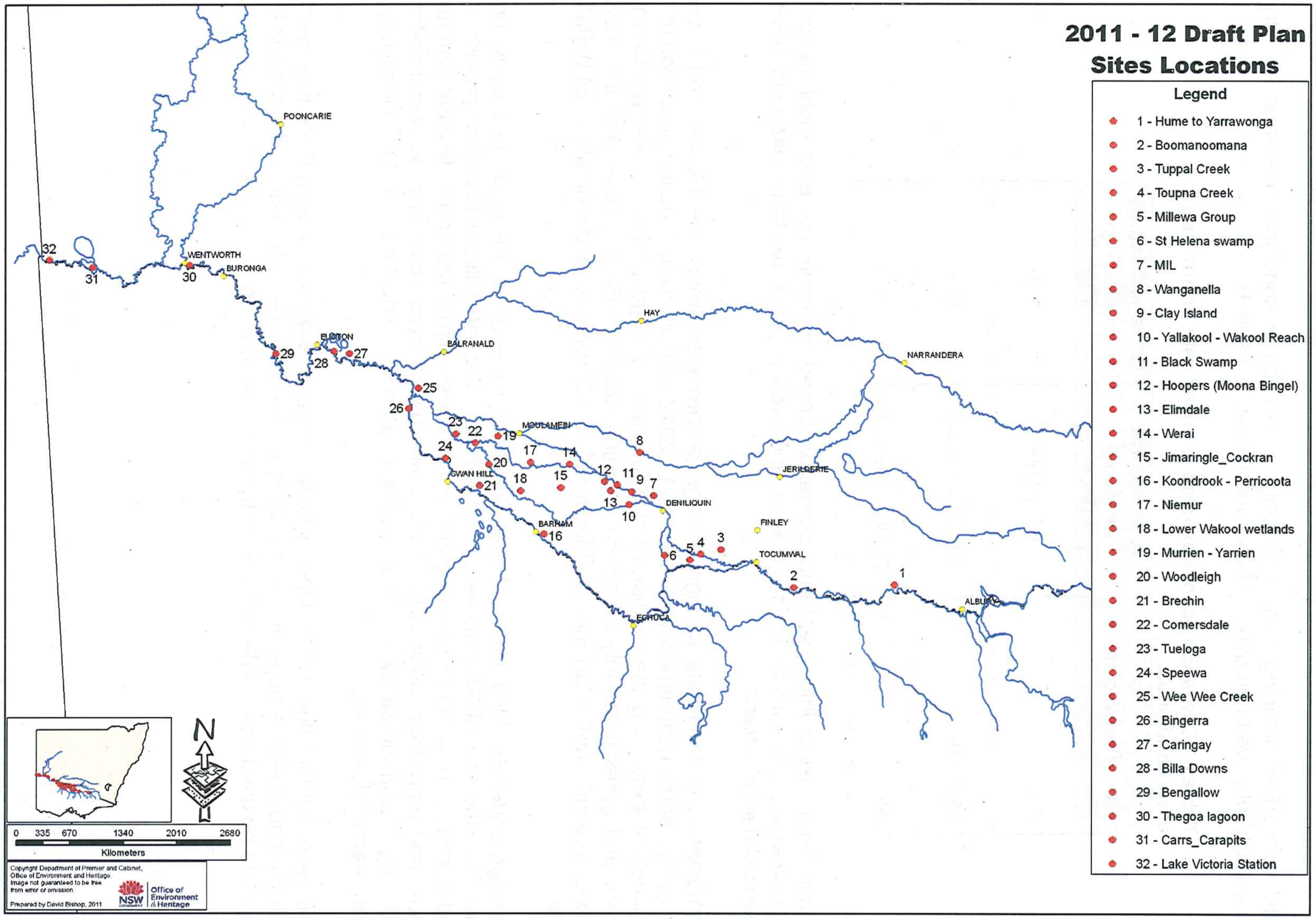

Figure 4: Location of wetland sites within the Murray and Lower Darling valleys listed for consideration to receive AEW in 2011-2012.

A. Dry Scenario (< 10,000 ML of AEW available)

Under the Dry Scenario six wetland assets (see Appendix 1 for site information) have been given priority for environmental watering and include:

- Jimaringle Cockran Creeks – 8,000 ML
- Comersdale – 66 ML
- Tueloga – 20 ML
- Speewa Creek – 1,000 ML
- Lake Victoria Station – 400 ML
- Brechin – 150 ML

Reason:

The use of AEW for the above listed sites will fulfil Objectives 1 – 5 for use of AEW (see Section 1.1). All of these sites are dominated by River Red Gums (RRG) which have dramatically declined in condition due to the severe drought conditions experienced over the past decade. Consequently the wetlands' condition range from very poor to moderate.

All sites were inundated during the 2010-2011 season either through significant rainfall run-off, environmental flow and/or higher system flows. To maximise on the biological response triggered by the recent inundation it is recommended that these sites receive a follow-up watering in 2011-2012. It is recommended that these projects not start until September - October to be in keeping with natural flooding times and therefore maximise the capacity of native faunal and floral responses.

The Jimaringle and Cockran Creeks (JCC) are ephemeral systems located near the township of Wakool. The last time a whole-of-system flow occurred was approximately 1995. The JCC system hydrologically connects the Colligen Creek with the Niemur River. There are known problem areas of Acid Sulphate Soils and highly saline groundwater intrusions which have adversely impacted on the immediate vegetation communities. During 2010-2011 higher system flows in the Niemur River backed up into Jimaringle and Cockran Creeks, whilst the top-end of Cockran Creek received some flow from the Colligen Creek. The middle section of the JCC system remained isolated due to insufficient flow and blockbank structures. A trial watering (in partnership with the Murray CMA and SEWPaC) was conducted in April-May 2011 targeting the isolated middle section of the JCC system. Water was delivered via two Murray Irrigation Limited escapes. Monitoring of water quality showed salinity levels decreased, substantially at times, as the water front moved through the system providing a 'flushing' effect. Landholder support for a larger flow event is strong. A proposal has been submitted to the Commonwealth to provide up to 11,000 ML to combine with NSW AEW (up to 8,000 ML) to try and achieve an end-of-system flow, as well as extend the project area to incorporate Gwynnes Creek which connects the Colligen Creek with the JCC system. It is recommended that an allocation of up to 8,000 ML be made available for this project.

Tueloga (6 Ha) and Comersdale (15 Ha) wetlands are located on private properties on the floodplain of the lower Wakool River. Prior to 2010-2011, the wetlands had been dry since 1990 (Tueloga) and 1993 (Comersdale) due to insufficient high flows through the Wakool River. Consequently the vegetation communities were showing signs of drought stress. In 2010-2011 environmental water was delivered using landholder infrastructure. Biological responses observed in the wetlands included a flush of new growth on RRG, lignum, and nitre goosefoot plants, good response from native wetland understorey species, water quality readings stayed well within the accepted ANZECC guidelines for freshwater systems, high abundance of microcrustacea observed within the water column and moderate numbers of waterbirds (eg white-faced herons, grey teal ducks) were attracted to the wetlands. A follow-up watering is recommended to further improve the condition of these wetlands through the provision of 86 ML (66ML for Comersdale and 6 ML for Tueloga). It is recommended that watering only occur if salinity levels in the Wakool River are below <1,500EC to prevent salinising the wetlands.

Speewa Creek, located approximately 30 km north of Swan Hill, is a 15 km creek line that connects with the Murray River. During 2010-2011 high system flows in the Murray River inundated the creek system. Prior to this event the creek had been dry since 2001 resulting in the fringing RRG showing signs of moisture stress. The vegetation is considered to be in a poor to moderate condition and would benefit from a follow-up environmental watering. The project would be looking to inundate 10 km of the creek which traverses over 5 properties. Local landholders are very supportive of the proposal, and are willing to provide in-kind contributions by managing the delivery of the AEW using their private pumping infrastructure as well as conduct required preparatory works. It is recommended that once works are completed and if required volumes (1,000 ML) are available the watering should be conducted.

Lake Victoria Station wetlands (20 hectares collectively) are located within the Lower Murray Darling catchment. The wetlands support lignum communities which were in very poor condition due to lack of flooding for more than 10 - 15 years and RRG in varying condition. During September 2010, when flows exceeded 20,220 ML/day at Rufus Junction (25.04m AHD d/s of Lock 7), inundation of the wetlands and surrounding floodplain commenced. The current vegetation condition is unknown due to the site being inaccessible due to flooding, however aerial surveys suggest a positive response by RRG in general. If drier conditions prevail and a sufficient volume of AEW is available (approximately 400 ML) it is recommended that these sites receive a follow-up allocation of AEW to help further improve the condition of the lignum and RRG communities.

Brechin (30 Ha) is a private property wetland located approximately 25km east of Swan Hill on the NSW-side of the Murray River. Landholder infrastructure would be used to deliver water – a 150 ML allocation. The wetland is a RRG dominated system and has received environmental allocations in 2008-2009., 2009-2010 and rainfall run-off in 2010-2011. This wetland would benefit from a follow-up watering to further improve the condition of RRG which showed signs of drought stress prior to the 2008-09 environmental flow. The wetland is also located in what was historically a strong-hold for Southern Bell Frog (*Litoria ranformis*). This frog species was last recorded at Brechin in 2003.

B. Moderate Scenario (10,000 – 25,000 ML of AEW available)

Under the Moderate Scenario 18 wetland sites have been given priority for environmental watering (see Appendix 1 for site information). The sites (with indicative allocation volumes) include:

- Private Property Wetland (MIL) - 4,000 ML
- Billa Downs – 500 ML
- Bengallow Creek – 5,000 ML
- Carrs, Cappitts and Bunberoo Creeks – 900 ML
- Thegoa Lagoon – 500 ML
- Bingerra Creek – 300 ML
- Lower Wakool wetlands – up to 2,000 ML
- Boomanoomana – 500 ML
- Yallakool-Wakool Fish Flow – 5,000 ML
- Hooper – 80 ML
- Clay Island – 200 ML
- Black Swamp – 250 ML

- Elimdale – 72 ML
- Murray Valley National/Regional Park sites (includes: Duck Lagoon, Toupna Creek, Walthours Swamp / Deadwood, Douglas Swamp, St. Helena Swamp, Reed Beds, Gulpa Creek, Moira Lake) – volume to be determined if/when required
- Werai Forest - 5,000 ML
- Niemur Forest - 10,000 ML
- Koondrook-Perricoota State Forest sites (include Thule Creek, Unnamed Creek, and the following Lagoons – 390 Mile, Black Box, Horseshoe and Swan) - volume to be determined if/when required
- Darling Anabranch

Reason:
Sites listed under the 'Moderate Conditions' scenario range in condition from poor to good and in some instances require larger volumes of water or higher regulated river flow rates to be conducted.

The majority of the above listed sites were inundated during 2010/2011 with higher system flows and/or environmental allocations. As for the Dry scenario sites, it is recommended that follow-up watering events be conducted in 2011-2012 to maximise on the biological response of the wetlands. Some of the MIL private wetlands, Lower Wakool wetlands, Elimdale and (possibly) Clay Island were not inundated.

Collectively, the sites will fulfil the first five AEW Objectives and depending on system inflows may also fulfill Objectives 6 - 8. Some sites are known to be important breeding and/or foraging habitat for threatened and vulnerable fauna species including the Bush Stone-Curlew (*Burhinus grallarius),* Southern Pygmy Perch (*Nannoperca australis*), Southern Bell Frog (*L. raniformis*) and Brolga (*Grus rubicundus*).

The Private Property Wetlands project is conducted on private landholdings distributed over the Murray Irrigation Limited (MIL) Area of Operation. The dominant vegetation communities are Black Box, Lignum and RRG. The wetlands provide critical habitat for a wide variety of flora and fauna species including threatened and vulnerable species such as Bush Stone-Curlews and Brolgas (respectively). The project is considered an important component of the Murray watering programme as it provides an opportunity to inundate wetlands that are isolated on the floodplain and has been recognised as one of Australasia's Top 25 Ecological Restoration Projects by the Global Restoration Network. The project is strongly supported by landholders. The project is a resource and cost-effective way of watering a large number of sites simultaneously. It is recommended that this project be conducted if the required volume of water (approximately 4,000 ML) is available and appropriate triggers are met.

Billa Downs is located south-west of the Euston Lakes, approximately 25km east of Euston township. River Red Gums dominate the vegetation of two wetlands that cover approximately 50 Ha. The site was inundated by higher system flows in 2010-2011 (flows into the wetland commenced on the 16 September 2010 when they were approximately 25,000ML/d at Euston Weir). The current vegetation condition is unknown due to the site being inaccessible due to flooding, however aerial surveys suggest a positive response by RRG in general. If drier conditions prevail and a sufficient volume of AEW is available (approximately 500 ML) it is recommended that these sites receive a follow-up allocation of AEW to help further improve the condition of the lignum and RRG communities. The landholder is strongly supportive of the project and all approvals are in place to enable the pumping of an AEW allocation into the wetland.

Bengallow Creek, located approximately 30 km north of Euston, is an extensive network of creeks, floodrunners and oxbow wetlands that cover approximately 100 km. The creek system is part of Kemendoc National Park and is of significant importance to a number of protected and threatened flora and fauna species, including the Regent Parrot (*Polytelis anthopeplus*). The importance of this system to local fish populations is currently unknown and poorly documented. Many of the deep-waterholes throughout the system are considered near to permanent by local landholders. The system received environmental water in 2005 as part of the 'Red Gum Rescue Project' conducted by the then NSW Department of Natural Resources but then remained dry until 2010-2011 when higher system flows inundated the majority of the system. It is recommended that a follow-up watering be conducted in 2011-2012 in the absence of higher system flows. Approvals are in the process of being sought.

Carrs, Cappitts and Bunberoo Creeks are located on the floodplain of the Moorna Forest Indigenous Protected Area, located within the Lock 8 and 9 reach of the Murray River (south) and Frenchmans Creek (north), approximately 45km west of Wentworth, NSW. There are numerous RRG and Black Box dominated ephemeral wetlands associated with the creeks. The natural hydrology of the wetlands has been interrupted by river regulation and the installation of 9 structures (concrete fords and rock levee banks). The wetlands now only receive flows from the Frenchmans Creek during periods of high flow either by overtopping structures and/or syphoning. During 2010/2011 a number of wetlands within the area were flooded by higher system flows coming in from the Frenchmans Creek system and in the Murray River. It is recommended that a follow-up watering be conducted in 2011-2012 in the absence of higher system flows.

Lower Wakool wetlands have been not been inundated for a number of years and as a consequence their vegetation communities are showing signs of stress. However, prior to a final decision being made on which wetlands should receive an allocation of AEW (if any) a field-based risk assessment is required. In particular to consider logistical information (what wetlands can be watered under different flow scenarios), the occurrence of high salinities within the Wakool River, and the presence of Acid Sulphate Soils (ASS) in some areas. Watering of wetlands with AEW should not occur during periods of high salinity (>1,500 EC) within the Wakool River or where ASS are detected.

The Yallakool-Wakool Fish Flow Project was initiated in 2010/2011 and managed by the Murray CMA, utilising 16,800 ML (plus 10 per cent losses) of water from the Commonwealth. The project aims to further the understanding of large-bodied native fish response to flow pulses by manipulating flow rates through a section of the Yallakool and Wakool Rivers. Information generated from the project will help inform environmental water managers on how best to deliver allocations to have positive benefits to native fish populations. A submission for 30,000 ML of water has been made to the Commonwealth to enable the project to be conducted for a second year. A contribution of 5,000 ML from AEW is recommended to be made towards the project.

The Murray Valley National/Regional Park sites (include Duck Lagoon, Toupna Creek, Walthours Swamp/Deadwood, Douglas Swamp, St. Helena Swamp, Gulpa Creek, Reed Beds and Moira Lake) are Ramsar-listed and are also part of the Barmah-Millewa Living Murray Icon Site. The wetlands are regionally significant breeding areas for a number of colonial nesting waterbirds such as Australian White Ibis, Spoonbills (Yellow and Royal), Nankeen Night Herons and Egrets (Intermediate and Great). The forest areas received a significant flooding during 2010-2011 triggered by natural high flows and complimented by the release of approximately 400GL of environmental water (Barmah-Millewa EWA, TLM and NSW AEW). During the 2011-2012 season, if moderate inflows to the Murray system occur i.e. average release rates over Yarrawonga Weir equals 15,000 ML/d for a month then this will result in some flooding through the Barmah-Millewa Forest, however flows downstream will remain in-channel. Under these conditions it is unlikely that any AEW would be required as it is unlikely to trigger a bird breeding event. However, if average release rates over

Yarrawonga were to range between 20,000 – 25,000 ML/d for a month then flooding throughout the forest will be more significant and likely to trigger bird breeding, downstream flows will break out of channel. The provision of an AEW allocation in this scenario would be used to compliment these higher flows to either extend the duration of the inundation and/or fill in gaps in the hydrograph which may have an adverse effect to bird or fish breeding events.

Werai Forest is part of the Ramsar-listed Central Murray Forests and is dominated by RRG. Remnant stands of *Phragmites* are also present which provide important habitat for a variety of species. Extensive watering through the forest occurred during 2010-2011 due to higher system flows and the release of approximately 400GL of environmental water through the Barmah-Millewa Forest system. In 2011-2012 if average release rates over Yarrawonga Weir were to range between 20,000 – 25,000 ML/d for a month, this will result in flooding of areas such as Werai and Niemur Forests. The use of AEW within Werai will only be possible by piggy-backing onto the higher flows to assist with the duration of the flooding event. The objective of the water provision would be to further improve vegetation (overstorey and mid-storey) health and/or support flood-dependant fauna.

Niemur Forest, located in a National Park, has the Niemur River running through. It is a RRG dominated floodplain that would have had a natural watering regime equal to 1 in 3 years. In 2010-2011 the site received high system flows which triggered a significant bird breeding event of Nankeen Night Herons, Intermediate and Great Egrets and Pied Cormorants. Previous to this flow event, the forest had been dry since approximately 2000. As with Werai Forest, flooding of the system will occur once average release rates over Yarrawonga Weir were to range between 20,000 – 25,000 ML/d for a month. Use of environmental water in 2011-2012 will only be conducted if higher flows are triggered either naturally and/or through larger-scale environmental flows released upstream. Water could either be piggy-backed onto the higher flows and/or supplemented by releases from MIL escapes. A submission to the Commonwealth has been made for up to 15,000 ML to assist with flooding of the Niemur Forest if upstream flows are sufficiently high, 10,000 ML of AEW would be added to this. The objective of the watering would be to further improve vegetation (overstorey and mid-storey) health which responded strongly following higher system flows during 2010-2011 and/or if another significant bird breeding event was triggered and upstream flows look to be insufficient to support the event until majority of young birds have fledged.

The Koondrook-Perricoota State Forest sites are semi-permanent wetlands that are dominated by RRG. During 2010-2011 all sites were flooded by higher system flows. In 2011-2012 the objective of watering the lagoons (Horseshoe, Blackbox, Swan and 390 Mile) is to provide a follow-up watering to maintain basic wetland function and improve the ecological health of approximately 80% of the floodplain and wetland. For Thule and Unnamed Creeks the objective is to avoid irretrievable loss of key environmental assets within the forest and improve the condition of up to 30% of RRG and 80% of the floodplain and wetlands. For the Koondrook Perricoota sites there is an intention to apply for TLM allocations in 2011-2012 under the TLM Environmental Watering Plan, approved by the Murray Darling Basin Ministerial Council. The listing in the Annual Environmental Watering Plan is to ensure that these sites receive some environmental allocation if TLM process has insufficient volumes of water available and/or drier conditions prevail.

The Darling Anabranch, located west of the lower Darling River, received an environmental allocation (25.4GL) followed by a substantial period of supplementary flow in 2010-2011. The flow event was the first in twelve years and inundated the entire channel of the anabranch connecting it with the Murray River, as well as inundating nearly all of the lakes to some extent (full to partial filling). It has been recommended that a follow-up flow be provided for (allocation permitting) in 2011-2012. Currently regulated water cannot be diverted into the Anabranch as it is listed as an unregulated system and therefore lies outside of the Murray Lower Darling Regulated Rivers Water Sharing Plan. However NSW is investigating ways and allocations that could be used to provide a flow.

C. **Wet Scenario (> 25,000 ML of AEW available)**

Under the Wet Scenario eleven sites (see Appendix 1 for site information) have been given priority for environmental watering and include:

- Hume to Yarrawonga wetlands – 6,000+ ML
- Wee Wee Creek – 2,500-4,000 ML
- Tuppal Creek – 3,000 ML
- Lake Caringay – 10,000 ML
- Murrain-Yarrein System
- Murray Valley National/Regional Park sites (includes: Duck Lagoon, Toupna Creek, Walthours Swamp / Deadwood, Douglas Swamp, St. Helena Swamp, Moira Lake, Reed Beds, Gulpa Creek)
- Werai Forest
- Niemur Forest
- Koondrook-Perricoota State Forest sites (include Thule Creek, Unnamed Creek, and the following Lagoons – 390 Mile, Black Box, Horseshoe and Swan)
- Wanganella Swamp
- Lake Nearie Nature Reserve

Between Hume to Yarrawonga on the Murray River there are approximately 771 wetlands. With a flow rate of 25,000 ML/day up to 62% of mapped wetland area (244 wetlands) in this reach can be inundated. Prior to high flows experienced during 2010/2011 a large number of wetlands had not been inundated since March 2006. Consequently the vegetation communities within these wetlands are showing signs of drought stress. The Hume to Yarrawonga project looks at piggy-backing onto higher regulated flows to enable the watering of lower benched wetlands within the reach. In 2009/2010 flows peaked at 15,400 ML/day at Doctor's Point resulting in approximately 170 wetlands (with commence-to-flow levels of less than 15,000 ML/day) being inundated. The ability to piggy-back onto higher regulated flows makes this a resource and cost-effective approach to watering a large number of wetlands. The use of AEW (6,000+ ML) would be to cover additional river losses if peaked releases are varied and last for 3-4 days. It is therefore recommended that this project be conducted if the likelihood of getting regulated flows of 18,000 – 25,000 ML/day is small, if appropriate triggers are met and the required volumes of water (6,000+ ML) are available.

Lake Caringay is a large (1022 Ha) deflation wetland located approx. 25km east of Euston, NSW. It is the largest of three wetlands commonly known as the Euston Lakes. Caringay has been isolated from flood flows in the Murray River since the 1960s following the installation of levee banks on Washpen and Caringay Creeks. During 2010-2011 some water had inundated the centre of the lake by leaking through a broken regulator on Washpen Creek, however high flows (i.e. > 55,000 ML/d at Euston) were prevented from entering the lake via Caringay Creek because of the solid levee bank. The lake is a mix of RRG, Black Box and lignum which show signs of stress caused by lack of flooding. There are a number of issues that require addressing prior to providing water to the system i.e. licensing of structures, landholder negotiations etc. Unlike the majority of other large deflation basins in the region, Lake Caringay has not been used for water storage nor is it adversely impacted by salinity. Such wetlands have been known to be important as bird and native fish breeding sites. The lake therefore provides a unique opportunity to reinstate a wetting/drying regime to such a system.

For the Murray Valley National/Regional Park sites, Werai and Niemur Forests and Koondrook-Perricoota sites – the use of AEW will be same as outlined in the Moderate conditions scenario except AEW volumes may be increased if available.

Wanganella Swamp, located near Deniliquin, is a regionally significant site. It is a known breeding site for various species of ibis as well as other wetland bird species such as the NSW vulnerable listed Brolga and Australasian Bittern (*Botaurus poiciloptilus*) and migratory species such as Latham's Snipe (*Gallinago hardwickii*) and Sharp-tailed Sandpipers (*Calidris acuminata*). The wetland is connected to the Forest Creek system which receives water from both the Murray and Murrumbidgee Rivers. During 2010-2011 a significant bird breeding event was triggered attracting up to 13,000 pairs of Straw-necked Ibis, as well as national and internationally listed species of waterbirds. It is recommended that a provision of AEW be made available for the site if another large bird breeding event is triggered naturally and there are insufficient inflows to support the event to the end.

Lake Nearie Nature Reserve is located on the southern end of the Darling Anabranch in the lower Murray Darling catchment. The lake is 2,140Ha (44% of the reserve), has a fringing community of Black Box trees, was last inundated in 1998 and is the deepest lake along the Anabranch i.e. holding water to 2-3m. During the 2010-2011 Anabranch flow event, water inundated approximately 80% of Lake Nearie. It is recommended that if flow is available and appropriate flow rates result in the anabranch, that water be diverted into the lake to provide a 'top-up' watering. As the lake is listed within an unregulated system, regulated flows are unable to be diverted according to rules under the Murray Lower Darling Regulated Rivers Water Sharing Plan. NSW is investigating ways that could be used to provide a flow.

3.4 Supplementary Water, Contingency Allocations and Unallocated Volumes

The NSW Office of Water is responsible for declaring supplementary access within the Murray Valley. As required under the Murray Lower Darling Regulated Rivers Water Sharing Plan NOW is to consider wetland/ecological needs prior to the declaration of supplementary access. In the event of this occurring NOW could use this Plan to help guide their decision-making process. Other wetlands that are not listed in the Plan should be assessed using the same selection criteria (see Section 1.2) as used for listed sites.

In the event that a bird (or other fauna species) breeding event is triggered, consideration for the provision of AEW and/or additional AEW should be made to ensure that the breeding event is successfully completed.

If in the event that there are unallocated volumes of AEW, considerations for the management of the water should include:

- potential use in complimenting other watering events, including events not considered in this Plan, and /or
- trading on the temporary water market to generate funds that can support future implementation and on-ground delivery of environmental watering projects.

4.0 Risk and Mitigating Strategies

Using the Risk Assessment matrix (see Appendix 2) a number of risks have been identified in association with the proposed management of AEW (Table 7). Responses on how best to manage the potential risk have also been listed.

Table 7. Identified risks associated with the management of AEW.

Risk	Rating	Response
Unpredictable weather – turns drier than expected.	Medium (unlikely & major)	Review asset condition and future priorities for watering. Consult with EWAG.
Unpredictable weather – turns wetter than expected.	High (likely & major)	Additional wetting options possible – continually assess volumes available. Consult with EWAG.
Unpredictable weather – turns hotter than expected early.	High (likely & major)	Review timing for watering. Consult with EWAG.
Flow management is uncoordinated	Medium (possible & moderate)	Early communication with State Water and River Murray Water.
Water use and works approvals not in place and/or linked to licences.	High (possible & major)	Confirm status with NOW and SWC. Seek discretionary one-off approval if necessary.
Estimated allocation volumes are substantially wrong.	Medium (unlikely & moderate)	Monitor flow delivery and area of inundation closely. Seek adjustments; revise targets for future attempts
Unforeseen physical impediments to flow delivery e.g. low river levels which prohibit pumping activities.	Medium (rare & major)	Early communication with River Murray Water (RMW), Landholders and State Water, where appropriate. Alert NOW if illegal obstructions identified.
Insufficient water available to complete colonial waterbird breeding, if initiated.	Medium (unlikely & severe)	Liaise with SEWPaC for possibility of acquiring additional water. Liaise with RMW and State Water to look at flow delivery options.
Water delivery infrastructure (i.e. pump or regulator) faulty or not adequate.	Medium (possible & moderate)	Liaise with contractor, landholder to resolve issue.
Poor water quality in the main water source (e.g. high salinities, black water, low dissolved oxygen etc.) or from wetlands flowing back into main creeks/rivers.	High (possible & major)	Monitor water quality closely.
Poor water quality threatening aquatic fauna.	High (possible & major)	Liaise with DPI (Fisheries) in relation to timing of water delivery and cooperation on monitoring response.

5.0 Monitoring

All wetland sites that receive AEW will have some level of monitoring conducted. Some sites will have more intensive monitoring determined by the site's watering objectives. The majority of monitoring will be conducted by OEH project officers. In National Parks and Indigenous Protected Areas monitoring responsibilities will be shared with NSW National Parks and Wildlife staff (where possible). The services of contractors may be engaged for larger-scaled projects eg: Werai Forest and/or where OEH staff resources are limited.

Methods used are consistent with Natural Resource Council and state-wide standards. Table 8 lists the ecological and environmental monitoring that will be conducted at each site.

Table 8. Proposed monitoring for identified sites.

	Wetland Site	Ecological monitoring	Environmental monitoring
1	• MIL • Comersdale • Tueloga • Hooper • Elimdale • Black Swamp • Clay Island • Puckawidgee • Normans Lagoon • Lower Wakool Wetlands • Boomanoomana • Tuppal Ck • Murrain-Yarrein Cks system	• Vegetation response	• Volume of AEW delivered (ML) • Timing of water delivery (days) • Duration of inundation (days) • Area and extent of inundation mapped using GIS (Ha) • Water Quality • Photo-points
2	• Jimaringle Cockran Cks • Wee Wee Ck • Brechin • Bingerra Ck • Speewa Ck • Billa Downs • Lake Victoria Station • Lake Nearie	• As above (1) • Frog diversity	• As above (1)
3	• Thegoa Lagoon	• As above (2) • Birds • *Typha* mapping	• As above (1) • Groundwater
4	• Lower Wakool wetlands	• As above (1)	• As above (1)
5	• Werai Forest	• As above (2) • Birds* • Fish#	• As above (1) • Area of inundation mapping – via satellite imagery/ground truthing*
6	• Niemur Forest • Wanganella Swamp	• As above (1) • Birds*	• As above (5)
7	• Yallakool-Wakool Reach	• Fish#	• As above (5)
8	• Toupna Ck • Bengallow Ck system • Carrs, Cappitts, Bunberoo Cks • Lake Caringay	• As above (1) • Fish*	• As above (5)
9	• Murray Valley National/Regional Park sites • Koondrook Perricoota State Forests sites	• TLM requirements	• As above (5)
10	• Darling Anabranch	• DAAMMP	• DAAMMP

^ potential monitoring by Sunraysia Bird Observers (SBO)
# monitoring managed by Murray CMA in conjunction with DPI Fisheries
* monitoring to be contracted out
** monitoring contracted out to the MDFRC

6.0 Approvals, Access Licences and Associated Works

All wetland sites require appropriate approvals and licences to be in place prior to the watering event commencing. Water use and work approvals are granted by the NSW Office of Water (NOW). Table 9 shows which listed sites have approvals in place and which require approvals to be sought.

Preparatory works required to compliment the environmental watering in some instances also require permits and/or approvals which are sought from NOW (Table 9).

Table 9. Approvals status for identified wetland sites.

Wetland Asset	Work & Use Approvals in place &/or identified Work.
• Wee Wee Ck • Brechin • Thegoa Lagoon • Billa Downs	Yes (10 year approval)
• Comersdale and Tueloga • Bingerra Ck • Speewa Ck • Werai Forest • Hooper • Boomanoomana • Barmah-Millewa Forest sites • Koondrook-Perricoota State Forest sites • Black Swamp • MIL • Hume to Yarrawonga • Yallakool-Wakool Reach	Yes
• Carrs, Capitts, Bunberoo Cks • Wanganella Swamp • Jimaringle Cockran Cks • Niemur Forest • Tuppal Ck • Murrain-Yarrein Cks system	Needs clarification
• Bengallow Ck system • Lake Victoria Station • Elimdale – in progress • Lower Wakool wetlands • Clay Island • Lake Caringay	No – to be sought

A meeting has been scheduled for August between OEH, NOW and SWC to discuss issues relating to projects that require clarification for work approvals and identify appropriate works.

7.0 Reporting

Reporting to:

- Divisional Director, Waters, Wetlands and Coast, OEH – monthly update on conditions (climate, available environmental water) and weekly update during flow delivery events.

This plan is to be **revised** when conditions dictate. Good communication with MLD EWAG, State Water, NOW, NPWS, Forests NSW, SEWPaC and landholders will help clarify the timing and scale of revision.

Prepared by: Paula D'Santos
Position: Senior Wetlands and Rivers Conservation Officer, Waters, Wetlands and Coast Division
Date: 30 June, 2011

Approved by: Derek Rutherford

Position: Divisional Director, Waters, Wetlands and Coast

Sign:

Date:

26/7/11

Appendix 1: List of identified and prioritised wetland sites for the Murray Valley 2011 – 2012.

Refer to attached spreadsheet.

VICTORIAN ENVIRONMENTAL WATER HOLDER

mallee catchment management authority

NORTH CENTRAL Catchment Management Authority

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

Seasonal Watering Plan 2011–12

Schedule 14: Northern wetlands and floodplains

State Government Victoria

Schedule 14:
Northern wetlands and floodplains

This schedule is the seasonal watering proposal prepared by Goulburn Broken, North Central and Mallee Catchment Management Authorities. It has been accepted by the VEWH and now forms part of the *Seasonal Watering Plan 2011–12*. As such, it incorporates any changes resulting from feedback from the VEWH.

The seasonal watering plan outlines the environmental watering actions that are a priority in 2011–12. It considers the actions that would occur under a range of planning scenarios. As conditions unfold and water becomes available throughout the year, seasonal watering statements will be released to communicate decisions on environmental watering actions and to authorise the relevant catchment management authority to implement those decisions.

The VEWH acknowledges and thanks Goulburn Broken, North Central and Mallee Catchment Management Authorities for their hard work and dedication in developing the seasonal watering proposal and inputting to the *Seasonal Watering Plan 2011–12*.

Please contact the VEWH, Goulburn Broken, North Central or Mallee Catchment Management Authorities for more information.

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2	Final	Goulburn-Broken, Mallee and North Central Catchment Management Authority	30/06/2011

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Organisation	Coordinated by Department of Sustainability and Environment with the assistance of Goulburn Broken, Mallee and North Central Catchment Management Authorities
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Front cover photo: Keith Ward – Goulburn Broken Catchment Management Authority. Northern part of Barmah Lake (showing contrasting patches of open water, Common Reed, Giant Rush and Pacific Azolla, with Steamer Plain in the background with extensive beds of Moira Grass.

EXECUTIVE SUMMARY

The proposal provides the Victorian Environmental Water Holder (VEWH) a range of wetland and floodplain sites which are considered in scope to receive environmental water and sites which require a drying phase in 2011/12. Additionally it provides a recommended process for allocation of water during the year to ensure environmental water use is maximised across northern Victoria.

The proposal focuses on the Mallee, North Central and Goulburn Broken Catchment Management Authority areas where regulated environmental water can be delivered. It also includes the Victorian Icon sites, which are key environmental sites identified by the Murray Darling Basin Authorities' Living Murray Program.

Northern Victoria's rivers and wetlands are a highly connected as a result of the general catchment hydrology and northern Victoria's irrigation distribution system. The ability to move water around both physically, and through trade, provides an opportunity to maximise the effectiveness of environmental water to ensure the greatest ecological outcomes.

Victorian wetland and floodplain sites may be allocated water from a number of sources, including Victorian Environmental Water Holder entitlements, Murray Darling Basin Authority entitlements (through the Living Murray Program - TLM), Commonwealth Environmental Water Holder (CEWH) holdings, and through donations from individuals, community groups and organisations. The information in the proposal is to be used to inform other stakeholders of potential watering actions which are possible in northern Victoria in 2011/12.

In 2010/11, much of northern Victoria experienced above average rainfall. Significant flooding occurred in the Murray, Goulburn, Campaspe and Loddon, system.

As we transition into an improved water resource position, the focus is to provide water to restore wetland values that were not able to be maintained in drier periods, and to improve the long-term resilience of wetlands and rivers across northern Victoria.

Environmental water requirements of priority wetland sites across northern Victoria are identified under a range of potential climatic scenarios tables 14 and 15. These water requirements have been established by the relevant CMA, through consultation with the community and other stakeholders. Site which require a drying phase and therefore no environmental water to meet ecological requirements, are identified in section 3.2.

The process for the prioritisation, allocation and delivery of water to northern Victorian wetlands involves further collaboration and involvement of the Mallee, North Central and Goulburn Broken CMAs and their partners through out the year.

To ensure that environmental water is used to its most effective use, it is proposed that the Northern Victorian Environmental Watering Project Control Board (PCB) continue their role in assisting in the prioritisation and recommendation of sites for the allocation of available environmental water by the VEWH.

As the season progresses and allocations are made available, the Northern Victorian Environmental Watering PCB will continue to review the water and management requirements to sites as seasonal conditions change. This information will be provided to the VEWH to make fast and timely decisions on approving decisions on watering the sites.

TABLE OF CONTENTS

1. INTRODUCTION

1.1. Purpose

This Seasonal Watering Proposal identifies the desired environmental water use for the northern Victorian wetlands and floodplains in the coming year under a range of climatic scenarios.

The proposal provides the VEWH a range of environmental assets which are considered in scope to receive environmental water in 2011/12. Additionally it provides a recommended process for allocation of water during the year to ensure environmental water use is maximised across northern Victoria.

1.2. System overview

Northern Victoria's Rivers and wetlands are a highly connected as a result of the general catchment hydrology and northern Victoria's irrigation distribution system. The ability to move water around both physically, and through trade, provides an opportunity to maximise the effectiveness of environmental water to ensure the greatest ecological outcomes.

The waterways of some wetland systems have been included in this proposal as they are considered part of the wetland. For example Gunbower Creek is included as part of the Gunbower Icon site. Figure 1 shows the three main catchment management regions in which this proposal relates to. Figures 2, 3 and 4 show the individual catchments and a selection of priority watering assets in the Mallee, North Central and Goulburn Broken regions.

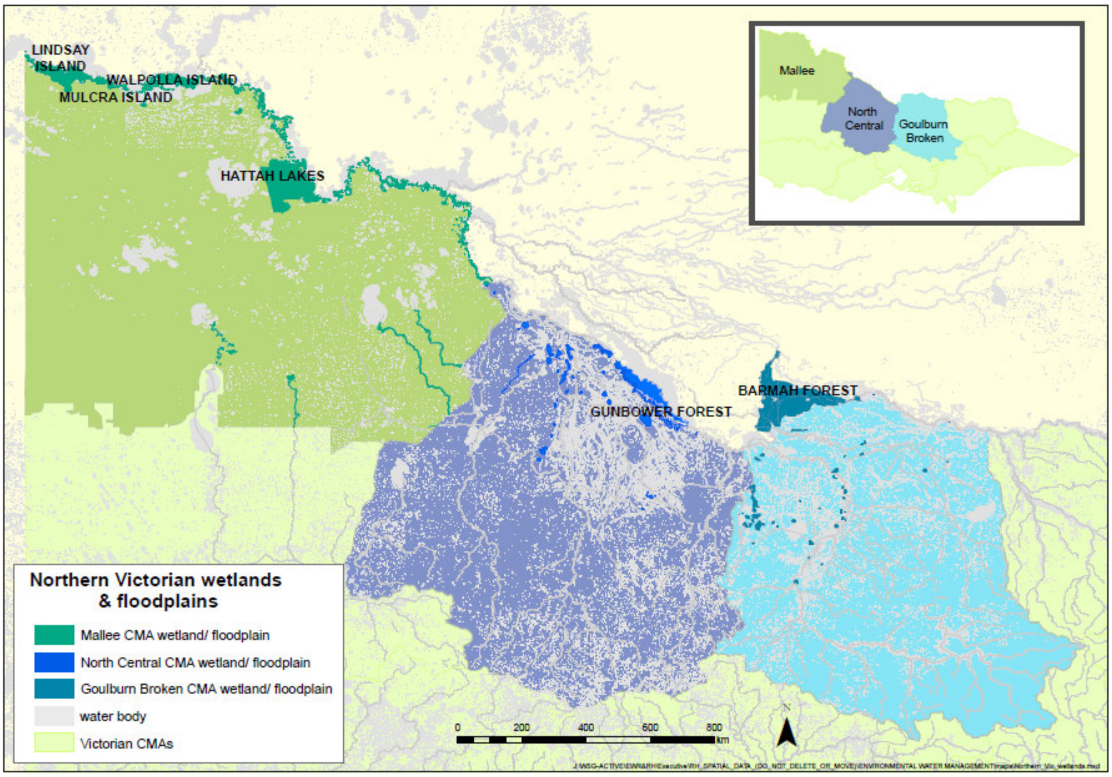


Figure 1. Map of the northern Victorian indicating the CMA regions.

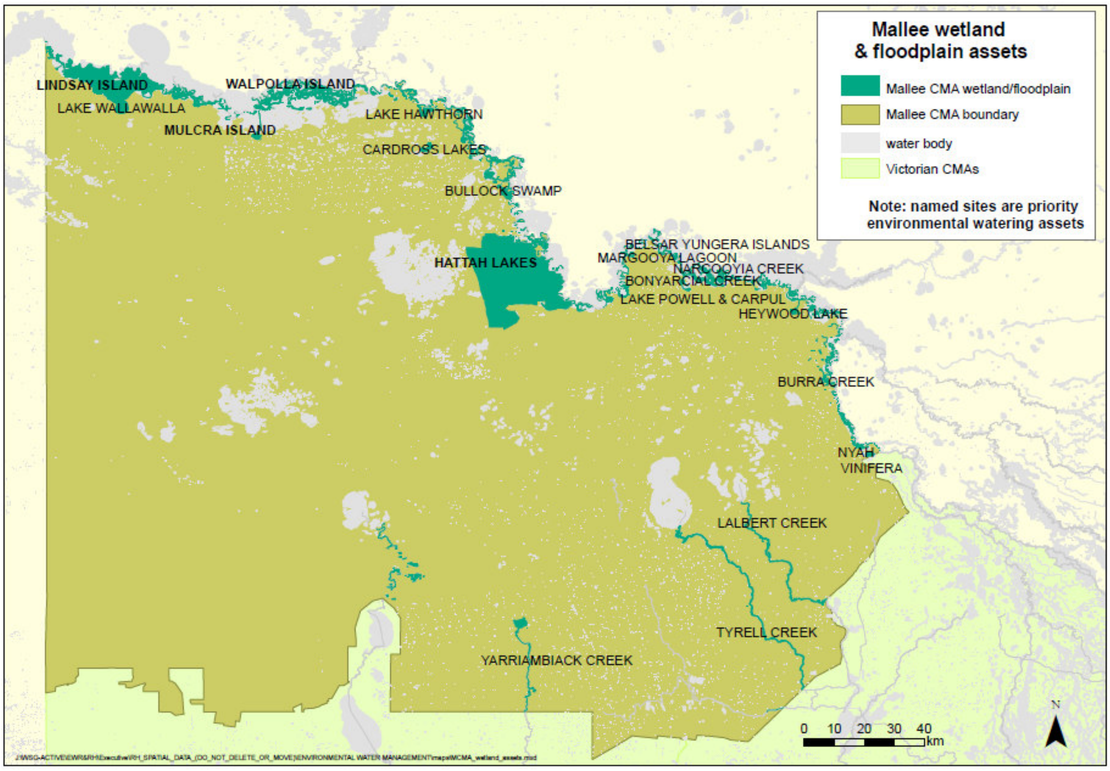


Figure 2. Map of the Mallee Catchment Management Authority region.

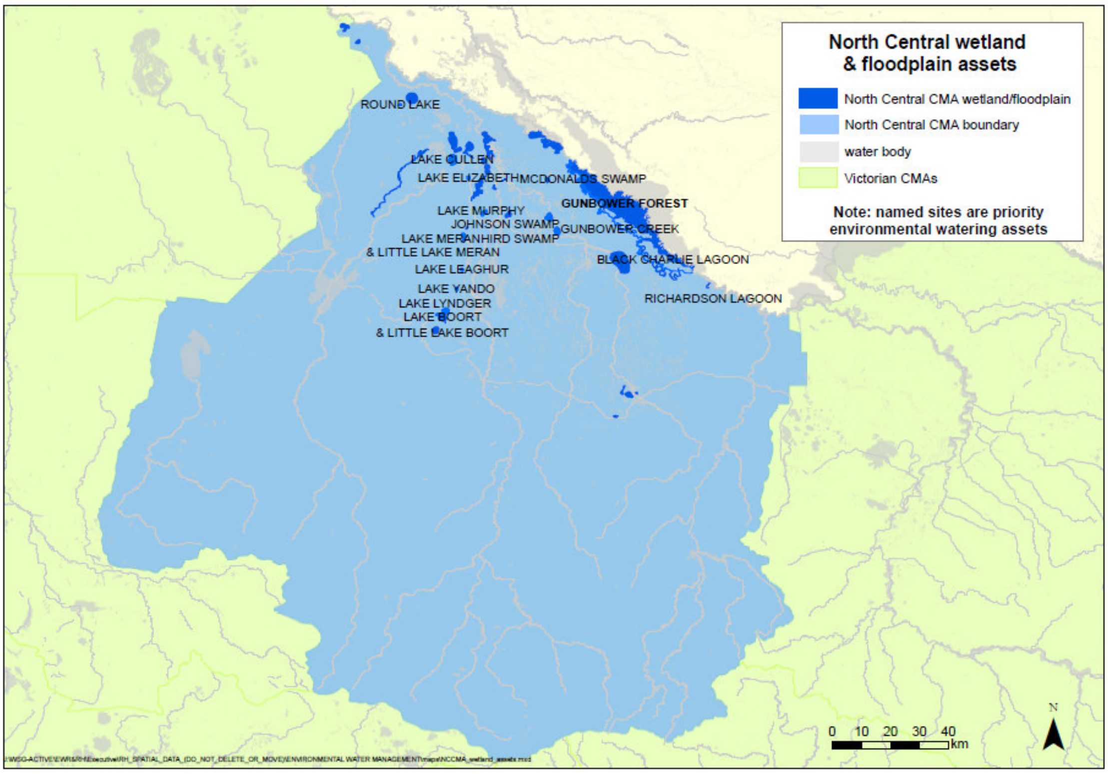


Figure 3. Map of the North Central Catchment Management Authority region.

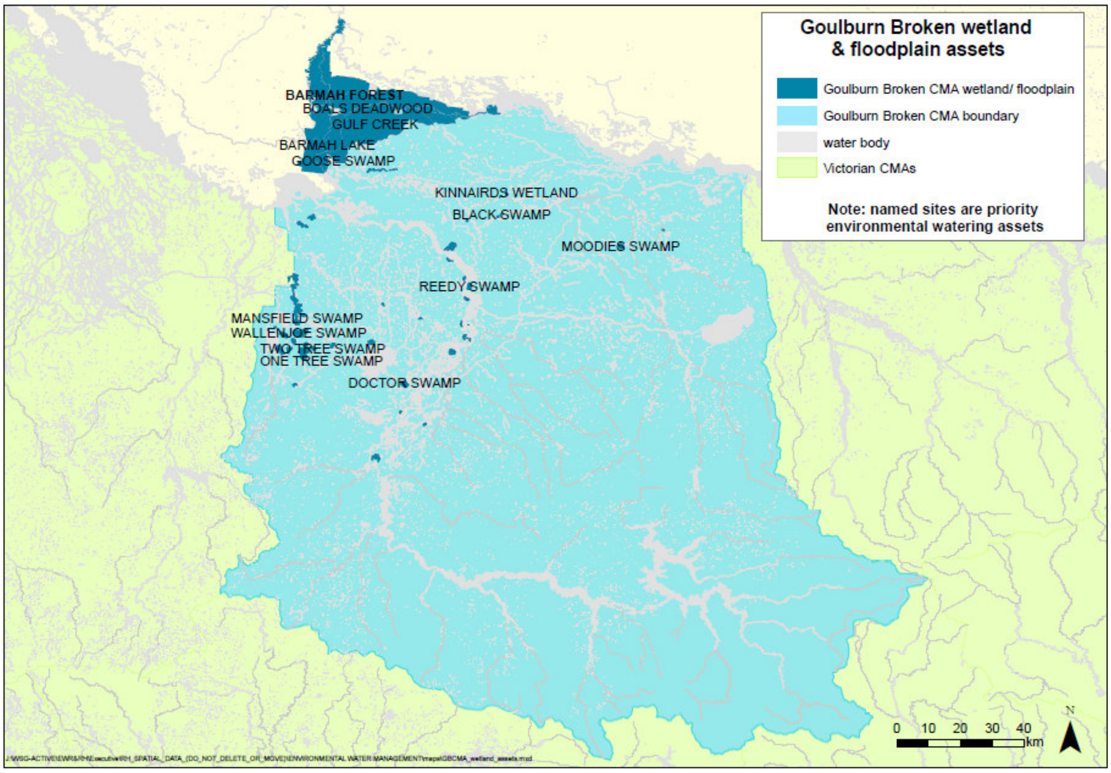


Figure 4. Map of the Goulburn Broken Catchment Management Authority region.

1.3. Sources of water

Victorian river and wetland sites may be allocated water from a number of sources, including VEWH entitlements, Murray Darling Basin Authority entitlements (through the Living Murray Program - TLM), Commonwealth Environmental Water Holder (CEWH) holdings, and through donations from individuals, community groups and organisations.

1.3.1 Victorian Environmental Water Holder entitlements

The Victorian Environmental Water Holder (VEWH) will be responsible for holding and managing Victorian environmental water entitlements and allocations, and deciding upon their best use throughout the State. Environmental entitlements held by the water holder that may potentially be made available to wetlands and floodplain sites within northern Victoira include:

- Bulk Entitlement (River Murray - Flora and Fauna) Conversion Order 1999
- Bulk Entitlement (Loddon River - Environmental Reserve) Order 2005
- Environmental Entitlement (River Murray - Environmental Water Reserve) 2010
- Environmental Entitlement (Goulburn System - Environmental Water Reserve) 2010
- mitigation water from Northern Victoria Irrigation Renewal Project (NVIRP)

In 1987 an annual allocation of 27,600 ML of high security water was committed to flora and fauna conservation in Victorian Murray wetlands. In 1999, this commitment was formalized in an entitlement for the environment, the Bulk Entitlement (River Murray - Flora and Fauna) Conversion Order 1999. This entitlement can be used throughout the Murray, Goulburn, Loddon and Campaspe systems.

The Bulk Entitlement (Loddon River - Environmental Reserve) Order was declared in 2005. This entitlement provided for river flows and 2,000ML of high reliability entitlement to be used for Boort district wetlands. In 2006, 2,024ML of low-reliability entitlement water was additionally recovered as a consequence of the unbundling of prior water rights. Water saving from the Wimmera-Mallee pipline has meant water from the Loddon and Goulburn system no longer needs to be transferred west. An additional 7,490 ML from the London and 1,432 ML from the Goulburn (Goulburn River Environmental Entitlement 2010) are now available below Loddon weir.

Water savings generated through NVIRP are expected to provide up to an additional 75 GL of entitlement for the environment, which will be used to help improve the health of priority stressed rivers and wetlands in northern Victoria. The entitlement will have properties which enable the water to be used at multiple locations as the water travels downstream (provided losses and water quality issues are accounted for); meaning that the water can be called out of storage at desired times to meet specific environmental needs.

As part of NVIRP a proportion of the saving is set aside as `mitigation water' to manage the ecological consequences of hydrological changes arising from implementation the program, including avoiding any contribution to diminishing ecological values in waterways and wetlands. This water is to be used at assets were there are approved environmental watering plans and mitigation water has been recommended. These assets include:

NVIRP approved Environmental Watering Plans	
Johnson Swamp	Lake Meran*
Lake Elizabeth*	Round Lake*
Lake Murphy	Campaspe River
McDonald Swamp*	Broken Creek
Lake Leaghur	Loddon River (Reach 5) d/s Kerang Weir*
Lake Yando	Loddon River (Reach 4) (Loddon Weir to Kerang)*
Little Lake Boort*	Twelve Mile Ck
Note: those sites with approved mitigation have been marked with an asterisk	

The Barmah-Millewa Forest has its own high security environmental water allocation (EWA) of 100 GL per year, which is contributed equally from Victoria and New South Wales (NSW), based on Victorian high reliability water share (HRWS) allocations. In addition the EWA includes a lower security allocation of 50 GL per year (again to be contributed equally from Victoria and NSW). The use of this water is defined by a set of rules which include flow targets before releases can be made.

Full details of all environmental entitlements and there conditions are available from the Victorian water register website (http://waterregister.vic.gov.au).

1.3.2. The Living Murray Water Holdings

The Living Murray (TLM) was established in 2002 as a partnership between the Commonwealth, NSW, Victorian, South Australian and Australian Capital Territory (ACT) governments. The long term goal of this program is to achieve a healthy working Murray River system for the benefit of all Australians.

In 2004, under the Living Murray ‘First Step' decision, Ministers from TLM partner governments committed to recover a long term average of 500 GL of water to improve environmental outcomes at six Icon Sites. The recovery of the 500 GL target is now nearing completion and this water can be used for environmental watering at any of the following six Icon Sites: the River Murray Channel, Barmah–Millewa Forest, Gunbower–Koondrook–Perricoota Forest, Hattah Lakes, Chowilla Floodplain and Lindsay–Wallpolla Islands, Lower Lakes, and Coorong and Murray Mouth.

Decisions on the allocation of TLM water are made by the MDBA, on advice from the Environmental Watering Group – a multi-jurisdictional group with representatives from Victoria, South Australia, NSW, ACT and the Australian government. These decisions are made in line with the Living Murray Annual Watering Plan (http://www.mdba.gov.au/programs/tlm/programs_to_deliver/environmental_delivery).

1.3.2 Commonwealth Environmental Water Holdings

The Commonwealth *Water Act 2007* established the Commonwealth Environmental Water Holder to manage the Commonwealth's environmental water holdings. The purpose of the environmental water is to protect or restore the environmental assets of the Murray-Darling Basin, and of other areas outside the Basin where the Commonwealth holds water, so as to give effect to relevant international agreements.

The CEWH currently has purchased a total of 916,732.2ML of entitlement in the Murray Darling Basin. This water has been purchased in Queensland, NSW, Victoria and South Australia and is made up of a variety of entitlements which have different reliabilities and conditions of use. Some of these entitlements can be traded between systems.

Water held by the CEWH is required to be managed in accordance with the environmental watering plan, part of the Basin Plan being developed by the MDBA in consultation with state governments and stakeholders.

Table 1: Potential sources of environmental water

Water source: Nature of water source	Water source: Volume (ML)*	Flexibility of management	System	Conditions of use	Management responsibility
ENTITLEMENTS					
Bulk Entitlement (River Murray - Flora and Fauna) Conversion order 1999	27,600 HR	Fully flexible management	Murray/Goulburn/ Loddon/Campaspe	Can be used across multiple system, within trade protocols	VEWH
	40,000 Unregulated	Some ability to manage	Murray	Available only in periods of unregulated flows	VEWH
Bulk Entitlement (River Murray - Flora and Fauna) Conversion order 1999 Barmah-Milllewa EWA	50,000 HR 25,000 LR	Management in accordance with rules specified in bulk entitlement.	Murray	Set triggers as specified in bulk entitlement including flow triggers. Water which flows through the forest is re regulated for consumptive use	VEWH
Bulk Entitlement (River Murray - Flora and Fauna) Conversion order 1999 Living Murray	5,710 HR 101,850 LR	For use at Living Murray Icon Sites	Murray	Only available for use on Living Murray Icon sites, in Victoria, Hattah, Barmah, Lindsay-Wallpolla-Mulcra Islands, Gunbower Forest.	MDBA
	34,300 Unregulated	Some ability to manage	Murray	Available only in periods of unregulated flows	VEWH
Environmental Entitlement (River Murray - Environmental Water Reserve) 2010	0	Fully flexible management	Murray	The volume available under this entitlement will be amended upon completion of water savings projects associated Stage 1 of the Northern Victoria Irrigation Renewal Program (NVIRP). In the interim period, the environment's 1/3 share of the annual water savings achieved from Stage 1 of NVIRP are provided under a Supply by Agreement.	VEWH
Bulk Entitlement (Loddon River Environmental Reserve) Order 2005	9,490 HR 2024 LR	For use in Boort district wetlands Fully flexible management	Loddon – Boort Loddon/Murray/ Goulburn/ Campaspe	Available for use in the Boort district wetlands. * Can be used across multiple system, within trade protocols	VEWH
Environmental Entitlement (Campaspe River - Living Murray Initiative) 2007	126 HR 5,048 LR	For use at Living Murray Icon Sites	Campaspe	Only available for use on Living Murray Icon sites	MDBA
Goulburn River Environmental Entitlement 2010	1,432 HR	Flexible management	Loddon	Available for use in Loddon Zone 1B.	VEWH
Environmental Entitlement (Goulburn System – Environmental Water Reserve) 2010	0	Fully flexible management	Goulburn	The volume available under this entitlement will be amended upon completion of water savings projects associated Stage 1 of the Northern Victoria Irrigation Renewal Program (NVIRP). In the interim period, the environment's 1/3 share of the annual water savings achieved from Stage 1 of NVIRP are provided under a Supply by Agreement.	VEWH

Environmental Entitlement (Goulburn System - Living Murray) 2007	39,625 HR 156,980 LR	For use at Living Murray Icon Sites	Goulburn	Only available for use on Living Murray Icon sites	MDBA
Commonwealth Water Shares**	47 HR 4 LR	Agreement required with CEWH	Broken		CEWH
	5,783 HR 395 LR	Agreement required with CEWH	Campaspe		CEWH
	1,564 HR 527 LR	Agreement required with CEWH	Loddon		CEWH
	129,946 HR 11,125 LR	Agreement required with CEWH	Murray		CEWH
	95,705 HR 10,526 LR	Agreement required with CEWH	Goulburn		CEWH
OTHER WATER SOURCES					
Consumptive water en route: Inter-valley transfer	N/A	Some ability to manage	Murray, Goulburn, Broken.	Any additional losses are deducted from environmental account	Water Corporation /MDBA
Consumptive water en route		Limited/no ability to manage		Any additional losses are deducted from environmental account	Water Corporation /CMA
Unregulated flow		Limited/no ability to manage	Goulburn, Loddon, Campaspe	Available only in periods of unregulated flows	Water Corporation /CMA
River Murray Unregulated Flows		Some ability to manage	Murray	Available only in periods of unregulated flows announced by MDBA River Operations after Victorian and NSW unregulated commitments have been meet. Currently trail in place through MDBA to co-ordinate the delivery of this unregulated flows	MDBA - Environmental Watering Group, on a trial basis.

*** Volumes as at 31st May 2011**

1.4. Consultation

The Northern Victorian wetland proposal was developed by with member of the Northern Victorian Environmental Watering Project Control Board (PCB). Members of the PCB are outlined in Table 2.

Table 2: Northern Victorian Environmental Watering PCB members

Who	Roles and responsibilities	Purpose of consultation	Mode and timing of consultation
Goulburn Broken CMA	Informs the development of the proposal. Provides approved watering actions for the Goulburn Broken CMA region. Collaboratively recommends watering actions.	Approval regional watering actions Recommends watering actions during year	Ongoing
Mallee CMA	Informs the development of the proposal. Provides approved watering actions for the Mallee CMA region. Collaboratively recommends watering actions.	Approval regional watering actions Recommends watering actions during year	Ongoing
North Central CMA	Informs the development of the proposal. Provides approved watering actions for the North Central CMA region. Collaboratively recommends watering actions.	Approval regional watering actions Recommends watering actions during year	Ongoing
Parks Victoria	Inform the development of the proposal. Approves watering actions at Parks Victoria sites Provides advice on land management interface.	Approval of regional watering actions at Park Victoria sites Provides advice on watering actions during year	Ongoing
Department of Sustainability and Environment	Coordinates the development of the proposal on behalf of the Catchment Management Authorities* Provides policy advice on watering actions	Consult	Ongoing
Victorian Environmental Water Holder	Considers Seasonal Watering Proposal and uses information to develop seasonal watering plan. Co-ordinates PCB through 2011/12 to assign water to assets in line with seasonal watering plan	Approves seasonal watering proposal	Ongoing

Note: future years DSE will not be involved in the development of the proposal. This occurred this year as proposal required to be developed before VEWH started operations.

2. ECOLOGICAL OBJECTIVES

2.1 Ecological objectives

The Environmental Water Reserve Objective as defined in the Victorian *Water Act (1989)* objective states the that the environmental water reserve (which includes environmental entitlements) be maintained so as to preserve the environmental values and health of water ecosystems, including, their biodiversity, ecological functioning and quality of water, and the other uses that depend on environmental condition.

2.1.1 Environmental Water Management Plans (EWaMPs)

Mallee, North Central and Goulburn Broken CMAs are progressively developing EWaMPs for priority wetlands in northern Victoria. An EWaMP outlines the environmental, social and economic values of wetland systems, their environmental condition, threats and environmental watering objectives. The plan identifies the watering history and the longer-term water regime requirements for the wetland to meet environmental objectives under a range of climatic conditions. These plans will play an important role in the environmental water planning framework (appendix 1).

EWaMPs have not been developed for all wetlands. Watering requirements for wetland sites where these plans have not been developed are based on the best available knowledge and available scientific information, including NVIRP EWPs where applicable.

The Living Murray Program also develops Environmental Water Management Plans (EWMPs) for each Icon Site. The purpose of the EWMP is to outline the ecological objectives of the icon site and describe the works proposals funded through the Living Murray program, as well as ongoing management arrangements. These plans provide the same function as EWaMPs and will be used at Victorian Icon Sites.

The information that is currently available and used to identify the water requirements for 2011/12 can be found in attachment 2.

3. FLOW PRIORITISATION

3.1. Situation review

In 2010/11, much of northern Victoria experienced above average rainfall. Significant flooding occurred in the Murray, Goulburn, Campaspe and Loddon, systems.

During the start of 2010/11, environmental water was being delivered to a number of priority wetlands. As conditions continued to improve environmental water was supplied to additional wetlands. The wet conditions across the state over summer resulting in high rainfall and catchment runoff has filled many wetlands to capacity and generated high natural river flows in a number of systems. These natural events reduced the need to deliver environmental water to wetlands and floodplains across northern Victoria.

Flooding along the River Murray provided water to many wetlands and floodplains including the Hattah Lakes, Lindsay, Wallpolla and Mulcra Islands and many smaller wetlands along the River Murray channel.

Large scale flooding in the Boort and Kerang systems connected significant number of wetlands through their floodplain. Wetlands in the Goulburn Broken region also received significant inundation.

In 2010/11, environmental water was applied to enhance the environmental benefit of the naturally received inflows. For example approximately 410 billion litres of environmental water was delivered to Barmah Millewa forest, resulting in the largest bird breeding event in 60 years. Where there was any risk of flooding private land, environmental water deliveries ceased.

Northern Victorian wetlands which received environmental water from managed actions are listed in Table 3 below. In addition, CMAs worked closely with Water Corporations and River Murray Water providing advice on the diversion of unregulated flows into wetland systems.

Table 3. Site which receive environmental water from managed actions

Asset	CMA
Hirds Swamp	North Central CMA
Lake Cullen	North Central CMA
McDonald Swamp	North Central CMA
Richardson's Lagoon	North Central CMA
Round Lake	North Central CMA
Lake Boort	North Central CMA
Lake Meran	North Central CMA
Gunbower Creek	North Central CMA
Campaspe IVT losses 2009/10 Lake Kramen Murray River channel sites Liparoo Complex Yungera J1	North Central CMA Mallee CMA Mallee CMA Mallee CMA Mallee CMA
Merbein Common	Mallee CMA
Neds Corner	Mallee CMA
Heywoods Lake	Mallee CMA
Koorlong	Mallee CMA
Cardross Basin 1 East	Mallee CMA
Lindsay Island	Mallee CMA
Lindsay Island – Lake Wallawalla	Mallee CMA
Hattah Lakes - Autumn Goulburn River Barmah Forest	Mallee CMA Goulburn Broken CMA Goulburn Broken CMA

Note: Volumes delivered to assets will be provided in the annual environmental watering booklet after the year has been completed.

As a result of the long period of drought, which caused a build up of organic material on the floodplain, followed by the high rainfall subsequent flooding, significant amounts of organic matter present on these floodplains entered the river systems. This combined with high summer temperatures, resulted in a number of blackwater events. Systems affected included the Murray, Loddon and Goulburn Rivers, and

Broken Creek.

With the exception of Barmah Forest, which experienced a sustained blackwater event, the majority of wetland systems in northern Victoria were unaffected. In some cases these wetlands acted as important refuges from the blackwater for waterbirds and other water dependant species.

The occurrence of the natural flooding event experienced in 2010/11 will likely have a range of ecological benefits, including improvements in the condition of wetland and floodplain vegetation, significant water bird recruitment, in addition to boosting the health of aquatic plants and animals.
In many cases, the flood will have provided relief to wetlands that have been dry well beyond their desired flow regime, providing an important opportunity for reestablishment and re-colonisation of wetland flora and fauna.

As we transition into an improved water resource position, the focus on environmental water management is to provide water to restore wetland values that were not able to be maintained in drier periods, and to improve the long-term resilience of wetlands and rivers across northern Victoria.

3.2. Hydrological History and current system status

The following tables outline the hydrological condition of wetlands in northern Victoria over the last ten years. The tables do not distinguish between water delivered from environmental entitlements, water diverted to mitigate flooding (managed flows) and water which has been provided from rainfall, natural run-off, and overbank river flows (unmanaged flows).

This information is used assist in the scheduling of watering wetlands according to their desired watering regimes based on number of year in a specific period of time. Each wetland has different watering regimes based on the ecological objectives of the system. These objectives are identified in the relevant EWaMP, TLM EWP, NVIRP EWP or using best available knowledge of the system.

An overview is provided for each system below. Further detail regarding individual sites and the rational for watering is provided in attachment 3.

Key:	
Wet	(blue)
Wet - dry	(orange)
Dry	(yellow)

3.2.1 Goulburn Broken wetland system

Table 4. Hydrological history of Goulburn Broken wetland system

Asset	Water regime (yr/yr)	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Black Swamp	1/3	Wet	Wet	Wet	Wet	Wet	Wet	Dry	Wet	Dry	Wet
Doctors Swamp	1/3	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Dry	Wet - dry	Wet - dry	Wet	Wet
Kinnairds Swamp	1/3	Dry	Dry	Wet	Wet	Wet	Dry	Dry	Wet	Dry	Wet
Mansfiled Swamp	1/3	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet
Moodies Swamp	1/2	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet - dry	Dry	Wet
One Tree Swamp	1/2	Dry	Dry	Dry	Dry	Dry	Dry	Wet - dry	Dry	Dry	Wet
Reedy Swamp	1/2	Wet	Wet	Wet	Wet	Wet	Dry	Wet	Wet	Wet	Wet
Two Tree Swamp	1/2	Dry	Dry	Dry	Dry	Dry	Dry	Wet - dry	Dry	Dry	Wet
Wallenjoe Swamp	1/3	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet

System Status:

As a result of above average rainfall last year and early this year all of the wetlands listed above were filled, some for the first time in over ten years. The wetlands have held water for over 12 months already and are expected to hold water through to early summer. Due to their extended inundation (some wetlands have and are likely to exceed their maximum flood duration) the wetlands will not require environmental water this season. However, a number of the wetlands may require environmental water in spring 2012.

3.2.2 Barmah Forest

Table 5. Hydrological history of Goulburn Broken wetland system

Asset	Water regime (yr/yr)	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Barmah Floodplain	7/10	Dry	Dry	Wet - dry	Wet - dry	Wet - dry	Dry	Dry	Dry	Dry	Wet
Smiths Creek	10/10	Wet - dry	Wet - dry	Wet	Wet	Wet	Dry	Dry	Dry	Wet - dry	Wet
Gulf Creek	10/10	Wet - dry	Wet	Wet	Wet	Wet	Dry	Dry	Wet - dry	Wet - dry	Wet
Boals Deadwood	8/10	Wet - dry	Wet	Wet	Wet	Wet	Dry	Dry	Wet - dry	Wet - dry	Wet
Gooses Swamp	4/10	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet

System Status:

Extended natural flooding during 2010/11 continues in Barmah-Millewa Forest, although it has been fluctuating at a lower level than that experienced during the peaks that occurred in August and December 2010. Such extended flood events are unprecedented in 105 years of recorded hydrologic history, and have resulted in a range of positive and potentially negative influences on floodplain vegetation condition. The lower terrace floodplain (such as the Moira Grass Plains) would benefit with seasonal drying regime, although the opportunity for this to effectively occur has now passed and forecast winter-spring 2011 conditions mean that the plains have high likelihood of experiencing repeated natural inundation. As such, promoting extensive flooding to outer floodplain vegetation types, by building on natural flood peaks, is desired to re-water regions that had been drought affected. Re-flooding such sites is expected to better consolidate re-sprouting red gum overstorey and to provide improved conditions for an expected large seed load of understorey species that was promoted by the 2010/11 flood event. Concurrent flooding ought to also improve habitat and food resources for a variety of juvenile species (e.g. frogs, reptiles, birds and mammals) that were bred during the last flood event, and hence should improve the chances of their survival and hence probability of being incorporated into the adult breeding population. A drying regime in summer-autumn for the floodplain is then of high priority. This type of flood regime (wet winter-spring and dry summer-autumn) reflects the more natural flood regime for such mid-Murray wetlands.

Key:

Wet	
Wet - dry	
Dry	

3.2.3 Boort wetland system

Table 6. Hydrological history of Boort wetland system

Asset	Water regime (yr/yr)	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Lake Boort	1/3-5	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet
Lake Leaghur	1/3	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet	Wet
Lake Lyndger	1/7	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet
Lake Meran	9/10	Wet	Wet	Wet	Wet	Dry	Dry	Dry	Dry	Dry	Wet
Lake Yando	1/3	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet	Wet
Little Lake Boort	*	Wet	Wet - dry	Wet - dry	Wet	Wet	Wet	Wet	Wet	Wet	Wet
Little Lake Meran	3/10	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet

* Little Lake Boort is being operated as a recreational lake for water skiing and managed by the Committee of Management. No environmental water is recommended.

System Status:

Environmental water was provided to Lake Boort and Lake Meran in spring when surplus water was available. With continuing rainfall through the whole of the Loddon River catchment, all other wetlands in the Boort District Wetland complex were inundated, many for the first time in over a decade. The lateness of rainfall in 2010-11 has meant that the wetlands are still holding significant volumes of water.

Key:

Wet	
Wet - dry	
Dry	

3.2.4 Kerang Wetlands

Table 7. Hydrological history of Kerang wetland system

Asset	Water regime (yr/yr)	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Round Lake	1/1										
McDonald Swamp	1/1										
Hirds Swamp	1/5 (but maintaining water for 2yrs)										
Lake Cullen	2/10										
Lake Elizabeth	1/3										
Johnson's Swamp	1/3										
Lake Murphy	2/5										
Richardson's Lagoon	1/1										

System Status:

Prior to the large flood in January 2011, environmental water was provided to Round Lake, McDonald Swamp, Hirds Swamp, Lake Cullen and Richardson's Lagoon. The large flood event in January 2011 resulted in inundation of some wetlands in the Kerang system receiving unregulated and/or overland flows.

Ecological responses have been good, with significant numbers of waterbirds using the wetlands. The lateness of rainfall in 2010-11 has meant that the wetlands are still holding significant volumes of water.

Key:

Wet	(blue)
Wet - dry	(orange)
Dry	(yellow)

3.2.5 Mallee River Murray wetlands

Table 8. Hydrological history of Mallee River Murray wetland system

Asset	Water regime (yr/yr)	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Belsar/Yungera Islands	1/3	Dry	Dry	Dry	Dry	Wet - dry	Dry	Dry	Dry	Dry	Wet
Bonyarcial	1/3	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet
Bullocks Swamp	1/3	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet
Burra Creek	1/3	Dry	Dry	Dry	Wet - dry	Wet - dry	Dry	Dry	Dry	Dry	Wet
Butlers Creek	1/3	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet
Buxtons Bend	1/3	Dry	Dry	Dry	Dry	Wet - dry	Dry	Dry	Dry	Dry	Wet
Cardross Lakes	1/1	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet
Carina Bend	1/3	Dry	Dry	Dry	Dry	Wet - dry	Wet - dry	Dry	Dry	Wet - dry	Wet
Carwarp Creek	1/3	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet
Forest Bend	1/3	Dry	Dry	Dry	Dry	Wet - dry	Dry	Dry	Dry	Dry	Wet
Graces Bend	1/3	Dry	Dry	Dry	Dry	Wet - dry	Dry	Dry	Dry	Dry	Wet
Heywoods Lake	1/8	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet - dry
Lake Hawthorn	1/8	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Dry	Dry	Wet
Lake Koorlong	1/1	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet
Lakes Powell and Carpul	1/8	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet - dry
Lalbert Creek	1/8	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet
Liparoo	1/3	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Dry	Dry	Wet - dry	Wet
Margooya Lagoon	1/3	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Dry	Dry	Wet	Wet
Merbein Common	1/3	Dry	Dry	Dry	Wet - dry	Wet - dry	Wet - dry	Dry	Dry	Wet - dry	Wet
Murrumbidgee junction	1/3	Dry	Dry	Dry	Wet - dry	Wet - dry	Wet - dry	Dry	Dry	Dry	Wet
Narcooyia Creek	1/3	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet
Neds Corner	1/3	Dry	Dry	Dry	Dry	Wet - dry	Dry	Dry	Dry	Wet - dry	Wet
Neds Corner West	1/3	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet
Nyah	1/3	Dry	Dry	Dry	Wet - dry	Wet - dry	Dry	Dry	Dry	Wet - dry	Wet
Pile Bend	1/3	Dry	Dry	Dry	Dry	Wet - dry	Dry	Dry	Dry	Dry	Wet
Sandilong Creek	1/3	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet
Spences Bend	1/5	Dry	Dry	Dry	Wet - dry	Wet - dry	Dry	Dry	Dry	Dry	Wet
Tyrell Creek	1/8	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet
Viniferia	1/3	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet
Yarriambiack Creek	1/8	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet
Yungera J1	1/3	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet

System status:

The majority of these wetlands before 2010/11 had not received water for over ten years. This timing is longer than the recommended watering intervals for many of theses sites. To ensure recovery and maximise the benefit of the floods in 2010/11, many sites are recommend for a top up in 2011/12.

Key:	
Wet	(blue)
Wet - dry	(orange)
Dry	(yellow)

3.2.6 Gunbower System

Table 9. Hydrological history of Gunbower wetland system

Asset	Water regime (yr/yr)	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Black Charlie Lagoon	8/10	Wet - dry	Dry	Wet - dry	Dry	Dry	Wet - dry	Dry	Dry	Dry	Wet
Little Gunbower Creek Complex	7/10	Wet - dry	Dry	Wet - dry	Wet - dry	Wet	Wet - dry	Wet - dry	Wet	Wet	Wet
Little Reedy Complex	7/10	Wet - dry	Dry	Wet - dry	Wet - dry	Wet	Wet - dry	Wet - dry	Dry	Dry	Wet
Reedy Lagoon	9/10	Wet - dry	Dry	Wet	Wet	Wet	Wet - dry	Dry	Dry	Wet	Wet
Black Swamp	9/10	Wet - dry	Dry	Wet - dry	Wet - dry	Wet	Wet - dry	Wet - dry	Wet	Wet	Wet
Gunbower Forest Wetlands and Creeks - Floodplain	6/10	Wet - dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet
Gunbower Creek	10/10	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry	Wet - dry

System status: Gunbower received large overbank flows in November and January which inundated approximately 70% of the forest. This provided large scale vegetation response and also water bird breeding opportunities. The small scale watering over the last few years combined with 2010/11 flood has reduced the risk to the forest.

Construction of Living Murray works are planned to be undertaken in 2011/12 (http://www.mdba.gov.au/programs/tlm/programs_to_deliver/works_measures) are planned to be undertaken in 2011/12. These works are high priority for the long-term sustainability of the forest. Watering this year will be aimed at sites away from the construction to meet ecological objective outlined in the Living Murray EWMP, or to extend bird breeding if the forest floods naturally.

Key:	
Wet	(blue)
Wet - dry	(orange)
Dry	(yellow)

3.2.7 Hattah Lakes System

Table 10. Hydrological history of Hattah Lakes wetland system

Asset	Water regime (yr/yr)	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Chalka Creek South	1/3	Dry	Dry	Dry	Wet - dry	Wet - dry	Wet - dry	Dry	Wet	Wet	Wet
Chalka Creek North	1/3	Dry	Dry	Dry	Wet - dry	Wet - dry	Dry	Dry	Dry	Dry	Wet
Lake Lockie	1/3	Dry	Dry	Dry	Dry	Wet - dry	Wet - dry	Dry	Wet - dry	Wet	Wet
Lake Roonki	1/3	Dry	Dry	Dry	Dry	Dry	Wet - dry	Dry	Dry	Wet	Wet
Little Lake Hattah	1/3	Dry	Dry	Dry	Dry	Wet - dry	Wet - dry	Dry	Wet - dry	Wet	Wet
Little Lake Roonki	1/3	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet - dry	Wet	Wet
Lake Hattah	1/3	Dry	Dry	Dry	Dry	Wet - dry	Wet - dry	Dry	Wet - dry	Wet	Wet
Lake Yelwell	1/3	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet	Wet
Lake Bulla	1/3	Dry	Dry	Dry	Dry	Wet - dry	Wet - dry	Dry	Dry	Wet	Wet
Lake Arawak	1/3	Dry	Dry	Dry	Dry	Dry	Wet - dry	Dry	Dry	Wet	Wet
Lake Brockie	1/3	Dry	Dry	Dry	Dry	Dry	Wet - dry	Dry	Dry	Wet	Wet
Lake Nip Nip	1/3	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet
Lake Maramorck	1/3	Dry	Dry	Dry	Dry	Dry	Wet - dry	Dry	Dry	Dry	Wet
Lake Yerang	1/3	Dry	Dry	Dry	Dry	Wet - dry	Wet - dry	Dry	Dry	Wet	Wet
Lake Mourpall	1/3	Dry	Dry	Dry	Dry	Dry	Wet - dry	Dry	Dry	Wet	Wet
Lake Kramen	1/3	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet - dry
Lake Konardin	1/3	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Wet

System status: Hattah Lakes received water during the 2010/11 year from pumping early in the year and then from natural flooding events in late spring and summer. The majority of sites which can receive water from managed flows were watered by unmanaged flows. These sites have received their required watering regime and a drying phase is required. Lake Kramen did not receive water from the unmanaged flows and is still requires water for recovery.

Construction of water management works at Hattah Lakes under The Living Murray Program is schedule to commence late in 2011. The construction phase requires the works sites to be dewatered (dry); therefore, a drying phase is scheduled for the Hattah Lakes in 2011/12

Key:

Wet	
Wet - dry	
Dry	

3.2.8 Lindsay, Mulcra and Wallpolla Islands

Table 11. Hydrological history of Lindsay,Mulcra and Wallpolla Island systems

Asset	Water regime (yr/yr)	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Lindsay Island	1/3										
Lake Wallawalla	1/10										
Lindsay Island - Mullaroo Creek	1/1										
Mulcra Island	1/3										
Wallpolla Island	1/3										

System status:

Extensive inundation of Lindsay Mulcra and Wallpolla Islands occurred in 2010/11. The environmental watering program in 2011/12 seeks to capitalise upon the benefits on the flooding in 2010/11. The program will focus on top up volumes to maximise the ecological benefit.

4. ENVIRONMENTAL WATERING PROPOSAL

4.1 Seasonally adaptive approach

Victoria has adopted an adaptive and integrated management approach to environmental management. A key component of this approach for environmental watering is the 'seasonally adaptive' approach.

The seasonally adaptive approach identifies the priorities for environmental watering depending on different inflow scenarios and the amount of water available in a given year. It is a flexible way to deal with short-term climatic variability and helps to guide annual priorities and manage droughts.

The seasonally adaptive approach has been used to guide the watering regime under various climatic scenarios. The process involves considering the minimal flow components (and related water volumes) needed to meet ecological objectives and what additional objectives and flow components can be added as inflow increases and environmental water availability increases under any particular scenario.

The intention is that this approach builds flexibility to adjust to circumstances as they unfold to achieve ecological objectives.

4.2 Proposal for water use

Environmental water requirements of priority wetland sites across northern Victoria are identified under a range of potential climatic scenarios tables 14 and 15. These water requirements have been established by the relevant CMA, through consultation with the other stakeholders including community members where relevant.

The volumes and management actions indicated are an estimate of the required water to meet the ecological objective of the site. They are subject to change depending the seasonal conditions during the year.

The process for the prioritisation, allocation and delivery of water to northern Victorian wetlands and floodplains involves further collaboration and involvement of the Mallee, North Central and Goulburn Broken CMAs and their partners through out the year.

To ensure that environmental water is used to its most effective use, it is proposed that the Northern Victorian Environmental Watering PCB continue their role in assisting in the prioritisation and recommendation of sites for the allocation of available environmental water to the VEWH.

As the season progresses and allocations are made available, the Northern Victorian Environmental Watering PCB will continue to review the volumes allocated to sites, and any changes to watering requirements as seasonal conditions change. The prioritisation of environmental water will be based on the following criteria:

- Extent and significance of the environmental benefit expected from the watering
- Certainty of achieving the environmental benefit and ability to manage other threats
- Watering history
- Implications of not watering the site
- Ability to provide ongoing benefits at the site
- Risks associated with the watering
- Feasibility of the watering
- Cost effectiveness of the watering
- Opportunity to maximise outcomes by integration with other sources of water and complementary works

On the recommendation of the PCB, CMA's will develop a delivery plan (see appendix 1), covering the above criteria for the VEWH to make a decision in approving water to the site.

4.3 Scenario Planning

The planning of environmental water delivery is dependent three main components; the ecological condition of the site, the likely operation of the system and the water resources available for use.

4.3.1 Ecological condition of the site

The condition of the environmental site indicates if a site should be watered or not. The majority of wetlands and floodplains have wetting and drying cycles. Not enough water puts stress on the system reduces its productivity and can result in large scale deaths of important species, such as River Red Gums. A wetland that is watered too frequently can also place stress on the system, such as water logging Black Box.

4.3.2 Likely system operations

Rainfall and the subsequent inflows into the catchments provide a key driver in the ability and the need to delivery managed environmental water. The ways systems will operate in 2011/12 are a combination of current storage levels, inflows into the systems and consumptive water demand.

As of the 5 June 2011 the total storage levels in northern Victoria was ~ 80%. The major storages of Hume Dam (94%), Dartmouth Dam (63%) and Lake Eildon (84%) were in a significantly higher resource position than this time last year (http://www.g-mwater.com.au/water-resources/storage-levels). While Dartmouth Dam is on a relatively small catchment, the other two main storages have a large catchment area. The rainfall over the 2010/11 summer has meant that the catchment is still relatively wet and therefore inflows will respond quickly to rainfall events. The Loddon and Campaspe storages are at 90% and 97% capacity respectively.

The operation of the storages is driven by consumptive demand as it makes up the largest proportion of water in the storages. Generally the demand for water starts in spring and increases during the summer periods, reduces and then cease in Autumn. The demand for water decrease if there is rainfall over the irrigation system during the year. Currently there is a large amount of water in the system which will be carried over into 2011/12, which will influence system operations early in the new year.

The general implications of the current storage, catchments position and consumptive demands on system operations under different scenarios are listed below

Very low inflows:

Systems will operate under regulated conditions. With the large amount of carry-over in the system, it is likely that all the channel systems will be operating early in the season. There will be little influence from local catchment run-off and unregulated streams.

Low Inflows:

Systems will operate under mostly regulated conditions. Isolated rainfall may cause small periods of unregulated flows. With the large amount of carry-over in the system and some allocation early in the season, it is likely that all the channel systems will be operating early in the season. There will be minor influence from local catchemnt run-off and unregulated streams

Median Inflow:

Systems operations will shift between regulated and unregulated conditions. General rainfall will have an impact to the system and depending on timing are likely to influence dam operations including storage release curves. There will likely be some overbank flows in some systems. Local catchment run-off and unregulated streams will have a moderate influence on system condition.

High Inflow:

Systems will largely operate under unregulated conditions. The large storages will meet target storage release curves with small storages likely to spill. Local catchment run-off and unregulated streams will have a major influence on system condition, including flooding.

4.3.3 Water resources available

The northern Victorian wetlands have the potential to access water from three major environmental water holders; The Victorian Environmental Water Holder, Commonwealth Environmental Water Holder and the Murray Darling Basin Authority (Living Murray Program). Each environmental water holder has slightly different objectives for the use of their water. Table 12 and 13 provides an indication of the potential available water against each environmental water holder current entitlements in the Murray and Goulburn systems for 2011/12 based against Goulburn Murray Water outlook scenarios.

The Murray and Goulburn systems have the most environmental entitlements available and give a good indication of the amount of water which is available in northern Victoria. Water can also be traded from other states to Victoria to meet environmental requirements subject to trade rules.

Table 12. Predicted allocations against current high reliability environmental water holder entitlements in the Murray System for 2011/12

Water Holder	Inflow Conditions	1 July 2011	Allocations*	15 August 2011	Allocations*	17 October 2011	Allocations*	15 February 2011	Allocations*
VEWH	Wet	47%	12,972	61%	16,836	100%	27,600	100%	27,600
CEWH			61,074		79,267		129,946		129,946
MDBA			2,683		3,483		5,710		5,710
VEWH	Average	43%	11,868	49%	13,524	83%	22,908	100%	27,600
CEWH			55,876		63,673		107,855		129,946
MDBA			2,455		2,797		4,739		5,710
VEWH	Dry	40%	11,040	44%	12,144	67%	18,492	100%	27,600
CEWH			51,978		57,176		87,063		129,946
MDBA			2,284		2,512		3,825		5,710

*Does not included water carried over from 2010/11. Based on current holdings specified in table 1.

Table 13 Predicted allocations against current high reliability environmental water holder entitlements in the Goulburn System for 2011/12

Water Holder	Inflow Conditions	1 July 2011	Allocations*	15 August 2011	Allocations*	17 October 2011	Allocations*	15 February 2011	Allocations*
VEWH	Wet	68%	6,453	100%	9,490	100%	9,490	100%	9,490
CEWH			65,759		96,705		96,705		96,705
MDBA			26,945		39,625		39,625		39,625
VEWH	Average	48%	4,555	80%	7,592	100%	9,490	100%	9,490
CEWH			46,418		77,364		96,705		96,705
MDBA			19,020		31,700		39,625		39,625
VEWH	Dry	43%	4,080	53%	5,029	74%	7,022	96%%	9,110
CEWH			41,583		51,253		71,561		92,836
MDBA			17,038		21,001		29,322		38,040

*Does not included water carried over from 2010/11. Based on current holdings specified in table 1.

4.2.3 Seasonal Scenario Planning Table

The seasonal scenario planning table identifies sites which require environmental water this year. It considers the watering history, likely system operations and water resource availability to provide an estimate volume the site requires under different inflow scenarios.

Table 14: Summary of northern Victorian wetland's (excluding Victorian Living Murray Icon sites) environmental water requirements under a range of climatic scenarios

	Volume required under different scenarios and area/length watered															
	Very Low Inflow				**Low Inflow**				**Median Inflow**				**High Inflow**			
System operations	Limited rainfall, high evaporation, river systems in regulated conditions				Limited rainfall, high evaporation, river systems mainly in regulated conditions				Some spills from storages, river systems shift between regulated and unregulated conditions				Widespread flooding and rainfall, river systems in unregulated conditions			
Wetland	**Sites**	**Spring**	**Autumn**	**Total** (ML)	**Sites**	**Spring**	**Autumn**	**Total** (ML)	**Sites**	**Spring**	**Autumn**	**Total** (ML)	**Sites**	**Spring**	**Autumn**	**Total** (ML)
Goulburn Broken wetlands	N/A	0	0	**0**	N/A	0	0	**0**	N/A	0	0	**0**	N/A	0	0	**0**
Boort system wetlands	Lake Boort	1,000	0	**1,000**	Lake Boort	1,500	0	**1,500**	Lake Boort	1,500	0	**1,500**	N/A	0	0	**0**
Kerang system wetlands	Round Lake Lake Elizabeth Johnson's Swamp Hirds Swamp Richardson's Lagoon*	2,300	1,600	**3,900**	Round Lake Lake Elizabeth Johnson's Swamp Hirds Swamp Richarson's Lagoon*	2,300	1,600	**3,900**	Round Lake Lake Elizabeth Johnson's Swamp Hirds Swamp Richarson's Lagoon*	2,100	1,400	**3,500**	Round Lake Lake Elizabeth Johnson's Swamp Hirds Swamp Richarson's Lagoon*	1,200	800	**2000**
Mallee River Murray wetlands	Narrung wetlands Merbein Common Liparoo Neds Corner Cardross Lakes Lake Koorlong	800	2,170	**2,970**	Heywoods Lake **Narrung** Wetlands Lakes Powell and Carpul Merbein Common Sandilong Creek Liparoo Cardross Lakes Lake Koorlong	7,800	2,720	**10,520**	Heywoods Lake **Narrung** Wetlands Lakes Powell and Carpul Merbein Common Sandilong Creek Liparoo Cardross Lakes Lake Koorlong	7,750	3,170	**10,920**	Heywoods Lake Lake Hawthorn Cardross Lakes Lake Koorlong	2,450	5,450	**7,900**
Total		4,100	3,770	**7,870**		11,600	4,320	**15,920**		11,350	4,570	**15,920**		3,650	6,250	**9,900**

Table 15: Summary of Victorian Living Murray Icon sites environmental water requirements under a range of climatic scenarios

	Volume required under different scenarios and area/length watered															
	Very Low Inflow				**Low Inflow**				**Median Inflow**				**High Inflow**			
System operations	Limited rainfall, high evaporation				Limited rainfall, high evaporation				Some spills from storages				Widespread flooding and rainfall, limited use of regulated water required			
Wetland	**Sites**	**Spring**	**Autumn**	**Total** (ML)	**Sites**	**Spring**	**Autumn**	**Total (ML)**	**Sites**	**Spring**	**Autumn**	**Total (ML)**	**Sites**	**Spring**	**Autumn**	**Total (ML)**
Barmah Forest	Top Island Boals Deadwoods Gooses Swamp Gulf Creek Smiths Creek Unregulated creeks which receive water (under 15,000ML/day	273,000	0	**273,000**	Top Island Boals Deadwoods Gooses Swamp Gulf Creek Smiths Creek Unregulated creeks which receive water (under 15,000ML/day	273-450	0	**273,000 - 450,000**	Top Island Boals Deadwoods Gooses Swamp Gulf Creek Smiths Creek Unregulated creeks which receive water (under 15,000ML/day	273,000 - 450,000	0	**273,000 - 450,000**	Top up natural inflow in whole of Barmah Forest	600	0	**600,000**
Gunbower System	Black Charlie Lagoon Little Gunbower Creek Complex Little Reedy Complex Reedy Lagoon Gunbower Creek	58,300	0	**58,300**	Black Charlie Lagoon Little Gunbower Creek Complex Little Reedy Complex Reedy Lagoon Gunbower Creek	72,000	0	**72,000**	Black Charlie Lagoon Little Gunbower Creek Complex Little Reedy Complex Reedy Lagoon Gunbower Creek	91,800	0	**91,800**	Top up natural inflows in whole of Gunbower Forest	97,000	0	**97,000**
Hattah System	N/A	0	0	**0**	N/A	0	0	**0**	N/A	0	0	**0**	Lake Kramen	3,000	0	**3,000**
Lindsay Island System	Lindsay Island	0	1,500	**1,500**	Lindsay Island Lake Wallawalla	2,000	1,500	**3,500**	Lindsay Island Lake Wallawalla	8,000	700	**8,700**	N/A	0	0	**0**
Mulcra System	Mulcra Island (TLM works)	0	1,000	**1,000**	Mulcra Island (TLM works)	0	1,000	**1,000**	Mulcra Island (TLM works)	0	2,000	**2,000**	N/A	0	0	**0**
Wallpolla Island System	Wallpolla Island	0	2,000	**2,000**	Wallpolla Island	0	1,500	**1,500**	Wallpolla Island	0	700	**700**	N/A	0	0	**0**
Total		331,300	4,500	**335,800**		347,000 – 524,000	4,000	**351,000 – 528,000**		372.8 – 549.8	3,400	**376,200 – 553,200**		101,300	0	**700,000**

5. Environmental Water Delivery

5.1. Risk assessment and management

Delivery Plans will be developed for all wetland sites allocated environmental water. A broad risk assessment has been undertaken for each system to identify any major risks (appendix 5). A more detailed risk assessment will be undertaken by the relevant CMA in the development of the Delivery Plan (see appendix 1) taking into consideration the broad risk assessment. These plans are signed-off by the Victorian Environmental Water Holder before delivery commences.

5.2. Costs

Costs for delivery of environmental water differ across northern Victoria depending upon the delivery mechanisms, delivery system and infrastructure required.
Where irrigation infrastructure is utilised to facilitate delivery of environmental water, costs apply. Some sites, predominantly in the Mallee CMA, require water to be pumped into a wetland or wetland complex. Where this occurs, pumping costs are incurred. An estimate of costs for delivery for each system is provided in appendix 6.

6. Monitoring and Reporting

6.1 Monitoring

The requirement for monitoring will be reviewed on a case by case basis as identified in the CMA's delivery plan. Monitoring will be based around the requirement to show that the water delivered has met the ecological objective for watering. Where possible, this monitoring will be complemented by long-term ecological monitoring of priority sites

6.2. Reporting

Information on environmental watering events is reported throughout the watering event. Weekly estimates on volumes delivered will be provided to the VEWH, in addition to various progress reports and submission of final watering reports.

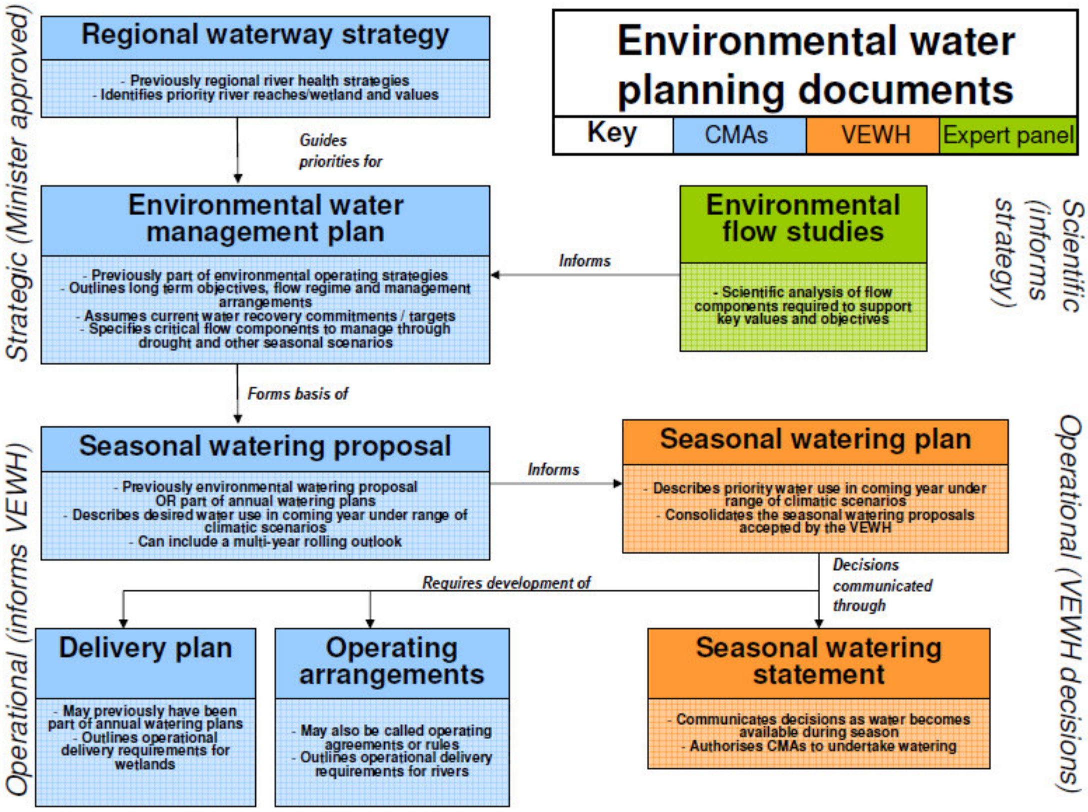
These delivery details and environmental outcomes and observations are to be used to inform the annual Environmental Watering in Victoria publication and to reconsolidate water volumes delivered against the Victorian Water Register.

7. Communications

A range of communication arrangements are in put in place to inform stakeholders during the planning and delivery of environmental water.

These arrangements are managed by the relevant CMA undertaking the watering event and are documented in the Delivery Plans.

APPENDIX 1. ENVIRONMENTAL WATER PLANNING FRAMEWORK



APPENDIX 2. CURRENT WATER PLANNING DOCUMENTATION

Environmental water management is a developing field. There is a large body of work which provides guidance in developing water requirements for each site. The table below provides the type of information which is being used to make water planning decisions.

System	Asset	Planning Information
Goulburn Broken Wetlands	Black Swamp	Draft Black Swamp Environmental Water Management Plan, Monitoring the Ecological Response of Wetlands in the Goulburn Broken Catchment to Flooding, Scientific Technical Committee, Black Swamp Flood Regime Determination, IWC assessment
	Doctors Swamp	Draft Doctors Swamp Environmental Water Management Plan, Monitoring the Ecological Response of Wetlands in the Goulburn Broken Catchment to Flooding, Scientific Technical Committee, IWC assessment, Doctors Swamp Environmental Management Statement
	Kinnairds Swamp	Draft Kinnairds Swamp Environmental Water Management Plan, Monitoring the Ecological Response of Wetlands in the Goulburn Broken Catchment to Flooding, Scientific Technical Committee, IWC assessment, Kinnairds Swamp Environmental Management Plan
	Mansfield Swamp	Monitoring the Ecological Response of Wetlands in the Goulburn Broken Catchment to Flooding, Scientific Technical Committee, IWC assessment, Mansfield Swamp Environmental Management Plan
	Moodies Swamp	Monitoring the Ecological Response of Wetlands in the Goulburn Broken Catchment to Flooding, Scientific Technical Committee, IWC assessment, Moodies Swamp Flood Regime Determination Study, Moodies Swamp Water Management Recommendations, Moodies Swamp Wildlife Reserve: Proposed Management Plan.
	One Tree Swamp	Draft One Tree and Two Tree Swamp Environmental Water Management Plan, Monitoring the Ecological Response of Wetlands in the Goulburn Broken Catchment to Flooding, Scientific Technical Committee, IWC assessment, Wanalta Creek Wetlands: Identification of water regime requirements for One Tree, Two Tree and Wallenjoe Swamps.
	Reedy Swamp	Draft Reedy Swamp Environmental Water Management Plan, Monitoring the Ecological Response of Wetlands in the Goulburn Broken Catchment to Flooding, Scientific Technical Committee, IWC assessment, Reedy Swamp Environmental Management Plan, Reedy Swamp Environmental Watering Plan.
	Two Tree Swamp	Draft One Tree and Two Tree Swamp Environmental Water Management Plan, Monitoring the Ecological Response of Wetlands in the Goulburn Broken Catchment to Flooding, Scientific Technical Committee, IWC assessment, Wanalta Creek Wetlands: Identification of water regime requirements for One Tree, Two Tree and Wallenjoe Swamps.
	Wallenjoe Swamp	Monitoring the Ecological Response of Wetlands in the Goulburn Broken Catchment to Flooding, Scientific Technical Committee, Wanalta Creek Wetlands: Identification of water regime requirements for One Tree, Two Tree and Wallenjoe Swamps.
Barmah Forest	Barmah Floodplain	Living Murray Barmah-Millewa Forest Draft Environmental Water Management Plan
	Smiths Creek	
	Gulf Creek	
	Boals Deadwood	
	Gooses Swamp	
Boort Wetlands	Lake Boort	Draft Environmental Water Management Plan

Kerang Lakes	Lake Leaghur	NVIRP EWP
	Lake Lyndger	Derived from previous investigations and literature
	Lake Meran	NVIRP EWP
	Lake Yando	NVIRP EWP
	Little Lake Boort	NVIRP EWP
	Little Lake Meran	Derived from previous investigations and literature
	Round Lake	NVIRP EWP
	McDonald Swamp	NVIRP EWP
	Hirds Swamp	Draft Environmental Water Management Plan
	Lake Cullen	Draft Environmental Water Management Plan
	Lake Elizabeth	NVIRP EWP
	Johnson's Swamp	NVIRP EWP
	Lake Murphy	NVIRP EWP
	Richardson's Lagoon	Draft Environmental Water Management Plan
Mallee River Murray wetlands	Belsar/Yungera Islands	Draft Belsar and Yungera Environmental Water Management Plan
	Bonyarcial	Draft Belsar and Yungera Environmental Water Management Plan
	Bullocks Swamp	Derived from previous investigations, literature and Environmental Water Management Plans
	Burra Creek	Derived from previous investigations, literature and Environmental Water Management Plans
	Butlers Creek	Draft Kings Billabong Environmental Water Management Plan
	Buxtons Bend	Derived from previous investigations, literature and Environmental Water Management Plans
	Cardross Lakes	Derived from previous investigations, literature and Murray Hardyhead Action Plan
	Carina Bend	Derived from previous investigations, literature and Environmental Water Management Plans
	Carwarp Creek	Derived from previous investigations, literature and Environmental Water Management Plans
	Forest Bend	Derived from previous investigations, literature and Environmental Water Management Plans
	Graces Bend	Derived from previous investigations, literature and Environmental Water Management Plans
	Heywoods Lake	Derived from previous investigations, literature and draft Heywoods Lake Environmental Water Management Plan
	Lake Hawthorn	Derived from previous investigations, literature and Environmental Water Management Plans
	Lake Koorlong	Derived from previous investigations, literature and murray Hardyhead Action Plan
	Lakes Powell and Carpul	Derived from previous investigations, literature and draft Belsar and Yungera Environmental Water Management Plan
	Lalbert Creek	Derived from previous investigations, literature and Environmental Water Management Plans
	Liparoo	Derived from previous investigations, literature and Environmental Water Management Plans
	Margooya Lagoon	Derived from previous investigations, literature and draft Margooya Lagoon Environmental Water Management Plan
	Merbein Common	Derived from previous investigations, literature and Merbein Common Environmental Water Management Plan – to be developed in 2011/12
	Murrumbidgee junction	Derived from previous investigations, literature and Murrumbidgee Junction Environmental Water Management Plan – to be developed in 2011/12

	Narcooyia Creek	Derived from previous investigations, literature and draft Belsar and Yungera Environmental Water Management Plan
	Neds Corner	Derived from previous investigations, literature and Environmental Water Management Plans
	Neds Corner West	Derived from previous investigations, literature and Environmental Water Management Plans
	Nyah	Derived from previous investigations, literature and draft Nyah Vinifera Park Environmental Water Management Plan
	Pile Bend	Derived from previous investigations, literature and Environmental Water Management Plans
	Sandilong Creek	Derived from previous investigations, literature and Environmental Water Management Plans
	Spences Bend	Spences Bend Environmental Water Management Plan – to be developed in 2011/12
	Tyrell Creek	Derived from previous investigations, literature and Environmental Water Management Plans
	Viniferia	Draft Nyah Vinifera Park Environmental Water Management Plan
	Yarriambiack Creek	Derived from previous investigations, literature and Environmental Water Management Plans
	Yungera J1	Derived from previous investigations, literature and draft Belsar and Yungera Environmental Water Management Plan
Gunbower Forest	Black Charlie Lagoon	Derived from previous investigations, literature and Living Murray Gunbower Forest Draft Environmental Water Management Plan
	Little Gunbower Creek Complex	
	Little Reedy Complex	
	Reedy Lagoon	
	Black Swamp	
	Gunbower Forest Wetlands and Creeks - Floodplain	
	Gunbower Creek	
Hattah Lakes	Chalka Creek South	Derived from previous investigations, literature and Living Murray Hattah Lakes Draft Environmental Water Management Plan
	Chalka Creek North	
	Lake Lockie	
	Lake Roonki	
	Little Lake Hattah	
	Little Lake Roonki	
	Lake Hattah	
	Lake Yelwell	
	Lake Bulla	
	Lake Arawak	
	Lake Brockie	
	Lake Nip Nip	
	Lake Maramorck	
	Lake Yerang	
	Lake Mourpall	
	Lake Kramen	
	Lake Konardin	
Lindsay, Mulcra	Lindsay Island	Derived from previous investigations, literature and Living Murray

and Wallpolla Islands	Lake Wallawalla	Lindsay Island Draft Environmental Water Management Plan
	Lindsay Island - Mullaroo Creek	
	Mulcra Island	Derived from previous investigations, literature and Living Murray Mulcra Island Draft Environmental Water Management Plan Mulcra Island draft operating plan
	Wallpolla Island	Derived from previous investigations, literature and Living Murray Wallpolla Island Draft Environmental Water Management Plan

APPENDIX 3. ASSET STATUS AND RATIONAL FOR WATER REQUIREMENT IN 2011/2012

The current status of the system and the rational for water requirements in 2011/12 (information correct as of 31 May 2011)is listed in the table below. As wetlands require wetting and drying regimes it is just as important to enable a drying regime as well as applying water.

System	Asset	Status
Goulburn Broken Wetlands	Black Swamp	Currently full. Due to its extended inundation (the wetland is likely to exceed its maximum flood duration) it will be allowed to naturally drawdown this summer and autumn. No water required.
	Doctors Swamp	Currently full. Due to its extended inundation (the wetland is likely to exceed its maximum flood duration) it will be allowed to naturally drawdown this summer and autumn. No water required.
	Kinnairds Swamp	Currently full. Due to its extended inundation (the wetland is likely to exceed its maximum flood duration) it will be allowed to naturally drawdown this summer and autumn. No water required.
	Mansfiled Swamp	Currently full. Due to its extended inundation (the wetland is likely to exceed its maximum flood duration) it will be allowed to naturally drawdown this summer and autumn. No water required.
	Moodies Swamp	Currently full. Due to its extended inundation (the wetland is likely to exceed its maximum flood duration) it will be allowed to naturally drawdown this summer and autumn. No water required.
	One Tree Swamp	Partly full. Due to its extended inundation (the wetland is likely to exceed its maximum flood duration) it will be allowed to naturally drawdown this summer and autumn. No water required.
	Reedy Swamp	Currently full. Due to its extended inundation (the wetland has exceed its maximum flood duration – it has held water for 81 months out of the last 119) it will be allowed to naturally drawdown this summer and autumn. No water required.
	Two Tree Swamp	Partly full. Due to its extended inundation (the wetland is likely to exceed its maximum flood duration) it will be allowed to naturally drawdown this summer and autumn. No water required.
	Wallenjoe Swamp	Currently full. Due to its extended inundation (the wetland is likely to exceed its maximum flood duration) it will be allowed to naturally drawdown this summer and autumn. No water required.
Barmah Forest	Barmah Floodplain	Currently undergoing drawdown following extended natural flood. Requires re-flooding in spring.
	Smiths Creek	Currently full – Maintain flow in winter & spring.
	Gulf Creek	Currently full – Maintain flow in winter & spring.
	Boals Deadwood	Currently undergoing drawdown following extended natural flood. Requires re-flooding in spring/summer.
	Gooses Swamp	Currently undergoing drawdown following extended natural flood. Requires re-flooding in spring.
Boort Wetlands	Lake Boort	

Draft environmental flow recommendations suggest filling one year in four, with a shallower inundation level every second and third filling event to promote River Red Gum recruitment through the bed of the wetland. However, given it has been a number of years since water was held in Lake Boort and the inundation occurred over summer primarily, there may be merit in providing an spring 2012 top up to ensure water remains in the wetland base during 2012, giving the aquatic vegetation a

		chance to go though life-cycle and establish seed source for next inundation event
	Lake Leaghur	Environmental water regime suggests filling wetland one year in three, allowing natural drawdown over subsequent 18 months. Therefore, recommend that no environmental water be provided during 2011-12 or 2012-13.
	Lake Lyndger	Lake Lyndger received significant inundation during the 2010-12 flooding. Water reached the drought-stressed Black Box communities, providing them with water (the Black Box community should have approximately 1 in 7 to 10 year inundation). Lake Lyndger has a drier natural flooding regime than Lake Boort and should be allowed to draw down naturally now.
	Lake Meran	Environmental water regime suggests maintaining Lake Meran as a permanent wetland, allowing it to completely dry 1 year in 10. Environmental water target is 79.5m AHD and recommendation is to fluctuate water levels around this target. One year in five (on average, water should reach 82m AHD to inundate surrounding vegetation. This was achieved with the January 2011 floods. It is not expected that Lake Meran will draw down to 79.5m AHD due to evaporation until spring 2013, therefore water environmental water will not likely be sourced until 2013-14 season
	Lake Yando	Environmental water regime suggests filling wetland one year in three, allowing natural drawdown over subsequent five months. Therefore, recommend that no environmental water be provided during 2011-12 or 2012-13.
	Little Lake Boort	Environmental water recommendation is to maintain inundation for four to six years, with a dry period of at least 12 months prior to re-wetting. Lake Boort is currently full and being used as a recreational lake for water skiing and managed by the Committee of Management. Therefore, no environmental water is recommended for the foreseeable future.
	Little Lake Meran	Wetland filled during 2010-11 floods. Water will not be required for approximately three years
Kerang Lakes	Round Lake	Maintain water to support Murray Hardyhead population
	McDonald Swamp	Environmental flow recommendations suggest a 1 in 1 year inundation regime for wetland, with dry period from late-summer/autumn through to spring when water is delivered again. However, due to floods, wetland is currently holding water and will not dry completely before spring 2011. Therefore, no environmental water is recommended until spring 2012.
	Hirds Swamp	Wetland is current at FSL (79.1m AHD) with water in both the eastern and western sections. Wetland should be maintained with water over spring and summer 2011-12 to inhibit growth of Phragmites and Typha and allow aquatic macrophytes to grow in open water habitat (promoting continued waterbird use).
	Lake Cullen	Due to the use of Lake Cullen as flood mitigation during the January 2011 event, the wetland is currently holding water at approx 73 m AHD. This should be allowed to drawdown over summer 2011-12, with the potential to provide a top up to approx 72m AHD in spring 2012 if required (Ruppia is re-establishing, provision of water will be based on requirement to support vegetation and/or waterbirds).
	Lake Elizabeth	Environmental water recommendation suggests filling to 1.5m deep 1 year in 3, and maintaining water for 18 months. Therefore, an autumn 2012 top up is proposed
	Johnson's Swamp	Environmental water recommendations suggest filling wetland to inundate Black Box and Lignum communities for not more than 2 - 3 months, then maintain water to 30cm depth for up to 18 months (at approx 77.7m AHD). Additional water may be required in spring 2011, depending on climatic conditions during winter.
	Lake Murphy	Environmental water recommendation suggests filling to 1 m depth 2 in 5 years with an inundation duration of 6 months. It is expected that some water will remain in wetland over summer 2011-12, therefore not water is required this season. An additional fill may be required in 2012-13.

	Richardson's Lagoon	Draft environmental water recommendations (in preparation) suggest providing fill in year one, allowing to draw down over summer, and top up in year two. Therefore, a top up in spring 2011 may be required, however this should only maintain water in the wetland channels, not spread out to Black Box communities again.
Mallee River Murray wetlands	Belsar/Yungera Islands	Extensive inundation in 10/11, system likely to remain wet for most of 11/12
	Bonyarcial	Extensive inundation in 10/11, system likely to remain wet for most of 11/12
	Bullocks Swamp	Inundation not required this year
	Burra Creek	Inundation not required this year.
	Butlers Creek	Inundation not required this year.
	Buxtons Bend	Inundation not required this year.
	Cardross Lakes	Inundation required to Maintain Murray Hardyhead population
	Carina Bend	Inundation not required this year
	Carwarp Creek	Inundation not required this year
	Forest Bend	Inundation not required this year
	Graces Bend	Inundation not required this year
	Heywoods Lake	Heywoods Lake had been dry for approximately 10 years prior to 2011. Delivery in 2011/12 will capitalise upon natural inundation and environmental water delivery in 2010/11 enhancing the ecological outcomes.
	Lake Hawthorn	To be consistent with the Lake Hawthorn operating plan – currently in development
	Lake Koorlong	Inundation required to maintain Murray Hardyhead population
	Lakes Powell and Carpul	Inundation required this year
	Lalbert Creek	An inability to currently deliver environmental water
	Liparoo	The system is in a recovery phase of its water regime and requires watering in 2011/12
	Margooya Lagoon	Inundation not required this year
	Merbein Common	The system is in a recovery phase of its water regime and requires watering in 2011/12
	Murrumbidgee junction	The system is in a recovery phase of its water regime and requires watering in 2011/12. Water management infrastructure will be installed in 2011, increasing the manageable area and ecological benefit.
	Narcooyia Creek	Inundation not required this year

	Neds Corner	The system is in a recovery phase of its water regime and requires watering in 2011/12
	Neds Corner West	Inundation not required this year
	Nyah	Inundation not required this year
	Pile Bend	Inundation not required this year
	Sandilong Creek	The system is in a recovery phase of its water regime and requires watering in 2011/12, Works to improve fish passage within the creek were implemented in 2010/11.
	Spences Bend	Inundation not required this year
	Tyrell Creek	An inability to currently deliver environmental water
	Viniferia	Inundation not required this year
	Yarriambiack Creek	An inability to currently deliver environmental water
	Yungera J1	The system is in a recovery phase of its water regime and requires watering in 2011/12
Gunbower Forest	Black Charlie Lagoon	Water regime requirement not met - needs to fill 9 years in 10.
	Little Gunbower Creek Complex	Water to be delivered to consolidate benefits of naturally occurring flooding in 2010/11 allowing reestablishment of native aquatic species and to encourage further waterbird breeding activity. Proposed regime consistent with flooding requirements.
	Little Reedy Complex	Water to be delivered to consolidate benefits of naturally occurring flooding in 2010/11 allowing reestablishment of native aquatic species and to encourage further waterbird breeding activity. Proposed regime consistent with flooding requirements.
	Reedy Lagoon	Water regime requirement not met - needs to fill 9 years in 10.
	Black Swamp	Water regime requirement not met - needs to fill 9 years in 10.
	Gunbower Forest Wetlands and Creeks - Floodplain	Water regime requirement not met - needs to fill 6-7 years in 10. Can't satisfy until Living Murray works are in place. Water will be required if natural flooding in the forest to prolong the floodplain inundation.
	Gunbower Creek	Recovery of threatened species - Murray cod, Freshwater catfish, Silver perch, Golden perch, Murray-darling rainbowfish, Trout cod.
Hattah Lakes	Chalka Creek South	Commencing drying phase for TLM construction
	Chalka Creek North	
	Lake Lockie	
	Lake Roonki	
	Little Lake Hattah	

	Little Lake Roonki	
	Lake Hattah	
	Lake Yelwell	
	Lake Bulla	
	Lake Arawak	
	Lake Brockie	
	Lake Nip Nip	
	Lake Maramorck	
	Lake Yerang	
	Lake Mourpall	
	Lake Kramen	Lake Kramen had been dry for 10 years prior the watering in 2010/11. Delivery in 2011/12 will build upon the benefits achieved in 2010/11, enhancing ecological outcomes
	Lake Konardin	Commencing drying phase for TLM construction
Lindsay, Mulcra and Wallpolla Islands	Lindsay Island	Lindsay Islands water regime has been too dry. Delivery in 2011/12 will capitalise upon inundation in 2010/11 enhancing the ecological outcomes.
	Lake Wallawalla	Lake Wallawalla has been dry for 10 years prior to watering in 2010/11. The wetland is in a recovery phase and watering in 2011/12 will assist in restoring ecological condition.
	Lindsay Island - Mullaroo Creek	This is a severe drought option; there is sufficient water in storage that environmental water is not required for the Mullaroo Creek.
	Mulcra Island	In 2011/12 environmental watering will focus on instream flow
	Wallpolla Island	Wallpolla Island was largely inundated in 2010/11. Watering in 2011/12 will focus on maximising the ecosystem outcomes.

APPENDIX 5. BROADSCALE RISK ASSESSMENT

This broad scale risk assessment identify risks that may apply to the system. The major risk under the three broad categories are identified in the consequence of the risk occurring. It does not imply that all assets in this system have the same risk. This is to be used to flag where further detail risk assessments need to place before water is assigned to an asset. This risk assessment does not look at the ecological consequence of applying or not applying water. These will be addressed in the detailed risk assessment before water is assigned to the asset.

System	Risk categories	Major risk to system	Threat	Likelihood	Consequence	Preventative Actions
Goulburn Broken Wetlands	Operational	N/A	Low	Low	No planned environmental water delivery to the wetlands	N/A
	3rd party	N/A	Low	Low	No planned environmental water delivery to the wetlands	N/A
	Communication	Community questions why water is not being provide to wetlands	Low	Low	Community perceives that they are not getting enough environmental water in the system	Communicating the need for wetlands to have wetting and drying cycles
Barmah Forest	Operational	Potential re-development of blackwater in Murray River if forest flooding occurs after mid-November. Change in RMW operational water budgets and releases given large percentage of return flows from the wetland forest to the Murray River.	High High	High High	Blackwater leading to depleted dissolved oxygen levels and hence risk extensive fish and crustacean deaths. Downstream water level communication and potential impacts on users.	Ensure most widespread forest flooding occurs in cooler months of winter-spring, and target flows to specific wetlands in warmer months only to complete waterbird breeding activities if required. Involve RMW staff in release planning.
	3rd party	Environmental Water floods private land downstream between Hume Reservoir and Yarrawonga, and Bullatale Creek in NSW.	High	Medium	Exposure to claims for compensation from affected landholders/businesses.	Work with MDBA to ensure that environmental water releases to not have a material impact on flood flows.
	Communication	Misunderstanding of environmental water being released when natural flood peaks occur.	High	High	Reduced public support for environmental watering program.	Provide media releases and encourage associated opportunities to provide information about the program to

		Concern that Blackwater events are caused by EWA releases. Concern of reserve closure to public because of flooding.				the public.
Boort Wetlands	Operational	Lack of channel capacity to deliver water.	Medium	Medium	Inability to deliver water at required rate and volume	Work with G-MW to schedule environmental water delivery with other required deliveries
	3rd party	Flooding private land	High	Medium	Exacerbation of flooding risk to land downstream (including Lake Lyndger)	Planned environmental water management will not increase the held water in Lake Boort substantially, therefore flooding risk (beyond current) is considered low. Do no over-fill wetland beyond target level (which will ensure there is still some air-space in the wetland).
	Communication	Perceived risk of flooding	High	Medium	Reduced public support for environmental watering program	Provide media releases and encourage associate opportunities to provide information about the program to the public.
Kerang Lakes	Operational	Lack of channel capacity to deliver water.	Medium	Medium	Inability to deliver water at required rate and volume	Work with G-MW to schedule environmental water delivery with other required deliveries
	3rd party	Exacerbation of flooding risk to land downstream	Medium	Medium	Planned environmental water management will not increase the held water in most wetlands substantially, therefore flooding risk (beyond current) is considered low.	Some wetlands (e.g. Richardson's Lagoon) did not receive flood inundation in 2011, therefore the risk of these wetlands to flood outside of their boundaries is considered low Do no over-fill wetland beyond target level.

						Undertake detailed risk assessment prior to delivering environmental water.
	Communication	Perceived risk of flooding	High	Medium	Reduced public support for environmental watering program	Provide media releases and encourage associated opportunities to provide information about the program to the public.
Mallee River Murray wetlands	Operational	Water containment structures fail	Low	Medium	Return flow to Murray River	Inspect structures prior to inundation and monitor throughout.
	3rd party	Restricted access	Low	High	Temporary interruption of access to social activity sites	Community consultation and media to inform community.
	Communication	Perceived inappropriate water regime	Low	Medium	Misinformed community	Community consultation and media to inform community.
Gunbower Forest	Operational	Potential re-development of blackwater in Murray River if forest flooding occurs after mid-November. Capacity in Gunbower Creek	Low	Low	Blackwater leading to depleted dissolved oxygen levels and hence risk extensive fish and crustacean deaths. Inability to provided lows	Ensure most widespread forest flooding occurs in cooler months of winter-spring, and target flows to specific wetlands in warmer months only to complete waterbird breeding activities if required. Consult with GMW
	3rd party	Interruption of firewood collection by community Timber Harvesting	Low Moderate	Moderate Moderate	Reduced access to forest for wood collection	Work with DSE public lands to notify of any roads which may be closed
	Communication	Misunderstanding of environmental water being released when natural flood peaks occur. Concern that Blackwater events are caused by EWA releases. Concern of reserve closure to public because of flooding.	High	High	Reduced public support for environmental watering program.	Provide media releases and encourage associated opportunities to provide information about the program to the public.

Hattah Lakes	Operational	Inundation of dry work sites	Low	Low	Delay to construction of water management works	Monitor River Murray flows and install regulator to prevent inflows into Hattah.
	3rd party	N/A	N/A	N/A	N/A	N/A
	Communication	Perceived inappropriate water regime	Low	Medium	Misinformed community	Community consultation and media to inform community.
Lindsay, Mulcra and Wallpolla Islands	Operational	Unable to delivery water to site	Medium	Medium	Damage to water management structures	Work closely with MDBA and SA Water for operation
	3rd party	Water quality of return flows	Low	Low	There maybe a small return volume from Mulcra	Release of water will coordinate with dilution flow if required
	Communication	Perceived inappropriate water use	Low	Low	Community perceives reduction in irrigation entitlements	Community consultation and media to inform community.

APPENDIX 6. ESTIMATION OF COSTS IN EACH SYSTEM

The cost of delivery varies depending on the mechanism of delivery and the volumes being delivered.

The charges below only apply to managed environmental releases where a environmental manager has specifically called out water to be delivered to an asset. In large flow events when the water corporation are trying to mitigating the impact of flooding, environmental managers are asked for advice on which asset it is preferable to divert the floodwater into. There is not charge to the environment for the diversion of flood flows.

The current channel delivery charges are based on the current costing agreement between the Department of Sustainability and Environment and Goulburn-Murray Water. Further discussion are being undertaken to clarify the cost of environmental water delivery in irrigation systems based on the outcomes of the Northern Regional Sustainable Water Strategy (NRSWS).

The NRSWS recognises the public good benefits of environmental watering and the environmental obligations on the system operator. As such the environmental manager will be provided with `interruptible' access and will only pay the out-of-pocket costs, expect in natural waterway in distribution systems, where there will be no charge. There are opportunities for other arrangements including buying delivery shares or accessing causal use.

<table>
<tr><th>System</th><th>Type of Delivery</th><th>Cost</th></tr>
<tr><td>Goulburn Broken Wetlands</td><td>Channel Delivery</td><td>$5.48 - $8.92/ML</td></tr>
<tr><td rowspan="2">Barmah Forest</td><td>Over-bank Flow</td><td>No charge</td></tr>
<tr><td>Through River Murray regulators</td><td>Contractor costs to calculate water passing through regulators</td></tr>
<tr><td>Boort Wetlands</td><td>Channel Delivery</td><td>$6.64/ML</td></tr>
<tr><td rowspan="2">Kerang Lakes</td><td>Channel Delivery</td><td>$7.11/ML</td></tr>
<tr><td>Pumping - Richardson's Lagoon is required to be pumped</td><td>Payment of electricity bill. $/ML not known</td></tr>
<tr><td>Mallee River Murray wetlands</td><td>Pumping using temporary pumps</td><td>$35 - $70 Depending on volume delivered and type of pump used.</td></tr>
<tr><td>Gunbower Forest</td><td>Channel Delivery</td><td>$7.11/ML</td></tr>
<tr><td>Hattah Lakes</td><td>Pumping</td><td>$45/ML</td></tr>
<tr><td rowspan="2">Lindsay, Mulcra and Wallpolla Islands</td><td>Pumping</td><td>$50/ML</td></tr>
<tr><td>Living Murray Works</td><td>No charge</td></tr>
</table>

VICTORIAN ENVIRONMENTAL WATER HOLDER

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

Seasonal Watering Plan 2011–12

Schedule 10: Broken system

State Government Victoria

Schedule 10: Broken system

This schedule is the seasonal watering proposal prepared by Goulburn Broken Catchment Management Authority. It has been accepted by the VEWH and now forms part of the *Seasonal Watering Plan 2011–12*. As such, it incorporates any changes resulting from feedback from the VEWH.

The seasonal watering plan outlines the environmental watering actions that are a priority in 2011–12. It considers the actions that would occur under a range of planning scenarios. As conditions unfold and water becomes available throughout the year, seasonal watering statements will be released to communicate decisions on environmental watering actions and to authorise Goulburn Broken Catchment Management Authority to implement those decisions.

The VEWH acknowledges and thanks Goulburn Broken Catchment Management Authority for their hard work and dedication in developing the seasonal watering proposal and inputting to the *Seasonal Watering Plan 2011–12*.

Please contact the VEWH or Goulburn Broken Catchment Management Authority for more information.

GOULBURN BROKEN
CATCHMENT MANAGEMENT AUTHORITY

Lower Broken Creek Seasonal Watering Proposal for 2011/12

June 2011

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It should be noted that specific reference to funding levels in this strategy are for indicative purposes only. The level of Government investment in this strategy will depend upon budgets and Government priorities

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Executive summary

This is a proposal to use available environmental entitlements and other water to maximise the environmental outcomes in the lower Broken Creek in 2011/12. The proposal focuses on the the most downstream reach of the lower Broken Creek, the weir pools from Nathalia to the Murray River.

The 2010/11 year was unusual, involving extensive flood flows after several years of an extended drought with low but managed creek flows. The 2010/11 year provided most of the environmental flow needs from catchment runoff. However, the catchment runoff in November through to February resulted is an extensive blackwater event, with very low dissolved oxygen levels and some fish deaths.

The focus in 2011/12 is to continue to provide the desirable flow regimes to maximise the native fish populations in the lower Broken Creek. This includes providing fish passage, providing improved fish habitat between September and December during the migration and breeding seasons, and importantly management of the threats to fish from excessive azolla growth and low dissolved oxygen levels. Following the high flows in 2010/11 year, these threats could be somewhat elevated in 2011/12. In addition, the potential for blackwater events from the upper catchment needed to be considered.

Up to 59,000 ML could be required to provide for the desirable environmental outcomes in the lower Broken Creek. However, 45,000 ML is more likely given the likely limitations in channel delivery capacity. Climatic scenarios do not greatly influence these flow needs.

Importantly, there is significant potential to use water-in-transit in the Murray and Goulburn River systems to provide much of these needs. Murray River water can be potentially diverted through the Broken Creek as well as Goulburn River inter-valley transfers (to the Murray River) and returned to the Murray River. If these sources can be maximised, the need for additional environmental entitlement water is limited to up to 21,000 ML from the Goulburn system. The Goulburn Water Quality Reserve of up to 30,000 ML is also available to deal with emergency water quality issues (such as blackwater events).

If Murray River water and/or Goulburn inter-valley transfers are not available to Broken Creek, the need for available environmental entitlement water increases to 40 GL from Murray entitlements and 39 GL from Goulburn entitlements.

The key risk to providing the desired environmental outcomes in the lower Broken Creek is the likelihood for high irrigation demand in 2011/12, limiting the available channel capacity for delivery of water to the creek for environmental flow management, particularly to minimise the risk from low dissolved oxygen and azolla buildup. To minimise this impact as much as possible, the proposal seeks to have water available from both the Goulburn and Murray Rivers, to allow use of any available channel capacity to be maximised. It is also

proposed to release high creek flows pre-emptively when high irrigation demand is imminent.

This proposal does not take account of competing needs for environmental water use from either other river/creek systems or downstream along the Murray River.

As all of the flows proposed are well within the river channel, there is very low risk of adverse outcomes to private assets or the general public from releasing environmental water.

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Chapter 1 Introduction

This seasonal watering proposal describes the Broken Creek catchment and sources of water available for environmental use, outlines the current condition of the lower Broken Creek and requirements for environmental flows in the lower Broken Creek in 2011/12.

1.1 System overview

The Broken Creek is an effluent stream that flows north west from the Broken River to its confluence with the Boosey Creek. At this point the Broken Creek then follows a generally westerly direction until it meets the Murray River (see **Figure 1**).

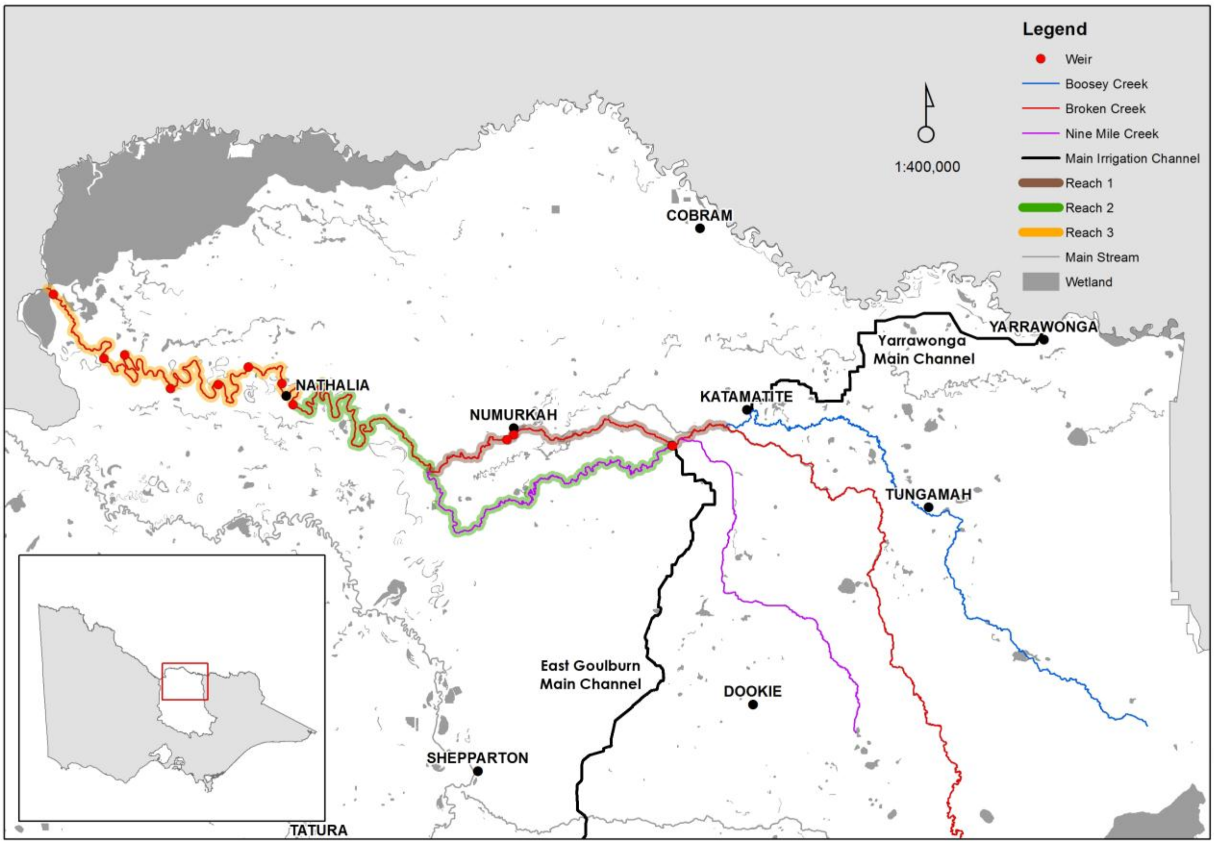

Figure 1: Broken Creek catchment

Prior to regulation, the Broken Creek was an ephemeral stream and would have regularly ceased to flow for months over the summer and autumn period. The Broken River and Broken Creek would have been connected by flood flows approximately one in every five years prior to regulation (Water Technology, 2010). The upper Broken Creek continues to be ephemeral. However the lower Broken Creek is now a highly regulated stream, and has been regulated for 50 years. Flow is maintained in the summer and autumn months by irrigation, and in the winter months flow is dominated by upper catchment run off.

The lower Broken Creek (i.e. from Katamatite downstream) is generally surrounded by two irrigation areas; the Shepparton Irrigation Area and the Murray Valley Irrigation Area.

Environmental flows can only be delivered from this reach downstream. Water is delivered to the Broken Creek via the East Goulburn Main channel (from the Goulburn River), the 7/3 Main channel (from Lake Mulwala on the Murray River), and a few smaller channels.

Landuse in the catchment is dominated by agriculture including dairy, horticulture and mixed cereal and grazing. The floodplain has been close to completely cleared with very narrow remnants along the Creek of box dominated grassy woodland. This vegetation and the remaining floodplain wetlands provide habitat for threatened species such as Murray cod, Crimson-spotted rainbowfish, Brolga, Bush-stone Curlew, Mallee Golden Wattle and Buloke (Water Technology, 2010).

There have been six native fish species surveyed in the lower Broken Creek with the main species being Murray cod (*Macullachella peelii peelii*), Golden perch (*Macquaria ambigua*), Unspecked hardyhead (*Craterocephalus stercusmuscarum fluvus*) and the Crimson spotted rainbowfish (*Melanotaenis fluviatilis*). Some electrofishing surveys along the lower Broken Creek showed that fish diversity and abundance substantially decrease upstream of Nathalia, (i.e. in reaches 1 and 2), with the exception of Katandra Weir pool (located in reach 2) (ARI, 2006).

1.2 Sources of water

There are no environmental entitlements specifically for the Broken Creek. However, water can be sourced from the Goulburn or Murray system and delivered to the creek via the channel systems.

Water-in-transit within the Murray and Goulburn River systems can be diverted via the Broken Creek on their way to the downstream Murray River system. In the Goulburn system, this water is called inter-valley transfers. Environmental entitlements are also held in both the Murray and Goulburn systems.

The sources of water available in the Goulburn and Murray system that may be able to be re-routed to the Broken Creek include:

- Murray River flows,
- Goulburn inter-valley transfers,
- Commonwealth Environmental Water Holder Holdings,
- Victorian Environmental Water Holder Holdings (including Murray Flora and Fauna Bulk Entitlement), and
- Goulburn Water Quality Reserve.

To provide a basis for planning for the 2011/12 year, the availability of water is not assumed to constrain provision of the required flow regimes in the lower Broken Creek.

1.3 Consultation

Table 1 outlines the consultation process the Goulburn Broken Catchment Management Authority (CMA) has undertaken during the development of this seasonal watering proposal.

Table 1 – Consultation during proposal preparation

Who	Role and Responsibility	Purpose of consultation	Mode and timing of consultation
Goulburn-Murray Water	Provision of information on water system outlooks and river management, and check feasibility of proposal	Consult	Personal discussion with key staff, March to July
MDBA	Management of inter-valley transfer and use of Murray River water	Consult	Personal discussion with key staff in June/July
DSE	Advice on policy issues regarding environmental water delivery	Inform/consult	Workshop and discussion with key staff in May-July
CMA Board	Approval of proposal to send to VEWH	Approve	July Board meeting
Yorta Yorta	Advice on indigenous issues	Inform/consult	After plan preparation
CMA Implementation Committees	Advice on community and river health issues	Inform/consult	After plan preparation

Chapter 2 Ecological objectives

2.1 Environmental flow objectives

Environmental flow objectives have been developed for the Broken Creek (Goulburn Broken Catchment Management Authority 2008 and updated in Water Technology 2010) for three specific reaches, as follows:

- Reach 1- Broken Creek downstream of the Boosey Creek confluence to the Nine Mile Creek confluence (approximately 32 km in length)
- Reach 2- The Nine Mile Creek and the Broken Creek downstream of the Nine Mile Creek confluence to the upstream end of the Nathalia weir pool (approximately 87 km in length)
- Reach 3- From the Nathalia weir pool to the Murray River (approximately 65 km in length).

Flow recommendations have been developed for the following four main ecological objectives in the study area:

1. provide native fish passage through all fish ladders, particularly the fish ladder at Rices Weir. The most critical time is winter/spring, but required all year round
2. maintain azolla to levels below those that are detrimental to aquatic ecosystems. Azolla can lead to low dissolved oxygen levels in the water by blanketing the surface of the water and by decomposing azolla consuming oxygen. The critical azolla growth period is July to November. The general management principle is to stop azolla building up by exporting it from the creek (through flows) at the same rate as it builds up (generally 100 – 200 ML/day). To do this, a variable base flow is required through the Broken Creek. However, azolla can also build up behind obstructions in the creek and become dense and matted, and hence require a high flow pulse of water to break up the mat.
3. maintain dissolved oxygen levels above 5mg/L (i.e. at levels that are not life threatening to aquatic ecosystems). Bed sediments in lower Broken Creek are high in organic carbon which removes oxygen from the water, particularly in warmer weather. There are eight weirs in the Broken Creek downstream of Nathalia that can have poor water quality in summer and autumn, with the most downstream (and lowest flow) Rices Weir being the most critical. The critical time for DO management is between December and March (with some demand into April and May).
4. ensure persistence of native fish habitat during migration and breeding seasons particularly for Murray Cod. Critical time is September to December.

Water delivery requires the use of irrigation channels and therefore can only be delivered to the Broken Creek during irrigation season (i.e. mid August – mid May). Although some of the objectives require flow throughout the non-irrigation season, there is no ability to deliver flows and hence management can only be carried out through the irrigation season.

The key reach is the weir pools from Nathalia to the Murray River (this reach tending to pull the required flows through the upper reaches). Flow requirements are set as passing flows at Rices Weir, the most downstream weir. All four objectives are managed by providing a set minimum flow to provide a base level of management. Depending on growth rates of azolla in spring and water temperature in summer, this minimum flow often needs to be increased during the year to maintain the azolla and dissolved oxygen objectives. A rapid increase in flow rate can be required in response to swiftly changing conditions or to break up a localised azolla buildup.

2.1.1 Low dissolved oxygen and azolla blooms

Water quality in the Broken Creek is generally considered degraded (Sinclair Knight Merz 1996). Monitoring at Rices Weir shows high turbidity, suspended solids and nutrient concentrations, low dissolved oxygen levels. The monitoring data at Rices Weir generally do not meet the water quality objectives of the State Environment Protection Policy (SEPP) – Waters of Victoria (WoV) (GHD 2005).

The low dissolved oxygen is primarily caused by large azolla populations in the Creek. Azolla growth is enhanced by high nutrient levels, slow flowing water and reasonable temperatures. These low DO levels can also promote the release of nutrients from bottom sediments which encourages further azolla growth. Management of azolla is crucial between July and November.

Dissolved oxygen is also a problem in its own right, with bed sediments generating high oxygen demand in warmer weather.

2.1.2 Fish passage and habitat

Key native fish species that have been recorded in the lower Broken Creek include the Murray cod (*Macullachella peelii peelii*), Golden perch (*Macquaria ambigua*), Crimson spotted rainbowfish (*Melanotaenis fluviatilis*) and the Unspecked hardyhead (*Craterocephalus stercusmuscarum fluvus*). Habitat requirements and migration patterns for these species are listed in Table 2.

Table 2: Key native fish species in the lower Broken Creek (adapted from Water Technology, 2010)

Species	Preferred habitat	Spawning migration patterns
Murray Cod	Deep pools with cover undercut banks and overhanging vegetation, and snags	Murray cod migrate upstream in late winter/early spring for spawning. Migration is triggered by rising water temperatures; i.e. exceeding 15°C, increased daylight and rising water levels. It's believed Murray Cod will breed with or without spring floods. The species spawn in spring and early summer, then move downstream to the same area they

Species	Preferred habitat	Spawning migration patterns
		occupied before the spawning migration. (www.nativefish.asn.au)
Golden perch	Deep, slow flowing pools with cover from snags and overhanging vegetation	Golden perch migrate upstream from spring to summer for spawning. The following are needed for the initiation of migration: • rising water temperatures exceeding 20°C • increased daylight • rising water levels Studies suggests Golden perch are able to spawn during stable, bankfulll irrigation flows. Most movement occurs between October and April (Lintermans 2007)
Crimson spotted rainbowfish	Slow flowing rivers, wetlands and billabongs	Breeding occurs in spring and summer when water temperatures exceeds 20°C. These fish have been recorded moving through fishways (www.nativefish.asn.au)
Unspecked hardyhead	Slow flowing or still habitats with aquatic vegetation	Spawning occurs between October and February, and when water temperatures are above 24°C in spring. They have been recorded moving through fishways (www.nativefish.asn.au)

2.1.3 Flow requirements

The following tables identify the annual daily flows required in each month to maintain or improve the aquatic dependent ecological assets and/or reduce the impact of key threats.

Table 3: Daily flow recommendations; Reach 1 (Boosey Creek confluence to the Nine Mile Creek confluence)

Flow Target	Daily Flow ML/d												Expected Response
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	
Native Fish Habitat									50	50	50	50	Ensure persistence of aquatic habitats during migration and breeding seasons particularly for Murray cod.
Native Fish Passage	40	40	40	40	40	40	40	40	40	40	40	40	Supply sufficient flow to operate the fishways and provide fish access to appropriate habitat all year.
Collective Requirement	40	40	40	40	40	40	40	40	50	50	50	50	

Table 4: Daily flow recommendations; Reach 2 (downstream of Nine Mile Creek confluence to upstream end of Nathalia weir pool)

Flow Target	Daily Flow ML/d												Expected Response
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	
Native Fish Habitat									250	250	250	250	Ensure persistence of aquatic habitats during migration and breeding seasons particularly for Murray cod.
Native Fish Passage	40	40	40	40	40	40	40	40	40	40	40	40	Supply sufficient flow to operate the fishways and provide fish access to appropriate habitat all year.
Collective Requirement	40	40	40	40	40	40	40	40	250	250	250	250	

Table 5: Daily flow recommendations; Reach 3 (Nathalia weir pool to the Murray River)

Flow Target	Daily Flow ML/d												Expected Response
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	
Azolla and Algal Blooms						80	80	80	80	80	80		Reduced Azolla and Algal blooms and dissolved oxygen levels maintained above 5 mg/L
Dissolved Oxygen	100	100	100									100	Dissolved oxygen levels maintained above 5 mg/L
Native Fish Habitat									250	250	250	250	Ensure persistence of aquatic habitats during migration and breeding seasons particularly for Murray cod.
Native Fish Passage	40	40	40	40	40	40	40	40	40	40	40	40	Supply sufficient flow to operate the fishways and provide fish access to appropriate habitat all year.
Collective Requirement	100	100	100	40	40	80	80	80	250	250	250	250	

Notes:

1 Daily flow figures for native fish habitat in all 3 reaches are based on having one door open in the weirs to maintain sufficient depth over the weir and tail water.

2 In addition to the daily flows identified in the above table for azolla management, flushes of 200+ ML/d for 7 days are required during August and September. At least two flushing flows are required during this period and need to be delivered on request.

3 Flow compliance for reach 1 and 2 is at Katandra Weir. Flow compliance for reach 3 is at Rice's Weir.

4 Along the length of the Broken, and Nine Mile Creeks there are eleven weirs which help to regulate flow. All of the weirs have vertical slot fishways to allow fish passage up and downstream and require a minimum flow of approximately 40ML/day for operation.

It should be noted that for the 2011-12 planning flow recommendations are slightly different from those in **Table 5** because the flows required for native fish passage are separate to those required for azolla management i.e. if 80 ML/day is required for azolla and 40 ML/day required for fish passage, then a total of 120 ML/day is required for this period rather than just 80 ML/day. This is to provide adequate flow through weir doors for azolla movement (whereas fish ladder flows do not allow azolla to pass through weirs).

In addition, low dissolved oxygen persisted into May 2011, despite flows of 150 to 300 ML/day. Hence the period of dissolved oxygen management at 150 ML/day has been extended to mid-May.

2.2 Optimal flow components and critical tolerances

In the lower Broken Creek, the recommended flows can only be provided through irrigation channels, and thus only provided during the irrigation season. This limits the ability to deliver fish passage requirements throughout the year as recommended. Further, channel capacity is a major constraint in delivering environmental water in years where there is high irrigation demand and hence restricted capacity in the channel to provide additional (environmental) water.

For the purposes of this proposal the following optimal flow deliveries and timing are listed in **Table 6**.

Table 6: Optimal flow deliveries for the Broken Creek

Ecological objective	Flow requirement	Optimal flow delivery	Contingent flow delivery
Native fish passage	40 ML/day	mid August to May = 10,880 ML	
Azolla management	120 ML/day	Mid August to November = 12,840 ML	For high growth or blockage management, two events of 250 ML/day for 14 days = 7,000 ML total (or 3,640 ML in excess of 120 ML/day)
Low DO management	approx. 150 - 250 ML/day (including fish ladder flow)	December to mid May at 150 ML/day = 24,900 ML	2 months at 250 ML/d = 15,000 ML total (or 6,000 ML in addition to 150 ML/day)
Native fish habitat during migration and breeding seasons	250 ML/day	September to December = 30,500 ML (or 15,570 ML above 120/150 ML/day)	

Maximum flow required is approximately 59,000 ML.

Chapter 3 Flow prioritisation

3.1 2010/11 Season review

Flows in the Broken Creek are measured at a number of sites, with the main gauges for flow planning being Boosey Creek at Tungamah, Broken Creek at Katamatite and Broken Creek at Rices Weir. The first two gauging stations provide information about catchment run off and Rices Weir provides data on the most downstream flow.

Dissolved oxygen and temperature is measured in 15 minute intervals at two sites at Rices Weir; the downstream end of the Broken Creek. These are shown for the 2010/11 year in **Figure 2** and **Figure 3**.

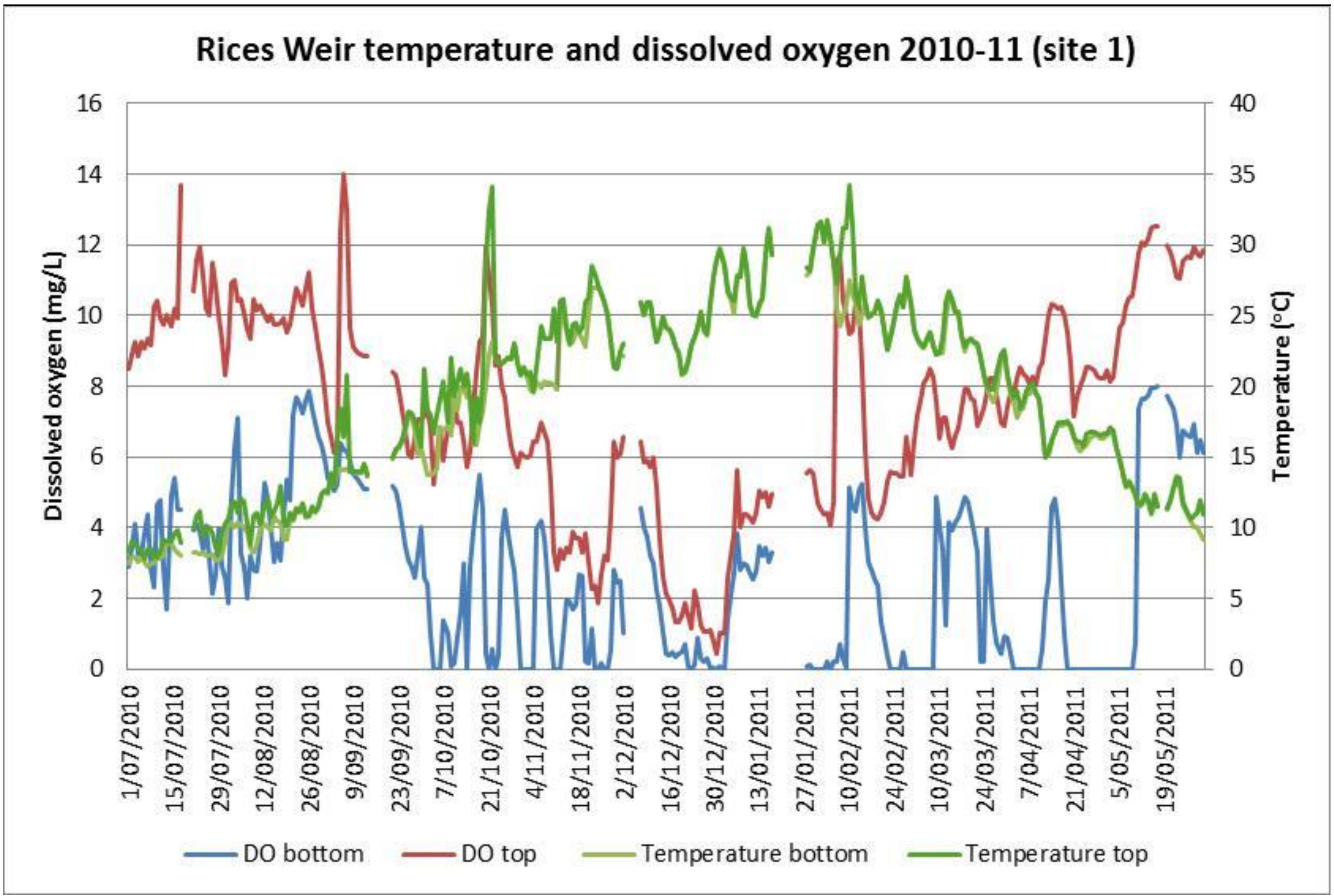

Figure 2: Site one monitoring at Rices Weir.

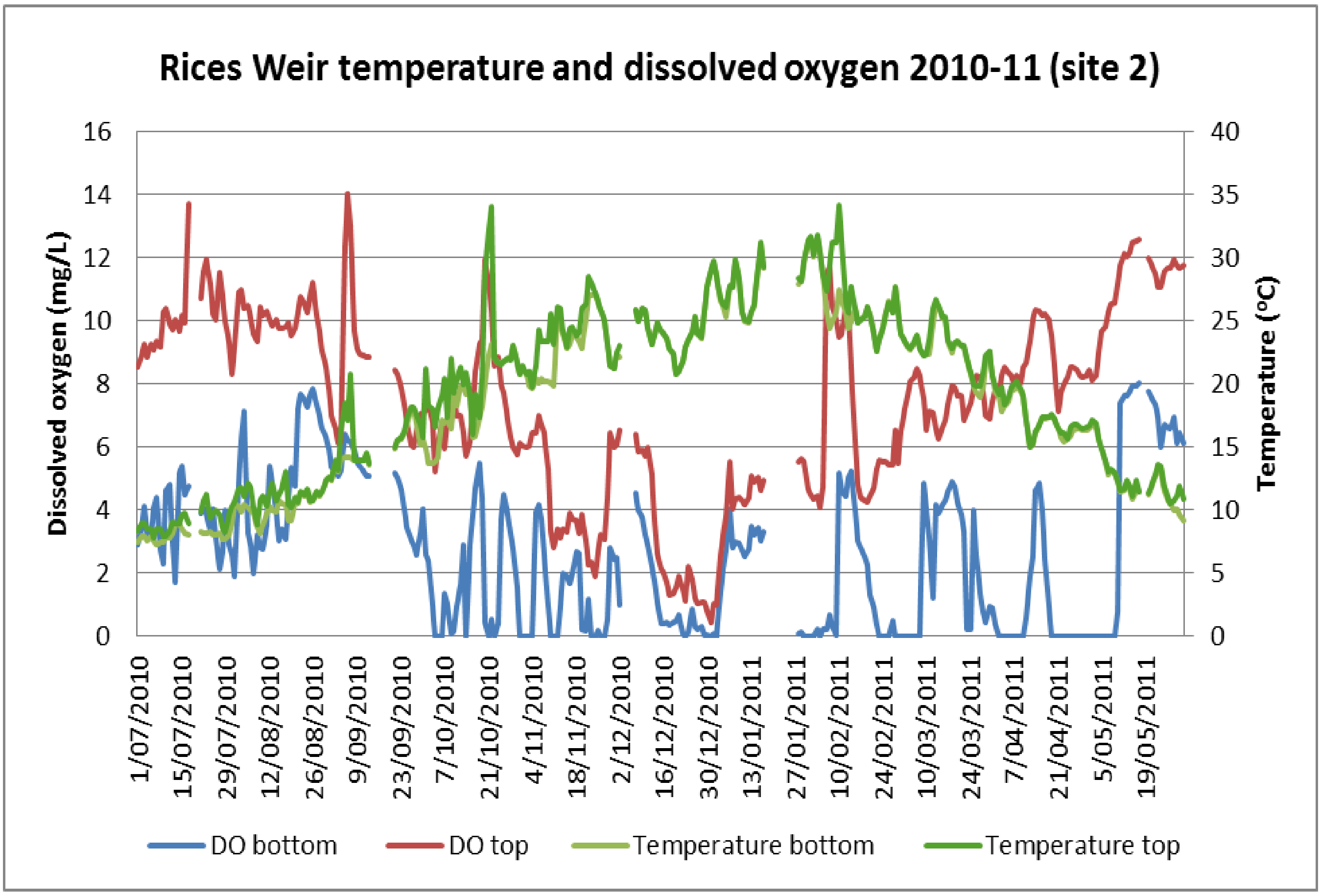

Figure 3: Site two Rices Weir monitoring

Both these graphs show that as temperature rises, the dissolved oxygen levels generally fall. There were many times throughout the 2010/11 summer that dissolved oxygen levels where lower than the recommendation of 5 mg/L. Interestingly low DO levels at the bottom of the water column occurred into mid Autumn.

In December blackwater appeared in the Broken Creek at Katamatite and the Boosey Creek at Tungamah. The blackwater was a result of upstream catchment floodplain inundation during the hot summer months that input high amounts of organic matter to the creek. As the organic matter decomposed, it used oxygen in the water resulting in low dissolved oxygen and fish deaths in the lower Broken Creek. Goulburn Broken CMA staff reported 21 fish killed in Broken Creek, predominately Golden perch and Murray cod. The blackwater event is shown in **Figure 4** where the large increase in daily flow during the December and January floods corresponds to low (i.e. zero) dissolved oxygen levels.

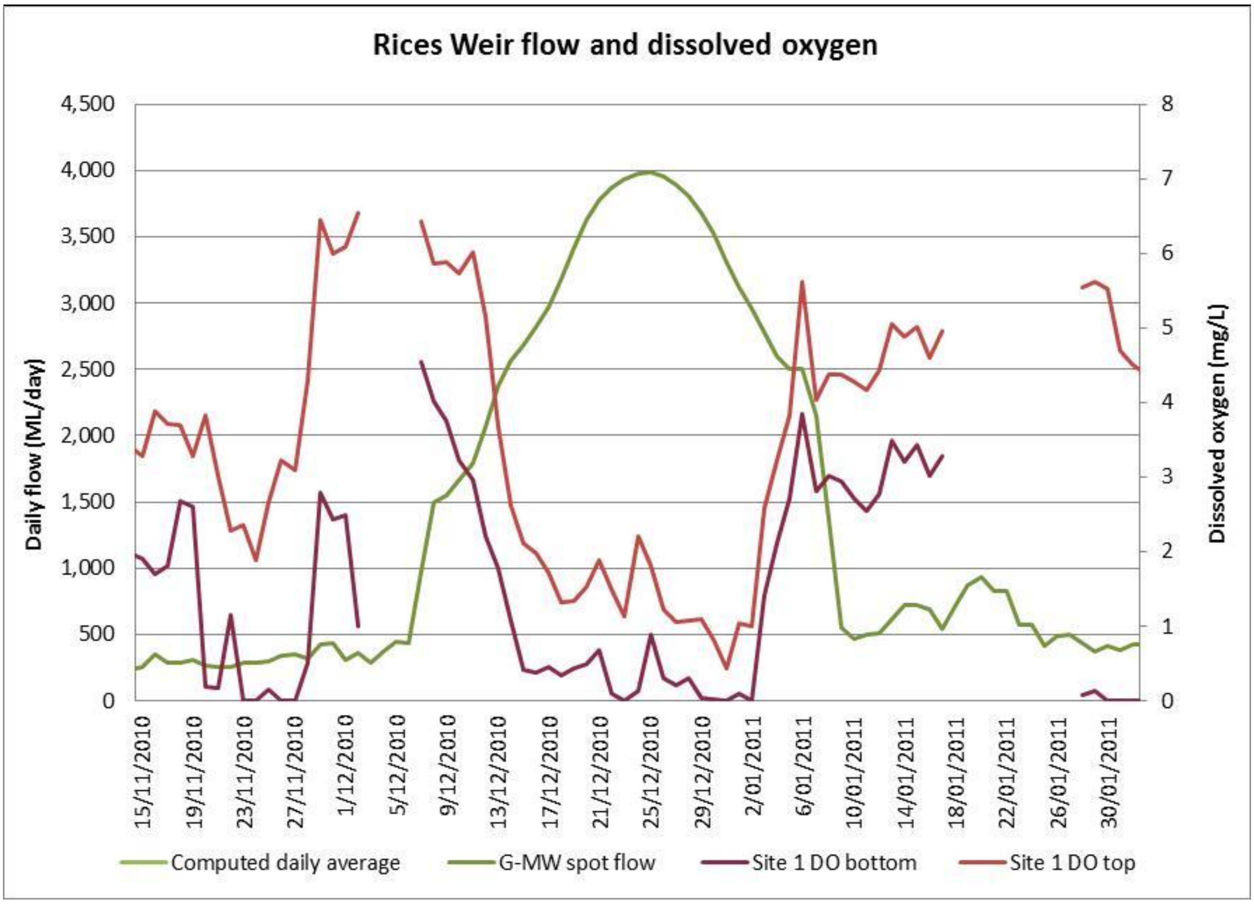

Figure 4: Broken Creek at Rices Weir flow and dissolved oxygen (Sept 2010 – April 2011)

In response to the blackwater event, a flow of 200 ML/day was provided from the Goulburn Water Quality Reserve in addition to 150 ML/day from Murray River flows to 'clean up' the creek after the high flows had passed. To manage the ongoing low dissolved oxygen levels that occurred along the Broken Creek during the summer of 2010/11, a minimum flow of 150 to 250 ML/day was provided through to Autumn. However, as shown in **Figure 5,** dissolved oxygen levels still dropped to zero at the bottom of the water column during this period.

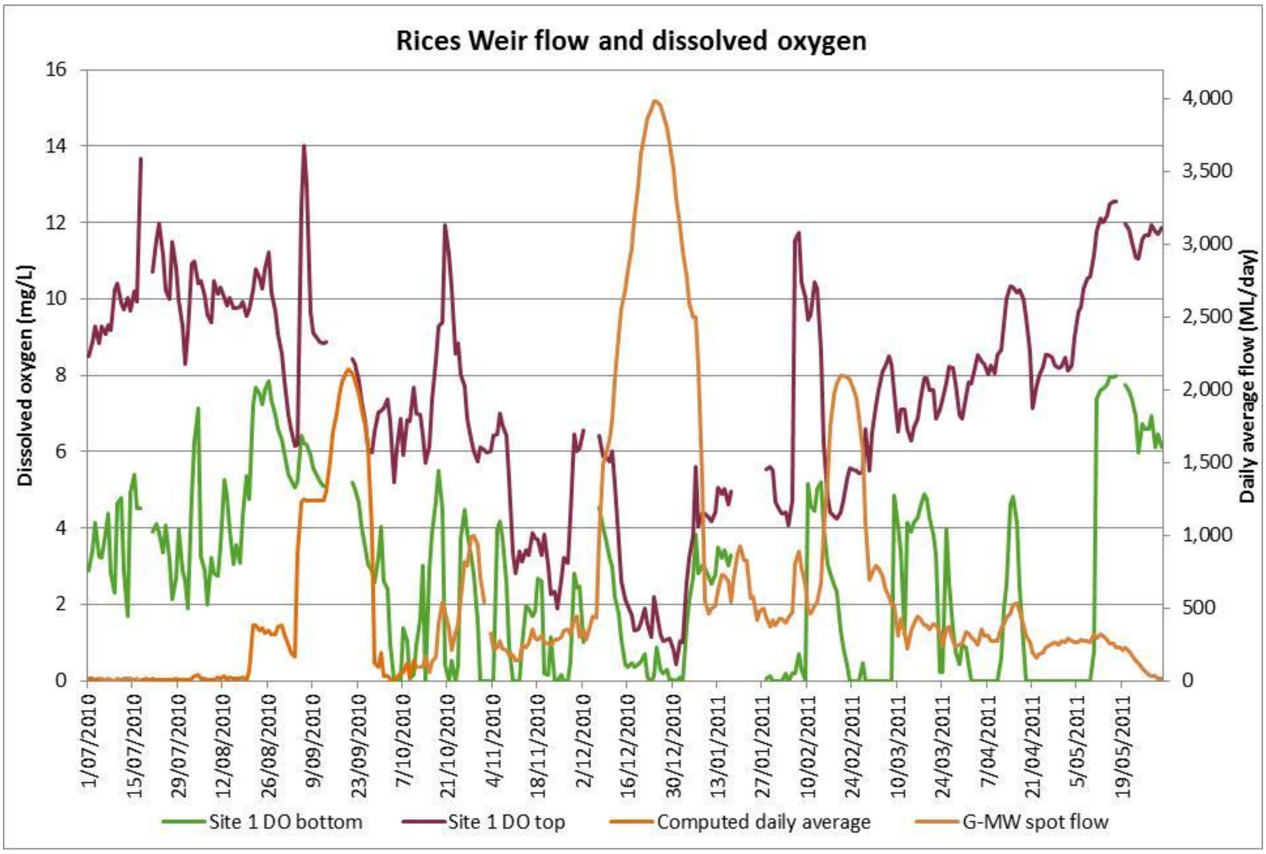

Figure 5: Flow and dissolved oxygen at Rices Weir 2010-11

Environmental releases to the Broken Creek were made from November to May (with gaps during flood flows), with earlier needs met by high catchment flows.

3.1.1 Current ecological conditions

Fish monitoring was undertaken post floods in 2010 and 2011 and surveyed 12 species in the lower Broken Creek including Flat-headed gudgeon, Golden perch and Murray cod, along with exotic Carp and Oriental weatherloach. Monitoring in 2010/11 showed greater species richness in the Broken Creek than monitoring results in the last three years. However, abundance and biomass was lower (URS, 2011).

Chapter 4 Environmental Watering proposal

4.1 Seasonal Water Planning

Lower Broken Creek is a series of weir pools, with flow dominated by spring/summer/autumn irrigation deliveries and potentially some winter/spring catchment runoff flows. The catchment runoff flows will flow through all weir pools along the length of the lower Broken Creek, while irrigation deliveries can provide good flows through the upstream weir pools, but no flow out of the last weir pool (Rices Weir).

Environmental flow planning is therefore about providing required flows past the most downstream Rices Weir, and where possible, utilising catchment runoff to meet these needs.

There are no environmental entitlements (or water storages) in Broken Creek. All water to achieve environmental outcomes must be delivered to the creek through irrigation channels from the Murray River or the Goulburn River.

Plans are prepared for a range of possible climatic scenarios to understand how the required volumes for deployment of water change, and importantly the likely availability of channel capacity to deliver the required flows at different times of the year.

Given the flow needs of the lower Broken Creek are small relative to the water resources available to meet them from the Murray and Goulburn River systems, the plans define the ecological needs of the creek and are not constrained by resource availability. However, they do depend on access to water-in-transit down the Goulburn and Murray Rivers, with environmental entitlement water used to meet gaps in water-in-transit availability and delivery.

Importantly, the actual management of water through the season needs to be adaptive, with water deployment decisions adjusting as the season unfolds, particularly in response to timing issues within the season and the variable flow needs of azolla and dissolved oxygen management.

4.2 Priority Flow Objectives

The environmental flow needs of the lower Broken Creek are relatively fixed from year to year. 40 ML/day is required to keep open the fish ladders along the creek, but particularly at Rices Weir. This allows fish to migrate and move for breeding, and also potentially to escape poor water quality in a particular pool.

Two of the priority flow components are heavily driven by the last 5 years of azolla and dissolved oxygen management experience. Experience has shown that azolla buildup can be managed by a steady baseflow of 120 ML/day, with occasional flushes up to 250 ML/day to meet high growth periods. Dissolved oxygen can be managed by a steady baseflow of 150 ML/day, but can need up to 250 ML/day for extended periods (particularly in response to very hot weather).

The flows required to manage azolla and dissolved oxygen are very high priorities, given their potential to kill the fish populations the plan is seeking to maximise.

A flow of 250 ML/day to improve fish habitat during the migrating/breeding season is also desirable.

The priority flow components are summarised in **Table 7**.

Table 7: Summary of priority environmental flow components

Priority	Flow component	Reach
1	August to May fish ladder flow of 40 ML/day	Past Rices Weir
2	August to November azolla management flow of additional 80 ML/day	Past Rices Weir
3	December to March dissolved oxygen management flow of 150 ML/day	Past Rices Weir
4	December to mid-May high flow of 250 ML/day for 1 to 2 months for dissolved oxygen management	Past Rices Weir
5	August to November flush of 250 ML/day for 2 weeks for azolla buildup management	Past Rices Weir
6	September to December fish habitat flow of 250 ML/day	Past Rices Weir

Note - Flow components shaded in green are definite high priorities. Delivery of components shaded in blue are desirable.

4.3 2010/11 Scenario planning

Table 8 outlines the range of scenarios available for water use in the lower Broken Creek in the 2011/12 year. Climatic scenarios are based on receiving catchment inflows (to Broken Creek, the Goulburn system and the Murray system) with a particularly Probability of Exceedence (POE). Hence the very dry scenario receives flows which have a 90% chance of being exceeded.

Table 8: Scenario summary descriptions for the Broken Creek

BROKEN CREEK – DOWNSTREAM REACH	SCENARIO 1 VERY DRY 90% POE	SCENARIO 2 AVERAGE 50% POE	SCENARIO 3 WET 30% POE
Water Supply	**100% HRWS allocation** Perhaps 80% available as private carryover	**100% HRWS allocation** Perhaps 80% available as private carryover	**100% HRWS allocation** Perhaps 80% available as private carryover
Expected Creek Flow and Water Management	18-20 ML/day in July	25 ML/day from August to November, with a 700-900 ML/day high flow and 200-300 ML/day freshes	45-50 ML/day from August to October, with a 2,500-3,000 ML/day high flow and 600 ML/day fresh
	No flow past Rices Weir from August to May	No flow past Rices Weir from October to May	No flow past Rices Weir from November to May
	252 GL of IVT available to deploy	167 GL of IVT available to deploy	100 GL of IVT available to deploy
	30 GL Water Quality Reserve available	30 GL Water Quality Reserve available	30 GL Water Quality Reserve available
Environmental Entitlement Volumes Available	Murray and Goulburn	Murray and Goulburn	Murray and Goulburn
Environmental Objectives	Maintain fish passage	Maintain fish passage	Maintain fish passage
	Prevent azolla buildup	Prevent azolla buildup	Prevent azolla buildup
	Maximise dissolved oxygen levels	Maximise dissolved oxygen levels	Maximise dissolved oxygen levels
	Maximise fish habitat	Maximise fish habitat	Maximise fish habitat

BROKEN CREEK – DOWNSTREAM REACH	SCENARIO 1 VERY DRY 90% POE	SCENARIO 2 AVERAGE 50% POE	SCENARIO 3 WET 30% POE
Preferable Murray Diversions and Inter Valley Transfer (IVT) Water Use	Divert Murray water from mid-August to mid-May at up to 120 to 150 ML/day (up to 40 GL)	Divert Murray water from mid-August to September at 100 ML/d, and October to mid-May at up to 120 to 150 ML/day (up to 39 GL)	Divert Murray water from mid-August to October at 80 ML/d, and November to mid-May at up to 120 to 150 ML/day (up to 37 GL)
	Divert IVT water from November to April at up to 150 ML/day (up to 27 GL)	Divert IVT water from December to April at up to 150 ML/day (up to 24 GL)	Divert IVT water from January to April at up to 150 ML/day (up to 18 GL)
Preferable Environmental Water Use	Use Goulburn environmental water in August to October and in April/May at up to 150 ML/day (up to 12 GL)	Use Goulburn environmental water in August to November and in April/May at up to 150 ML/day (up to 17 GL)	Use Goulburn environmental water in August to December and in April/May at up to 150 ML/day (up to 21 GL)
	Release Water Quality Reserve water in response to emergency water quality problems (eg blackwater)	Release Water Quality Reserve water in response to emergency water quality problems (eg blackwater)	Release Water Quality Reserve water in response to emergency water quality problems (eg blackwater)

Importantly, if diversion of Murray River water or Goulburn inter-valley transfers are not available, additional environmental entitlement water is required. In total, up to 40 GL could be needed from Murray entitlements and up to 39 GL could be needed from Goulburn entitlements.

4.4 Proposal for water use

The lower Broken Creek has relatively fixed environmental watering needs (i.e. largely independent of annual climatic conditions). Catchment runoff may contribute to meeting early baseflows and some azolla flushing flows. However, for the large part, flows must be brought in from the Murray and Goulburn Rivers. The environmental watering needs are however variable on a short term basis, depending on azolla growing conditions and dissolved oxygen management needs.

As flow from Broken Creek is returned to the Murray River, water-in-transit along the Murray River or water being sent from the Goulburn River to the Murray River can be diverted via Broken Creek to meet significant parts of the environmental flow needs. The availability of these sources will need to be confirmed with River Murray Water.

The Murray water is potentially available throughout the year.

However, the Goulburn inter-valley transfers have a limited period in which they can be delivered (which depends on climate) and potentially a limited volume for transfer. Hence the proposal identifies the need for Goulburn environmental entitlement water to be available to supply the creek from the Goulburn supply system in the months when Goulburn inter-valley transfers are not available. A volume of 21 GL could be required from Goulburn environmental water entitlements.

There will also be unexpected water needs in response to low dissolved oxygen events, and it is proposed the Goulburn Water Quality reserve is held in reserve to meet these needs (including any catchment runoff blackwater events).

The key issue for this proposal is the likely difficulty in gaining access to enough channel capacity to provide the required flow rates at different times of the year, and particularly in spring and autumn. The proposal therefore aims to have water available from both the Goulburn and Murray Rivers at the same time, so that water can be delivered through any available channel capacity, hence maximising the flows achieved in the creek.

In addition, when irrigation demand is about to increase significantly in the spring, it is proposed to provide a flush through the creek to reduce azolla buildup as much as possible before the period of high irrigation demand and hence low environmental water delivery.

As the proposal is maximising the availability of water for delivery through constrained channel systems, the volumes specified in the above table will not be used in total. Hence, the proposal envisages these as maximum potential usage from each source and would expect some or all of these sources using less than the maximum volumes given. The maximum overall water required could be up to 45 GL.

Under the proposal, if channel capacities allow, flows would be added to the creek as necessary to maintain the following flows at Rices Weir.

- The minimum flow of 120 ML/day would commence in mid August 2011, preferably from the Murray River.
- The minimum flow would increase to 250 ML/day in September to the end of December (or as long as possible) for improved fish habitat. This would require from both the Murray and Goulburn systems as the Murray channels are limited to a maximum delivery to the creek of 170 ML/day.
- If 250 ML/day could not be provided consistently, surges to 250 ML/day for up to 2 weeks would be pursued (if required) to minimise azolla buildup, and particularly pre-emptively if a period of low channel delivery capacity availability is imminent.
- From December onwards, the minimum flow of 150 ML/day would be provided if possible, and potentially up to 250 ML/day is dissolved oxygen levels decrease.
- Flows would be reduced (probably in April) as the dissolved oxygen threat passes.
- Flows would cease in mid May.

Where possible, the Murray resource would be used first, and Goulburn resource would be used to top up where Murray resource is inadequate.

In summary, this proposal suggests the use in-transit water from the Murray River and Goulburn inter valley transfers, with Goulburn environmental water used in addition as summarised in **Table 9**.

Table 9: Summary of environmental water volumes required to support this proposal (GL)

LOWER BROKEN CREEK	VERY DRY	AVERAGE	WET
Murray water planned	Up to 40	Up to 39	Up to 37
Inter-valley water planned	Up to 27	Up to 24	Up to 18
Goulburn environmental water planned	Up to 12	Up to 17	Up to 21

The total water needed is approximately 59 GL. However, given the likely channel capacity constraints, particularly in spring, a maximum total of 45 GL is more likely.

Chapter 5 Environmental Water Delivery

5.1 Risks assessment and management

There are some risks involved in deploying environmental water. Listed below are a number of key risks faced in the Broken Creek:

- Restricted channel capacity in high irrigation demand periods may result in limited ability to provide water to mitigate low dissolve oxygen levels or high azolla build up, both which may in turn result in fish deaths. This is a high risk to the Broken Creek for this planning year and this is proposed to be somewhat reduced by planning to have supply available from both the Murray and Goulburn systems to maximise use of any available channel capacity.

- Improved environmental conditions for carp – providing environmental flows to increase the area of slackwater habitats for native fish may also increase the habitat availability for introduced pest species such as carp. Currently there is little known about the dispersal and proliferation of pest species specifically in relation to environmental flows, but its likely the benefits provided for native species are also enjoyed by introduced species also (Chee et al, 2006). No management of this risk is currently possible.

- Overbank flows could result in flooding private property. No overbank flows are proposed in this proposal. In June 2011, very large numbers of carp have been found in the Rices Weir fish ladder and are being manually removed.

- As in 2010/11, a blackwater event can be generated in the Broken Creek catchment from overland flooding, producing very low dissolved oxygen levels along the upper and lower Broken Creek. Given the high flows usually accompanying these events, there is little that can be done to avoid the impact of the event. The best management response is to provide an environmental flow after the high flows have passed to improve the water quality in the lower Broken Creek as quickly as possible. Some of the Goulburn Water Quality Reserve should be held in reserve for this purpose.

5.2 Costs

The Environmental Water Manager does not have to make any payment for headworks costs relating to the environmental entitlements. If chargeable, these costs are met by the entitlement holders.

Delivery of environmental water entitlements with interuptable supply incurs out-of-pocket expenses for delivery costs. Up to 21,000 ML could cost $238,0000 (at $11.35/ML) to deliver. These costs will need to be funded by environmental entitlement holders.

5.3 Notice and time required

Four days notice is generally required for ordering water from Goulburn or Murray system storages.

Releases from Lake Eildon take approximately 2½ days to reach Goulburn Weir. Flows through the Shepparton channel system can occur within hours. If outfalled from the East Goulburn Main channel, flow can take 7 days to reach Nathalia, and potentially a further day to reach Rices Weir (by manipulating the weirs). The smaller capacity Hicks and Hollands outfalls flow directly into weir pools at Nathalia and downstream.

Releases from Hume Dam take 2 days to reach Lake Mulwala, with a further day to reach Broken Creek through the Yarrawonga main channel and spur channels. The main 7/3 channel outfall enters the creek upstream of the East Goulburn Main channel, while other smaller outfalls can input water into the downstream weir pools.

Chapter 6 Monitoring

6.1 Current Monitoring Programs

A number of programs are currently conducted by the Goulburn Broken CMA to monitor environmental flow and river and ecological conditions. The main program for environmental flow monitoring is the Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP). This program is being undertaken at 13 sites in the Broken Creek from the confluence with the Broken River to the Murray River. The program is monitoring vegetation, fish, macroinvertebrates, channel features, and physical habitat. Not all parameters are measured at each site. These assessments are carried out on a range of timeframes (varying from annually, to when a channel changing event occurs) and are a long-term assessment (5 - 10 years) of the impacts of and changes from environmental flows. The analysis of this data is based on statistical methods rather than before-after style monitoring. Monitoring has been occurring since 2008 (i.e. three years) and to date no data analysis has occurred. Additionally, 2010/11 was the first year of the monitoring to have significant flows, and hence the first year that any response to flows may occur with previous years providing base line data only.

The Arthur Rylah Institute for Environmental Research is also undertaking fish monitoring for the Goulburn Broken CMA. This is aimed at understanding fish dynamic and movement in the weir pools from Nathalia to the Murray River. The work involves electrofishing and pit tag readers on several weirs and fish ladders.

Flows are measured in the Broken Creek catchment at four hydrographic gauging stations along the Broken Creek and one on the Boosey Creek. The majority of dryland catchment inflows come from the upper catchment and are measured at the Boosey Creek at Tungamah and the Broken Creek at Katamatite. The key flow monitoring site is at Rices Weir. Goulburn-Murray Water also measure outfalls from channels into the creek, and flows past each of the weirs.

Water quality monitoring on the Broken Creek has been in place for a number of years. Continuous monitoring (i.e. 15 minute intervals) is located at Rices Weir (2 sites) and monitors temperature, dissolved oxygen, wind direction and speed, and hourly photos upstream of Rices Weir. Goulburn-Murray Water also continuously monitors temperature and dissolved oxygen at Rices Weir as well as at Hardings Weir (3 weirs upstream from Rices Weir). Goulburn-Murray Water also undertakens routine spot readings of dissolved oxygen, temperature and azolla cover along the reach from Nathalia to Rices Weir. Continuous dissolved oxygen and temperature monitoring occurs at the Boosey Creek at Tungamah and the Broken Creek at Katamatite. Nutrients and turbidity are also measured weekly at Rices Weir.

6.2 Monitoring 2011/12 Environmental Flow Outcomes

Monitoring of environmental flows in 2011/12 will continue as in previous years. Flows, water quality and azolla at Rices Weir will be used to determine flow delivery and water quality maintenance, and VEFMAP and Arthur Rylah Institute for Environmental Research fish monitoring in particular will determine the longer term fish outcomes from overall flow management.

6.3 Reporting

The first level of reporting is on use of environmental entitlements. Weekly reporting is planned to advise environmental entitlement holders of progressive water use, and on any adaptive water deployment decisions made.

The second level of reporting is on flows occurring in the creek system. Weekly reporting is planned to advise environmental entitlement holders of current flows and the effectiveness of environmental water deployed in achieving desired flows.

The third level of reporting is on environmental outcomes achieved. During the year, this will tend to be more anecdotal in nature.

An annual report will be prepared after the end of the 2011/12 year to collate all information on the use of environmental water, the river flows achieved, and the environmental outcomes observed.

Chapter 7 Communications

There are two key audiences for communications under the proposal.

The primary audience are those involved in delivering the proposed flow management.

- Goulburn-Murray Water is the key flow delivery agency. When the final proposal for 2011/12 is agreed, communications with Goulburn-Murray Water are aimed at making clear what the intended environmental flow release plans are and their intended purpose. Then, throughout the season, there will be regular communications (phone, email) directly with the Goulburn-Murray Water water resource management group to understand unregulated flows, Goulburn-Murray Water planned consumptive use releases, and to organise environmental flow releases.

- River Murray Water is responsible for calling out inter-valley transfers and for approving diversion of Murray River water through Broken Creek. Communications (phone, email) will primarily be via Goulburn-Murray Water, and aimed at initially planning inter-valley transfers and Murray flow diversions to achieve Murray system operational objectives and lower Broken Creek environmental objectives, and then regularly throughout the season, adjusting the plans to conditions as they unfold.

- The Victorian Environmental Water Holder will use the proposal as the basis (in whole or part), in developing the Seasonal Watering Plan. Water allocated is to be delivered in accordance with the Plan and the Plan is used to seek agreement from other water holders for the use of their water. Routine communication (phone, email) will report on deployment of water under the Plan.

- Commonwealth Environmental Water Holder may have allocated water to the Seasonal Watering Plan which is based on this proposal, and are responsible for achieving further benefits from the water at downstream environmental sites. Routine communication will be via the Victorian Environmental Water Holder.

The secondary audience is those potentially affected by or interested in environmental flows and/or the health of the river environment. This includes Parks Victoria and DSE (public land managers), water users along the river (Goulburn-Murray Water diversion licence holders), campers and recreation users, local government, environment groups and the general public. As the effect of the proposal on these groups is expected to be minimal, the communication objective is to provide information about the decision to provide environmental flows and what it is trying to achieve. These communications will be through media articles and potentially talks directly with special interest groups.

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VICTORIAN ENVIRONMENTAL WATER HOLDER

NORTH CENTRAL
Catchment Management Authority

Seasonal Watering Plan
2011–12

Schedule 11: Campaspe system

State Government Victoria

Schedule 11:
Campaspe system

This schedule is the seasonal watering proposal prepared by North Central Catchment Management Authority. It has been accepted by the VEWH and now forms part of the *Seasonal Watering Plan 2011–12*. As such, it incorporates any changes resulting from feedback from the VEWH.

The seasonal watering plan outlines the environmental watering actions that are a priority in 2011–12. It considers the actions that would occur under a range of planning scenarios. As conditions unfold and water becomes available throughout the year, seasonal watering statements will be released to communicate decisions on environmental watering actions and to authorise North Central Catchment Management Authority to implement those decisions.

The VEWH acknowledges and thanks North Central Catchment Management Authority for their hard work and dedication in developing the seasonal watering proposal and inputting to the *Seasonal Watering Plan 2011–12*.

Please contact the VEWH or North Central Catchment Management Authority for more information.

Document History

Version	Date Issued	Prepared By	Reviewed By	Date Endorsed
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Document name: **Campaspe River downstream of Lake Eppalock – 2011/12 Seasonal Watering Proposal**

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Front cover photo: Campaspe River at Doak's Reserve, Axedale (Darren White, North Central CMA)

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EXECUTIVE SUMMARY

The Season Watering Proposal for the Campaspe River system downstream of Lake Eppalock has been produced by the North Central CMA to detail environmental flow plans for the 2011-12 season. The plan details three planning scenarios for the river ranging from; the worst drought on record (2006-07 inflows), a dry year (80 % POE of inflows) and average (50% POE of inflows). There are no scenarios above 50% POE as environmental flow management decisions do not change after this point.

There are three principal sources of environmental water that can be deployed on the Campaspe River system. At the commencement of next season, including carryover, the Commonwealth Environmental Water holder will hold approximately 11,000 ML and the Victorian Environmental Water Holder (VEWH) under the Living Murray Initiative holds 10,200 ML. Goulburn-Murray Water's Bulk Entitlement provides passing flows in two reaches of the river, along with the ability to bank these flows. An alternative delivery route of consumptive water can also provide environmental benefit during the irrigation season to the lower reaches of the river.

The Campaspe River system has been in severe drought for the 2000 to mid 2010 period. River flows during this time were very limited with prolonged 'cease to flow' periods for many reaches of the river. Rainfall conditions significantly improved in the 2010 winter period with well above average rainfall, resulting in high river flows for the first time in a number of years. In January 2011 extensive floods occurred along the Campaspe River inundating the Rochester township, providing significant overbank flows for the system.

The seasonal watering proposal has been developed with extensive community consultation by the North Central CMA. The primary engagement process is the Campaspe Environmental Water Advisory Group (CEWAG) comprising community representatives residing on the Campaspe River and key agency staff. This group meets at least twice a year to provide feedback on the river's management, community observations and advice in the planning process.

The aim of this year's Seasonal Watering Proposal is to build upon the recovery of the Campaspe River following the prolonged drought. The proposal considers all sources of environmental water that may be available for deployment in the Campaspe River, likely river conditions and details the flow regime required to achieve prioritised environmental objectives for the river for each scenario considered in the proposal. The focus of the proposal is the critical winter flow components that have not been provided to the river in recent seasons.

To meet the ecological objectives in the Campaspe River system, the North Central CMA has identified the best deployment of environmental water under the three management scenarios of volumes outlined in Table 10. The North Central CMA is seeking the VEWH source the additional water required. This water will be delivered in line with the environmental objectives listed in section 2.1.

This proposal (2011-12) is to remain in operation until such a time as the subsequent Seasonal Watering Proposal (2012-13 season) has been endorsed by the Victorian Environmental Water Holder.

Campaspe River	DROUGHT	DRY	AVERAGE
Total environmental water required	13,500 ML	7,900 ML	3,000 ML

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Acknowledgements

The development of this 2011/12 Season Watering Proposal for the Campaspe River would not have been possible without the input from a number of parties. The North Central CMA wishes to acknowledge the assistance of the following parties:

Geoff Elliott, community representative

John McKinstry, community representative

Wal Somerville, community representative

Ian Whatley, community representative

James Williams, community representative

Jenny Williams, community representative

Andrew Shields and Kym Wilson, Goulburn-Murray Water

Tory Perrin, Department of Sustainability and Environment

Abbreviations

BE – Bulk Entitlement

CEWAG – Campaspe Environmental Water Advisory Group

CMA – Catchment Management Authority

CEWH – Commonwealth Environmental Water Holder

CRG – Community Reference Group

EWR – Environmental Water Reserve

G-MW – Goulburn-Murray Water

IVT – Inter-Valley Transfer

MDBA – Murray Darling Basin Authority

MFF – Murray Flora and Fauna Environmental Entitlement

ML – Megalitres

SWP – Seasonal Watering Proposal

VEWH – Victorian Environmental Water Holder

VWQMN – Victorian Water Quality Monitoring Network

The **White Paper –** The Victorian Government's White Paper *Our Water Our Future,* Securing our Water Future Together

Volumes of water:

One litre	1 litre	1 litre 1L
One thousand litres	1,000 litres	1 kilolitre 1KL
One million litres	1,000,000	1 megalitre 1ML
One billion litres	1,000,000,000	1 gigalitre 1GL

1. Introduction

1.1. Purpose

The 2011-12 water year is the first year the new state-wide Victorian Environmental Water Holder (VEWH) framework will be in place for the management of environmental water across the state (Figure 1). The VEWH was enacted as action from the Northern Victorian Sustainable Water Strategy and the Victorian Government's Biodiversity white paper. In previous seasons, the North Central CMA has prepared an Annual Watering Plan each year to strategically plan and communicate environmental water management the Campaspe River.

This Seasonal Watering Proposal (SWP) identifies the desired environmental water use for the Campaspe River System downstream of Lake Eppalock for the 2011-12 water year under a range of climatic scenarios. It replaces the previous Annual Watering Plan. This proposal provides a clear rationale to directly inform the Victorian Environmental Water Holder (VEWH) of priorities for its development of the state-wide Seasonal Watering Plan (Figure 1).

1.2. System overview

The Campaspe Catchment (Figure 2) extends from the Great Dividing Range in the south to the Murray River in the north, a total distance of approximately 150 km. The catchment has an average width of approximately 25 km for a total area in the region of 4,000 km². This represents in the order of 17% of the North Central CMA region (NCCMA 2006a).

The major waterways of the catchment are the Upper Campaspe River, the Coliban River (both upstream of Lake Eppalock) and the lower Campaspe (downstream of Lake Eppalock). Major tributaries are the Axe, McIvor, Mount Pleasant and Pipers Creeks.

Major Thomas Mitchell named the Campaspe River in 1836. The catchment has undergone significant changes since Europeans first traversed it. The cumulative effects of the introduction of European farming techniques, native vegetation clearance, the gold rush plus the construction of reservoirs and water supply systems for agriculture and urban developments are reflected in the current condition of the catchment (NCCMA 2006a).

The Campaspe Seasonal Water Proposal is limited to the Lower Campaspe River downstream of Lake Eppalock. This reach of the river meanders across almost level alluvial plains for approximately 140 km to the confluence with the Murray River at Echuca. The floodplain of the river is narrow at approximately only 1 km wide until closer to Echuca, where it broadens out to more than 2 km (NCCMA 2006b).

The Campaspe River is now a regulated river to supply water for irrigation and urban demands. In 1882, the Campaspe Weir was constructed 12 km south of Rochester. This structure has a capacity of 2,700 ML and delivers irrigation water through the east and west channels. In 1902, the Campaspe Siphon was constructed 2 km north of Rochester. The Waranga Western Channel crosses the river at this point and the siphon structure allows water from the Goulburn River to be inflowed into the river, or continue its flow to the western irrigation districts. The Campaspe pumps located at the siphon also allow water from the Campaspe River to be inflowed into the Waranga Channel for delivery to western irrigation areas.

The most significant structure on the Campaspe River is Lake Eppalock. While first mentioned in the 1890s, it was not until 1930 that construction began. Construction ceased due to the depression in 1933 when the dam had a capacity of 1,500 ML. Construction then recommenced in 1963 and when completed, capacity had increased to the present 304,000 ML. Lake Eppalock was constructed to secure water for the Campaspe irrigation area, to safeguard the Coliban Supply system and allow increased development of urban areas.

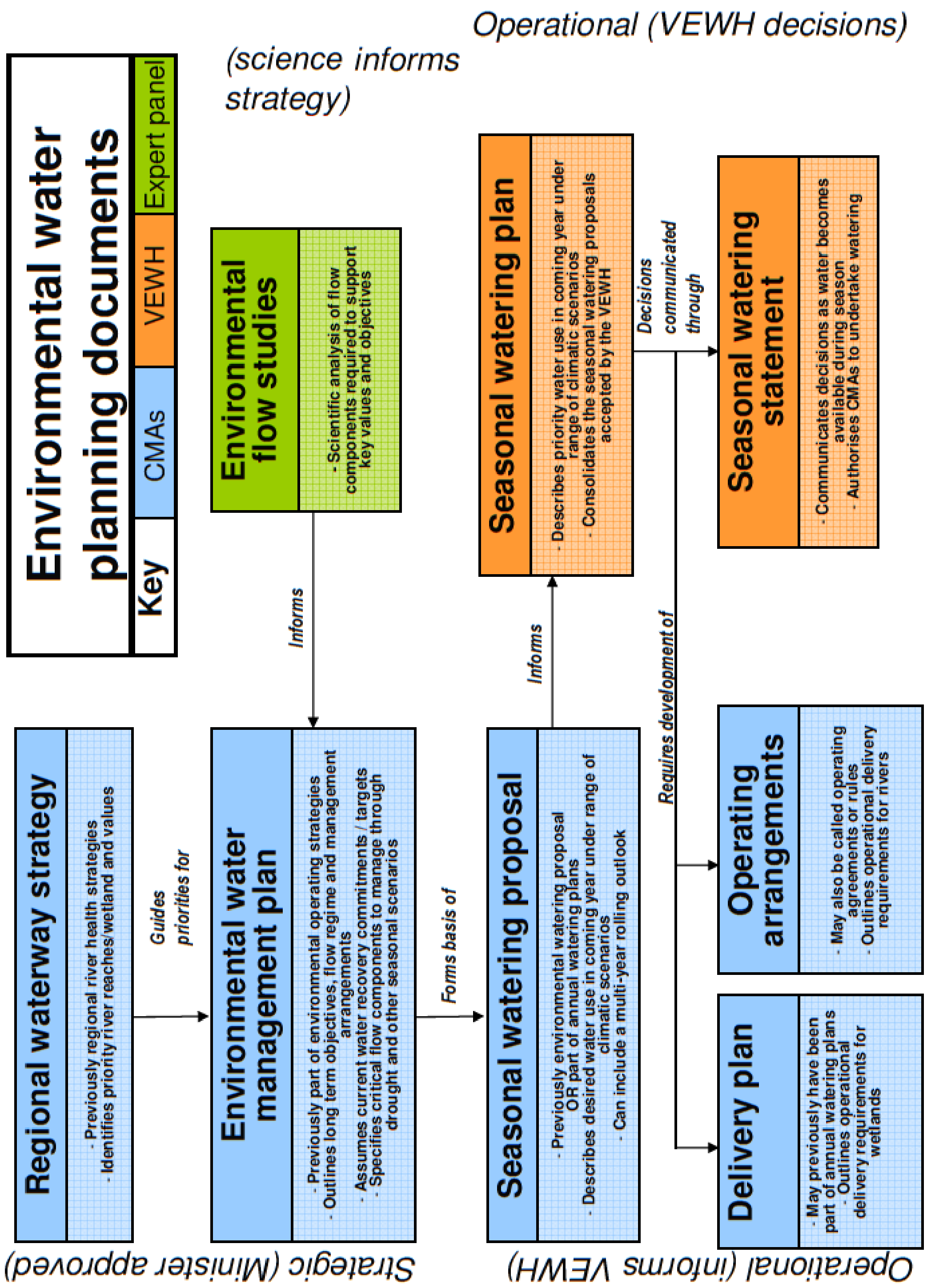


Figure 1 Victorian Environmental Water Holder Framework

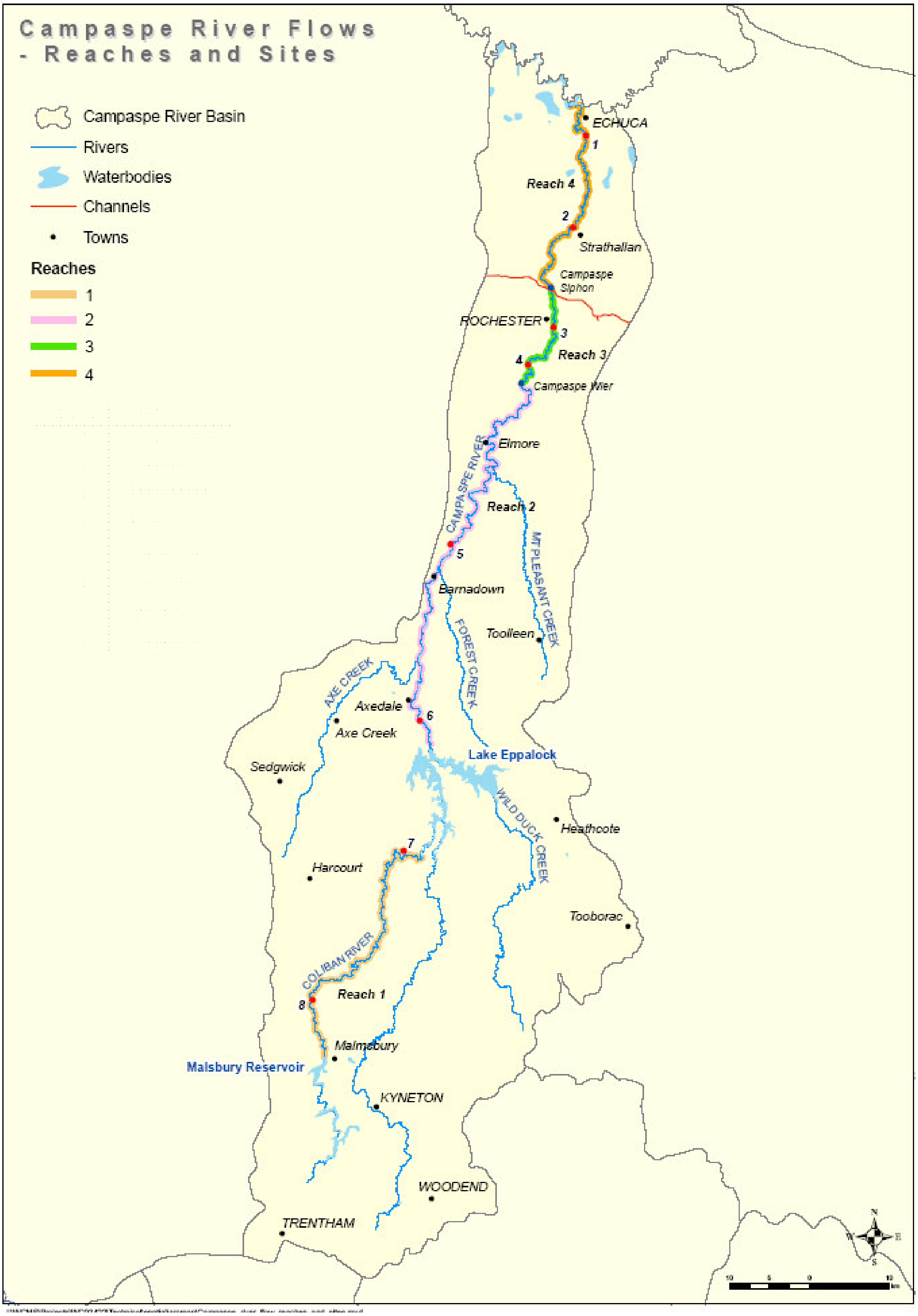


Figure 2- Overview of the Campaspe River catchment

1.3. Sources of water

There are four sources of environmental water that can be deployed in the Campaspe River system (Table 1)

1.3.1 Bulk Entitlement (Campaspe System - Goulburn-Murray Water) Conversion Order 2000

The right to water in the Campaspe River was defined in 2000 through the Bulk Entitlement (Campaspe System - Goulburn-Murray Water) Conversion Order. While there is no separate Environmental Bulk Entitlement, water for the Campaspe environment is defined as 'passing flows' within Goulburn-Murray Water's and Coliban Water's Bulk Entitlements (Table 1) as well as unregulated river flows. The Campaspe Bulk Entitlement (2000) provides for minimum passing flows in sections of the Campaspe River downstream of Lake Eppalock to protect environmental values based upon recommendations by an environmental flows scientific panel (Marchant et al. 1997). It is important to note that there is no passing flow requirement for the reach between the Campaspe Weir and the Campaspe Siphon, however in most cases water will be passed down this reach to supply requirements below the Campaspe Siphon (unless sourced from the Waranga Western Channel).

1.3.2 Commonwealth Environmental Water Holder (CEWH)

Under the Federal Government's water buyback scheme or Restoring the Balance in the Murray-Darling Basin Program, as at 28 February 2011, a total of 5,710 ML of High Reliability Water Supplies (HRWS) and 395 ML of Low Reliability Water Supply (LRWS) have been purchased in the Campaspe Catchment. This water will be transferred to the Commonwealth Environmental Water Holder (CEWH), which will be responsible for the management and deployment. The stated objective of this program is to purchase water entitlements so that the water can be used for environmental purposes (DEWHA 2010). The water purchased from the Campaspe River catchment can be used to benefit environmental assets in this catchment and downstream. The CEWH also has the option to trade water in and out of the Campaspe as required. The use of this water in the Campaspe System is not guaranteed and is at the discretion of the CEWH.

1.3.3 Victorian Environmental Water Holder (VEWH)

The Victorian River Murray Flora and Fauna Bulk Entitlement provides a 27,600 ML entitlement of high reliability water. It is held by the Victorian Environmental Water Holder for the purpose of providing for flora and fauna needs. It has been used in a range of wetlands including Gunbower Forest (Living Murray icon site) and occasionally the Goulburn system wetlands. It can also be traded on the water market on an annual basis. The use of this water in the Campaspe System is not guaranteed and is at the discretion of the VEWH.

1.3.4 Environment Entitlement (Campaspe River - Living Murray Initiative 2007)

The Living Murray Initiative aims to recover up to 500 GL of environmental water to achieve environmental benefits for six icon sites (not including the Campaspe River) along the River Murray. This entitlement is managed by the Murray Darling Basin Authority (MDBA). Due to the unbundling process and the 80:20 sales deal water package, the Living Murray Initiative holds 126 ML of high reliability and 5,048 ML of low reliability water stored in Lake Eppalock. This water's primary target will be for deployment to the icon sites; however there is the opportunity for deployment to provide additional benefit to the Campaspe River system enroute to the Living Murray Icon sites. The use of this water in the Campaspe System is not guaranteed and is at the discretion of the MDBA.

1.3.5 Other possible sources of water

Northern Victoria Irrigation Renewals Program (NVIRP 2010) has purchased a majority of irrigation entitlement holders in the Campaspe Irrigation District. Entitlements were purchased where irrigators elected to accept an exit package and either leave the irrigation industry or connect to alternative water supplies. As a result, up to approximately 12,000 ML of HRWS entitlements have been purchased by NVIRP with the aim of selling this to the CEWH. The future ownership of this water is curretnly being resolved.

Table 1: Sources of Environmental water available in the Campaspe River system

Water source		Flexibility of management	Reaches	Conditions of availability	Conditions of use	Management responsibility	Compliance point
Nature of water source	Volume or rate of water delivery						
ENTITLEMENT							
CEWH	• 5,710 ML HRWS • 395 ML LRWS	Fully flexible management	2, 3 and 4	Requires approval from CEWH • Storage in Lake Eppalock • Irrigation allocation dependant		CEWH	N/A
Environment Entitlement (Campaspe River - Living Murray Initiative 2007	• 126 ML HRWS • 5,085 ML LRWS	Fully flexible management	2, 3 and 4	Requires approval from MDBA • Storage in Lake Eppalock • Irrigation allocation dependant	For use to meet ecological objectives of Living Murray program	MDBA	Rochester Gauge
Bulk Entitlement (River Murray Flora and Fauna) 1999	27,600 ML	Fully flexible management	4	Requires approval from VEWH		VEWH	N/A
PASSING FLOWS							
Passing Flow (under G-MW's BE)	Reach 2 Passing Flow rate required is dependant upon storage volume of Lake Eppalock, storage inflows and time of year	• Fully flexible management • Flows can be stored in the Eppalock Passing flows Account	2	None	Where Lake Eppalock Storage volume is: • Less than 150,000 ML, passing flow required 10 ML/d or actual inflow • 150,000 ML to less than 200,000 ML, passing flow required 50 ML/d or actual inflow • 200,000 ML to less than 250,000 ML, passing flow required is 80 ML/d or actual inflow • Greater than 250,000 ML, passing flow required o 90 ML/d or actual inflows in Jan, Mar, May, Jun and Dec o 80 ML/d or actual inflow in Feb & Apr o 150 ML/d or actual inflows in Jul & Nov o 200 Ml/d or actual inflows in Aug, Sep, & Oct.	Goulburn-Murray Water and North Central CMA	Downstream of Lake Eppalock
	Reach 4 Passing Flow rate required is dependant upon storage volume of Lake Eppalock, storage inflows and time of year	• Fully flexible management • Flows can be stored in the Eppalock Passing flows Account	4	None	Where Lake Eppalock Storage volume is • Less than 200,000 ML, passing flow required is o 20 ML/d or modified natural flows July to November o 35 ML/d or modified natural flow December to June • Greater than 200,000 ML, passing flow required is 70 ML/d or modified natural flow	Goulburn-Murray Water and North Central CMA	Downstream of Campaspe Siphon
OTHER SOURCES							
Inter-valley Transfer	Dependant upon negotiations between North Central CMA, G-MW, MDBA and VEWH	Fully flexible when available	4		Any losses need to be from environmental account	Goulburn-Murray Water	Echuca Weir

1.4. Consultation

To effectively manage environmental water, the North Central CMA undertakes an extensive engagement process with a number of key representative groups (Table 2). The principal groups are:

1.4.1 Campaspe Environmental Water Advisory Group (CEWAG)

The Campaspe Environmental Water Advisory Group was established by the North Central CMA in 2008. The group is the key community engagement forum for environmental water management on the Campaspe River system and provides advice at key decision points in the planning process. The group consists of key community members in the Campaspe River catchment and key agency staff including representatives from Department of Sustainability – water resources division.

1.4.2 Natural Resource Management Committee

The Natural Resource Management Committee (NRMC) is a sub-committee of the North Central Catchment Management Authority (CMA) Board. The NRMC advises the Board about environmental investment priorities in the region with a primary emphasis on protecting the region's rivers. The key role of the NRMC is to provide community and local perspectives on the projects and functions of the North Central CMA that have direct public benefits for current and future generations.

The principal role for the committee in environmental water management is to formally recommend the Seasonal Water Proposal (this proposal) to the North Central CMA board for endorsement.

1.4.3 North Central CMA Board

The North Central Catchment Management Authority's (CMA) Board's key role is to provide leadership, coordination and integration of sustainable natural resource management for the benefit of our rivers and the communities that depend on them. The Board leverages their diverse business and industry skills to determine strategic direction and to monitor the successful realisation of these benefits.

The principal role of the North Central Board CMA in environmental water management is to formally endorse the seasonal watering proposal (this proposal) for submission to the Victorian Environmental Water Holder.

Table 2: Groups engaged during the preparation the Campaspe Seasonal Watering Proposal.

Who	Roles and responsibilities	Purpose of consultation	Mode and timing of consultation
Campaspe Environmental Water Advisory Committee (CEWAG)	Provide North Central CMA local advice to inform the development of the Seasonal Water Proposal	Inform Advise	April 2011 May 2011
Goulburn-Murray Water	Inform and advise in preparing Seasonal Watering Proposal	Consult	Ongoing
Natural Resource Management Committee	To provide community and local perspectives	Inform Recommend	May 2011
North Central CMA Executive Board	North Central CMA formal board sign-off on proposal	Approve	June 2011

2. Ecological Objectives

The ecological objectives for the Campaspe River system were developed under the 2006 Campaspe Environmental flows assessment completed by Sinclair Knight and Merz. The flow assessment was developed using the Victorian state-wide FLOWS methodology and was completed in three stages. The first stage produced a site paper that outlined the Campaspe River, the site and reach selection process and then described the selected study sites. The second stage produced an issues paper that outlined the environmental values of the sites and detailed ecological objectives for these sites. The final stage produced the environmental flow recommendations for a flow regime that reflects the natural seasonal pattern and variability required to maintain or enhance the environmental values of the Campaspe River system.

2.1 Ecological objectives

The 2006 environmental flow study provides flow recommendations for three distinct reaches of the Campaspe River (Figure 1). The ecological objectives for Reaches 2, 3 and 4 are as follows.

2.1.1 Ecological Objectives for Reach 2 (Lake Eppalock to the Campaspe Weir)

Table 3: Flow components and relationship to ecological objectives for reach 2

Ecological Objectives	Flow Component		Magnitude, frequency, timing, duration, etc
• Increase food concentration for fish larvae and juveniles	Summer (December to May)	Cease to flow	1 per year of 14 days duration
• Maintain aquatic vegetation • Maintain fish habitat and reinstate slackwaters • Limit the effect of cold water releases from Lake Eppalock for fish • Maintain access to riffle habitat and water quality for macroinvertebrates • Maintain permanent connectivity for water quality	Summer (December to May)	Low flow	10-16 ML/d
• Maintain riparian and inchannel recruitment vegetation • Provide longitudinal connectivity for fish during periods of low flow • Respond to Blackwater events as required	Summer (December to May)	Fresh	100-125 ML/d for 5 days with managed rate of rise and fall. 3 events required
• Provide longitudinal connectivity for fish • Limit effect of cold water releases for fish • Maintain access to riffle habitat and water quality for macroinvertebrates • Maintain permanent connecting for water quality	Winter (June to November)	Low flow	100-125 ML/d
• Reduce encroachment of exotic and terrestrial vegetation • Enhance River Redgum recruitment • Cue fish movement and allow movement to downstream reaches • Flush and mix river pools for water quality • Respond to Blackwater events as required • Mix and flush river pools for macroinverbrates	Winter (June to November)	High Flow	1,000 - 1,200 ML/d for 4 days with managed rate of rise and fall. 4 events or natural required

• Provide channel forming processes • Scour *Typha spp*. from middle of river channel • Cue fish movement and allow movement to downstream reaches		Bankfull Flow	10,000 to 12,000 ML/d for 2 days with managed rates of rise and fall. 4 events or natural required each year
• Provide lateral connection to flood runners • Enhance River Redgum recruitment		Overbank Flow	12,000 to 14,000 ML/d with managed rates of rise and fall. 1 event required per year

2.1.2 Ecological Objectives for Reach 3 (Campaspe Weir to Campaspe Siphon)

Table 4: Flow components and relationship to ecological objectives for Reach 3

Ecological Objectives	Flow Component		Magnitude, frequency, timing, duration, etc
• Maintain aquatic vegetation • Maintain fish habitat and reinstate slackwaters • Maintain aquatic habitat for macroinvertebrates • Maintain permanent connectivity for water quality	Summer (December to May)	Low flow	10 - max 20 ML/d
• Maintain riparian and inchannel recruitment vegetation. • Provide longitudinal connectivity for fish during periods of low flow • Mix and flush pools for Water quality • Inundate additional snags and flush sediment off biofilms for macroinvertebrates		Fresh	100 ML/d for 6 days with managed rate of rise and fall. 3 events required Feb to May
• Provide longitudinal connectivity for fish • Maintain aquatic habitat for macroinvertebrates • Maintain permanent connectivity for water quality	Winter (June to November)	Low flow	200 ML/d or natural
• Reduce encroachment of exotic and terrestrial vegetation • Cue fish movement and allow movement between upstream and downstream reaches • Flush and mix river pools for water quality • Inundate additional snags and flush sediment off biofilms for macroinvertebrates		High Flow	1,500 ML/d for 4 days with managed rate of rise and fall. 4 events or natural required
• Provide channel forming processes • Scour *Typha spp*. from middle of river channel • Cue fish movement and allow movement between upstream and downstream reaches		Bankfull Flow	8,000 ML/d for 2 days with managed rates of rise and fall. 2 events or natural required each year
• Inundate wetlands and connect to main channel • Enhance River Redgum recruitment		Overbank Flow	12,000 ML/d with managed rates of rise and fall. 1 event required per year

2.1.3 Ecological Objectives for Reach 4 (Campaspe Siphon to Murray River Confluence)

Table 5: Flow components and relationship to ecological objectives for reach 4

Ecological Objectives	Flow Component		Magnitude, frequency, timing, duration, etc
• Maintain aquatic vegetation • Maintain fish habitat and reinstate slackwaters • Maintain aquatic habitat for macroinvertebrates • Maintain permanent connectivity for water quality	Summer (December to May)	Low flow	10 - max 20 ML/d
• Maintain riparian and inchannel recruitment vegetation. • Provide longitudinal connectivity for fish during periods of low flow and cue movement from the Murray River • Mix and flush pools for water quality • Inundate additional snags and flush sediment off biofilms for macroinvertebrates		Fresh	100 ML/d for 6 days with managed rate of rise and fall. 3 events required Feb to May
• Provide longitudinal connectivity for fish • Maintain aquatic habitat for macroinvertebrates • Maintain permanent connecting for water quality	Winter (June to November)	Low flow	200 ML/d or natural
• Reduce encroachment of exotics and terrestrial vegetation • Enhance River Redgum recruitment • Cue fish movement and allow movement between upstream and downstream reaches • Flush and mix river pools for water quality • Inundate additional snags and flush sediment off biofilms for macroinvertebrates		High Flow	1,500 ML/d for 4 days with managed rate of rise and fall. 2 events or natural required
• Provide channel forming processes • Scour *Typha spp*. from middle of river channel • Cue fish movement and allow movement between upstream and downstream reaches		Bankfull Flow	9,000 ML/d for 2 days with managed rates of rise and fall. 2 events or natural required each year

2.2 Optimal flow components and tolerances

The 2006 flow study does not document the optimal frequencies, duration and times of flow components to achieve the ecological objectives. The flow study recommends an annual flow regime and does not consider inter-annual variations and tolerances.

3. Flow Prioritisation

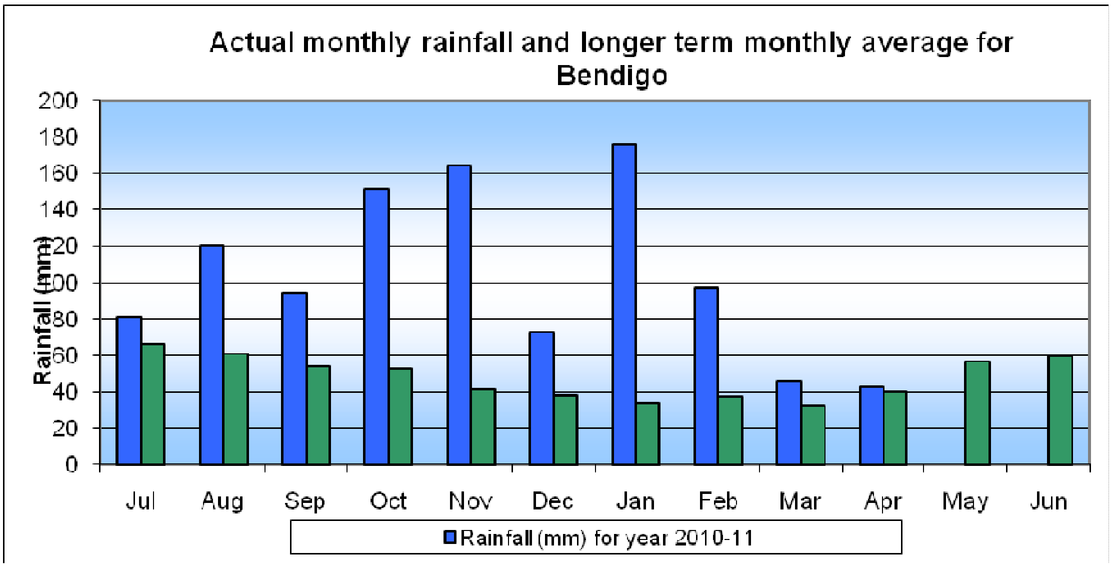
3.1. 2010-11 situation review

The Campaspe River system has been in drought for an extended period. In the 2010-11 season well above average rainfall and milder than average temperatures, resulted in substantial increases of flow in the river. An indication of the change is evidenced in the Lake Eppalock storage volume increasing from 9% at the beginning of July 2010 to spilling in early November 2010; over 270,000 ML of inflow.

3.1.1 Climatic conditions

Rainfall over the 2010-11 season has been well above average in all months. Until the end of February rainfall received was 999.6 mm in comparison to the longer term average for the same period of 361.7 mm or 276% (Figure 3). There have been four major rainfall events during the season where high daily rainfall has been recorded over a short timeframe. These are September 4 - 5 with 81.6 mm, 31 October with 53.8 mm, 25 - 28 November with 81.2 mm and finally, the January event when 163.8 mm of rain fell over the January 10 - 15 period. These events have resulted in river and flood flows in the Campaspe River catchment.

Figure 3, average monthly rainfall (green) and actual monthly rainfall received (Blue) for Bendigo for the 2010/11 season



3.1.2 River flows

During previous seasons, the Campaspe River has been managed from an environmental flow perspective with each reach managed as a separate entity. The return to high rainfall saw the river flow as a continuum during the 2010-11 season.

There were no environmental flow releases during the season and limited irrigation releases due to low irrigator demands, a reflection of the regular rainfall. The continued rainfall primed the catchment early in the season so that subsequent rainfall events resulted in heightened river flows. As detailed in section 3.1.1, there were four significant rainfall events where high rainfall was recieved over a short time. These rainfall events have been marked with arrows in the flow diagrams. The river responded quickly in all reaches to the high rainfall and bankfull or flood flows occurred along the river.

Flows in Reach 2 are represented by flow data from the Barnadown gauge (Figure 4). The peak (instantaneous) discharge from Lake Eppalock after the January 10-15 rainfall was approximately 80,000 ML/d. This attenuated and the peak flow at the Barnadown gauge was 52,000 ML/d. This high flow held at Barnadown for a period of days. Only 2 of the high flow events overtopped the bank at Barnadown to inundate the floodplain due to confinement by the steep banks in this section of the river. Downstream of Barnadown the flood water spread out and inundated larger sections of the flood plain (J McKinstry pers comm). Poor quality flood water was observed throughout the reach and the high flows appear to have scoured the river channel and banks.

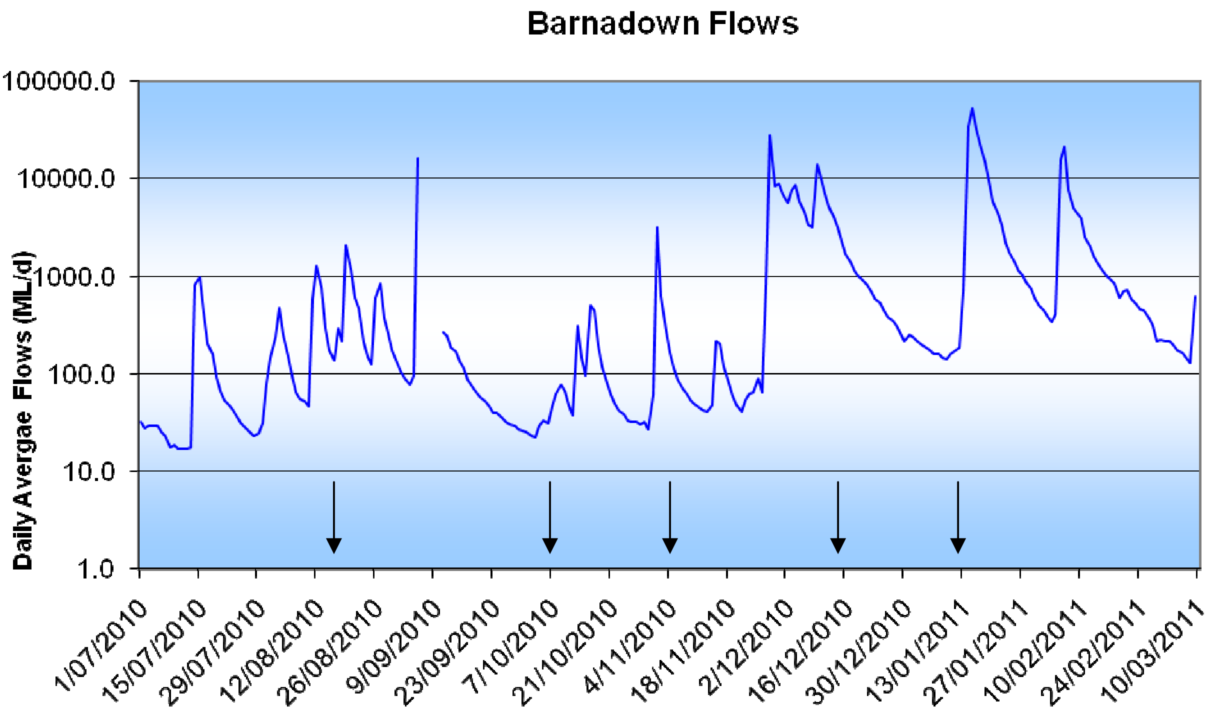


Figure 4 – River flows at Barnadown gauge for the 2010-11 season (G-MW operational data). Please note logarithmic scale

There is no gauging station in Reach 3. In previous seasons, G-MW operational releases from the Campaspe Weir have been used to indicate flows in the reach. This is not possible this year as unregulated river flows have occurred on a regular basis and overtopped the weir. Flow at the Echuca gauging weir is not representative for the entire year due to the river flows being backed up the Campaspe due to high River Murray flows.

Flows in Reach 3 and 4 are represented by flow at the Rochester Siphon (Figure 5). River flow in these reaches closely correlates with the upstream reaches. The Rochester Township was flooded twice during the year. The larger of the floods was the January event when the CBD district was inundated. Downstream of Rochester there is good flood plain storage for flows and along with flood distributaries that connect with the Murray River, major flooding in Echuca did not occur. Flood water quality was a major issue with rusty deposits observed after the water had receded (Wal Somerville, pers comm). Dead trees were also observed on the flood plain after the water had receded. The river at Echuca deposited a layer of sand on the floodplain after the flood water had receded (Ian Whatley pers comm). There is a general community perception that the river looks untidy and deeply scoured.

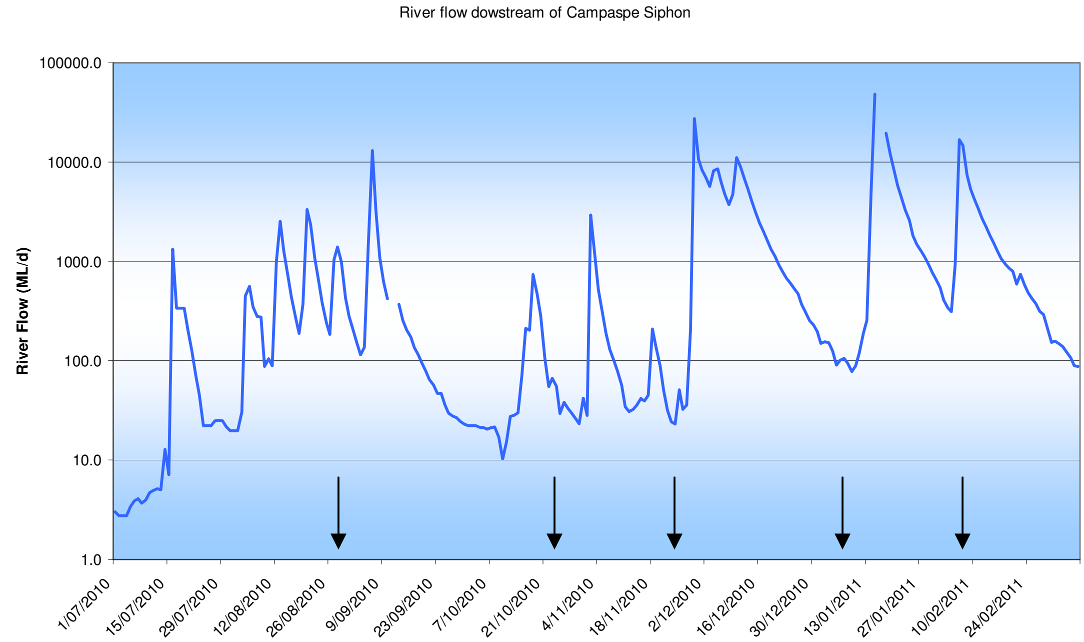


Figure 5 – River Flows at Rochester Siphon for the 2010-11 season (G-MW operational data). Please note logarithmic scale

3.2. Effectiveness of flow components delivered

The 2006 SKM environmental flow study prescribes a preferred flow regime for the Campaspe River system. Flows (natural and managed) in the river over the last 10 years have been compared to the required flow regime for Reach 2 (Table 6) and Reach 4 (Table 7) of the Campaspe River. A comparison was not completed for Reach 3 as a complete flow dataset is not available.

The certainty of whether ecological objectives have been achieved can be indicated when the flow component has been met in the absence of detailed ecological monitoring of the system. The required flow component can be achieved from managed releases (environmental flows, flows for irrigation) or from natural flows in the system.

Table 6: Historical achievement of environmental flow components and ecological objectives for Reach 2 (Barnadown data).

Flow component		Years									
		2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Summer	Cease to Flow										
	Baseflows										
	Freshes										
Winter	Low Flow										
	High Flow										
	Bankfull										
	Overbank flow										

Table 7: Historical achievement of environmental flow components and ecological objectives for Reach 4 (Rochester data).

Flow component		Years									
		2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Summer	Baseflows	Orange	Green	Green	Green	Green	Green	Green	Green	Green	Red
	Freshes	Orange	Red	Red	Red	Red	Red	Orange	Orange	Green	Green
Winter	Low Flow	Red	Red	Red	Red	Red	Red	Red	Red	Red	Green
	High Flow	Red	Red	Red	Red	Red	Red	Red	Red	Red	Green
	Bankfull	Red	Red	Red	Red	Red	Red	Red	Red	Red	Green

Key to tables

Red	No significant part of the flow component provided naturally or through managed flows
Orange	Flow component partially provided
Green	Environmental flow component has been completely provided

Note Winter Low flows are 120 ML/d or natural for Reach 3 and 200 ML/d or natural for Reach 4. There is no direct data available to measure the 'or natural' component other than extensive modeling based upon catchment condition and rainfall data. Therefore the winter base flow has been assessed without consideration of the 'or natural' clause.

Tables 6 and 7 show the almost total absence of achievement of environmental flow targets over the last decade. The only element consistently achieved has been summer low flows in Reach 4 and in recent years the summer freshes. These flows have been provided by active deployment of Inter-Valley Transfers from the Goulburn River.

However, in the wet 2010/11 year, almost all environmental flow targets have been met, which should have started the environmental recovery in the river after the stresses of the extended drought.

It is therefore important to continue the recovery in 2011/12 by providing environmental flows, and particularly the winter flow components that have been absent for so long.

4. Environmental Watering Proposal

4.1 Seasonally adaptive approach

The North Central CMA has been using a scenario based approach for the past 3 years for environmental water planning. This provides a seasonally adaptive basis for water planning covering a range of possible climatic conditions on the river.

The seasonally adaptive approach identifies the priorities for environmental watering depending on the amount of water available in a given year, the water corporation's management of the river and natural flows in the system. It is a flexible way to deal with short-term climatic uncertainty and helps to guide annual priorities, setting objectives and management principals for the coming season.

The seasonally adaptive approach has been used to guide the watering regime under various climatic scenarios. The process involves considering the minimum flow components (and related water volumes) needed to meet targeted ecological objectives. Objectives and flow components are added or changed as required as inflows increase and environmental water availability increases or decreases under any particular scenario.

The intention is that this approach builds flexibility to adjust to circumstances as they unfold to achieve ecological objectives.

4.2. Priority flow components

The Campaspe River system downstream of Lake Eppalock has been broken into 3 environmental flow reaches. Reach 2 from Lake Eppalock to the Campaspe Weir has some of the highest environmental values in the river. This reach also has the highest irrigation demand, which dominates river flows during the irrigation season. The remainder of the river from the Campaspe Weir to the confluence with the Murray River is environmental flow Reaches 3 & 4. Irrigation demand in these reaches is low in comparison to Reach 2 and is not so heavily influenced by irrigation demand. A key difference in this section is the ability to use the Inter-Valley Transfer to deliver water to the river downstream of the Campaspe Siphon (Reach 4).

4.3. Scenario Planning

To plan for the best use of the likely environmental water available for the 2011-12 season, three scenarios have been considered. Each scenario details the possible use of water from all sources, subject to approval from the relevant managers. These scenarios have been developed across the inflow record and are the critical decision points for environmental water management decisions.

Please note that there is no scenario above 50% POE as there is no change in environmental water management decisions required as inflows increase above 50% POE.

Drought

The drought scenario (Table 8) is based upon the 2006-07 inflow record for the Campaspe System, the record low inflow season. Under this scenario, there are effectively no unregulated/natural river flows. Passing flows required under the BE are also limited due to the ‘or natural clause’.

As there would be no winter/spring flow, the highest environmental priority is to provide the recommended winter base flow in Reach 2 of 100 ML/day, along with some variability in flow to mimic a natural system. This will be higher than the ‘or natural’ flow under these conditions, but given the past 10 years, it is important to significantly improve the flows to enable good environmental recovery to continue.

The next highest priority is to provide one of the 4 recommended winter high flow events of 1,000 ML/day for four days. As well as allowing for some fish migration and other benefits, this also removes organic matter from the river banks and benchs and hence reduces the risk of Blackwater events in the summer.

The proposed winter low flows and high flow event in Reach 2 will flow through Reaches 3 and 4 to the Murray River, providing some winter flows along the entire river length. However, the flows will be less than those recommended for Reaches 3 and 4, as there is insufficient environmental water to meet these higher flow needs.

Summer flows in Reach 2 will be much higher than environmentally desirable due to the high availability of irrigation water and high irrigation demand.

Summer flows of 10 to 20 ML/day will be provided in Reach 4 by Goulburn-Murray Water to deliver irrigation and domestic and stock demands. However, experience from previous seasons shows that with losses this flow struggles to reach Echuca. Hence the third environmental priority is to top up these flows (to no more than 20 ML/day) using Inter-Valley Transfers to achieve the desirable 10 ML/day at the lower end of the reach. With releases for irrigation, the low flows in Reach 3 should be at desirable levels.

The three summer freshes of 100 ML/day for six days in Reach 4 should also be provided as in the past 3 years. However, it is proposed that they be provided from Lake Eppalock to provide summer freshes in Reach 3 and some flow variability in Reach 2. Some water for increased losses will be required, but this will be a minor volume in comparison to past years.

The plan identifies a requirement of 18,200 ML, reserving 3,000 ML to respond to summer water quality issues or for deployment to support minimum flows in the 2012 winter.

If additional environmental water can be made available, up to 16,000 ML could be deployed to increase the number of winter high flows from 1 to 4 in Reach 2. Further water would be used to increase the high flows to meet the recommended flows for Reach 4.

Dry

The Dry scenario (Tables 8 & 9) is based upon the 80% inflow probability of exceedance. Under this scenario, there will be storage spills and catchment run off providing some of the required winter base and high flows. During the traditional spring inflow period, there will be high passing flows available. Storage spills will reduce the volume of carryover water available, reducing the number of environmental objectives that can be targeted.

With a variable winter low flow being provided by catchment runoff and Lake Eppalock spills, it is proposed that little topping up of the winter flow be provided. This is consistent with the ‘or natural’ clause in the environmental flow recommendations.

The highest priority under this scenario therefore shifts to providing an increased number of high flow events in Reach 2. With a reduced 15,600 ML of environmental water potentially available, the objective is to top up small natural events and/or create events to deliver some or all of the recommended 4 events.

As in the dry scenario, the natural winter low flows and the enhanced or created high flow events will flow through Reaches 3 and 4, but not at the recommended flow rates for those reaches.

As for the drought scenario, the next priority is to provide the desirable summer flow regime in Reach 4, topping up the low flows and providing the 3 summer freshes. In this scenario, all of the summer flows for Reach 4 would be provided using Inter-Valley Transfers, to maximise the use of Eppalock water for the winter high flow events.

The plan identifies requirement of 12,600 ML, reserving 3,000 ML to respond to summer water quality issues or for deployment to support minimum flows in the 2012 winter.

If additional environmental water can be made available, water would be deployed to ensure provision of the 4 winter high flows in Reach 2. Further water would be used to increase the high flows to meet the recommended flows for Reach 4, to provide the Reach 4 summer freshes from Lake Eppalock (rather than IVT), and to increase the Reach 2 winter low flows.

Average

The Average scenario (Tables 8 & 9) is based upon the 50% inflow probability of exceedance of inflows. Under this scenario, due to full storage at the commencement of the water year there will be storage spills and catchment run off providing much of the required winter base and high flows. During the traditional spring inflow period, there will be high passing flows available. Storage spills are likely to spill all carryover water available, reducing the number of environmental objectives that can be targeted.

The highest priority in this scenario is to top up the natural winter high flow events in Reach 2. The storage spills and some catchment run off will provide a high level of base flows and some high flows in the system during winter and spring. The preference is to top up these naturally occurring high flow events to ensure compliance with the environmental flow recommendations and ecological objectives. The enhanced winter base flow will traverse throught out Reaches 3 and 4 to reach the Murray River; providing the winter base and high flows to the entire river.

The next priority is to top up the summer base flows and three summer freshes of 100 ML/d for six days to Reach 4. Under the BE, passing flows for this reach will be in excess of the summer based flow, so should be banked and later used to provide the summer freshes. Due to the likelihood of storages spilling and the passing flows account being the first to spill, there is a risk that these withheld flows will be lost. Should this occur, the water would need to be sourced from an alternative source.

Under this scenario, more of the desired river flows are provided naturally, however environmental water and management options are lost with the storages spilling. Approximately 7,100 ML of water would be carried over under this scenario for use next season.

This proposal (2011-12) is to remain in operation until such a time as the subsequent Seasonal Watering Proposal (2012-13 season) has been endorsed by the Victorian Environmental Water Holder.

4.4 Water deployment

The proposal has been based on full access to the current CEWH and TLM entitlements available in the Campaspe supply system. These entitlements do not allow the full environmental flow needs to be met under the drought and dry scenarios, but are sufficient under the average scenario assuming the timing proposed for the Campaspe is consistent with downstream flow needs.

Water delivery would commence on 1 July to provide winter low flows under drought/dry conditions. Depending on catchment runoff, opportunities to top up high flow events would be taken, with creation of high flow events pursued later in the winter/spring.

If conditions are dry, it is important to commence deployment of the TLM extended use water as early as possible, to maximise its use its loss through spilling. The CEWH carryover water could be locked up until October/November, but there is adequate water under CEWH and TLM 2011-12 allocations and TLM extended use to provide the winter/spring flow components planned.

The decision on what Reach 4 summer flow components to supply from Lake Eppalock or IVT would be made after the winter/spring flow period and its associated environmental flow delivery.

Table 8: Summary of environmental conditions, ecological objectives and environmental water requirements under a range of climatic scenarios

	CAMPASPE RIVER – REACH 2-4	DROUGHT	DRY	AVERAGE
INFLOWS AND SYSTEM OPERATIONS	Water inflows and supply	**Repeat of 2006/07 inflows**	**Estimated 80% POE**	**Estimated 50% POE**
		Expected 100% HRWS and LRWS allocation	**Expected 100% HRWS and LRWS allocation**	**Expected 100% HRWS and LRWS allocation**
	River Flows	• Effectively no unregulated river flows • Minimal flows from Lake Eppalock during winter for stock and domestic supply • High summer irrigation flows in Reach 2 • Low summer irrigation flows in Reach 3 & 4	• Some Eppalock spills & catchment run off will provide some base and winter high flows • Moderate to high summer & possibly autumn irrigation flows (Reach 4) • Low summer irrigation flows in Reach 3 & 4 • High passing flows	• Frequent and potentially high unregulated river flows during winter/spring from Eppalock spills and catchment runoff • Potential to receive bankfull or over bank flows • Moderate summer irrigation flows in reach 2 • Low Summer irrigation flows in reach 2
ENVIRONMENTAL ENTITLEMENT AND ALLOCATION	Rules based entitlements	Minimal Passing flows (or natural clause)	• High level of passing flows • Limited ability to bank passing flows due to storage spills	• High level of passing flows • Limited ability to bank passing flows due to storage spills
	Potential managed entitlements and other sources which may be available	CEWH 5,500 ML	CEWH 5,500 ML	CEWH 5,500 ML
		TLM 5,100 ML	TLM 5,100 ML	TLM 5,100 ML
		Carry-over 10,600 ML	Estimated 5,000 ML (CEWH lost through storage spills)	Carry-over Nil (lost through spills)
		Total 21,200 ML	Total 15,600 ML	Total 10,600 ML
	Managed entitlements other sources which have been agreed to and `locked away'	CEWH 5,500 ML	CEWH 5,500 ML	CEWH 5,500 ML
ECOLOGICAL OBJECTIVES	Environmental Objectives	**Top up/ provide Winter Low Flow (100 ML/d or natural) to Reach 2** • Longitudinal connectivity for fish • Limit effect of cold water releases for fish • Maintain macro access to riffles and WQ • Maintain permanent connecting flow		All winter/spring flows met from storage spills, unregulated flows and catchment run off
		Provide 1 Winter High Flow (1000 ML/d for 4 days) to Reach 2 • Reduce encroachment of exotics and terrestrial vegetation • Enhance River Red Gum recruitment • Cue fish movement and allow movement to downstream • Mix and flush pools for WQ and macro diversity • Respond to Blackwater events as required	• **Create/ top up 4 Winter High Flows (1000 ML/d for 4 days)** • Reduce encroachment of exotics and terrestrial vegetation • Enhance River Red Gum recruitment • Cue fish movement and allow movement to downstream • Mix and flush pools for WQ and macro diversity • Respond to Blackwater events as required	
		If required top up summer base flows to 20 ML/d in Reach 4 • Maintain aquatic vegetation • Maintain habitat for fish • Maintain constant flow to reduce salinity and preserve oxygen levels • Maintain macroinvertebrate habitat habitate	**If required top up summer base flows to 20 ML/d in Reach 4** • Maintain aquatic vegetation • Maintain habitat for fish • Maintain constant flow to reduce salinity and preserve oxygen levels • Maintain macroinvertebrate habitat habitate	**If required top up summer base flows to 20 ML/d in Reach 4** • Maintain aquatic vegetation • Maintain habitat for fish • Maintain constant flow to reduce salinity and preserve oxygen levels • Maintain macroinvertebrate habitat habitate
		Provide 3 summer freshes after 1 February of 100 ML/d for 6 days in Reach 4 • Maintain riparian and in channel vegetation recruits • Provide longitudinal connectivity and cue fish movement from the Murray River • Flush and mix river pools to reduce salinity & improve oxygenation levels • Inundate additional snags and wash sediments off biofilms for macroinvertebrates	**Provide 3 summer freshes after 1 February of 100 ML/d for 6 days in reach 4** • Maintain riparian and in channel vegetation recruits • Provide longitudinal connectivity and cue fish movement from the Murray River • Flush and mix river pools to reduce salinity & improve oxygenation levels • Inundate additional snags and wash sediments off biofilms for macroinvertebrates	**Provide 3 summer freshes after 1 February of 100 ML/d for 6 days in reach 4** • Maintain riparian and in channel vegetation recruits • Provide longitudinal connectivity and cue fish movement from the Murray River • Flush and mix river pools to reduce salinity & improve oxygenation levels • Inundate additional snags and wash sediments off biofilms for macroinvertebrates
		Reduce all river flows during summer	Reduce all river flows during summer	Reduce all river flows during summer
		Minimise low dissolved oxygen risks (especially hot summer months) for fish	Minimise low dissolved oxygen risks (especially hot summer months) for fish	Minimise low dissolved oxygen risks (especially hot summer months) for fish

<table>
<tr><th></th><th>CAMPASPE RIVER – REACH 2-4</th><th>DROUGHT</th><th>DRY</th><th>AVERAGE</th></tr>
<tr><td></td><td>Priority flow components</td><td>1. Provide winter low flows to Reach 2
2. Provide 1 winter high flow to Reach 2
3. Top up summer base flow in Reach 4 (IVT)
4. Summer freshes to Reach 4 (from Eppalock)
5. Mitigate water quality</td><td>1. Winter high flows to Reach 2
2. Top up summer base flow in Reach 4 (IVT)
3. Summer freshes to Reach 4 (IVT)
4. Mitigate water quality</td><td>1. Sumer base flows and freshes in Reach 4
2. Mitigate water quality</td></tr>
<tr><td rowspan="3">ENVIRONMENTAL WATER PROPOSAL*</td><td>Estimated volume to meet ecological objective above current commitments (per component and in total)</td><td>1. 9,900 ML
2. 5,300 ML
3. 800 ML
4. 3,000 ML
5. Mitigate water quality#

Total 19,000 ML</td><td>1. 12,600 ML
2. 800 ML
3. Mitigate water quality#

Total 13,400 ML</td><td>1. 3,000 ML
2. Mitigate water quality#

Total 3,000 ML</td></tr>
<tr><td>Estimated volume of carryover</td><td>2,200 ML</td><td>2,200 ML</td><td>2,100 ML</td></tr>
<tr><td>Total environmental water required</td><td>13,500 ML</td><td>7,900 ML</td><td>3,000 ML</td></tr>
</table>

No volume specifically set aside for declining water quality, should water quality problems arise volume to be taken from carryover

4.4. Proposal for water use

To meet the ecological objectives in the Campaspe River system, the North Central CMA has identified a short-fall in environmental water under three management scenarios with the volumes required outlined in Table 9. This water will be delivered in line with the environmental objectives listed in section 2.1.

Table 9. Additional environmental water required to meet ecological objectives for the Campaspe River System

Campaspe River	DROUGHT	DRY	AVERAGE
Total environmental water required	13,500 ML	7,900 ML	3,000 ML

5. Environmental Water Delivery

5.1. Risk assessment and management

The delivery of environmental water will provide many benefits to the Campaspe River system environment and its associated ecosystems. There is however, inherit risks when delivering environmental flows to a natural system that needs to be considered and appropriate mitigating actions (if available) need to be considered. The North Central CMA assesses risk on an ongoing basis through out the season, providing a constant review of possible mitigation actions.

The key risks are:

5.1.1 Blackwater Event

Black water events are a naturally occurring phenomenon in the Campaspe River. They are characterised by the dark appearance of the water and are usually associated with low dissolved oxygen levels. Increased flows entrain organic material from in-channel benches or from previous dry tributaries. Decomposition of the organic material leads to increased bacterial action and oxygen consumption, releasing dark tannins. Severe events can result in anoxic conditions throughout the water column and elevated water temperatures due to increased absorption of solar radiation from the waters dark colour. The principal risk from this process is a major fish death incident.

The release of previous managed high flow events indicates that these flows can trigger Blackwater events. It is considered that the risk is reduced, but not eliminated for the 2011-12 season. The previous high flow events were made to a flow stressed river during the drought. Scientific advice from Cottingham et al (2010) provided two management actions to reduce the risk of triggering a Blackwater Event and reducing the impacts should it occur.

Summer freshes should not be delivered unless the river’s organic matter that has accumulated over the previous summer has been flushed by high spring-early summer flows. Under all three scenarios, winter base flow and at least one winter high flow event will be provided to all reaches of the Campaspe River. This will flush any accumulated organic matter from the river channel reducing the risk of a Blackwater event occurring later in the summer.

The second management action is that a fresh will not be initiated unless there is sufficient water available to follow up the fresh and overcome the reduced dissolved oxygen levels through dilution and reaeration from flow. In each of the planning scenarios, there is sufficient carry over volume available to provide these flows if required.

5.1.2 Winter high flow events

A key management action is the delivery of winter high flow events from Lake Eppalock to the Murray River. These flows ramping up to 1,000 ML/d for four days with managed rise and fall rates will be well contained within the channel of the Campaspe River and will not exit the banks to inundate the floodplain or adjoining private land. Reach 4 has the smallest channel capacity at 9,000 ML/d, ensuring sufficient channel capacity above the maximum managed flow release of 1,500 ML/d should a rainfall event occur simultaneously. Should the river be in flood, it will not be necessary to deploy a winter high flow event and the risk of unintentional floods is therefore considered low.

5.2. Costs

Water delivered in accordance with the North Central CMA advisory role for G-MW's Bulk Entitlement water has no costs for delivery of head works. Water delivery by other holders such as the CEWH or TLM may be subject to management costs.

6. MONITORING

The monitoring program for the Campaspe River system is outlined in Table 11. The principal monitoring program for the release of environmental water on the Campaspe River is the Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP). This is primarily a longer term monitoring program with the objective of assessing the changes to the river through the provision of a long term flow regime. The program provides web based instantaneous water quality measures at 4 sites along the river. This can be used for adaptive management of the rivers water quality, providing the ability to intervene early should water quality problems arise during a water delivery. Additionally ad hoc, monitoring will be undertaken as required by North Central CMA staff.

Table 11. Environmental Water monitoring for the Campaspe River

Monitoring	Objective	Flow component	Indicator(s)	Monitoring sites	Frequency	Other considerations
Victorian Environmental Flows Monitoring Program (VEFMAP)	Evaluate ecosystem responses to environmental flows	Full flow regime	• Flow • Channel features • Habitat survey • Vegetation survey • Fish survey • Water quality	17 sites located between Lake Eppalock and Murray river	• Fish – annually • Other parameters- every 5 years	Long-term monitoring program which aims to generate information about long-term ecosystem responses at a 5-10 year timeframe
VEFMAP continuous water quality monitoring	Real time WQ monitoring	Various	Continuous water quality monitoring probes measuring • Dissolved oxygen • salinity • water temperature	• Reach 2 -Doakes reserve and Backhaus Road • Reach 3 – Bonn Road • Reach 4 – Fehrings Lane	Real Time	N/A
Photo point monitoring	Demonstrate delivery of flow components	Various	N/A	Various	As required	As required
Field observation	Observe ecological responses	Various	N/A	Various	As required	As required

7. Communications

The North Central CMA has developed a communication and engagement plan for the management of the EWR in the North Central Region. Communications for the Campaspe River environmental water delivery will be in accordance with this plan. Stakeholders, their level of influence and water delivery impact have been identified and are listed in Table 12.

Table 12 - Stakeholders for Environmental Water delivery in the Campaspe River

Target group	Project stakeholder	Degree of influence (H, M, L)	Degree to which water deliveries will impact on them (H, M, L)
General community	Diversion licence holders Farmers Irrigators Landholders Recreational Water users	M M M L L	H H H L L
Stakeholder groups	CEWAG/LEWAG	H	H
Bulk Entitlement holders	Storage operators and holders of the Bulk Entitlements Goulburn-Murray Water Coliban Water Central Highland Water	H	H
Partners	DSE DPI VEWH CEWH	H M H H	H M H H
North Central CMA employees (Board, Staff and NRMC)	North Central CMA Board Natural Resource Management Committee	H M	H M

Degree of influence refers to the extent to which this stakeholder can impact environmental water delivery. Stakeholders whose buy-in is highly critical to the success are considered as high.

Degree of impact reflects the extent to which environmental water delivery potentially will impact on them and their area of responsibility.

Based upon the assessment in Table 12, each of the groups will require a different level of engagement. An action plan has been developed that details the level of engagement required, timelines and appropriated tools for engagement detailed in Table 13.

Table 13 - Action plan for management of environmental water in the Campaspe River System

Activity	Target audience / stakeholders	Level of communication and engagement (Refer to section 5)	Timeline
Environmental water being delivered will be advertised in relevant papers when: • The environmental water release is new • It is the first environmental water release for the season • There are noticeable changes in the water of the river • There is a significant increase/reduction of flows • There are risks to the community	General Community	Inform	Before water is deployed and ongoing
Regular updates of environmental water delivered in the North Central CMA region • Webpage update • Other communications as required	General Community	Inform	Ongoing
Campaspe Environmental Water Advisory Group • Regular meetings • Other communications as required	Stakeholder group	Consult/collaborate/involve	March and May Annually
Communicating with Bulk Entitlement Holders in aspects of Environmental Water management • Regular meetings • Other communications as required	Bulk Entitlement holders	Collaborate/inform	Ongoing
Environmental Water planning and delivery • Regular meetings • Other communications as required	Partners VEWH CEWH	Collaborate/inform	Ongoing
Inform and engage partners • Weekly eflow update • Meetings as required	Partners VEWH CEWH DSE DPI	Inform	Ongoing
Update Board	North Central CMA Board	Involve	Quarterly Basis
Update Natural Resource Management Committee	NRMC	Inform	As required

Definition:

Inform: To provide with balanced and objective information to assist them in understanding environmental flow releases

Consult: To obtain feedback on analysis, alternatives and/or decisions.

Involve: To work directly with throughout the process to ensure that concerns and aspirations are consistently understood and considered.

Collaborate: To partner with in each aspect of the decision, including the development of alternatives and the identification of the preferred solution.

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VICTORIAN ENVIRONMENTAL WATER HOLDER

GOULBURN BROKEN CATCHMENT MANAGEMENT AUTHORITY

Seasonal Watering Plan 2011–12

Schedule 9: Goulburn system

State Government Victoria

Schedule 9:
Goulburn system

This schedule is the seasonal watering proposal prepared by Goulburn Broken Catchment Management Authority. It has been accepted by the VEWH and now forms part of the *Seasonal Watering Plan 2011–12*. As such, it incorporates any changes resulting from feedback from the VEWH.

The seasonal watering plan outlines the environmental watering actions that are a priority in 2011–12. It considers the actions that would occur under a range of planning scenarios. As conditions unfold and water becomes available throughout the year, seasonal watering statements will be released to communicate decisions on environmental watering actions and to authorise Goulburn Broken Catchment Management Authority to implement those decisions.

The VEWH acknowledges and thanks Goulburn Broken Catchment Management Authority for their hard work and dedication in developing the seasonal watering proposal and inputting to the *Seasonal Watering Plan 2011–12*.

Please contact the VEWH or Goulburn Broken Catchment Management Authority for more information.

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Executive summary

This is a proposal to use available environmental and other water to maximise the environmental outcomes in the Goulburn River in 2011/12. The plan focuses on the Goulburn River between Goulburn Weir and the Murray River which has the lowest flow regime within the regulated reaches of the Goulburn River. Releasing flows for this reach can also provide benefits to the reach between Lake Eildon and Goulburn Weir in dry winter/springs.

The conditions leading into the 2011/12 year have involved several years of an extended drought with low river flows, particularly in the Goulburn River between Goulburn Weir and the Murray River, followed by extremely wet conditions in 2010/11 where all environmental flow objectives have been met by natural catchment runoff. With the prolonged drought causing river health degradation, the wet 2010/11 has started the ecological recovery of the river.

The focus of the 2011/12 proposal for environmental watering is therefore to continue the ecological recovery, particularly focussed on the winter/spring flows which were so absent during the drought years. This involves providing increase minimum flows up to 830 ML/day at Murchison and a good spring fresh to 5,600 ML/day at Murchison (and desirably another winter/spring fresh).

Improved summer/autumn minimum flows of 940 ML/day at McCoys Bridge and one or two freshes to 5,600 ML/day are also proposed, using inter valley transfers or environmental entitlements.

Overbank flows occurred in 2010/11 and hence are not required in 2011/12. Given risks associated with delivery of overbank flows, they are not to be delivered in the immediate future in any case.

The proposal considers environmental water management under a range of possible climate scenarios from extremely dry to very wet. Under the dry scenarios, all of the environmental entitlements are used to provide improved winter/spring flows, while inter valley transfers provide improved summer/autumn flows. However, under the average to wetter scenarios, winter/spring flow needs are provided by catchment runoff, and the availability of inter valley transfers decreases dramatically, resulting in the environmental entitlements progressively transitioning to providing the improved summer/autumn flows.

The volumes of environmental water sought in 2011/12 under each scenario are summarised in the following table, consisting of the water use possible under the existing Goulburn environmental entitlements and carryover if all allocated to the Goulburn River, plus additional water that could be used if available.

GOULBURN RIVER – REACH 4 and 5	WORST DROUGHT	VERY DRY	DRY	AVERAGE	WET	VERY WET
Total environmental water planned	113	151	210	137	155	172
Additional water usable	97	63	34	Nil	Nil	Nil

In summary, the Goulburn Broken CMA is seeking access to, or be involved in the timing of releases of, all the water available under environmental entitlements in the Goulburn system (Commonwealth, Living Murray and State), and preferably additional water, under the drier climates. Under average to wetter climates, less of the water available under the environmental entitlements is required.

Importantly, the Goulburn environmental flow study defines a range of flow components that need to be optimised. The proposal specifies bulk water volumes required to achieve various environmental objectives. However, as the season unfolds, the design of specific flow regimes to optimise outcomes will be required, requiring flexible and adaptive water deployment.

This proposal does not take account of competing needs for environmental water use from either other river/creek systems or downstream along the Murray River. Nor is it a good guide to longer term flow needs in the Goulburn River given its dependence on current and recent seasonal conditions.

As all of the flows proposed are well within the river channel, there is very low risk of adverse outcomes from releasing environmental water.

Table of Contents

Chapter 1 Introduction

This seasonal watering proposal describes the Goulburn River catchment and sources of water available for environmental use, outlines the current condition of the Goulburn River and requirements for environmental flows in 2011/12.

This proposal is not a good guide to longer term flow needs in the Goulburn River given its dependence on current and recent seasonal conditions.

1.1 System overview

Based on water supply infrastructure the Goulburn River can be divided into 3 reaches:

- upstream of Lake Eildon,
- between Lake Eildon and Goulburn Weir (Lake Nagambie), and
- from Goulburn Weir to the Murray River.

The Goulburn River upstream of Lake Eildon is a natural waterway and does not need improvement to its environmental flow regime, and thus is not considered in this plan. The river downstream of Lake Eildon has been divided into five reaches for environmental flow studies and management as shown in **Figure 1**.

Lake Eildon has a capacity of 3,334 GL which is approximately twice the average annual flow in the Goulburn River at the storage. With such a large storage capacity, the storage fully regulates upstream flows in all but wet years (GBCMA, 2008).

Between Lake Eildon and the Goulburn Weir flows are seasonally reversed; meaning flows are greatly reduced in winter/spring and greatly increased in summer and autumn. The majority of irrigation water is diverted from the Goulburn River at Goulburn Weir (Nagambie) into channels. A large majority of the water flowing from Eildon to Goulburn Weir is for irrigation delivery and management, and somewhat limits the ability to manage the water for environmental purposes. Consequently most management of environmental water occurs from Goulburn Weir downstream.

Goulburn Weir, located at Nagambie, holds 25 GL and is usually held close to full for the diversion of water into irrigation channels and to supply Waranga Basin (capacity of 432 GL). Waranga Basin is used to store winter/spring flows from tributaries downstream of Lake Eildon (GBCMA, 2008).

Downstream of Goulburn Weir, river flow is reduced throughout the entire year but does retain some seasonal flow pattern. Tributaries in this reach are mostly ephemeral and add natural flows to the river, including the Broken River that joins the Goulburn River at Shepparton. In recent years significant flows have been released in summer and early autumn from Goulburn Weir to the Murray River as Inter Valley Transfers (IVT) to supply entitlements traded from the Goulburn system to the Murray system.

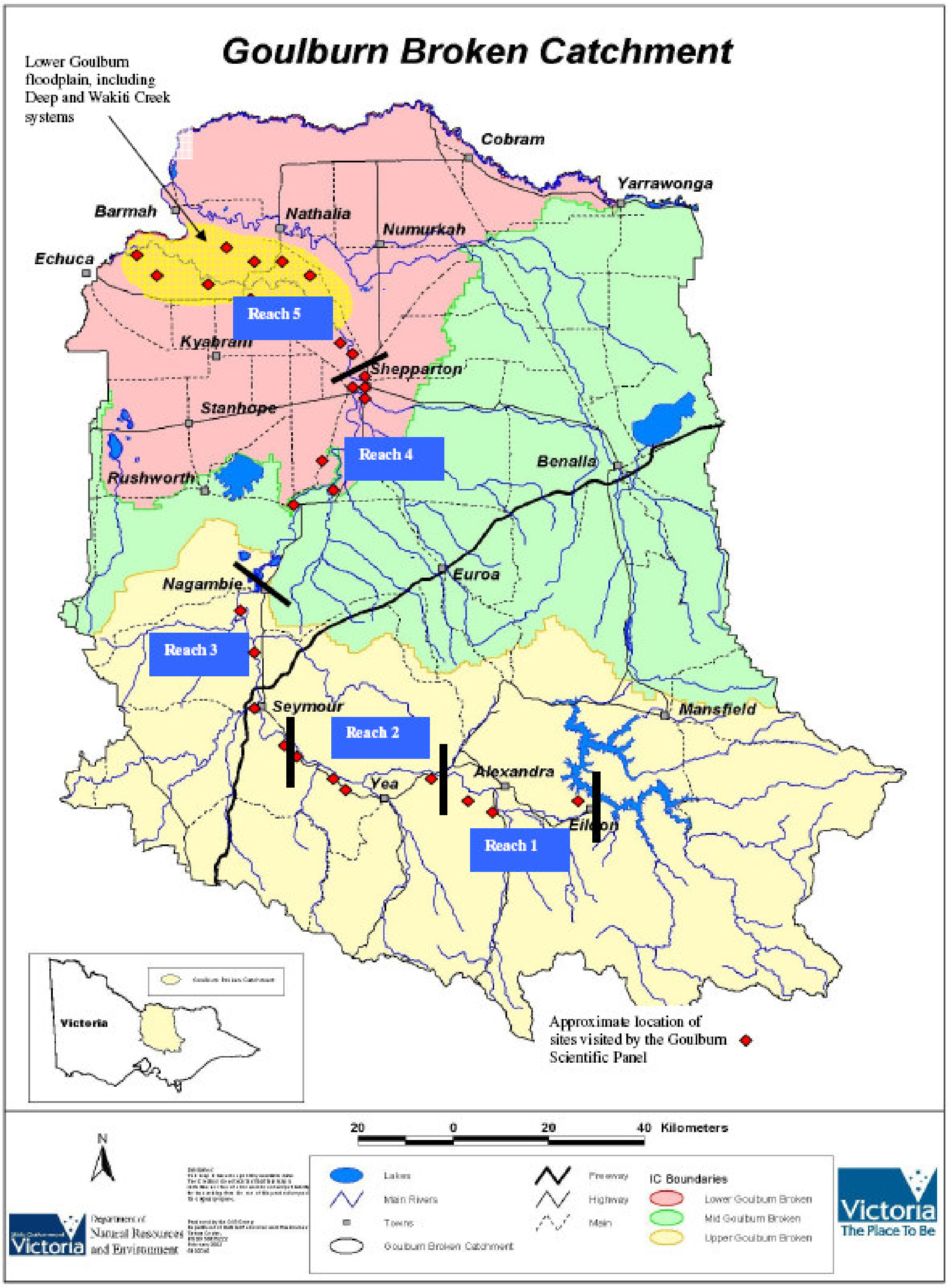

Figure 1 – Goulburn River catchment showing environmental flow study reaches (Cottingham *et al.*, 2003)

1.2 Sources of water

Environmental water for the Goulburn system is available through rules of the Bulk Entitlement (Eildon – Goulburn Weir) Conversion Order 1995 (and subsequent amendments).

The Bulk Entitlement provides for minimum passing flow requirements at the following locations:

- downstream of Eildon Pondage Weir,
- downstream of Goulburn Weir and
- at McCoys Bridge.

The Bulk Entitlement also has an allowance for water to be used to maintain water quality in the waterways. There is an extra passing flow allowance in the Bulk Entitlement for an additional 80 GL subject to high inflows to Lake Eildon for 24 months prior.

The bulk entitlement provisions, the potential inter valley transfers and the entitlements for environmental use are shown in **Table 1**.

Environmental entitlements are available in the Goulburn system, but are not specifically linked to use in the Goulburn (Commonwealth Environmental Water Holder Holdings, Victorian entitlements) or the release timing is determined by environmental priorities outside the system (Living Murray entitlements). However, theses volumes represent likely volumes that will be available for release through the Goulburn River. Additional volumes may be accessed via trade from other systems and while are considered in the planning are not specifically identified here

To provide a basis for planning for the 2011/12 year, all environmental entitlements are assumed to be available with their associated seasonal allocations and carryover volumes to improve Goulburn River environmental outcomes. The actual volumes available will be determined after discussion with the environmental entitlement holders.

Table 1 – Environmental water available to the Goulburn River

River reach	Flow requirements / volume	Conditions of flow requirements	Management responsibility
Bulk Entitlement water (passing flows)			
Eildon Pondage Weir	Minimum flow of 120 ML/day		Goulburn-Murray Water
Goulburn Weir	Minimum average weekly flow of 250 ML/day	at daily rate no less than 200 ML/day	Goulburn-Murray Water
McCoy Bridge gauging station	Minimum average monthly flow of 350 ML/day for November to June (inclusive)	at daily rate no less than 300 ML/day	Goulburn-Murray Water
	Minimum average monthly flow of 400 ML/day for July to October (inclusive)	at daily rate no less than 350 ML/day	Goulburn-Murray Water
Maintenance of water quality	30 GL per year		Resource Manager (Goulburn-Murray Water)
Additional passing flow below Eildon Pondage Weir	Minimum passing flow increased to 250 ML/day	Inflows to Lake Eildon for previous 24 months must reach a specified volume	Goulburn-Murray Water
	Up to 80 GL to provide up to 16,000 ML/day peak flow for one day	Inflows to Lake Eildon for previous 12 and 24 months must reach specified volumes, and the Secretary of DSE confirms the need for a release.	Secretary Department of Sustainability and Environment
Other sources			
Inter valley transfer	136 GL of High reliability water supply plus 260 GL of carryover	As needed in the Murray system, with some flexibility on when and how this water is moved from Eildon to the Murray system.	MDBA / River Murray Water
Commonwealth Environment Water Holder	78 GL - High reliability water shares with contracts for total of 120 GL	Water used subject to agreement with the CEWH	CEWH

River reach	Flow requirements / volume	Conditions of flow requirements	Management responsibility
(CEWH) (as at 28 Feb 2011)	10 GL - Low reliability water share Carryover between 40 and 70 GL		
Shepparton and Central Goulburn 1,2,3,4 Mitigation Water	1.5 GL - high reliability water shares 7.6 GL - low reliability water shares	Savings not currently available, but could be finalised during 2011/12	VEWH
NVIRP Water Savings	Volume based on works implemented and water losses saved in previous years climate – assumed 8 GL for 2011/12		VEWH
The Living Murray Water Entitlements (These entitlements are for use at Murray Icon Sites but need to pass down the Goulburn River to reach the Murray River)	39.6 GL High Reliability Water Share 157 GL Low Reliability Water Share	Water to be delivered in accordance with the Living Murray annual watering plan. Entitlements also have the provision for "extended use" i.e. allows an allocation to these entitlements to be used until 31 December in the next financial year after the allocation was made. Flow delivery at McCoys Bridge	MDBA

1.3 Consultation

Table 2 outlines the consultation process the GBCMA has undertaken during the development of this seasonal watering proposal.

Table 2 – Consultation during proposal preparation

Who	Role and Responsibility	Purpose of consultation	Mode and timing of consultation
Goulburn-Murray Water	Provision of information on water system outlooks and river management, and check feasibility of proposal	Consult	Personal discussion with key staff, March to June
MDBA	Management of inter valley transfer	Consult	Personal discussion with key staff in June
Parks Victoria	Advice on issues for Crown Land management	Consult	Personal discussion with key staff in May/June
DSE	Advice on policy issues regarding environmental water delivery	Inform/consult	Workshop and discussion with key staff in May/June
CMA board	Approval of proposal to send to VEWH	Approve	June Board meeting
Yorta Yorta	Advice on indigenous issues	Inform/consult	June/July
CMA Implementation Committees	Advice on community and river health issues	Inform/consult	June/July

Chapter 2 Ecological objectives

2.1 Environmental flow objectives

For the Goulburn River an environmental flows study was carried out in 2003 (Cottingham et al, 2003) and another in 2007 (Cottingham et al, 2007a). The 2003 study was one of the earliest flows studies in Victoria and focused on the whole Goulburn River downstream of Lake Eildon. The 2007 study was undertaken specifically to assess the impact and management of high summer flows resulting from Inter Valley Transfers in the lower Goulburn River (i.e. from Goulburn Weir downstream). Further studies were undertaken in the drought years between 2007 and 2010, including a fresh objectives study. Overbank flow recommendations in the Cottingham et al 2007 study were updated in a study by Department of Sustainability and Environment in February 2011 (DSE, 2011). These flows studies developed flow objectives and recommendations for the delivery of environmental flows in five reaches of the Goulburn River (**Figure 1**). The reach delineation was:

Reach 1: Lake Eildon to Molesworth

Reach 2: Molesworth to Seymour

Reach 3: Seymour to Nagambie

Reach 4: Nagambie to Loch Garry (downstream of Shepparton)

Reach 5: Loch Garry to the Murray River

The 2003 flows study is used in this proposal primarily for flow recommendations in Reaches 1 to 3 inclusive, and the 2007 study and the 2010 Freshes study and the 2011 Overbank Flow study provide the flow objectives and recommendations in Reaches 4 and 5.

The 2003 flows recommended targeting the following objectives:

- Vegetation
    a. enhance the extent and diversity of aquatic vegetation
    b. increased contribution to processes such as river productivity
    c. maintain diversity of riparian vegetation
    d. reduce the extent and impact of weeds
    e. maintain continuity and cover of riparian vegetation

- Floodplain
    a. enhance the extent and diversity of aquatic vegetation
    b. increased contribution to processes such as river productivity
    c. flood regime has all elements of a natural floodplain in terms of seasonality, frequency and duration
    d. connection of floodplain ecosystem components (e.g. grasslands, wetlands)

- Invertebrates
    a. biomass and trophic structures closely resemble local tributaries
    b. dynamic and diverse food webs
    c. diverse resilient communities through full range of physical conditions

- Fish
    1. suitable thermal regime for spawning, growth and survival stages
    2. suitable in channel and off channel habitat for all life stages
    3. fish passage for all life stages
    4. cues for adult migration during spawning season
    5. access to floodplain and off channel habitats for spawning/larval rearing
    6. low flows for spawning and recruitment
    7. floodplain and bench inundation for exchange of food and organic material

Based on these objectives, specific flows were developed to address channel attributes, reaches and flow components. In particular, the study focussed on flow changes required to the then current regime, rather than on the total regime required. The study did not take into consideration social or economic constraints and has recommended flows based purely on achieving an environmental outcome. **Table 3** details the recommended flows for the Goulburn River.

Table 3 – Goulburn River environment flow objectives (Cottingham *et al*, 2003)

Issue	Channel attribute targeted	Flow component	Reach	Flow recommendation
High water velocity	- In channel macrophytes	Summer low flow	1 – 3 (i.e. Lake Eildon to Nagambie)	Summer/autumn baseflow below 1,000 – 3,000 ML/day in Reach 1.
Duration of bench inundation	- Aquatic macrophytes - Macroinvertebrates - Biogeochemical processes (e.g. carbon and nutrient cycling)	Spring low flow and Summer low flow	1 – 4	
Availability of riffle habitat	- Macroinvertebrates - Fish	Summer low flow	1 – 3	
Availability of shallow water habitat	- In channel macrophytes - Small fish	Summer low flow	1 – 3	
Frequency of freshes	- Geomorphology - Aquatic macrophytes - Macroinvertebrates - Fish	Summer freshes	4 – 5	Current frequency of freshes maintained, with natural magnitude and duration
Frequency of wetland inundation	- Geomorphology - Wetland vegetation - Macroinvertebrates - Fish	Spring flood	1 – 5 (i.e. all reaches)	Annual flood of varying magnitude (15,000 – 60,000 ML/d peak magnitude). No action required if natural flood occurs
Duration of bench inundation	- In channel macrophytes - Macroinvertebrates	Spring and summer low flow/freshes		Experiment to evaluate extended duration of bench inundation events
Availability of deep water habitat	- Fish	Summer low flow	4 – 5	Minimum flow of 610 ML/day measured at Murchison
Rate of rise and fall in river levels	- In channel macrophytes - Macroinvertebrates - Fish	Rate of rise and fall	1 and 4	No specific volume required. Care is required to avoid rates of rise and fall exceeding 95th percentile values of the natural flow regime

In 2007, the second environmental flows study (Cottingham *et al* 2007a) was completed for Reaches 4 and 5 (between Goulburn Weir and the Murray River). This study primarily looked at the issues and appropriate limits of high summer flows resulting from the potential need for large inter valley transfers, but also specified desirable environmental flow regimes for the whole year.

The method used in the 2007 study was altered significantly from that used in 2003. The changes included going:

- from using a single flow to meet several environmental objectives, to specifying the flow required for each objective;
- to provide for between year flow variability; and
- to specifying different flows for two different levels of risk.

As such, the 2007 study provides a complex range of flow recommendations for each environmental objective for different times of year, in different years, and with different levels of risk to the environmental outcomes.

Ecological objectives from the 2007 study are outlined in **Table 4**.

Table 4: Ecological objectives for Reach 4 and 5 of the Goulburn River (Cottingham et al, 2007)

Ecological Attribute	Ecological objective	Notes	Seasons	Flow component	Range of flow
Geomorphic diversity					
	Avoid bank erosion (notching) due to long duration summer flows (Geo 1)	Makes it difficult for plants to colonise the bank face	Dec-Apr	Fresh and overbank (F025)	Reach 4 3,142 – 19,000 ML/day Reach 5 3,800 – 23,900 ML/day
	Avoid slumping caused by rapid draw down leading to mass failure of banks (Geo 2)	Reduced habitat value of banks + increased turbidity	Summer	Rates of fall	
	Reduced filling of pools and maintain pool depth by managing the redistribution of sand at regulated flows (Geo 3)	Reduced fish habitat?	Summer	Baseflow and fresh to overbank (F026)	Reach 4 856 – 19,000 ML/day Reach 5 1,096 – 23,900 ML/day
	Maintain bench accretion and erosion as per natural occurrence. Requirement for bench formation: reduction in rate of vertical accretion of concave benches, and increase in erosion of bench margins (restricted to upper third of target reach) (Geo 5)	Unique terrestrial habitat, consistent backwater area	Dec-Apr	Fresh	Reach 4 ~1,000 – 5,000 ML/day
	Maintain natural rate of disturbance for management of scour of aquatic macrophytes (especially *Vallisnaria)* (Geo 6)	Key aquatic plant	Dec-Apr	Fresh (F006)	Proportion of time when shear stress varies between 7 N/m^2 and 5 N/m^2
Planktonic algae					
	Biomass levels resembling sites unaffected by flow regulation	Food source for macro/micro invertebrates and fish	Spring-Summer	Fresh (F001 & F012 & F013)	
	Productivity consistent with supporting food webs comparable		Spring-Summer	Fresh (F002)	6,060 ML/day

Ecological Attribute	Ecological objective	Notes	Seasons	Flow component	Range of flow
	with sites unaffected by flow regulation				
Periphytic algae/biofilm					
	Productivity resembling sites unaffected by flow regulation and consistent with supporting comparable food wed to unregulated conditions		Spring-Summer-Autumn	Freshes (F016, F017, F018)	856-8080 ML/day
	Diverse community composition resembling sites unaffected by flow regulation				
	Biomass levels resembling sites unaffected by flow regulation		Spring, Summer, Autumn	(F014, F015, F016, F017)	
Submerged macrophytes					
	Production rates, biomass levels and community composition more resembling un-impacted sites and dynamic diverse food webs		Spring, Summer, Autumn (and winter)	Fresh (F014, F015, F016)	856-8080 ML/day
Bankside vegetation					
Terrestrial tussock grasses on riverbank	Abundance (cover) Increase abundance of grasses to minimise likelihood of extensive bank erosion Maintain persistent cover over part of the upper part of the bank	Flow critical: Duration of submergence (inundation) has potential to drown out terrestrial vegetation; critical values for duration expected to vary with season, whether cool (autumn-winter) or growing (spring-summer)	Dec - April	Fresh to overbank (F006)	1,096 – 23,900 ML/day

Ecological Attribute	Ecological objective	Notes	Seasons	Flow component	Range of flow
	Maintain composition that is mainly native species (notionally at least 75% by cover) Avoid conditions that favour significant riparian and aquatic weeds known to occur in the area.				
Terrestrial woody vegetation on river bank and within channel(shrubs and trees)	Prevent further encroachment of terrestrial shrubs and trees in channel.	Uses flow as agent so dependent on flow. Re-instating wetter conditions is expected to create anaerobic conditions in the substrate which if repeated annually will result in stress, loss of vigour, root weakening, and eventual death or toppling		Dec-April	1,096 – 23,900 ML/day
	Protect vigour of trees in existing River Red Gum woodland established on inset benches Minor role in carbon contribution through direct contribution of leaf litter	This objective is concerned with the risk of soil saturation through sustained or persistent inundation of wooded inset benches through high summer flows resulting in water logging.			
Macroinvertebrates					
Diversity - Biodiversity over space and time	Aquatic Veg (especially emergent) on banks and bars variable over years but similar (in sum) to natural. (MI1)		Summer (F007)	Baseflow	Reach 4 310 ML/day Reach 5 240 ML/day

Ecological Attribute	Ecological objective	Notes	Seasons	Flow component	Range of flow
	Range of snag habitats (natural inter and intra year distribution not significantly diminished) (MI2)		All (F008) (F004)	Baseflow Fresh	Reach 4 400 ML/day (summer/autumn) 830 ML/day (winter/spring) Reach 5 540 ML/day (spring /summer) 940 ML/day (winter/spring) Reach 4 – 856 – 1186 ML/day
	Low flow & slackwater zones maintained (similar to sites unaffected by flow regulation) (MI3)		Summer	Baseflow-Fresh	310 – 1,500 ML/day
	Litter packs available, augmented and free of excess sediment (MI4)		All (F003) All (F021)	Baseflow Overbank	Reach 4 - 540 ML/day Reach 5 – 770 ML/day Reach 4 & 5 – 32,700 to 55,000 ML/day
	Water quality appropriate to supporting range of MI taxa as per 'natural' (MI6)		All	Baseflow	Reach 4 - 540 ML/day Reach 5 – 770 ML/day
Native fish					
	Suitable thermal regime for spawning, growth and survival of all life stages	Increased flows may reduce warming of water downstream of Eildon	Summer	Nil	Nil
	Suitable in channel habitat for all life stages	Protect existing habitat and habitat restoration. Management of introduced species	All year (F007, F008)	Baseflow	Reach 4 – 500/400 ML/day Reach 5 – 320/540 ML/day
	Suitable off channel habitat for all life stages	Riparian and wetland floodplain management. Removal of unnecessary levees and block banks	Spring (F027)	Overbank	Reaches 4&5 24,000 ML/day
	Passage for all life stages of fish	Removal of instream barriers and/or installation of fish ladders	All Year	Baseflow	Bulk entitlement minimum flows adequate

Ecological Attribute	Ecological objective	Notes	Seasons	Flow component	Range of flow
	Cues for adult migration during spawning	Removal of instream barriers and/or installation of fish ladders	Spring, summer (F022/F023)	Rise and Fall Rates	Reach 4 2.20/0.38 rise 1.15/0.15 fall
	Low flows for spawning and recruitment		Summer (F008)	Baseflows	

In 2007, 2008, 2009, and 2010, the drought conditions and very low flows raised ecological questions not previously considered in the 2003 and 2007 studies. A panel of ecologists and hydrologists were gathered to assess the impact of the low flows to the ecosystem and develop recommendations for water management to minimise ecological risk in times of drought. These recommendations are included in a number of separate reports with recommendations specific to climatic conditions.

Importantly, in Cottingham et al (2010), the panel provided additional advice on the objectives for flow freshes in the lower Goulburn River for 2010/11. This report drew on the information provided in the 2007 report to design freshes.

Further, the Overbank Flow study in 2011 (DSE, 2011) set flow objectives for ecological features of the river and floodplain adapted from the 2003 flows study. These objectives are shown in **Table 5**.

Table 5: Adopted environmental assets, environmental objectives and flow objectives (modified from Cottingham et al., 2003) (DSE, 2011)

Ecological feature(s)		**Environmental asset(s)**	**Environmental objective(s)**	**Flow Objective(s)**	**Provided by the 25,000 ML/d recommendation** [1]	**Provided by the 40,000 ML/d recommendation** [1]
	Wetland	• Representative and natural plant communities • Habitat and refuge for small wetland and floodplain fauna • Contribute to river productivity	• Increase the extent and diversity of aquatic vegetation • Increase contribution of wetlands to processes such as river productivity	Provide a range of flood peaks: A. To provide suitable ponding duration for wetlands so that plant life cycles can be completed B. Of suitable frequency to provide a diversity of wetland wetting and drying patterns C. To maintain the natural connectivity to the channel from wetlands	✓ ✓ -	✓ ✓ ✓
Vegetation	Floodplain matrix	• Spatial and structural diversity • Connects floodplain features • Native plant communities • Heterogeneous floodplain mosaic	• Increase the extent and diversity of aquatic vegetation • Increase contribution of floodplain to processes such as river productivity • Connection of floodplain ecosystem components, including grasslands, woodlands, permanent and temporary wetlands	Provide a range of flood peaks: D. Of suitable duration so that understorey diversity is maintained i.e. maintain a balance between terrestrial, flood tolerant and flood dependent understorey species E. Of suitable frequency and duration to maintain the health of river red gums	✓ -	✓ ✓
	Floodplain connectivity with channel	• Heterogeneous floodplain hydraulic characteristics	• Maintain an open exchange between the river and the floodplain for propagules, carbon, nutrients and biota • Flood regime has all the elements of a natural floodplain	Provide a range of flood peaks: • As specified for flow objectives A, B, C, D and E F. Of suitable frequency to maintain permanent habitat in low lying wetlands for fish that are wetland specialists G. To provide opportunity for fish to recolonise and use low lying floodplain habitats H. To provide sufficient floodplain	refer to other objectives ✓ - -	refer to other objectives - ✓ ✓

[1] The final recommendations of 25,000 ML/d and 40,000 ML/d are presented in section 3 in DSE 2011. Their relation to the flow objectives is described in section4 in DSE 2011.

Ecological feature(s)		Environmental asset(s)	Environmental objective(s)	Flow Objective(s)	Provided by the 25,000 ML/d recommendation [1]	Provided by the 40,000 ML/d recommendation [1]
				inundation to facilitate exchange of propagules, carbon, nutrients and biota		
Macro-invertebrate	Wetland	• Processing organic matter and nutrients • Diverse food for fish and terrestrial vertebrates (birds, bats)	• Dynamic food webs maintaining wetland diversity and productivity	Provide a range of flood peaks: • As specified for flow objective A	refer to other objectives	refer to other objectives
		• Provide resilience and trophic support sustainability	• Diverse, resilient communities through full range of physical conditions (i.e. a broad spatial representation of hydrological regimes)	Provide a range of flood peaks: • As specified for flow objective B I. To provide suitable ponding duration for wetlands so that invertebrate life cycles can be completed	refer to other objectives ✓	refer to other objectives -
		• Productivity - food for fish & terrestrials	• Biomass expressed in diverse organisms supporting diverse floodplain system	Provide a range of flood peaks: • As specified for flow objective A	refer to other objectives	refer to other objectives
Fish	Floodplain and wetland	• Diversity of native fish • Naturally reproducing and self-sustaining populations of native fish • Populations of threatened and icon species	• Suitable off-channel habitat for all life stages of fish • Access to floodplain and off-channel habitats for spawning and/or larval rearing • Floodplain inundation for exchange of food and organic material between floodplain and channel	Provide a range of flood peaks: • As specified for flow objectives A, B, C, D, E, F, G and H	refer to other objectives	refer to other objectives
Bird	Colonial nesting waterbirds	• Representative and natural avian community	• Increase abundance by improving recruitment conditions • Achieve successful recruitment in as many years as possible	Provide a range of flood peaks: J. Of suitable frequency within a season to provide suitable ponding duration under nests (3 to 4 months) to facilitate successful breeding of target species K. Of suitable frequency between seasons to provide sufficient recruitment opportunities to support regional objectives	✓ ✓	- ✓
	Waterfowl:	• Representative and natural avian	• Increase abundance by improving	Provide a range of flood peaks:		

Ecological feature(s)		Environmental asset(s)	Environmental objective(s)	Flow Objective(s)	Provided by the 25,000 ML/d recommendation [1]	Provided by the 40,000 ML/d recommendation [1]
	longer flood durations (e.g. Musk Duck)	community	recruitment conditions • Achieve successful recruitment in as many years as possible	• As specified for flow objective K L. Of suitable frequency within a season to provide suitable ponding duration around nests (3 to 4 months) to facilitate successful breeding of target species M. To provide areas of deep water for feeding	refer to other objectives ✓ -	refer to other objectives - ✓
	Waterfowl: shorter flood durations (e.g. Freckled Duck)	• Representative and natural avian community	• Increase abundance by improving recruitment conditions • Achieve successful recruitment in as many years as possible	Provide a range of flood peaks: • As specified for flow objective K N. Of suitable frequency within a season to provide suitable ponding duration in the vicinity of nests (2 to 3 months) to facilitate successful breeding of target species	refer to other objectives ✓	refer to other objectives ✓
	Woodland birds	• Representative and natural avian community	• Increase abundance by improving recruitment and feeding conditions	Provide a range of flood peaks: O. To facilitate productivity and flowering opportunities for canopy and fructiferous species P. To maintain aquatic insect production for insectivores	✓ ✓	✓ ✓
Frog	Wetland frogs	• Representative and natural amphibian community	• Increase the diversity and distribution of amphibian species	Provide a range of flood peaks: • As specified for flow objective L (for long breeders) Q. Of suitable frequency within a season to provide suitable ponding duration around nests (approximately 1 month) as often as possible (for short breeders) – local rainfall events will significantly contribute to this	refer to other objectives ✓	refer to other objectives ✓

2.2 Optimal flow components and critical tolerances

For the Goulburn River from Goulburn Weir to Lake Eildon, the 2007 environmental flow study provides a variety of flow recommendations. With the exception of out of bank events, the recommendations are for each flow component every year. However, the rate of flow and the duration of flow can vary significantly within each flow component. The study proposed two duration variation criteria:

1. climatic conditions (from dry to wet to provide inter annual flow variability), and
2. low and moderate ecological risk (i.e. the risk of not achieving the ecological objective)

A range of recommended flows are included below:

Minimum flow at McCoys Bridge – 240 to 940 ML/day (310 to 830 at Murchison)

- Minimum flow in a median year with low ecological risk,
  - 540 ML/day is recommended for 99% of the time (all year),
  - 770 ML/day is recommended for 95% of the time (all year),
  - 940 ML/day is recommended for 95% of the winter/spring/summer and 80% of the autumn months.
- Minimum flow in a 90% Probability of Exceedance (dry) year with low ecological risk,
  - 540 ML/day is recommended for 99% of the time (all year),
  - 770 ML/day is recommended for 80% of the time in summer and winter, and 70% of the time in autumn and spring,
  - 940 ML/day is recommended for 70% of the summer, 50% of the autumn months, and 90% of the winter/spring months.
- Minimum flow in a median year with moderate ecological risk,
  - 540 ML/day for 80% of the time (all year),
  - 770 ML/day for 90% of the time (all year),
  - 940 ML/day for 55% of the summer/autumn and 80% of the winter/spring months.

In summary, the ecological preference is to have the highest minimum flow effectively for all the time, and if required, to take risk by reducing durations at the highest flow levels and generally more so in summer or autumn.

Freshes at McCoys Bridge in a median year with low risk – 1,500 to 6,600 ML/day

- Preferably two freshes of 14 days duration in winter/spring of up to 5,600 ML/day, with one in spring (October onwards) to align with warmer temperatures for Golden Perch breeding.

- Preferably two freshes of no more than four days duration in summer (and autumn) of up to 5,600 ML/day, separated by 30 or 60 days. A range of fresh flow rates and durations are specified for summer months and do not need to be in one event.
- A range of upper durations of fresh flows are also set for summer months to avoid the damaging outcomes from summer flow reversal. For example, in a median year with low ecological risk, flows between December and February should not exceed 3,800 ML/day for more than 20% of the time.

The overbank flow recommendations have been provided in the DSE 2011 report and are shown in Table 6 and Table **7**.

Table 6: Primary overbank flow recommendations

Period	**Component**	**Magnitude**	**Frequency (mean number of event years per 10 years)**			**Median duration**	**Maximum period between events**
			Lower	**Optimal**	**Upper**		
Jun - Nov	Overbank	25,000 ML/d	7	8	10	5+ days	3 years
Jun - Nov	Overbank	40,000 ML/d	4	5	6	4+ days	5 years

Rates of rise and fall to follow both 2003 and 2007 recommendations. The 2003 recommendations are for the maximum rate of rise to be 135% and maximum rate of fall to be 85%, expressed as change in discharge (p50). The 2007 recommendations are for the maximum rate of rise to be limited to 2.70-3.60 metres in winter/spring, and maximum rate of fall to be limited to 1.75-2.70 metres in winter/spring (p88).

Spell independence of 5 days as per 2007 recommendations (p86).

The compliance point for the recommendations is the Shepparton gauge (number 405204).

Table 7: Secondary overbank flow temporal distribution recommendations

Magnitude	**Mean number of event years per 10 years**			**Mean number of events in an event year**		**Mean number of events per 10 years**	
	Lower	**Optimal**	**Upper**	**Lower**	**Upper**	**Optimal**	**Natural**
25,000 ML/d	7	8	10	2	3	16 - 24	24
40,000 ML/d	4	5	6	1	2	5 - 10	16

Chapter 3 Flow prioritisation

3.1 2010/11 Season review

Between August and December 2010 the Goulburn River received a number of spring freshes and two overbank flows (Figure 2). The highest magnitude overbank flow occurred in early September (the 4th to 10th). This flood is rated as a 1 in 100 year flood on the Goulburn River at Dohertys (above Lake Eildon), a 1 in 8 year event at Seymour and a 1 in 10 year event at Shepparton. The overbank flow that occurred in December was not to the same extent. Between these two overbank events, a number of spring and summer freshes occurred and continued to occur well into summer.

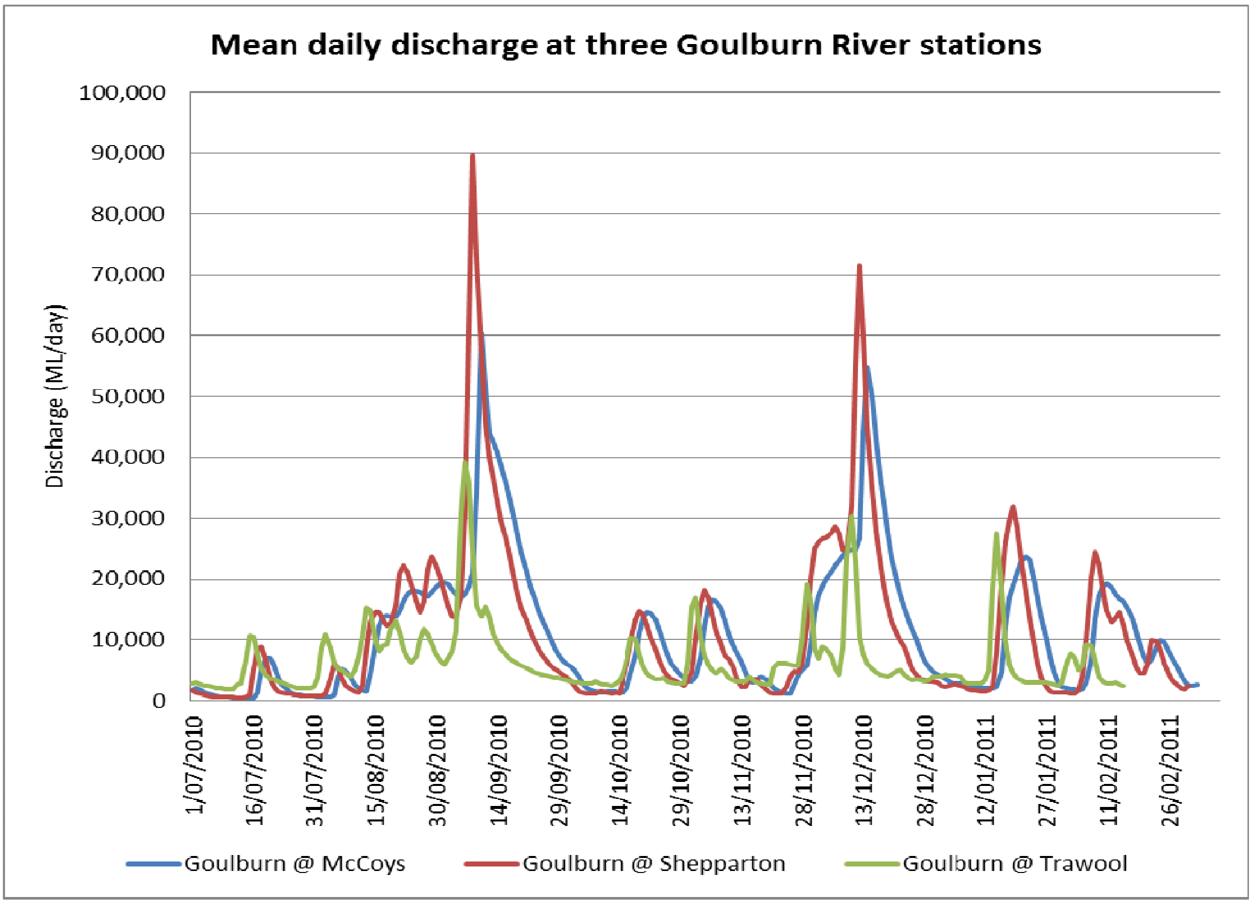

Figure 2: Goulburn River flows for 2010/11 at three locations downstream of Lake Eildon

Due to the above average unregulated flows in the catchment, environmental flow components have been delivered to the river naturally rather than through managed releases. However, some environmental water was delivered to the lower Goulburn River to manage low dissolved oxygen levels. During the season, DO levels regularly dropped to levels of concern (Figure 4 and Figure 3). This occurred during the first overbank flow in September 2010, and again in December, January and February. It appears that the high flows throughout the season have entrained organic material from the floodplain (flows of 17,000 ML/day at Shepparton would be starting to get onto the lower levels of the floodplain) which has resulted in a high oxygen demand in the river. A blackwater event and fish kills occurred with the drop in DO in December. The drop in DO levels in December was greater than that in September and is assumed to be a result of the increased water temperatures (7°C warmer in December than September).

Dissolved oxygen levels reached 0 mg/L throughout December to February at McCoys Bridge. Interestingly, the decrease in DO was consistent at the three levels of measurement in Shepparton, however stratification was obvious at McCoy's Bridge with the top probe generally displaying a noticeably higher DO level than the middle and bottom probes.

A quantity of 24,744 ML was used to improve water quality in the lower Goulburn River during 2010/11 following the December event. The sources of water varied from the Living Murray Entitlement, the Goulburn Water Quality Reserve and the Murray Flora and Fauna Bulk Entitlement.

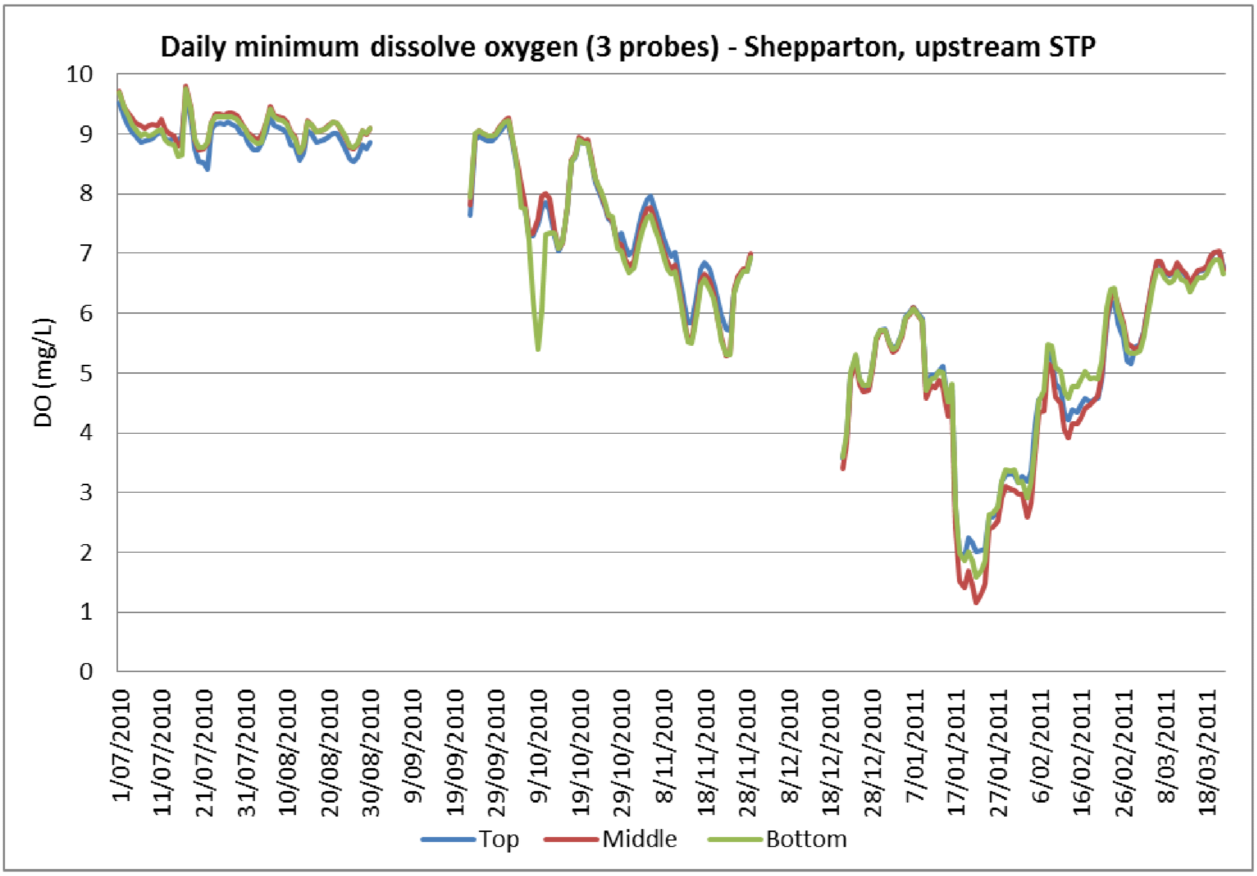

Figure 3: Dissolved oxygen levels at Shepparton

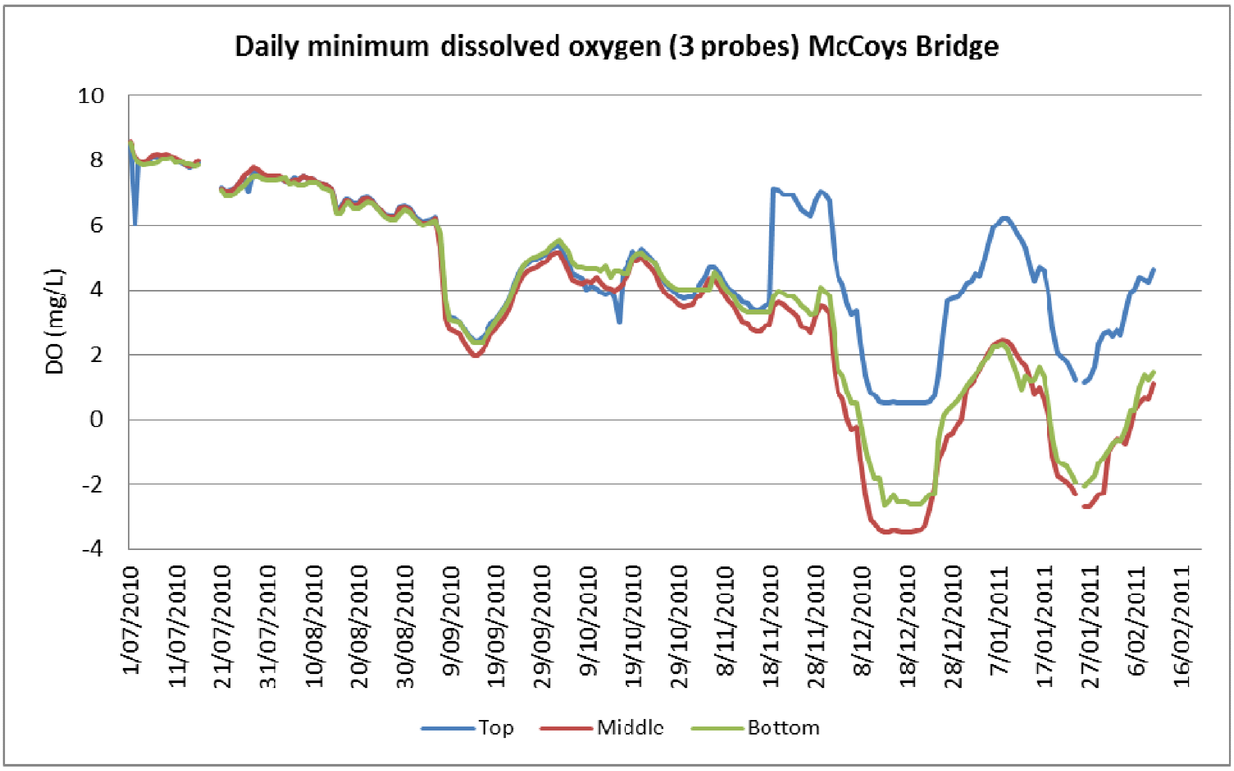

Figure 4: Dissolved oxygen levels at McCoys Bridge

Environmental releases have also been made through the Goulburn River in December 2010 to improve a blackwater event in the Murray River and in May/June 2011 to supply water to the Lower Lakes.

3.1.1 Current ecological conditions

These floods and freshes have provided water to a system visually suffering drought effects. The floods provide an input of nutrients, carbon and organic matter to the stream and an exchange of sediments and biota between the channel, floodplain and wetlands. The floods and freshes connected floodplains that have not been connected for 10 – 15 years and improved riparian vegetation health. Improved productivity on the floodplain appears to have resulted in the spawning of Golden perch (*Macquaria ambigua*) in the Goulburn River for the first time in eight years (since monitoring commenced).

Although the high flows of spring and summer 2010/11 have improved many aspects of river health along the Goulburn River and its floodplain, there have been some negative impacts. The blackwater event of December resulted in fish kills with exact numbers of fish killed unrecorded. Additionally, many saplings low on the banks of the river have been killed due to continuous inundation during the spring and summer months. Herbs and forbs have also not germinated since September 2010, due to continuous inundation and deposition of sediment on the river banks (approximately 5cm) (Water Technology, 2011).

Recent floods have also been responsible for geomorphic work on the banks of the Goulburn River. In some areas significant bank erosion has occurred as a result of the flooding. Although no monitoring of the bed channel was conducted it can be assumed that flows of this magnitude scoured pools and moved fine sediment along the river.

3.2 Effectiveness of flow components delivered

The following section describes the range of flow components that have occurred in the lower Goulburn River since 2001/02. These flows are not a result of delivery of any environmental water, and are instead a reflection of regulated and unregulated flows in the catchment. Criteria used to determine various flow components at two gauging stations; Shepparton and McCoys, is shown in **Table 8**.

Table 8: Flow component values for the lower Goulburn River

Flow component	Shepparton	McCoys Bridge
Spring fresh	anything around or over 1,500ML/day	anything around or over 1,500ML/day
Bankfull	Around 18,000 ML	Around 19,000 ML
Overbank	19,000 ML	22,000 ML
Summer baseflow	Over 610ML	Over 610ML

Table 9 show the flow component delivery at McCoys Bridge. The colours on the table correspond to the flow component was not provided/met (red) and the flow component was completely met (green).

Table 9: Flow component delivery on the Goulburn River at McCoys Bridge

Flow component	Years									
	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Summer baseflows	red	red	green	green	green	red	green	red	green	green
Summer freshes	red	red	red	green	red	red	green	red	green	green
Overbank	red	red	red	red	red	red	red	red	red	green
Spring fresh	green	green	green	green	green	red	green	red	red	green
Winter bankfull	red	red	green	red	green	red	red	red	red	green
Winter baseflow	green	red	green	green	green	red	red	red	red	green

3.2.1 Current weather and climatic conditions

The inflows to the Goulburn River in spring and summer 2010/11 have been well above average. In the Goulburn catchment Lake Eildon has filled from 27% at 1st July 2010 to 84% at 2nd May 2011. The Bureau of Meteorology has forecast a continuation of these higher than average flows into June 2011, which will provide more inflow to Lake Eildon and potential catchment run off due to the saturated catchment.

Chapter 4 Environmental Watering proposal

4.1 Seasonal Water Planning

The Goulburn River has a highly variable flow, depending on catchment runoff and on the operation of the water supply system to deliver water for consumption. Environmental flow planning aims to allow catchment runoff and water system operation to meet as many environmental flow objectives as possible, and then deploy water from environmental entitlements into the highest priority gaps that remain. However, under different possible climatic conditions (from very dry to very wet), the environmental flow gaps move dramatically, and the priorities for deployment of environmental water change.

Therefore, plans are prepared for a range of possible climatic scenarios to understand how the priorities and required volumes for deployment of environmental water change.

The scenarios are based on current conditions within the water supply system such as the volumes of water stored in the reservoirs. They then assume the availability of all environmental water entitlements and their associated water allocations in the Goulburn system, and determine how best to maximise the environmental outcomes from their use.

Importantly, the planning is not concerned with the probability of any particular climate scenario (or in picking the most likely scenario) – it merely ensures there is a plan if any scenario does occur. For the Goulburn system, while various indicators are available, predicting climatic conditions in the current autumn/early winter for the coming season (both winter/spring and summer/autumn) has little reliability.

The scenarios have been picked to highlight the key decisions that will need to be made about environmental water deployment for 2011/12, and hence will change from year to year.

Importantly, the actual management of water through the season needs to be adaptive, with water deployment decisions adjusting as the season unfolds, particularly in response to timing issues within the season.

4.2 Priority Flow Components

For the purposes of this plan, the needs of the Goulburn River between Goulburn Weir and the Murray River drive the plan, with the reach between Lake Eildon and Goulburn Weir benefiting from flows being passed to the lower reach or being unaffected by them.

The Goulburn Weir to Murray River reach has two ecologically different reaches, upstream and downstream of Loch Garry. As a general rule, the plan aims to achieve McCoys Bridge (downstream reach) flow targets in (spring)/summer/autumn as under normal dry summer conditions, this will ensure adequate flow moves through Murchison (in the upper reach) to meet the Reach 4 targets. Alternatively, in winter/spring when catchment runoff contributes more flow to the lower reach, the plan aims to achieve flow targets at the Murchison (upper reach) and so ensure both reaches meet their flow targets.

The priority flow components are heavily driven by the recent flow history of 10+ years of drought with very low flows, and last year where all environmental flow target were met (including extensive overbank flooding). Effectively the 10 drought years produced significant environmental health degradation, and the good flows in the current season have started ecological recovery.

Hence it is important in the 2011/12 year to maximise the environmental flows that can be delivered to continue the recovery, particularly in the winter/spring (in which flows were so low during the drought), but not to create another extreme wet year to follow the one just received (to ensure inter annual flow variability). Hence the median year recommended flow targets are generally being pursued. Even if the year is dry, we would aim to create median environmental flow conditions to drive continued recovery (rather than a return to drought conditions).

For minimum flows, the priority is to provide for all of the fish objectives (flows of 500 ML/day and 540 ML/day at Murchison and McCoys Bridge respectively). The next priority is to provide for all macroinvertebrate objectives (830/940 ML/day). Geomorphic objectives (aimed at maintaining pool depth) at higher flow rates are a much lower priority given the recent year of very high flows. Where water is limited, the 2011 winter/spring period is most important, followed by the 2012 autumn/winter, and then the summer period.

For freshes, the priority is to provide freshes in winter/spring at the higher end of the flow range at 5,600 ML/day for 14 days to provide a significant ecological signal. A spring fresh is preferred as it has the added target of Golden perch breeding (given 2010 demonstrated that they will breed in the Goulburn River). Next priority is a second (earlier) winter/spring fresh. The duration of the freshes is particularly important as current events under dry conditions tend to be only of short duration. The final priority is for one or two freshes of 5,600 ML/day for two days in summer (or autumn). Freshes have complex environmental outcomes than shown here, and will need to be carefully designed to maximise outcomes.

The movement of large inter valley transfers can create summer flows that are too high, and the design of the summer (and autumn) flow regime will need to take this into account.

Having had major floodplain inundation in 2010/11, no further floodplain inundation is required in 2011/12. With the risk of flooding private land still unresolved, overbank flooding is not to be attempted in the immediate future in any case.

In considering priority flow components in 2011/12, the potential needs for 2012/13 were also considered (and whether any flow components would be foregone in 2011/12 in preference for a flow component in 2012/13). With the exception of a lower level overbank flow in 2012/13 which, while desirable, cannot be delivered, there is no more important need in 2012/13 than in 2011/12. The main tradeoffs occur under the dry scenarios, and it is more important to maximise the ecological outcomes in 2011/12 in a known dry year than hold water back in case 2012/13 is also a dry year.

The priority flow components are summarised in **Table 10**.

Table 10: Summary of priority environmental flow components

Priority	Flow component	Reach
1	2011 winter/spring baseflow at 500/540 ML/day	Downstream of Goulburn Weir
2	2011 spring fresh of 5,600 ML/day (or as high as possible)	Downstream of Goulburn Weir
3	2012 autumn/winter base flow of 540 ML/day	Downstream of Goulburn Weir
4	2011 winter/spring baseflow at 830/940 ML/day	Downstream of Goulburn Weir
5	Summer baseflow at 830/940 ML/day	Downstream of Goulburn Weir
6	1 or 2 summer freshes at 5,600 ML/day	Downstream of Goulburn Weir
7	2012 winter/spring baseflow at 830/940 ML/day	Downstream of Goulburn Weir
8	2011 winter fresh of 5,600 ML/day	Downstream of Goulburn Weir

Note - Flow components shaded in green are definite high priorities. Delivery of components shaded in blue will depend on the seasonally adaptive allocation process

4.3 2010/11 Scenario planning

Table 11 outlines the range of scenarios available for water use in the Goulburn River in the 2011/12 year.

Table 11: Scenario summary descriptions for Goulburn Weir to Murray River reach

GOULBURN RIVER – DOWNSTREAM REACH	SCENARIO 1 WORST DROUGHT 06/07 inflows	SCENARIO 2 VERY DRY 90% POE	SCENARIO 3 DRY 70% POE	SCENARIO 4 AVERAGE 50% POE	SCENARIO 5 WET 30% POE	SCENARIO 6 VERY WET 10% POE
Water Supply	**40% HRWS allocation** Perhaps 80% available as private carryover	**64% HRWS allocation** Perhaps 80% available as private carryover	**100% HRWS allocation** Perhaps 80% available as private carryover	**100% HRWS allocation** Perhaps 40% available as private carryover Dam spilling	**100% HRWS allocation** Perhaps 20% available as private carryover Dam spilling	**100% HRWS allocation** **100% LRWS Allocation** No carryover available Dam spilling
Expected River Flow and Water Management	Effectively no unregulated flows in winter/spring	One or two freshes (2,000-14,000 ML/day) in winter/spring of short duration	One to three freshes (3,000-20,000 ML/day) in winter/spring of short duration	Strong base flows (2,000-10,000) and one or two high flows (20,000-50,000) in winter/spring	Strong base flows (2,000-20,000) and one to three high flows (30,000-80,000) in winter/spring	Strong base flows (2,000-20,000) and several high flows (>20,000) and at least one major flood in winter/spring
	Normal 400 ML/day minimum flow at McCoys Bridge from July to October	Normal 400 ML/day minimum flow at McCoys Bridge from July to October	Normal 400 ML/day minimum flow at McCoys Bridge from July to October	Normal 400 ML/day minimum flow at McCoys Bridge from July to October	Normal 400 ML/day minimum flow at McCoys Bridge from July to October	Normal 400 ML/day minimum flow at McCoys Bridge from July to October
	Normal minimum summer flow at McCoys Bridge of 350 ML/day	Normal minimum summer flow of at McCoys Bridge 350 ML/day	Normal minimum summer flow at McCoys Bridge of 350 ML/day	Normal minimum summer flow at McCoys Bridge of 350 ML/day	Normal minimum summer flow at McCoys Bridge of 350 ML/day One or two summer freshes could occur naturally.	Normal minimum summer flow at McCoys Bridge of 350 ML/day One or two summer freshes could occur naturally.
	220 GL of IVT available to deploy	252 GL of IVT available to deploy	300 GL of IVT available to deploy	167 GL of IVT available to deploy	100 GL of IVT available to deploy	No IVT deployed
	30 GL Water Quality Reserve available	30 GL Water Quality Reserve available	30 GL Water Quality Reserve available	30 GL Water Quality Reserve available	30 GL Water Quality Reserve available	30 GL Water Quality Reserve available
Environmental Entitlement Volumes Available	Commonwealth – 88 GL State – 9 GL TLM - 16 GL	Commonwealth – 117GL State – 9 GL TLM - 25 GL	Commonwealth – 160GL State – 10 GL TLM - 40 GL	Commonwealth – 150GL State – 10 GL TLM - 40 GL	Commonwealth – 130GL State – 10 GL TLM - 40 GL	Commonwealth – 130GL State – 17 GL TLM - 197 GL

GOULBURN RIVER – DOWNSTREAM REACH	SCENARIO 1 WORST DROUGHT 06/07 inflows	SCENARIO 2 VERY DRY 90% POE	SCENARIO 3 DRY 70% POE	SCENARIO 4 AVERAGE 50% POE	SCENARIO 5 WET 30% POE	SCENARIO 6 VERY WET 10% POE
Environmental Objectives	Maximise fish habitat for large bodied and small adult fish and juveniles	Maximise fish habitat for large bodied and small adult fish and juveniles	Maximise fish habitat for large bodied and small adult fish and juveniles	Maximise fish habitat for large bodied and small adult fish and juveniles	Maximise fish habitat for large bodied and small adult fish and juveniles	Maximise fish habitat for large bodied and small adult fish and juveniles
	Improve macroinvertebrate habitat and its availability	Improve macroinvertebrate habitat and its availability	Maximise macroinvertebrate habitat and its availability	Maximise macroinvertebrate habitat and its availability	Maximise macroinvertebrate habitat and its availability	Maximise macroinvertebrate habitat and its availability
	Bench inundation for carbon/nutrient cycling & vegetation	Bench inundation for carbon/nutrient cycling & vegetation	Bench inundation for carbon/nutrient cycling & vegetation	Bench inundation for carbon/nutrient cycling & vegetation	Bench inundation for carbon/nutrient cycling & vegetation	Bench inundation for carbon/nutrient cycling & vegetation
	Maintain pool depth	Maintain pool depth	Maintain pool depth	Maintain pool depth	Maintain pool depth	Maintain pool depth
	Stimulate Golden perch breeding	Stimulate Golden perch breeding	Stimulate Golden perch breeding			
Preferable Inter Valley Transfer Water Use	Release IVT water for as long as possible over November to April to increase minimum flows to 940 ML/day (107 GL)	Release IVT water for as long as possible over November/December to April to increase minimum flows to 940 ML/day (89-107 GL)	Release IVT water for as long as possible over November/December to April to increase minimum flows to 940 ML/day (89-107 GL)	Release IVT water for as long as possible over December to April to increase minimum flows to 940 ML/day (89 GL)	Release IVT water for as long as possible over January to March to increase minimum flows to 940 ML/day (53 GL)	
	Provide two summer/autumn freshes to 5,600 ML/day (100 GL)	Provide two summer/autumn freshes to 5,600 ML/day (100 GL)	Provide two summer/autumn freshes to 5,600 ML/day (100 GL)	Provide one summer/autumn fresh to 5,600 ML/day (50 GL)	Contribute to one summer/autumn fresh to 5,600 ML/day if possible (46 GL)	
	Remainder (13 GL+100 GL)	Remainder (61 to 43 GL+100 GL)	Remainder (111-93GL+100 GL) – release rest in accordance with high-summer-flow study **(to avoid env damage)**	Remainder (28 GL+100 GL)	Remainder (0 GL+100 GL)	Remainder (137 GL)

GOULBURN RIVER – DOWNSTREAM REACH	SCENARIO 1 WORST DROUGHT 06/07 inflows	SCENARIO 2 VERY DRY 90% POE	SCENARIO 3 DRY 70% POE	SCENARIO 4 AVERAGE 50% POE	SCENARIO 5 WET 30% POE	SCENARIO 6 VERY WET 10% POE
Preferable Environmental Water Use	Release Water Quality Reserve water in response to water quality problems	Release Water Quality Reserve water in response to water quality problems	Release Water Quality Reserve water in response to water quality problems	Release Water Quality Reserve water in response to water quality problems	Release Water Quality Reserve water in response to water quality problems	Release Water Quality Reserve water in response to water quality problems
	Increase minimum July to October (or Nov) flows to 540 ML/day at Murchison (36 to 44 GL)	Increase minimum July to November flows to 540 ML/day at Murchison (max 44 GL)	Increase 2 to 3 months of minimum winter/spring flows to 830 ML/day at Murchison (35-53 GL)	Increase 1 to 2 months of minimum winter/spring flows to 830 ML/day at Murchison (17-35 GL)	Increase 2 months of minimum July to December flows to 830 ML/day at Murchison (35 GL)	Increase 1 month of minimum July to December flows to 830 ML/day at Murchison (17 GL)
	Provide a spring flush to say 4,500 ML/day (63 GL)	Provide a spring flush to say 5,600 ML/day (85 GL) Attempt to extend duration of natural flushes (??)	Provide a spring flush to say 5,600 ML/day (75 GL) Attempt to extend duration of natural winter flush (50 GL)			
				Provide 1 summer fresh (50 GL)	Provide 1 month of minimum flows (January) (18 GL) Provide 1 summer fresh (50 GL)	Provide 3 months of minimum flows (January-March) (53 GL) Provide 1 summer fresh (50 GL)
	Increase minimum flows to 540 ML/day at Murchison through May-June 2012 (18 GL - if available)	Increase minimum flows to 540 ML/day at Murchison through May- June 2012 (18 GL)	Increase minimum flows to 540 ML/day at Murchison through April-June 2012 (18 GL)	Increase minimum flows to 830 ML/day at Murchison through April-June 2012 (52 GL)	Increase minimum flows to 830 ML/day at Murchison through April-June 2012 (52 GL)	Increase minimum flows to 830 ML/day at Murchison through April-June 2012 (52 GL)
Environmental water carried over to 2012/13	Nil	4 GL	14 GL	63 GL	25 GL (or more)	172 GL (or more)

GOULBURN RIVER – DOWNSTREAM REACH	SCENARIO 1 WORST DROUGHT 06/07 inflows	SCENARIO 2 VERY DRY 90% POE	SCENARIO 3 DRY 70% POE	SCENARIO 4 AVERAGE 50% POE	SCENARIO 5 WET 30% POE	SCENARIO 6 VERY WET 10% POE
Desirable Additional Environmental Water usable	Increase spring fresh to 5,600 ML/d (23 GL) Increase winter/spring min flow to 830 ML/d (40 GL) Secure 2012 winter 830 ML/d min flow to end July (34 GL)	Increase winter/spring min flow to 830 ML/d (29 GL) * Secure 2012 winter 830 ML/d min flow to end July (34 GL)	Secure 2012 winter 830 ML/d min flow to end July (34 GL)	Nil	Nil	Nil

* Trading water into Goulburn would reduce inter valley transfers which risks reducing meeting summer flow objectives – needs to be assessed

4.4 Proposal for water use

The Goulburn Broken CMA is proposing to use the carryover and allocations of all environmental entitlements expected to be available in the Goulburn system in 2011/12, as outlined in **Table 11**. Of these, the Commonwealth Environmental Water Holder water volumes are the major driver of this proposal.

The environmental water is aimed at meeting winter/spring flow objectives under dry scenarios, with inter valley transfers primarily meeting summer/autumn flow objectives. The environmental water use progressively transitions as conditions get wetter to meet summer/autumn flow objectives, as winter/spring flow objectives are met from catchment runoff and inter valley transfers have reduced their ability to meet summer/autumn flow needs.

The proposal assumes similar climatic conditions across the Goulburn system and also in the Murray system. However, there is a risk that conditions in the Murray system are significantly different to those in the Goulburn system, and in particular that inter valley transfers are needed for less time and/or in less volume than proposed here. This would leave a shortfall in meeting summer/autumn environmental flow objectives. However, the environmental priority would still be to deploy environmental water for 2011 winter/spring minimum flows and the 2011 spring fresh in preference to bolstering summer flows.

Additional water can be used under the drier scenarios to achieve more objectives. If water is traded into the catchment from the Murray, this would result in inter valley transfer reductions which may limit achieving the summer flow objectives. However, given the priority for winter/spring flows, some reduction in summer/autumn environmental flows (eg one fresh) is reasonable.

The proposed priority flow components; increased minimum flows and freshes, are a significant improvement to the flow regimes that would otherwise occur. Hence they should significantly improve most elements of the in channel river environment, particularly fish and macroinvertebrates, and continue the ecological recovery started in 2010/11 after the prolonged drought years.

The provision of these flows should be quite feasible as they are well within the sort of flows normally regulated within the Goulburn system.

Importantly, the flows would leave the Goulburn system in winter/spring in drier years and in summer/autumn in wetter years, with potential to be used again for downstream environmental benefits in the Murray system, including the Lower Lakes.

Under the proposal, conditions are uncertain at the start of the winter season and adaptive management decisions need to be made as the season unfolds.

- The minimum flow of 540 ML/day would commence in July 2011. As the winter continued, allocation increases would be used to save volumes for the spring fresh and then the 2012 winter minimum flow of 540 ML/day, while catchment runoff would reduce the use of environmental water to maintain the 2011 winter/spring minimum flow.

- When sufficient water was saved, the minimum flow would be increased to 830 ML/day.
- The next decision point is in October on whether to release the spring fresh (or is it happening naturally) and when to release it (October/November or maybe December).
- In October (if dry) through to December (if wet), planning for inter valley transfers would occur, particularly when provision of minimum flows could start (and hence use of environmental water could stop). This planning would be based on Murray (not Goulburn) unregulated flow conditions and water use demands, volumes available after allocations and spills, and any back trade of water allocations from the Murray to the Goulburn. Planning for the required timing for transfers and the ability to provide freshes would also occur. If inter valley transfers were limited (average to very wet scenarios), the deployment of environmental water over summer would be planned and then started.
- In March/April, the end of inter valley transfers, meeting minimum flows and the start of environmental releases to maintain minimum flows for the autumn/winter would occur. Preparation of the 2012/13 proposal would also be identifying needs beyond June 2012.

Importantly, the Goulburn environmental flow study defines a range of flow components that need to be optimised. The proposal specifies bulk water volumes required to achieve various environmental objectives. However, as the season unfolds, the design of specific flow regimes to optimise outcomes will be required, requiring flexible and adaptive water deployment.

In summary, this proposal suggests the use of the available environmental entitlements held in the Goulburn water supply system, the seasonal allocations and any carryover associated with those entitlements. It assumes the Commonwealth holding is 120 GL of High Reliability Water Shares (HRWS) and 10 GL of Low Reliability Water Shares (LRWS), Living Murray holding is 40 GL of HRWS and 157 GL of LRWS, NVIRP savings of 8 GL of allocation and Shepparton modernisation savings of 2 GL HRWS and 8 GL LRWS. The volumes of water assumed to be available and useful under those entitlements are given in

Table 12. Additional water can be used if available and this is also listed in

Table 12. Likewise, less water can be used by not delivering flow components under each scenario in **Table 11**.

Table 12: Summary of environmental water volumes required to support this proposal (GL)

GOULBURN RIVER – REACH 4 and 5	WORST DROUGHT	VERY DRY	DRY	AVERAGE	WET	VERY WET
Total environmental water planned	113	151	210	137	155	172
Additional water usable	97	63	34	Nil	Nil	Nil

The 80 GL entitlement available from Lake Eildon under the Goulburn Bulk Entitlement for a flush to 16,000 ML/day for one day is only available in a narrow window of climatic conditions, between 75% and 88% probability of exceedence inflows, and is called out at the discretion of the Secretary of the Department of Sustainability and Environment. If it becomes available, it is proposed that it should be called out to provide a small flush in the upper reaches downstream of Lake Eildon. As the flow has never been deployed, it should be released to achieve a lower peak flow, and the river monitored to see what can be inundated effectively and safely. Under the dry conditions in which it would be available, the flow would be expected to be harvested in Waranga Basin and not flow to the river below Goulburn Weir.

Chapter 5 Environmental Water Delivery

5.1 Risks assessment and management

There are some risks involved in deploying environmental water. Listed below are a number of key risks faced in the Goulburn River:

- Flooding private assets – overbank flows have potential to flood private land and public and private infrastructure. Liability for this flooding remains an issue of investigation. In this proposal, the highest flow proposed is 5,600 ML/day which is well below the bankfull flow level of approximately 18,000 ML/day. Hence the risk from these flows causing damage is low, and provides ample opportunity for Goulburn-Murray Water to reduce releases if high catchment runoff flows are predicted as possible.

- Public safety from rising water levels – increases in water levels from release of environmental water during a dry period may pose hazards for water users such as canoeists, fishermen etc. The risk should be low given the freshes have a maximum rises in water level of 0.8 metres per day in winter at Goulburn Weir (and a slower rate of rise further downstream) and 0.38 m in summer. Public advice of events will also be undertaken where necessary.

- Overbank flows in the hot summer/autumn months can increase the amount of organic matter delivered to the river, which can lead to low dissolved oxygen and cause water quality problems (e.g. blackwater events) that can result in fish kills and other aquatic species death. No overbank flows are proposed in this proposal.

- Improved environmental conditions for carp – providing environmental flows to increase the area of slackwater habitats for native fish may also increase the habitat availability for introduced pest species such as carp. Currently there is little known about the dispersal and proliferation of pest species specifically in relation to environmental flows, but it's likely the benefits provided for native species are also enjoyed by introduced species also (Chee et al, 2006). No management of this risk is currently possible.

5.2 Costs

The Environmental Water Manager does not have to make any payment for headworks costs relating to the environmental entitlements or the Goulburn Bulk Entitlement. If chargeable, these costs are met by the entitlement holders. There are no water delivery costs.

5.3 Notice and time required

A notice period of one to two days minimum and preferably four days is required for environmental water orders from Goulburn system storages.

If constraints in making environmental water available are foreseen by G-MW, the Environmental Water Manager will be advised accordingly.

Releases from Lake Eildon take approximately 2½ days to reach Goulburn Weir. Releases from Goulburn Weir take one day to reach Murchison, four days to reach Shepparton, and seven to eight days to reach McCoys Bridge (near the Murray River). However this can be influenced by existing conditions in the river channel and seasonal conditions.

If flows are being harvested at Goulburn Weir into Waranga Basin, releases can be made from Goulburn Weir by reducing harvesting, hence saving travel time from Lake Eildon.

Chapter 6 Monitoring

6.1 Current Monitoring Programs

A number of programs are currently conducted by the Goulburn Broken CMA to monitor environmental flow and river and ecological conditions. The main program for environmental flow monitoring is the Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP). This program is being undertaken at 12 sites in the Goulburn River from Goulburn Weir to the Murray River and is monitoring vegetation, fish, macroinvertebrates, channel features, physical habitat. Not all parameters are measured at each site. These assessments are carried out on a range of timeframes (varying from annually, to when a channel changing event occurs) and are a long term assessment (5 - 10 years) of the impacts of and changes from environmental flows. The analysis of this data is based on statistical methods rather than before-after style monitoring. Monitoring has been occurring since 2008 (i.e. three years) and to date no data analysis has occurred. Additionally, 2010/11 was the first year of the monitoring to have significant flows, and hence the first year that any response to flows may occur with previous years providing base line data only.

River flows are currently monitored through the North East Monitoring Partnership, at Lake Eildon, Killingworth, Trawool, Seymour, Murchison, Shepparton and McCoys Bridge. Goulburn-Murray Water also monitors releases from Goulburn Weir.

Water quality monitoring on the Goulburn River has been in place for a number of years. This monitoring includes continuous monitoring (i.e. 30 minute intervals) that has been occurring for approximately 2½ years (primarily in response to drought) and monitoring on a monthly basis that has been occurring for more than 10 years. **Table 13** lists the sites, frequency and parameters that are used for environmental flow monitoring. This monitoring is used very frequently (sometimes daily) in short term management of environmental flows to assist decision making in terms of minimising the risk of dissolved oxygen sags and potential fish kills or other water quality issues.

Table 13 - Monitoring sites on the Goulburn River

Site	Parameter
Continuous monitoring	
Goulburn River@McCoys Bridge	Dissolved oxygen, electrical conductivity, temperature, pH
Goulburn River@Shepparton STP	Dissolved oxygen, electrical conductivity, temperature, pH, level
Goulburn River@Trawool	Turbidity, level
Goulburn River@Goulburn Weir	Dissolved oxygen, temperature, turbidity

Goulburn River@Tabilk	Dissolved oxygen, temperature, electrical conductivity
Non continuous monitoring	
Goulburn River@Murchison	Dissolved oxygen, temperature, turbidity, EC, suspended solids, TP, TN
Goulburn River@Trawool	Dissolved oxygen, temperature, turbidity, EC, suspended solids, TP, TN
Goulburn River@Eildon	Dissolved oxygen, temperature, turbidity, EC, suspended solids, TP, TN

Turbidity and water level is monitored continuously on a number of Goulburn River tributaries located between Lake Eildon and Seymour (i.e. reaches 1 and 2 of **Figure 1**) affected by the 2009 bushfires. Goulburn-Murray Water monitors dissolved oxygen and turbidity in Goulburn Weir.

Additional fish monitoring has also been carried out in the lower Goulburn River for the last eight years. This monitoring includes boat electrofishing, drift net surveys, including larval drift sampling and acoustic tracking. This monitoring provides extra data on fish assemblages, fish movement and recruitment.

A new program has recently commenced to investigate fish assemblages and populations in floodplain wetlands. This project will be addressing what fish are currently in the wetlands, why they go into some types of wetlands and not others, and how long do fish remain in the wetlands.

6.2 Monitoring 2011/12 Environmental Flow Outcomes

The proposed delivery of minimum flows and freshes in 2011/12 aims to achieve a range of environmental objectives (see sections 4.2 and 2.1). Many of these are contributing to ongoing improvement in various elements of the environment. Hence it is likely to see the results of improved environmental flows only after a number of years of continued provision of desirable flows. In other cases, such as Golden perch breeding, it will be possible to see the occurrence of a breeding event, but may not to be clearly able to attribute it to a released flow. The VEVMAP program for example is generally aimed to detect environmental improvement over some years.

Further, the provision of particular flow elements is based on a range of hypotheses of likely benefits to occur, often in the following months or year rather than a long term response to the flow regime. As these flow elements are provided, the hypotheses need to be tested to determine if the objectives of the designed flows are achieved. In some instances, hypotheses can only be tested with a 'before-after' design (Cottingham et al, 2010b).

Table 14 outlines the current and additional monitoring needs for the delivery of flow components specifically suggested in this proposal. This additional monitoring is required to ensure environmental flow delivery is achieving the desired goals.

Table 14: Additional monitoring needs in the Goulburn River

Reach	Objective	Hypotheses	Flow component	Indicator(s)	Monitoring sites	Frequency	Notes
4 and 5	Provision of flows for Golden perch spawning from the delivery of a spring fresh of 5,600ML	Providing a spring fresh will improve conditions for Golden perch migration and breeding	Spring fresh	Golden perch larvae	Existing ARI monitoring sites in the Goulburn River downstream of Murchison	Spring, summer and autumn	Continuation of the current monitoring will show the occurrence of a breeding event. However, it may not be able to determine the extent of contribution from this environmental fresh.
4	Map bench inundation during fresh flows	Fresh flows of 5,600ML will inundate benches in Reach 4	Freshes	Visual inspection of benches at low flow and during a fresh flow	Benches located in Reach 4	Prior to and during inundation events	Survey planned as part of 2011/12 environmental flow proposal and delivery
4	Evaluation of extended duration of bench and river bank inundation on vegetation structure	Extended duration of bench inundation will favour native aquatic and amphibious species over terrestrial species	High flows and freshes that inundate benches	Vegetation community structure and reduction in terrestrial vegetation on low banks and benches	River banks and benches located in Reach 4 (say 10 representative sites)	Before and 2 months after event	$30,000 needed for vegetation surveys
All	Improve the abundance and extent of macrophytes in the river	Flow regime will provide conditions that encourage macrophyte establishment and growth on channel margins	Low flows	Macrophyte presence and establishment	TBD	Annually (spring)	The 2010 VEFMAP vegetation survey may be able to provide some indication of this. However, due to the limited presence of macrophytes in the river it likely that VEFMAP sites are not representative of areas with macrophytes. A survey of presence and extent of macrophytes is needed.
4	Evaluation of duration of bench inundation during fresh flows on macroinvertebrates	Extended duration of bench inundation will increase rates of primary production and invertebrate	Freshes of 5,600ML	Invertebrate populations during inundation events; looking at abundance at a	Benches located in Reach 4	Before and after inundation events	Monitoring of biomass to species level is required.

Reach	Objective	Hypotheses	Flow component	Indicator(s)	Monitoring sites	Frequency	Notes
		abundance and diversity		species level			
All	Ensure occasional freshes resuspend and move fine sediment	Settlement of fine sediment on surfaces disadvantages some macroinvertebrate taxa	Freshes of approximately 5,600ML	Change in sediment layer and macroinvertebrate communites	TBD	Prior to, and after, a fresh flow	Funding required.

6.3 Reporting

The first level of reporting is on use of environmental entitlements. Weekly reporting is planned to advise environmental entitlement holders of progressive water use, and on any adaptive water deployment decisions made.

The second level of reporting is on flows occurring in the river system. Weekly reporting is planned to advise environmental entitlement holders of current flows and the effectiveness of environmental water deployed in achieving desired flows.

The third level of reporting is on environmental outcomes achieved. This will tend to more anecdotal in nature and is planned to be reported fortnightly.

An annual report will be prepared after the end of the 2011/12 year to collate all information on the use of environmental water, the river flows achieved, and the environmental outcomes recorded.

Chapter 7 Communications

There are two key audiences for communications under the proposal.

The primary audience is those involved in delivering the proposed flow management.

- Goulburn-Murray Water is the key flow delivery agency. When the final proposal for 2011/12 is agreed, communications with Goulburn-Murray Water are aimed at making clear what the intended environmental flow release plans are and their intended purpose. Then, throughout the season, there will be regular communications (phone, email) directly with the Goulburn-Murray Water water resource management group to understand unregulated flows, Goulburn-Murray Water planned consumptive use releases, and to organise environmental flow releases.
- River Murray Water is responsible for calling out inter valley transfers. Communications (phone, email) will be aimed at initially planning inter valley transfers to achieve Murray system operational objectives and lower Goulburn River environmental objectives, and then regularly throughout the season, adjusting the plans to conditions as they unfold.
- The Victorian Environmental Water Holder will use the proposal as the basis (in whole or part), in developing the Seasonal Watering Plan. Water allocated is to be delivered in accordance with the plan and the plan is used to seek agreement from other water holders for the use of their water. Routine communication (phone, email) will report on deployment of water under the plan, and seek to modify release plans to align with downstream site needs as the year unfolds.
- Commonwealth Environmental Water Holder may have allocated water to the Seasonal Watering Plan which is based on this proposal, and are responsible for achieving further benefits from the water at downstream environmental sites. Routine communication will be via the Victorian Environmental Water Holder.

The secondary audience is those potentially affected by or interested in environmental flows and/or the health of the river environment. This includes Parks Victoria and Department of Sustainability and Environment (public land managers), water users along the river (Goulburn-Murray Water diversion licence holders), campers and recreation users, local government, environment groups, and the general public. As the effect of the proposal on these groups is expected to be minimal, the communication objective is to provide information about the decision to provide environmental flows and what it is trying to achieve. A secondary objective is to build a public understanding of the change from past flow regimes to a future one managed to achieve improved river health. These communications will be through media articles and potentially talks directly with special interest groups.

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VICTORIAN ENVIRONMENTAL WATER HOLDER

NORTH CENTRAL Catchment Management Authority

Seasonal Watering Plan 2011–12

Schedule 12: Loddon system

State Government Victoria

Schedule 12: Loddon system

This schedule is the seasonal watering proposal prepared by North Central Catchment Management Authority. It has been accepted by the VEWH and now forms part of the *Seasonal Watering Plan 2011–12*. As such, it incorporates any changes resulting from feedback from the VEWH.

The seasonal watering plan outlines the environmental watering actions that are a priority in 2011–12. It considers the actions that would occur under a range of planning scenarios. As conditions unfold and water becomes available throughout the year, seasonal watering statements will be released to communicate decisions on environmental watering actions and to authorise North Central Catchment Management Authority to implement those decisions.

The VEWH acknowledges and thanks North Central Catchment Management Authority for their hard work and dedication in developing the seasonal watering proposal and inputting to the *Seasonal Watering Plan 2011–12*.

Please contact the VEWH or North Central Catchment Management Authority for more information.

Document name: Loddon River Seasonal Watering Proposal 2011-12

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Version 3	23/5/2011	Phil Slessar	NCCMA Board	7/6/2011
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Distribution

Version	Date	Issued To
Version 4		
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EXECUTIVE SUMMARY

This document outlines the environmental water requirements for the regulated reaches of the Loddon River between Cairn Curran Reservoir and Kerang Weir, Tullaroop Creek downstream of Tullaroop Reservoir and Boort district wetlands for the water year 2011-12.

Water availability in 2011-12 will be greatly enhanced in the Loddon system compared to other recent years for two reasons. Firstly, the extremely wet year in 2010-11 has left storages at close to capacity and allocations will be >0% at the start of the season, unlike in many recent years. Secondly, additional sources of environmental water are coming on line. These include the Wimmera – Mallee Pipeline savings (WMP) of 7,490 ML at 1% allocation in the Goulburn system on April 1 of the previous water year, and an additional 1,432 ML from Goulburn System Wimmera Mallee Pipeline savings (GWMS). The Commonwealth Environmental Water Holder (CEWH) also has a holding of 1,700 ML in the Loddon System.

Following on from an extremely wet year in 2010-11 and an expected strong storage position at July 1 2011, scenarios have been developed for watering under a range of conditions that include Drought (with a 99% Probability of inflows being exceeded), Dry (90% POE), Average (50% POE) and Wet (10% POE). These scenarios inform the management of available environmental water and represent the best outcomes for the environment under each climatic scenario.

Scenarios for 2011-12 are focussed on the delivery of priority components in reach 4 (Loddon R from Loddon Weir to Kerang Weir) as identified in the revised flow recommendations (SKM, 2010). These are a winter low flow (100 ML/day from May to October), and a spring fresh (750 ML/day for 5 – 7 days November to December). Given the current storage situation, these are deliverable this year in all scenarios, but may not be in future years if dry conditions prevail.

The table below indicates the volumes North Central CMA is seeking from the Victorian Environmental Water Holder (VEWH) for the 2011-12 season. The volume in the table for reaches 1, 2, 3a and 3b is the total required according to the Bulk Entitlement (Loddon River Environmental Reserve) Order 2005 for Reach 3b. Deployment of this water is assumed to meet the requirements of the Bulk Entitlement for the other upstream reaches.

This proposal details the proposed management of the Loddon Environmental Reserve BE for the flow year from 1 July 2011 to 30 June 2012. This proposal (2011-12) is to remain in operation until such a time as the subsequent Seasonal Watering Proposal (2012-13 season) has been endorsed by the Victorian Environmental Water Holder.

Table 1: Environmental water requirements for watering under 2011-12 scenarios

	DROUGHT or DRY	AVERAGE or WET
Reaches 1, 2, 3a and 3b (Upstream of Loddon Weir)	Up to 16,049 ML	
Reach 4	12,911 ML	15,999 ML
Boort District Wetlands	Up to 1,500 ML	0

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1. INTRODUCTION

1.1 Purpose

This Seasonal Watering Proposal identifies the desired environmental water use for the Loddon system in the coming year under a range of climatic scenarios. The plan provides a clear rationale to directly inform the Victorian Environmental Water Holder (VEWH) of priorities in the Seasonal Watering Plan (see Appendix 1), including an overview of the situation over the last year (2010-11).This proposal (2011-12) is to remain in operation until such a time as the subsequent Seasonal Watering Proposal (2012-13 season) has been endorsed by the VEWH.

1.2 System overview

This Seasonal Watering Proposal covers the regulated Loddon River as described in the Bulk Entitlement (Loddon River – Environmental reserve) Conversion Order 2005 (Loddon BE). This takes in the main upper catchment storages of Cairn Curran and Tullaroop Reservoirs, re-regulating structures including Laanecoorie Reservoir, Serpentine Weir and Loddon Weir in the middle reaches, downstream to Kerang Weir. Included also in the Loddon BE are the Boort District Wetlands, located on the floodplain to the west of the Loddon River downstream of Loddon Weir. Figure 1 is a map of the Loddon System showing these features.

The catchment setting of the system is described by North Central CMA (2005), while environmental flow objectives for the system are described in LREFSP, 2002 and SKM, 2010. This Seasonal Watering Proposal does not include the Loddon River between Kerang Weir and the Murray River, as this reach is covered by a separate Bulk Entitlement and managed through the Torrumbarry Irrigation District. However the delivery of flows through reaches 1 to 4, combined with flows from the Bendigo-Pyramid Ck system contribute to the achievement of flow objectives in Reach 5, including Murray-Darling Basin Authority (MDBA) end-of-valley targets.

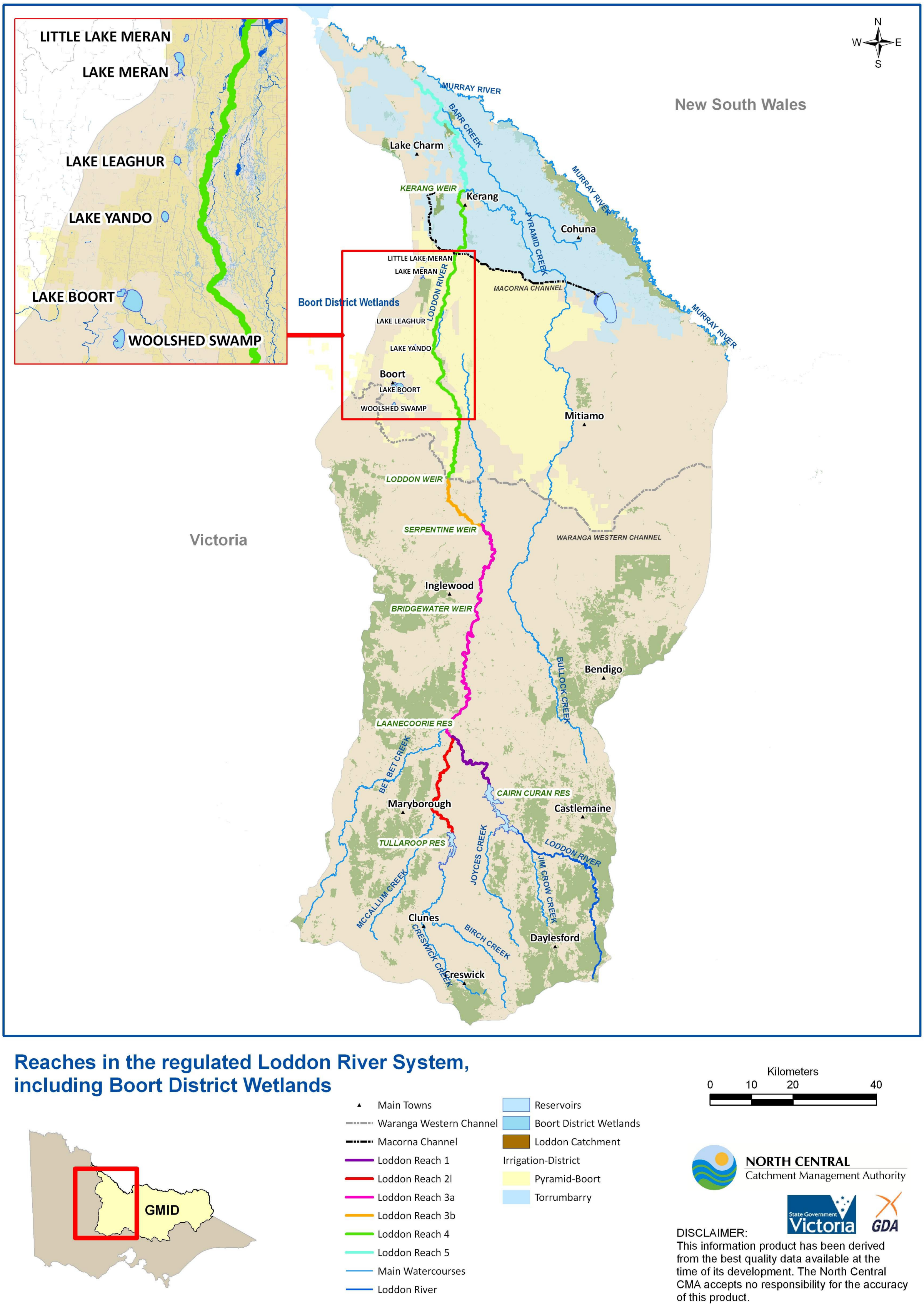
Environmental flow recommendations (LREFSP, 2002; SKM, 2010) are based on the environmental watering needs of assets and values along five reaches of the Loddon River:

- Reach 1: Loddon River - Cairn Curran Reservoir to Laanecoorie Reservoir
- Reach 2: Tullaroop Creek - Tullaroop Reservoir to Laanecoorie Reservoir
- Reach 3a: Loddon River - Laanecoorie Reservoir to Serpentine Weir
- Reach 3b: Loddon River - Serpentine Weir to Loddon Weir
- Reach 4: Loddon River - Loddon Weir to Kerang Weir.

A revised flow study by SKM (2010) separated reach 4 into a further 4 reaches:

- Reach 4a: Loddon Weir to Twelve Mile Creek regulator
- Reach 4b: Twelve Mile Creek
- Reach 4c: Loddon River between Twelve Mile Creek regulator and Macorna Channel
- Reach 4d: Loddon River between Macorna Channel and Kerang Weir

Figure 1: Map of the North Central CMA region, showing the regulated reaches of the Loddon River



1.3 Sources of water

The Loddon system receives environmental water from a number of sources, some of which are new for the 2011-12 season. Sources are summarised in Table 2.

1.3.1 Loddon Bulk Entitlement

The Loddon BE prescribes the minimum flow rates and freshes for the Loddon system. The minimum flows are delivered at two rates, a higher rate when combined (Tullaroop and Cairn Curran) storage exceeds 60 GL, and a lower rate when storage falls below 60 GL. The balance of the flows when the lower rate is applied accumulates in a Deficit and Reimbursement account, available once storages exceed 80 GL.

1.3.2 Wimmera Mallee Pipeline savings

The Wimmera Mallee Pipeline (WMP) sourced water is a new source for 2011-12. It consists of a total of 7,490 ML available at Loddon Weir if the allocation in the Goulburn system is 1% or greater at the 1st April in the preceding water year. In 2011-12, this water will be available, with a proviso that the delivery of environmental water does not disadvantage other G-MW customers.

An additional volume of water is available to the Loddon System as part of the savings from the Wimmera – Mallee pipeline being held in Lake Eildon. This water is approximately 1,400 ML available pro-rata with allocations at Loddon Weir via the Waranga Western Channel.

1.3.3 Commonwealth Environmental Water Holdings

Commonwealth Environmental Water holdings (CEWH) in the Loddon River are approximately 1,700 ML available pro-rata with allocations. The use of this water is determined by the CEWH.

1.3.4 Low Reliability Water Share

The Loddon BE includes up to 2,024 ML of low-reliability water share (LRWS). This is only available where allocations exceed 100%, and is available pro-rata with LRWS allocation. It is only likely to be available where storage levels are high in a wet year.

1.3.5 Loddon System Withheld Flows account

The Loddon System Withheld Flows account (LSWFA) was established as part of the Qualification of Rights (QoR), to account for flows that were not delivered during the drought. This account currently holds 5,550 ML, and is available as carry over should it be available.

Table 2: Sources of water

Water source		Flexibility of management	Reaches	Conditions of availability	Conditions of use	Compliance point
Source	**Volume**					
ENTITLEMENT						
Bulk Entitlement (Loddon River – Environmental Reserve) 2005						
Wetland entitlement	2,000 ML HR	Delivered to wetlands in the Boort district	N/A	Pro rata according to water allocations in the Loddon River system	Management according to priorities in SWP	Inlet regulating structures to each individual wetland
Low Reliability entitlement (LR)	Up to 2,024 ML LR	Available in Loddon System.		Only available @ >100% allocation. Part of BE		Cairn Curran, Laanecoorie, Serpentine Weir Loddon Weir
Wimmera Mallee Pipeline savings Entitlement (WMP)	7,490 ML HR	Available at Loddon Weir. Can be used over two years	4	Full volume available once allocation in Goulburn system is >1% at April 1st of previous water year.	No impact on other customers. Can be supplied from Loddon or Goulburn system	Loddon Weir
Passing flows	(see Table 3)					
Loddon system withheld flows account	5,314 ML HR	Available in Loddon System. Up to 2,000 ML available for Boort wetlands	All	Spills		Cairn Curran, Laanecoorie, Serpentine Weir Loddon Weir
Goulburn River Environmental Entitlement 2010						
Goulburn - Wimmera Mallee pipeline (GWMS)	Max 1,432 ML HR	Can be made available via WWC	4	Pro rata according to water allocations in the Goulburn River system		Loddon Weir
Commonwealth Environmental Water Holder						
Water shares	Approximately 1,560 ML HRWS	Available in the Loddon system	All	Pro rata according to water allocations in the Loddon River system		TBA
OTHER SOURCES						
Consumptive water en route	Determined by irrigation demand in Boort District	Passing flows can be piggy backed if irrigation demand does not meet min flow	1, 2, 3a, 3b	Determined by irrigation demand in Boort District		Cairn Curran, Laanecoorie, Serpentine Weir
Unregulated flow	Refer to scenarios.	Passing flows are ‘or natural’	1 – 4	Dependant on rainfall – if storages spilling water not able to be well controlled		Cairn Curran, Laanecoorie, Serpentine Weir, Loddon Weir

Table 3: Passing flow requirements in the Bulk Entitlement (Loddon River – Environmental Reserve) 2005

Reach	Reach No	Minimum Passing Flow				ML required			Freshening		ML required
		Summer (Nov - April)		Winter (May to October)		Summer (Nov - April)	Winter (May to October)		Summer (Nov - April)		
		<60,000 CS	>60,000 CS	<60,000 CS	>60,000 CS		<60,000 CS	>60,000 CS	Volume	Duration	
Cairn Curran to Laanecoorie	1	20	20	20	35	**3200**	**3680**	**6440**	35 ML/day	3 x 7 days	**735**
Tullaroop Ck Between Tullaroop Res and Laanecoorie	2	10	10	10	10	**1600**	**1840**	**1840**	13.5 ML/day	3 x 7 days	**283.5**
Laanecoorie Weir to Serpentine Weir[1]	3a	15	15	15	52	**3525**	**1380**	**4784**	52 ML/day	3 x 13 days	**2028**
Serpentine Weir to Loddon Weir	3b	19	19	19	61	**2812**	**3496**	**11224**	61 ML/day	3 x 11 days	**2013**
Loddon Weir to Kerang Weir	4	9.5[3]	9.5[3]	10	61	**1586.5**	**1840**	**11224**	50 + Losses (Incl min flow)	14 days	**700[3]**

[1]For this reach, summer = Nov – Jul, winter = Aug – Oct.
[2]Average of recommended flow (7 – 12 ML/day over first week, 12 – 7 ML/day over second week)
[3]Plus Losses

1.4 Consultation

During development of the Seasonal Watering Proposal, North Central CMA undertakes an extensive engagement process with a number of representative groups (Table 4). The principal groups are:

1.4.1 Loddon Environmental Water Advisory Group (LEWAG)

The Loddon Environmental Water Advisory Group was established by the North Central CMA as the key community engagement forum for environmental water management in the Loddon River system, providing advice at key decision points in the planning process. The group consists of community members from the Loddon River catchment and representatives from agency stakeholders. This includes representatives from Goulburn – Murray Water (G-MW) who is the storage operator for the Loddon Bulk entitlement, DSE, and in future VEWH.

1.4.2 Natural Resource Management Committee

The Natural Resource Management Committee (NRMC) is a sub-committee of the North Central Catchment Management Authority (CMA) Board. The NRMC advises the Board on investment priorities in the region with an emphasis on protecting the region's rivers. The role of the NRMC is to provide community and local perspectives on North Central CMA projects and functions that have direct public benefits.

The principal role for the NRMC in the environmental water planning process is to formally recommend the Seasonal Water Proposal (this proposal) to the North Central CMA board for endorsement.

1.4.3 North Central CMA Board

The main role of the North Central CMA Board is to provide leadership, coordination and integration of sustainable natural resource management focussed on waterways and communities in the North Central region. This includes setting the organisation's strategic direction.

The principal role of the North Central Board in the context of environmental water management is to formally endorse the seasonal watering proposal (this proposal) for submission to the Victorian Environmental Water Holder.

Table 4: Groups engaged during the preparation the Seasonal Watering Proposal

Who	Roles and responsibilities	Purpose of consultation	Mode and timing of consultation
Loddon Environmental Water Advisory Group (LEWAG)	Inform and advise North Central CMA during development of Seasonal Water Proposal	Inform Advise	April 2011 May 2011
Goulburn-Murray Water	Inform and advise in preparing proposal	Consult	Ongoing
Natural Resource Management Committee	To provide community and local perspectives	Inform	May 2011
North Central CMA Executive Board	North Central CMA formal board sign-off on proposal	Approve	June 2011

2. ECOLOGICAL OBJECTIVES

2.1 Ecological objectives

The regulated section of the Loddon River is divided into 5 reaches according to the flow recommendations in LREFSP (2002) (see section 1.2). Of these, reaches 1, 2, 3a and 3b are managed according to the Loddon BE, with passing flows and freshes as stipulated in that entitlement. Reach 4 is managed in more detail according to its highly variable natural character, and because some entitlements for the Loddon River (eg the Wimmera-Mallee Pipeline component of the Loddon BE) are only available at Loddon Weir.

2.2 Optimal flow components and critical tolerances

2.2.1 Reaches 1, 2, 3a and 3b

Table 5 shows the ecological objectives identified in LREFSP (2002) for reaches 1, 2, 3a and 3b, and Table 6 relates these objectives to the flow components for the four reaches.

2.2.2 Reach 4

Reach 4 of the Loddon River is treated separately from reaches 1 to 3b. Flow recommendations for reach 4 were updated in 2010 (SKM, 2010) and this is reflected in the updated flow priorities and ecological objectives outlined in Table 7. These flow recommendations treat reach 4 essentially as an ephemeral stream, and ecological objectives focus on vegetation, geomorphology and water quality. Fish are a lower priority for reach 4 given that reach's natural tendency to cease to flow during prolonged dry periods. Fish opportunistically migrate into the reach either from downstream via the Kerang Weir fishway or from upstream during high flows. The presence of fish in this reach does not change the way in which flows are managed.

2.2.3 Boort District Wetlands

The Loddon BE contains a component for the Boort district wetlands. Ecological objectives for individual wetlands are contained in a number of documents, including Environmental Watering Plans for Lakes Leaghur, Yando and Meran, a draft EWP for Little Lake Meran, and the EwaMP for Lake Boort. Table 8 outlines environmental watering objectives for each wetland.

Table 5: Flow objectives and flow components for reaches 1, 2, 3a and 3b

BE Flow components				
Flow Component#	**Reach**	**Volume/Duration/ Timing**	**Objectives**	**Rationale**
Summer Low flow	1	Minimum 20 ML/d Nov – April between irrigation releases*	▪ Restore or maintain River blackfish population ▪ Facillitate habitat and movement for all fish ▪ Restore/maintain habitat availability and disturbance for macro invetebrates ▪ Restore/maintain mosaic of aquatic macrophytes ▪ Restore/maintain mosaic of bank vegetation	Maintain area of flowing water at 0.5 m depth or more
	2	Minimum 10 ML/d all year	▪ Restore or maintain River blackfish population ▪ Restore/maintain habitat availability and disturbance for macro invetebrates ▪ Restore/maintain mosaic of aquatic macrophytes ▪ Restore/maintain snag habitat	Maintain area of flowing water at 0.4 m depth or more
	3a	Minimum 15 ML/d Nov – Jul between irrigation releases*	▪ Restore/maintain habitat availability and disturbance for macro invetebrates ▪ Improve instream and submerged macrophyte habitat ▪ Restore/maintain snag habitat	Maximise submerged macrophyte habitat and regeneration opportunity
	3b	Minimum 19 ML/d Nov – Apr between irrigation releases*	▪ Restore/maintain mosaic of aquatic macrophytes ▪ Improve instream macrophyte habitat ▪ Restore/maintain habitat availability for macro invetebrates ▪ Restore/maintain snag habitat	Maintains area of flowing water at 0.1 m depth
Summer fresh	1	35 ML/d 3x/yr 7days	▪ Facillitate habitat and movement for all fish ▪ Maintain habitat availability for macro invetebrates ▪ Maintain mosaic of aquatic macrophytes ▪ Restore/maintain mosaic of bank vegetation ▪ Clean bed surface (disturbance)	Allows temporary movement of large fish (0.5 m depth), clean biofilms and entrains litter
	2	>13.5 ML/d 4x/yr 7 days	▪ Maintain habitat for macro invetebrates ▪ Maintain mosaic of aquatic macrophytes (disturbance) ▪ Clean bed surface (disturbance)	Clean biofilms and stream bed
	3a	>52 ML/d Nov – Apr 3x/season min 13 days	▪ Breeding cues for native fish (silver, golden perch) ▪ Maintain habitat for macro invetebrates ▪ Clean bed surface (disturbance) ▪ Restore/maintain snag habitat	Golden perch upstream movement to spawn
	3b	>61 ML/d 3x/season min 11 days	▪ Breeding cues for native fish (silver, golden perch) ▪ Maintain habitat for macro invetebrates ▪ Maintain mosaic of aquatic macrophytes (habitat availability) ▪ Clean bed surface (disturbance) ▪ Restore/maintain snag habitat	Golden perch upstream movement to spawn
Winter low flow	1	Min 35 ML/d May – Oct*	▪ Restore or maintain habitat availability for River blackfish population ▪ Facillitate habitat and movement for all fish	Allows permanent movement of large fish (0.5 m depth),

			▪ Maintain habitat for macro invetebrates	
	2	See above. Winter/Summer not distinguished for reach 2		
	3a	Min 52 ML/d Aug – Oct*	▪ Facillitate habitat and movement for all fish ▪ Breeding cues for native fish (silver, golden perch)	Permanent large bodied fish movement through reach
	3b	61 ML/d May – Oct	▪ Facillitate habitat and movement for all fish	Maintain passage for large fish
Non – BE flow components (from LRESFP, 2002)				
Winter fresh	1	>181 ML/d May – Oct 3x/yr 25 days	▪ Restore or maintain River blackfish population ▪ Facillitate habitat and movement for all fish ▪ Maintain habitat for macro invetebrates	Benefit uncertain under management for irrigation
	2	>132 ML/d 2 x/yr 7 days	▪ Restore or maintain River blackfish population ▪ Restore/maintain mosaic of aquatic macrophytes for habitat ▪ Clean bed surface (disturbance)	
	3a	900 ML/d 2x/yr 9 days	▪ Restore/maintain pools (scour) ▪ Restore/maintain runs (disturbance)	Maintain disturbance processes
	3b	>400 ML/d Aug – Oct 2x/yr min 6 days	▪ Breeding cues for native fish (Murray Cod) ▪ Restore/maintain mosaic of bank vegetation ▪ Clean bed surface (disturbance)	Inundate low-lying benches, and help stimulate fish breeding
Bank full	1	3,000 ML/d Aug – Nov 1 yr in 4 4 days	▪ Breeding cues for native fish (silver, golden perch) ▪ Breeding cues for native fish (Murray Cod)	Native fish breeding
	1	3,000 ML/d every year 4 days	▪ Maintain habitat for macro invetebrates ▪ Restore/maintain pools (scour) ▪ Restore/maintain runs (disturbance) ▪ Re-shape in-channel form to maintain habitat diversity and complexity	Pool scouring
	2	500 ML/d 3x/yr 4 yrs in 5 4 days	▪ Restore/maintain mosaic of aquatic macrophytes for habitat ▪ Reverse terrestrialisation of bank/bench grasses ▪ Restore/maintain pools (scour) ▪ Restore/maintain runs (disturbance) ▪ Entrain organic litter (carbon cycling)	
	3a	7,300 ML/d Jun – Oct 1 yr in 2 1 day peak (nat rise and fall)	▪ Restore/maintain pools (scour) ▪ Restore/maintain runs (disturbance) ▪ Re-shape in-channel form to maintain habitat diversity and complexity ▪ Entrain organic litter (carbon cycling)	Inundates high level benches, performs geomorphic work
	3b	>2,000 ML/d Aug – Oct 2x/yr min 6days	▪ Breeding cues for native fish (Murray Cod) ▪ Restore/maintain mosaic of bank vegetation ▪ Restore/maintain pools (scour) ▪ Entrain organic litter (carbon cycling)	Maintain disturbance processes, and inundate high-level benches

#Overbank flows not included
*Or natural

Table 6: Loddon reach 4 flow components and their relationship to ecological objectives (After SKM, 2010)

Asset	Objective	Function	Flow component	Timing	Flow components
Geomorphology	Maintain channel form and processes along the main channel of the Loddon and its system of anastomosing distributaries, such as Kinypanial Creek, Bannagher Creek and Venables Creek	Channel maintenance	Freshes / High Flows	Summer and Winter	▪ Winter/spring - 750 ML/day for 6 – 10 days every year ▪ Summer - 100 ML/day for 10 – 14 days, twice per year
		Channel forming processes	Bank full	Winter, spring or early summer	▪ 3,500 ML/day for 6 days, 3 – 5 times per decade. ▪ One event of 14 days every 10 – 15 years
		Creation of new flow paths across floodplain	Bank full and overbank	Winter-spring	▪ Overbank flows not actively managed - only provided by natural events
Vegetation	Rehabilitate in-stream aquatic vegetation and ecological processes in main channel Control existing terrestrialisation of main channel with non-aquatic species Maintain or rehabilitate flood-dependant riparian and floodplain EVCs Rehabilitate river-floodplain ecological interactions and ecological processes on floodplain	Establish aquatic environment for in-stream aquatic vegetation (e.g. Pondweeds, Water Ribbons etc)	Low flow	Summer and winter	▪ Winter – 100 ML/day May – Oct ▪ Summer – 25 ML/day Nov – April
		Drown-out invading terrestrial plant species (e.g. Common Reed, River Red Gum)	Low flow	Winter	▪ 100 ML/day May – Oct
		Maintain adults of plant species in relevant riparian and floodplain EVCs (e.g. River Red Gum, Black Box)	Bank-full and over-bank	Winter, spring or early summer	▪ Overbank flows not actively managed - only provided by natural events
		Facilitate recruitment of juveniles into relevant riparian and floodplain EVCs	Bank-full and over-bank	Winter, spring or early summer	▪ Overbank flows not actively managed - only provided by natural events
		Engage floodplain with river to entrain litter and allow movement of fauna across river-floodplain.	Over-bank	Winter-spring	▪ Overbank flows not actively managed - only provided by natural events

Water quality	Improve water quality Reduce incidence and severity of black water events Limit impacts associated with ASS	Connecting flow sufficient to maintain water quality, prevent algal blooms and acidity from acid-sulfate soils	Low	Summer	▪ 25 ML/day Nov – April
		Re-oxygenation of water column and sediments Entrain terrestrial organic matter accumulated on bars and benches	Fresh	Summer	▪ 100 ML/day for 10 – 14 days, twice per year
		Transport organic matter that has accumulated in the channel.	Bank full	Winter	▪ 3,500 ML/day for 6 days, 3 – 5 times per decade. ▪ One event of 14 days every 10 – 15 years
		Control ASS	Cease to flow	Summer	▪ 0 ML/day – only in driest years
Fish	Maintain pools or depressions in the bottom of the channel that fish may opportunistically use when wet	Scour pools to provide depth and habitat variety in the bottom of the channel	High to Bank-full Flows	Summer and Winter	▪ 3,500 ML/day for 6 days, 3 – 5 times per decade. ▪ One event of 14 days every 10 – 15 years
		Facilitate movement of fish	High flows	Spring and summer	▪ Winter/spring - 750 ML/day for 5 -7 days every year ▪ Summer - 100 ML/day for 10 – 14 days, twice per year
		Maintain aquatic habitat, but this is a lower priority for this reach because it will dry out periodically	Low flows	Winter and spring	▪ 100 ML/day May – Oct
Macro-invertebrates	Maintain habitat quality	Inundate exposed roots, emergent vegetation and woody debris	Low flows	All year round	▪ 25 ML/day Nov – April ▪ 100 ML/day May – Oct
		Flush sediment from hard substrate elements	fresh	Summer	▪ 100 ML/day for 10 – 14 days, twice per year

Table 7: Environmental watering objectives for the Boort District Wetlands

Wetland	Lake Leaghur	Lake Yando	Lake Meran	Little Lake Meran	Lake Boort
Objectives	▪ Maintain the health and restore the distribution of River Red Gum vegetation ▪ Maintain emergent aquatic plant community persisting at the channel outfall ▪ Restore diverse aquatic and amphibious plant communities ▪ Restore Cane Grass populations ▪ Establish breeding opportunities for waterbirds, frogs and invertebrates ▪ Maintain a viable seed and egg bank ▪ Restore connectivity between river, floodplain and wetland	▪ Maintain the health and restore the distribution of River Red Gum ▪ Maintain open water and associated mudflat habitat ▪ Maintain the health and restore the distribution of the fringing Riverine Chenopod Woodland ▪ Maintain health and restore the distribution of Tangled Lignum vegetation ▪ Restore diverse aquatic and amphibious plant species communities ▪ Restore habitat for the rare Winged Water-starwort ▪ Restore feeding and breeding opportunities for waterbirds, frogs and invertebrates ▪ Ensure a viable seed and egg bank is maintained	▪ Maintain emergent aquatic plant communities currently persisting at the channel outfall ▪ Maintain health of the fringing Intermittent Swampy Woodland ▪ Restore open water/submerged aquatic macrophyte habitat in the deeper sections of the wetland ▪ Restore Tall Marsh habitat across a greater area of the lake ▪ Restore abundance of Tangled Lignum vegetation within the fringing Intermittent Swampy Woodland ▪ Restore habitat and breeding opportunities for waterbirds (e.g. Pied Cormorants), fish, frogs and invertebrates ▪ Restore connectivity between river, floodplain and wetland Restore connectivity between river, floodplain and wetland	▪ Expand the distribution of River Red Gum and Black Box ▪ Maintain health and distribution of the fringing Riverine Chenopod Woodland ▪ Expand the extent of Lignum vegetation ▪ Reinstate diverse aquatic and amphibious plant species communities ▪ Reinstate breeding opportunities for waterbirds, frogs and invertebrates ▪ Maintain a viable seed and egg bank ▪ Restore connectivity between river, floodplain and wetland	▪ Restore the distribution of live River Red Gums and associated floristic community across the bed of Lake Boort, including rehabilitation of Southern Cane Grass populations ▪ Restore and rehabilitate vegetation species diversity typical of aquatic and semi-aquatic environments ▪ Reduce likelihood of recolonisation of bed of lake by mustard weed by promoting native vegetation growth
Source	North Central CMA Unpubl(a)	North Central CMA Unpubl(b):	North Central CMA Unpubl(c)	North Central CMA, 2010 (a)	North Central CMA Unpubl(d)

3. FLOW PRIORITISATION

3.1 Situation review

3.1.1 Climatic conditions

The 2010-11 year was characterised by a sequence of high rainfall, high flow events, including three major floods in September 2010, December 2010 and January 2011. All reaches of the Loddon River received significant flows during the spring and summer period, with Laanecoorie (August) Tullaroop (September) and Cairn Curran (January) reservoirs all spilling.

Figures 2 and 3 show flows in the Loddon River at Laanecoorie reservoir and Loddon Weir during the period from July 1 2010 to the time this report was prepared. These graphs are necessarily plotted on a logarithmic scale due to the large variation over that time. These high flows delivered bank full and overbank flows, with additional ecological benefits gained, including entrainment of floodplain organic material, watering of red-gum and black box communities, and floodplain nutrient cycling.

Monthly average rainfall figures for key stations within the Loddon River catchment are shown in Figures 4 and 5. These show that average monthly rainfall for most of 2010-11 was well above the long term average, although a reversion to below average rain was observed at both stations during autumn.

High flows were a reversal of conditions that have prevailed since the implementation of the Loddon BE. In past years the primary focus for environmental flow planning was on delivering water in drought conditions (low rainfall, low storage levels), reflected in the 2009 QoR for the system.

All wetlands in the Boort District received significant inflows after the September event. Wetlands from Lake Boort through to Little Lake Meran, including Leaghur and Wandella State Forests, were linked for the first time in many years, and beyond this system Tobacco, Great Spectacle and Round Lakes also received water derived from both overland flows and excess water from the Loddon River. Flows into the wetlands also came via distributory channels such as Kinypanial, Venables and Wandella Creeks.

Figure 2: Flows in the Loddon R at Laanecoorie Reservoir 2010-11

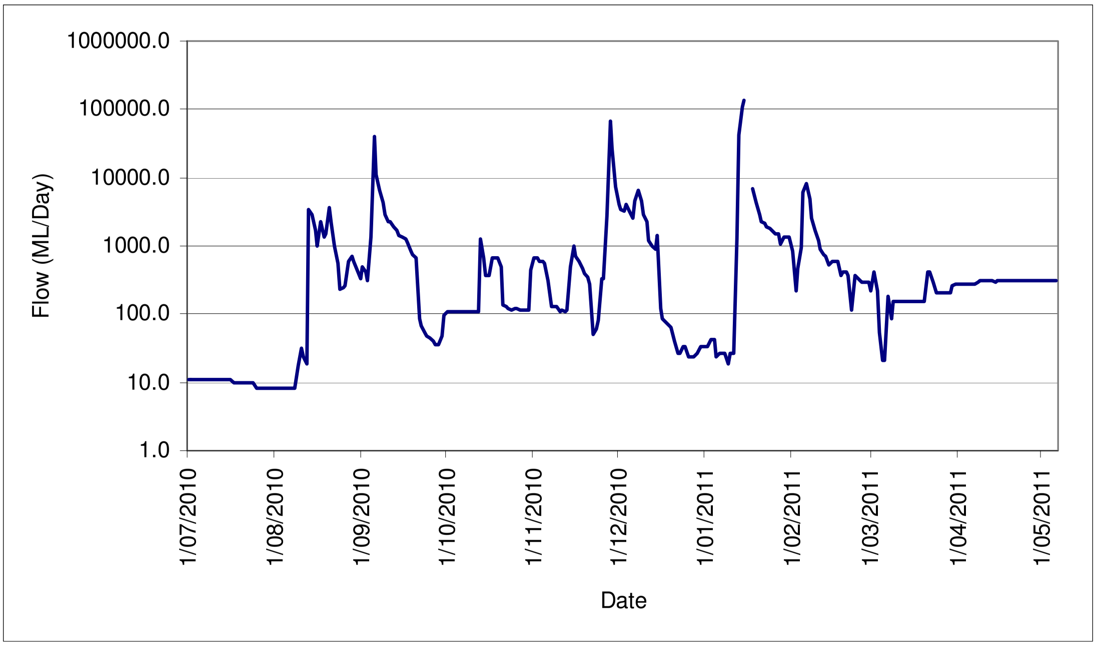


Figure 3: Flows in the Loddon R at Loddon Weir 2010-11

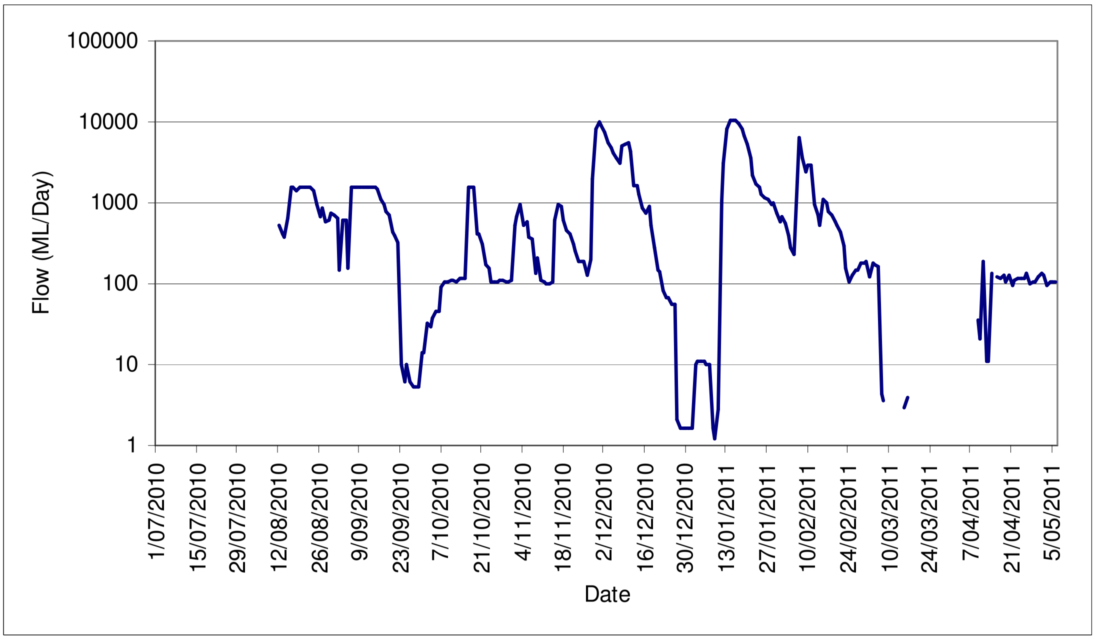


Figure 4: Monthly rainfall averages for Boort, 2010-11 vs long term average

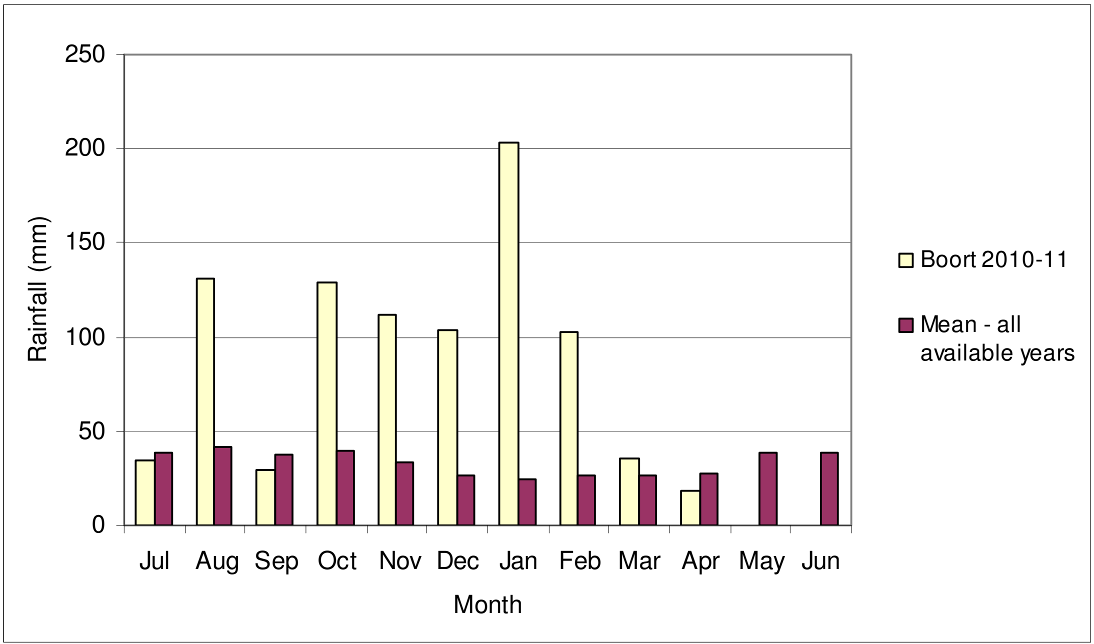
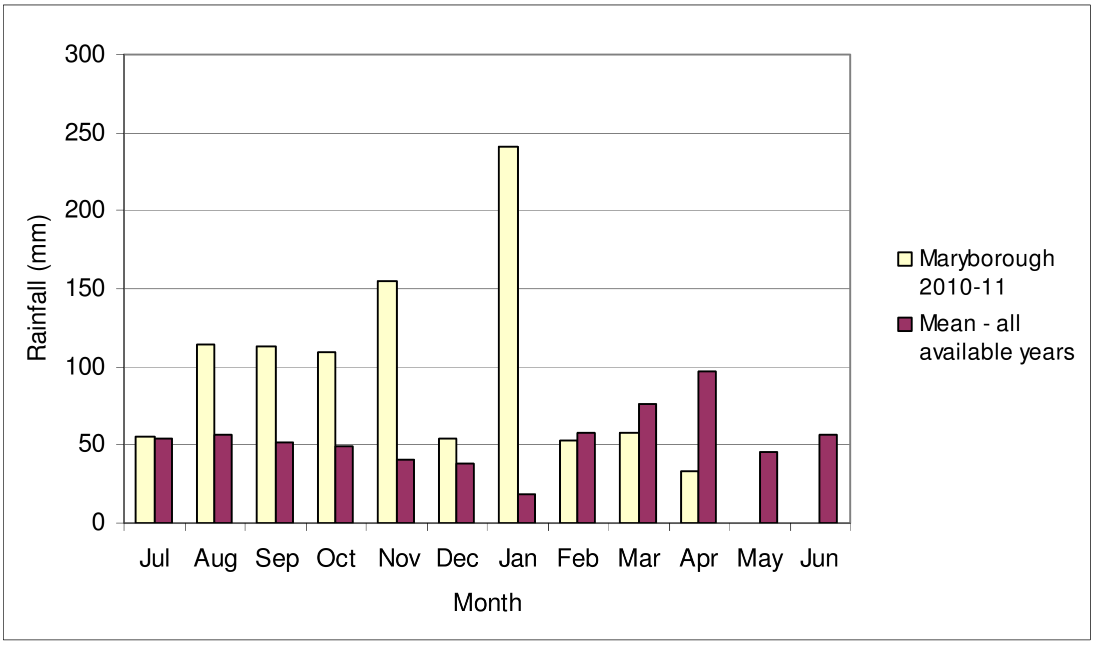


Figure 5: Monthly rainfall averages for Maryborough, 2010-11 vs long term average



3.1.2 Studies in 2010 – 11

Updated flow recommendations (SKM, 2010) were completed in September 2010. These have been discussed in earlier sections and in North Central CMA (2010).

A risk assessment project (RA) examining the risks associated with managed flows in the lower Loddon was also completed in the 2010-11 year (North Central CMA, 2011). This study focussed on the impact of black water and acid water on ecological values in Reach 4.

3.1.3 Policy & Strategy

During the last twelve months North Central CMA was required by the Minister to prepare a Bulk Entitlement Metering program for the Loddon BE. In conjunction with G-MW (Storage Operator) and Thiess Services (hydrographic contractor), an approach to ensure that flow releases in the Loddon River comply with the requirements of the Bulk Entitlement was developed.

A review of the Environment Operating Strategy for the Loddon BE is due in the next year. With the inception of the VEWH, this will become the Environmental Water Management Plan.

3.1.4 Current ecological condition

During the flooding sequence from August to February, river heights in the Loddon system provided a rare watering for the floodplain and fringing vegetation, and encouraged opportunistic migration of fish through the Kerang fishway. In some reaches (particularly in Tullaroop Ck) scouring improved the condition of pools, enhancing the habitat for blackfish.

Reach 4 was dry over the past three years, allowing red-gum saplings to colonise the bed in some areas. Floods in September, December and January inundated and pushed over these saplings, hindering further growth. Other in-stream vegetation (such as cumbungi) was also pushed over during flooding, highlighting their lack of impact on flows in such events.

Water quality has been a focus of monitoring since the floods. Continuous water quality probes situated in the Loddon River failed at times as a consequence of the floods, meaning some data is missing. Even so, observations and data confirmed that dissolved oxygen levels were low, with isolated samples <1 mg/l, but that black water did not occur. Salinity was variable during and after the events, but as flows subsided towards the end of March 2011, salinity levels started to increase, going from <1,000 us/cm to over 3,000 us/cm at some sites. Macroinvertebrates in reach 4 were much declined by late March, even though some recolonisation had been observed in October and December.

A range of bird species, including ibis, ducks, herons and egrets were observed making use of wetlands early in the flood period as they filled. Interestingly many dispersed into the shallower floodplain environments when overbank flows occurred. Some species were observed to have had two breeding events during the wet period (B.Barnes, pers comm).

3.2 Effectiveness of flow components delivered

Ecological objectives for the Loddon River system have been identified and linked to hydrological flow components in LREFSP, 2002 and SKM, 2010. In this section, the attainment of an ecological objective is indicated by the delivery of the relevant flow component. Flow data for the period 2001-02 to 2010-11 were compared to the recommended flows to ascertain whether the objectives were achieved.

This is recorded in Tables 9 to 13, which use a traffic light approach to indicate whether flow components were met, partially met or not met. The key to the traffic lights are as follows:

- **Red:** Flow data indicates that no significant part of the flow component was provided naturally or through managed actions
- **Orange:** Flow data indicates that the flow component has been partially provided, in terms of either magnitude, duration or frequency
- **Green:** Flow data indicates that the flow component is considered to have been completely provided.

Table 8: Historical achievement of environmental flow components and ecological objectives in Reach 1 of the Loddon River

Flow component Reach 1	Years									
	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Summer minimum										
Summer fresh										
Winter minimum										
Early winter fresh										
Spring fresh										
Bank full										
Overbank										

Table 9: Historical achievement of environmental flow components and ecological objectives in Reach 2 of the Loddon River

Flow component Reach 2	Years									
	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Minimum all year										
Fresh										
Early winter fresh										
Bank full										
Overbank										

Table 10: Historical achievement of environmental flow components and ecological objectives in Reach 3a of the Loddon River

Flow component Reach 3a	Years									
	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Summer – Autumn minimum										
Summer fresh										
Winter minimum										
Spring fresh										
Overbank										

Table 11: Historical achievement of environmental flow components and ecological objectives in Reach 3b of the Loddon River

Flow component Reach 3b	Years									
	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Summer minimum										
Summer fresh										
Winter minimum										
Winter – Spring fresh										
Bank full										
Overbank										

Table 12: Historical achievement of environmental flow components and ecological objectives in Reach 4 of the Loddon River

Flow component Reach 4	Years									
	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Summer minimum										
Summer fresh										
Winter minimum										
Winter – Spring fresh										
Bank full										
Overbank										

These tables reflect the extent to which flows were impacted by the drought in central Victoria over the past decade, particularly reach 4. They also demonstrate the influence of river operations on the attainment of flow objectives. For the most part, flows during spring and summer were delivered by river operations. Winter flows were consistently not met because it does not coincide with irrigation deliveries. With the inception of the Loddon BE (2005-06), achievement of flow components was still low as a result of the drought.

In 2010-11, flow components were mainly delivered by natural flows. Only a small volume (322 ML) was accessed from the Deficit and Reimbursement Account (established under the Bulk Entitlement) to supplement flows in reach 4 in October 2010.

The components that were ‘partially met’ were almost all rated thus because the flow magnitude was not consistently met, being usually lower than recommended. The 2001-02 winter-spring fresh in reach 3b was considered partially met because only one fresh was delivered when two are recommended. The winter flow component for reach 4 in 2010-11 was considered partially achieved because for the winter – spring period flows generally exceeded the recommended volume.

4 ENVIRONMENTAL WATERING PROPOSAL

4.1. Seasonally adaptive approach

Victoria has adopted an adaptive and integrated approach to environmental water management. A key component of this is the 'seasonally adaptive' approach, which identifies priorities for environmental watering based on the amount of water available in a given year. It recognises short-term climatic variability to help guide and manage annual watering priorities. The process involves considering the minimal flow components (and related water volumes) needed to meet ecological objectives and what additional objectives and flow components can be added as inflow increases and environmental water availability increases.

For the Loddon River, this approach necessitates the consideration of flow priorities over a number of years. One of the guiding principals for Loddon watering is to guarantee priority components in following years before delivering low priority components in the current year. The highly variable nature of the system and the influence of the Goulburn system allocations on Loddon River environmental water are also key factors for consideration in the development of watering scenarios.

4.2. Priority flow components

4.2.1. Loddon Reaches 1, 2, 3a and 3b

Flow components for Reaches 1,2,3a and 3b are not prioritised, and the fundamental management approach for these reaches is to maintain, as a minimum, passing flows according to Schedule 1 of the Loddon BE (see Table 3). Table 14 outlines the planned watering activities for the Loddon River between Cairn Curran and Loddon Weir. These flows are the same for all scenarios, and do not change unless combined storage volumes fall below 60 GL.

Flows are complemented by G-MW's river operations in most years, and by natural flows in average to wet scenarios, particularly if storages spill. This is likely in average to wet scenarios in 2011-12. It is also assumed that water being sourced from Tullaroop and/or Cairn Curran for delivery to reach 4 has environmental benefits in reaches 1 to 3b as it passes through the system.

Where combined storage in Tullaroop and Cairn Curran Reservoirs drops below 60 GL, minimum flows pass at a lower rate, and the balance accumulates in the Deficit and Reimbursement account. Given the strong storage position, this is unlikely to occur in 2011-12, and is only likely to happen if the region experiences a sequence of dry years.

In Tullaroop Ck (Reach 2), flow management also focuses on maintaining flows and freshes according to the BE, with some flexibility offered by the QoR. In periods of low water availability, minimum flows in Tullaroop Creek of 3-5 ML/day are released to ensure water quality in pools can support the population of regionally significant river blackfish. Flows of this magnitude are only likely to be delivered after a sequence of very dry years. This was the case until the first period of rainfall in August 2010, but is unlikely to happen in 2011-12.

Table 13: Minimum passing flows* in the Loddon System BE under all scenarios 2010-11

Reach No	Reach	Summer minimum passing flows		Winter minimum passing flows		Freshening		ML required
		Daily	Total ML	Daily	Total ML	Summer (Nov - April)		
						Volume	Duration	
1	Cairn Curran to Laanecoorie	20	**3200**	35	**6440**	35 ML/day	3 x 7 days	**735**
2	Tullaroop Ck Between Tullaroop Res and Laanecoorie	10	**1600**	10	**1840**	13.5 ML/day	3 x 7 days	**283.5**
3a	Laanecoorie Weir to Serpentine Weir	15	**3525**	52	**4784**	52 ML/day	3 x 13 days	**2028**
3b	Serpentine Weir to Loddon Weir	19	**2812**	61	**11224**	61 ML/day	3 x 11 days	**2013**

*Passing flows are 'or natural'

4.2.2 Loddon River Reach 4

Table 15 shows the scenarios for reach 4 in Drought (99% POE), Dry (90% POE), Average (50% POE) and wet (10% POE) conditions. Reach 4 remains the main focus for scenario planning in the regulated Loddon River and the revised flow recommendations for reach 4 recognise the inherent variability of the reach. The revised recommendations prioritise flow components as:

Priority 1: Bank full flow – 3,500 ML/day for 6 days, 3 – 5 times per decade. One event of 14 days every 10 – 15 years
Priority 2: Winter low flow – 100 ML/day between May and October (inclusive)
Priority 3: Spring fresh – 750 ML/day for 6 – 10 days every year
Priority 4: Summer fresh – 100 ML/day for 10 – 14 days, twice per year
Priority 5: Summer low flow – 25 ML/day between November and April (inclusive).

The total volumes of available water do not include the banked flows identified in Table 15. These are flows that would have been sent down reach 4 during summer, and are intended to be availabe as part of the following year's total water availability. Carry over represents the volume of water remaining from the total volume available if the scenario was to eventuate, for carry over into the following year. Calculations of the total water required do not include this volume.

A bank full flow was delivered to reach 4 in 2010-11, thus 2011-12 planning aims to ensure winter low flow and spring fresh components are delivered over the next two to three years. Summer flows in SKM (2010) are a low priority, and these should only be delivered if priority components can be guaranteed for following years.

4.2.2.1 Drought (99% POE)

A drought year equates to the record low inflows of 2006-07. Under this scenario, allocations start at around 30% + carry over, reaching a maximum of 35%, with full storages at the start of the season. No components will be delivered from unregulated flows, and irrigation demand will be high. WMP water, LSWFA and a pro-rata allocation for GWMS will be available. Subject to approval by the CEWH, an additional pro-rata allocation of their water may also be available. Summer flows will be banked and winter and spring components will be delivered. There is a very low probability that storages will fall below 60 GL in the latter part of a high irrigation demand year.

Assuming the following two years have inflows at 90% POE, there will be shortfalls in the delivery of priority components if additional water is not sourced, and summer flows will not be delivered in 2011-12. If 2013-14 is the third year of a dry sequence priority components cannot be guaranteed, and there is a real possibility that the reach could be allowed to dry up if outlooks suggest further dry weather. This does not conflict with ecological objectives for the reach, which allow for periods of cease to flow.

4.2.2.2 Dry (90% POE)

A dry scenario sees allocations starting the season at 32% + carry over, and reaching a maximum of 64%. Storages will be full at the start of the year, with a high irrigation demand likely. Based on historic flow data, no components are likely to be delivered by unregulated flows in this scenario. WMP water and a pro-rata allocation for GWMS will be available, while the LSWFA should be available if amended BE rules allow. Subject to approval by the CEWH, an additional pro-rata allocation of their water may also be available. Summer flows will be banked and winter and spring components will be delivered. Another dry year in 2012-13 means a shortfall if storages drop below 60 GL, and so the spring fresh component would be dropped in 2012-13 if the situation required it. Volumes and durations may need to be manipulated in a particularly dry year.

4.2.2.3 Average (50% POE)

Allocations for this scenario are in the order of 36% + carry over, increasing to 100% as the season progresses. Irrigation demand will be dependant on early winter rainfall, but is likely to be moderate to high Aug-Oct, and moderate in March and April. In an average scenario unregulated flows will deliver at least a spring fresh, and some winter flows, while a bank full, probably at a lower than recommended rate, might be delivered. In previous average years the river flowed but the magnitude of winter flows was often below 100 ML/day. This means environmental water will be sometimes needed to top up natural flows. WMP water, LSWFA and a pro-rata allocation for GWMS will be available. Subject to approval by the CEWH, an additional pro-rata allocation of their water may also be available. Summer flows will be banked and winter and spring components will be delivered with water to spare. If storages are spilling, only a small volume of environmental water will be needed to top up unregulated flows, and some carry-over at the end of the year is likely. A summer fresh can be delivered in 2011-12 in an average scenario, and priority components for both 12-13 and 13-14 can still be guaranteed even if they are dry.

4.2.2.4 Wet

The wet scenario is similar to 2011-12. Allocations will reach 100% early in the season and irrigation demand will be low, at least in the early part of the season. Storages will spill, probably early in the season, and some water will be lost (eg LSWFA). Even so, spilling storages will deliver water down river, and for the most part will provide priority components, including a bank full flow. If it is necessary to supplement flows, water from the WMP allocation can be deployed.

4.2.3 Boort district wetlands

The management of Boort district wetlands in 2011-12 is facilitated by the fact that all wetlands are currently at or close to full supply level (FSL). Therefore there is little scope for water to be added to these sites.

Lake Boort is an exception. There is a sound argument to support Lake Boort remaining wet for another year, given that it had been dry for such a long period, and there is an opportunity now to promote the recovery of aquatic vegetation. Watering can also contribute to ecological objectives that include:

- Restoring the distribution of live River Red Gums and associated floristic community (EVC 292) across the bed of Lake Boort, including rehabilitation of Southern Cane Grass populations
- Restore and rehabilitate vegetation species diversity typical of aquatic and semi-aquatic environments
- Reduce the likelihood of re-infestation of lake bed by mustard weed by reducing available surface area and reducing seed viability

It is likely that water will continue to cover the bed of Lake Boort into the next year, but if this is not the case, then environmental water will be available to deliver a top up to Lake Boort to contribute to achieving the above objectives. However, this is only a contingency if Lake Boort dries more quickly than anticipated, and no additional unregulated flows top it up.

Lake Meran has remained above the target level (79.5m AHD) throughout the 2010-11 season, and is not likely to fall much below this level in the next year. In this instance, some variability of lake height is tolerable from an ecological point of view, and it has been suggested that the local community would prefer to see the level drop somewhat through the next year, without losing its amenity. Therefore deployment of water to Lake Meran in 2011-12 is not recommended.

Table 16 summarises the watering schedule for the Boort district wetlands over the next 8 years, and Table 17 shows watering options for 2011-12 under the four scenarios Drought, Dry, Average and Wet. Information for Boort District wetlands has been gathered from sources that include a Technical Report for wetland watering (North Central CMA 2010(a)) Draft Environmental Watering Plans (EWPs) for Lakes Leaghur, Yando and Meran and a draft Environmental Watering Management Plan (EwaMP) for Lake Boort (North Central CMA unpubl a – d).

4.3 Scenarios – Loddon River Reach 4

Table 14: Environmental watering scenarios for the Loddon River Reach 4, 2011-12

			DROUGHT	DRY	AVERAGE	WET
			99% POE	**90% POE**	**50% POE**	**10% POE**
Allocation			30 + C/O to 35%	32 + C/O to 64%	36 to 100%	47 to 100% + 50% LRWS
Unregulated flows			No components delivered by unregulated flows	No components delivered by unregulated	Up to 50% required volume delivered by unreg flows, dependent on timing of flow	Up to 90% required volume delivered by unreg flows, dependent on timing of flow
River operations (consumptive demand)			High	High	Moderate - High	Low
Potential sources of environmental water (entitlements & allocations)	Source	Total Available	Maximum volume available under the scenario			
	WMP	7,490[1]	7,490	7,490	7,490	7,490
	GWMS	1,432	501	916	1,432	1,432
	CEWH	1,560[2]	546	998	1,560	1,560
	LRWS	1,712	0	0	0	856
	LSWFA	5,314	5,314	5,314	5,314 (some spills)	5,314 (spills)
Ecological objectives			▪ Channel Maintenance ▪ Maintain instream vegetation ▪ Reduce terrestrialisation ▪ Maintain water quality	▪ Channel Maintenance ▪ Maintain instream vegetation ▪ Reduce terrestrialisation ▪ Maintain water quality	▪ Channel Maintenance ▪ Maintain instream vegetation ▪ Reduce terrestrialisation ▪ Sediment flushing ▪ Reoxygenation	▪ Channel Maintenance ▪ Maintain instream vegetation ▪ Reduce terrestrialisation ▪ Sediment flushing ▪ Reoxygenation
Priority flow components			Volume required			
	Winter low flow		4,245	4,245	4,245	4,245
	Spring fresh		8,666	8,666	8,666	8,666
	Summer fresh		0	0	3.088	3.088
Potential total volume available			13,851	14,718	10,482[3] to 15,796	10,482[2] to 16,652
Banked (add to carry over)			5,147	5,147	5,147	5,147
Carry over			1,274	2,182	3,997	5,147
Total volume required[4]			**12,911**	**12,911**	**15,999**	**15,999**

[1] All volumes in megalitres
[2] Availability of this water source is contingent upon the approval of the CEWH
[3] Volume available if all spillable water accounts spill

4.4 Scenarios – Boort district wetlands

Table 15: Summary of watering projection for Boort district wetlands

Wetland	Area (Ha)	Capacity (ML)	Filling	Current status	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Leaghur	63.4 ha	664	1 yr in 3	Full	Full	0	0	664 max	0	0	664 max	0
Yando	83	478	1 yr in 3	Full	Full	0	0	478 max	0	0	478 max	0
Meran	175	9,218	9 yr in10	Full	Full	0	1,750	1,750	1,750	1,750	1,750	1,750
Little Meran	27.2	881	Channel capacity (15 – 20 ML/day) constrains GMW's delivery of water to Little Lake Meran. It will likely only fill in a large flood event. Further investigation required to determine value of increasing channel capacity.									
Boort	420	5,817	1 yr in 3 (variable to 1 in 5	Full	Full	1,500 max	0	0	5817	0	0	5,817
Lyndger	Only fill from flood flows – investigate options for upgrading inlet/outlet infrastructure											
TOTAL						**1,500 max**	**1,750**	**3,763**	**7,567**	**1,750**	**3,763**	**7,567**

[4] Excludes any water delivered by unregulated flows

Table 16: 2011-12 scenarios for Boort district wetlands

Wetland	Area (Ha)	Capacity (ML)	Filling	Current status	Drought	Dry	Average	Wet
Maximum vol available					700	1,280	2,000 + 2,000 C/O	
L. Leaghur	63.4 ha	664	1 yr in 3	Full	Allow to dry	Allow to dry	Avoid diverting unregulated flows if possible	
L. Yando	83	478	1 yr in 3	Full	Allow to dry	Allow to dry	Avoid diverting unregulated flows if possible. Small volume of unreg water can be diverted if required	
L. Meran	175	9,218	9 yr in10	Full	Draw down	Draw down	Watering of black box community not recommended, but L Meran can accept some unregulated flows	
Little L. Meran	27.2	881	1 yr in 3	Full	Allow to dry	Allow to dry	Not connected to floodplain. Unlikely to fill.	
L. Boort	420	5,817	Max 1 in 5	Full	**1,000 – 1,500**	**1,000 – 1,500**	Filled by unregulated flow	

4.5 Proposal for water use

Tables 15 and 17 identify the volumes of water required for watering in the Loddon system and the Boort District Wetlands for 2011-12. These volumes are summarised in table 18 below.

The volumes required to water reaches 1, 2, 3a and 3b are prescribed in the Bulk Entitlement, and include an 'or natural' clause. The volume in the table for reaches 1, 2, 3a and 3b is the total required according to the Bulk Entitlement (Loddon River Environmental Reserve) Order 2005 for Reach 3b. Given the connectivity of these reaches, deployment of this water is assumed to meet the requirements of the Bulk Entitlement for the other upstream reaches.. Reach 4 is managed separately to the other four reaches because some entitlements are only available for use at Loddon Weir (eg Wimmera Mallee Pipeline savings).

Table 17: Proposed environmental water requirements

	DROUGHT or DRY	AVERAGE or WET
Reaches 1, 2, 3a and 3b	Up to 16,049 ML	
Reach 4	12,911 ML	15,999 ML
Boort District Wetlands	0 to 1,500 ML	0

4.5.1 Expected benefits

Ecological objectives in reach 4 focus on the restoration or maintenance of riparian vegetation. Ongoing watering through winter and spring will achieve this objective, and also allow aquatic macrophytes to re-establish. Terrestrialisation in the river bed reduced by the floods can be further controlled by keeping areas vulnerable to in-stream river red gum germination inundated.

The blackfish population in Tullaroop Creek below Tullaroop Reservoir is recovering after several years of stress (D. Iervasi, pers comm). Therefore it is important that objectives associated with habitat and food sources for this regionally significant species are met in the next year, and guaranteed over time.

4.5.2 Certainty of benefit

The recommended flow regime supports priorities outlined in flow recommendations (LREFSP, 2002 and SKM, 2010). These documents describe flows required to achieve the range of environmental objectives identified for the Loddon River and Tullaroop Ck (Tables 5, 6 and 7) that can be delivered by managed flows, irrigation (consumptive) water or unregulated flows in the system. Monitoring undertaken as part of VEFMAP, photo point monitoring and field observations contribute to that assessment.

4.5.3 Implications of not watering

In the Loddon River below Loddon Weir the ecological function of the reach is recovering after a decade of flow stress, including a period of three years in which the reach was completely dry. While cease to flow is a valid component of the Loddon's flow regime, recent high flows have provided significant ecological benefits, with the highest priority component (bank full) having been delivered. This afforded an opportunity for ecological recovery in the reach to progress, by maintaining high priority winter and spring flow components. By not delivering flows an opportunity to progress that recovery is lost, reducing the capacity for longer term recovery and maintenance of the improved ecological conditions, particularly in winter and spring.

There are significant implications of not providing water to Tullaroop Creek, and the values associated with the reach mean it should not be allowed to dry out. Blackfish populations are starting to recover, having survived the drought by utilising pools maintained by very low environmental flows. There is also evidence to suggest that iconic species such as water rats and platypus have also recolonised the creek. Not watering will impact on the integrity of these populations.

4.5.4 Offsite risks

Given the recommended flow regime for the lower reach of the Loddon, the off-site risks are considered to be minimal. An overbank flow will only occur as a result of natural events and not from the active management of environmental water. A bank full flow has the potential to cause some flooding in the area at and below the Twelve Mile Creek regulator, however it is unlikely a flow of this magnitude will be delivered by environmental water in the short term.

Offsite impacts in the Boort Wetlands are associated with the potential for overflow into private land, particularly from Lake Lyndger, and damage to infrastructure should an average or wet year again deliver high unregulated flows to the Boort district. In average or wet scenarios no environmental water will be delivered. An assessment will be made in mid to late spring to determine in more detail the potential risk of delivering environmental water to Lake Boort.

4.5.5 Feasibility & cost effectiveness

North Central CMA has had a good relationship with the storage operator since the inception of the Loddon BE. As a consequence, there is ongoing cooperation in the delivery of environmental water. Therefore there is no impediment to delivering environmental water in the Loddon system once operating rules are established and implemented.

4.5.6 Watering history

Environmental water has been managed in the Loddon system since the inception of the Loddon BE (2005). Before this, irrigation operations provided most water to the river, as demonstrated by flow data in the years before the BE.

In reach 4, until the river dried up in 2007, flows were as stated in Schedule 1 Section 5 of the Loddon BE, or were under a QoR. Two QoRs are in operation until the 30th June 2011:

- Temporary Qualification of Rights in the Loddon Water System, July 2009
- Temporary Qualification of Rights in Reach Two of the Loddon Water System, June 2009 (where 'Reach 2' is a reference to the reach of the Loddon System between Tullaroop Reservoir (inclusive) and Laanecoorie Reservoir (exclusive) also referred to as Tullaroop Creek).

A review of the flow recommendations recognised the variability of reach 4 of the Loddon, its somewhat ephemeral nature and the risks associated with small flow volumes in that reach. Combined with better knowledge about the requirements of the system, the recommendations enhance the benefits of environmental watering in reach 4. An example of this is the reduced risk of black water and acid water that comes from an altered flow regime in summer.

5 ENVIRONMENTAL WATER DELIVERY

An Environmental Operating Strategy for the Loddon BE was prepared in 2005. This is an agreement between the North Central CMA and G-MW regarding the operation of the Loddon system, as well as presenting a strategic view of the management of environmental water over the period of the agreement. The operating strategy was due to be reviewed during 2011-12; however it will be replaced by the Environmental Water Management Plan to be prepared in the next year. This will include operating rules for the Wimmera – Mallee pipeline savings.

Delivery of water according to this plan will also be contingent upon ammendments to the Loddon Bulk Entitlement additional to those required by the inception of the VEWH. These potentially include an account to replace and hold LSWFA water, more flexible management of the Lower Loddon River akin to the QoR, and modifications to some spill rules. These ammendments are important to ensure that ecological objectives of the updated flow recommendations (SKM, 2010) are achievable.

5.1 Risk assessment and management

While it is widely acknowledged that the delivery of environmental water to the Loddon River System provides a major benefit to the health of the environment and ecosystems supported in the river system, there are a number of risks that need to be considered in the delivery of environmental water.

Risks from environmental watering in the Loddon River System are identified in Table 19.

5.2 Costs

The Environmental Water Manager does not make any payment for headworks costs relating to the Environmental Reserve BE. However, any additional delivery costs relating to the supply of the wetland entitlement where it is delivered through channel infrastructure will incur a cost.

Table 18: Risk assessment for environmental water in the Loddon System

Risk	Description	Reach	Likelihood	Consequence	Overall Risk	Management
Overbank flows	Environmental flows exceed channel capacity	1, 2, 3a, 3b, 4	Low – Overbank flows not deployed from environmental entitlements	High – Overbank flows cause damage to private property and infrastructure	Moderate	Ensure environmental flows are delivered according to flow recommendations. Investigate potential changes to channel morphology after floods that may influence river heights
		Boort lakes	High – average to wet scenarios will see wetlands over-full	High – Overflows cause damage to private property and infrastructure	High	No environmental water deployed in anything but a drought to dry scenario in 2011-12; review for 2012-13 year
Acid Water	Acid sulfate soils (ASS) are exposed and re-wet causing H_2SO_4 to be generated and low pH water to enter system	1, 2, 3a, 3b	Low – No ASS known in these reaches	Low	Low	No mitigation required
		4	Moderate – Only a small area of ASS in Reach 4	Moderate – Potential for fish kill but low native fish numbers in reach	Low	Avoid low volume flows during summer. Dilute acid water with scheduled fresh if required
Black water	Organic material in the water column causes deoxygenation	1, 2, 3a	Low – Black water events infrequent	High in reach 2 (blackfish death), low in other reaches	Low	Avoid low volume flows during summer. Dilute/mobilise water with scheduled fresh if required
		3b	Moderate – Black water events recorded in reach but not often	High – Can lead to deaths of native fish species	Low	Avoid low volume flows during summer. Dilute/mobilise water with scheduled fresh if required
		4	Moderate – Black water events recorded in reach in summer flow	Moderate – Potential for fish kill but low native fish numbers in reach		Avoid low volume flows during summer. Dilute/mobilise water with scheduled fresh if required

			conditions			
Blue-green algal bloom	Water (particularly flood water) contains high nutrients and when other ambient conditions, such as temperature, sunlight and turbidity are conducive, blue-green algal blooms can occur	Boort lakes	Moderate – high volumes of flood water may enter lakes in average to wet scenarios	Moderate – Can impact on recreational and aesthetic values. Can be a consequence for stock and domestic users if bloom is toxic	Moderate	Few options for management at site. Allow bloom to run its course
		1, 2, 3a, 3b, 4	Low – water movement generally great enough to avoid blooms	Moderate – can be a consequence for stock and domestic users if bloom is toxic	Low	Ensure water movement is adequate to avoid bloom. Complimentary works reduce nutrient entrainment. Dilute/mobilise water if required

6 MONITORING

Table 20 outlines monitoring of environmental flows in the Loddon System. The majority of monitoring is encompassed by the Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP). This includes vegetation assessments, fish surveys, channel morphology and water quality. The latter is monitored by means of continuous water quality probes. Some water quality data are also collected during field visits using a hand-held YSI multi-parameter instrument.

North Central CMA staff have undertaken macroinvertebrate sampling between October 2010 and March 2011, in response to flooding. A review of this program will determine whether there is value in it continuing as part of flow monitoring in reaches 2 and 4.

Table 19: Monitoring associated with environmental watering in the Loddon River

Monitoring	Objective	Flow component	Indicator(s)	Monitoring sites	Frequency	Other considerations
Victorian Environmental Flows Monitoring Program (VEFMAP)	Evaluate ecosystem responses to environmental flows	Full flow regime	• Flow • Channel features • Habitat survey • Vegetation survey • Fish survey • Water quality	▪ Reach 1 – 4 sites ▪ Reach 2 – 6 sites ▪ Reach 3a - 2 sites ▪ Reach 3b - 2 sites ▪ Reach 4 – 4 sites	Fish – annually Other parameter- every 5 years	Long-term monitoring program which aims to generate information about long-term ecosystem responses at a 5-10 year timeframe
VEFMAP continuous water quality monitoring	Real time WQ monitoring	Various	• Dissolved oxygen • Salinity (Electrical Conductivity) • water temperature	Tullaroop Ck : ▪ Mullins Rd Loddon R ▪ Turners Crossing ▪ Serpentine Weir ▪ Loddon Weir ▪ Yando Rd	Real Time	N/A
Photo point Monitoring	Demonstrate delivery of flow components	Various	N/A	Various	As required	As required
Field Observation	Observe ecological responses	Various	N/A	Various	As required	As required

7 COMMUNICATIONS

The North Central CMA has developed a communication and engagement plan for the management of the EWR in the North Central Region. Communications for the Loddon River environmental water delivery will be in accordance with this plan. Stakeholders, their level of influence and water delivery impact have been identified and are listed in Table 21.

Table 20: Stakeholders for Environmental Water delivery in the Loddon River

Target group	Project stakeholder	Degree of influence (H, M, L)	Degree to which water deliveries will impact on them (H, M, L)
General community	▪ Diversion licence holders ▪ Farmers ▪ Irrigators ▪ Landholders ▪ Recreational Water users	M M M L L	H H H L L
Stakeholder groups	▪ CEWAG/LEWAG	H	H
Bulk Entitlement holders	Storage operators and holders of the Bulk Entitlements ▪ Goulburn-Murray Water ▪ Coliban Water ▪ Central Highland Water	H	H
Partners	▪ DSE ▪ DPI ▪ VEWH ▪ CEWH	H M H H	H M H H
North Central CMA employees (Board, Staff and NRMC)	▪ North Central CMA Board ▪ Natural Resource Management Committee	H M	H M

Degree of influence is the extent to which a stakeholder can impact environmental water delivery. Stakeholders whose buy-in is highly critical to the success are considered as high.

Degree of impact is the extent to which environmental water delivery potentially will impact on them and their area of responsibility

Based upon the assessment in Table 21, each group requires a different level of engagement. The action plan in Table 22 details the level of engagement, timelines and appropriated tools for engagement for each stakeholder group where:

- **Inform** = To provide balanced, objective information to assist stakeholder understanding of the environmental flow release
- **Consult** = To obtain feedback on analysis, alternatives and/or decisions.
- **Involve** = To work directly with stakeholder to ensure their concerns and aspirations are consistently understood and considered.
- **Collaborate** = To partner with stakeholder in each aspect of decision making, including developing alternatives and identifying the preferred solution.

Table 21: Action plan for management of environmental water in the Loddon River System

Activity	Target audience / stakeholders	Level of engagement (Refer to section 5)	Timeline
Environmental water deployment will be advertised in relevant papers when: • The environmental water release is new • It is the first environmental water release for the season • There are noticeable changes in the water of the river • There is a significant increase/reduction of flows • There are risks to the community	▪ General Community	Inform	Before water is deployed and ongoing
Regular updates of environmental water delivered in the North Central CMA region by: • Webpage update • Other communications as required	▪ General Community	Inform	Ongoing
Loddon Environmental Water Advisory Group (LEWAG) • Regular meetings • Other Communications as required	▪ Stakeholder group	Consult/collaborate/involve	March and May Annually
Communication with other Bulk Entitlement Holders in aspects of Environmental Water management: • Regular meetings • Other Communications as required	▪ Bulk Entitlement holders	Collaborate/inform	Ongoing
Environmental Water planning and delivery	▪ Partners ▪ VEWH ▪ CEWH	Collaborate/inform	Ongoing
Inform and engage partners • Weekly e-flow update • Meetings as required	▪ Partners ▪ VEWH ▪ CEWH ▪ DSE ▪ DPI	Inform	Ongoing
Internal North Central CMA organisational updates	▪ North Central CMA Board	Involve	Quarterly Basis
	▪ NRMC	Inform	As required

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VICTORIAN ENVIRONMENTAL WATER HOLDER

Seasonal Watering Plan 2011–12

State Government Victoria

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Front cover image: Gunbower Forest wetlands, Alison Pouliot

Contents

* Planned watering actions in these systems will be added to the seasonal watering plan at a later date. The development of seasonal watering proposals for these systems has been pending the finalisation of the Barwon environmental flow study, and planning and infrastructure works to connect further Wimmera-Mallee wetlands to the Wimmera-Mallee Pipeline.

Foreword

It is a great honour to be appointed to Victoria's first independent statutory body for holding and managing the State's environmental water entitlements and allocations.

Having only been established since 1 July 2011, developing the first seasonal watering plan of the Victorian Environmental Water Holder (VEWH) has been a challenging, but at the same time satisfying experience.

The development of the detailed and comprehensive seasonal watering proposals by the regional catchment management authorities (CMAs) and Melbourne Water to inform the basis of this plan is acknowledged and much appreciated.

Similarly, the Department of Sustainability and Environment is commended for the significant environmental outcomes achieved by the Victorian environmental watering program during previous years, and particularly through the drought.

The seasonal watering plan has also benefited enormously from the knowledge and experience of the departmental and VEWH staff who have been involved in its development during the transitional period. Thanks go to Beth Ashworth, Mike Jensz, Tori Perrin and Lucy Alderton in this regard.

In a time of unpredictable, and at times, extreme climatic conditions, environmental water management is becoming increasingly complex. The challenges are greater, but the opportunities are also bigger than ever before.

The concept of an integrated statewide plan for environmental water management is a new one for Victoria. While challenging, this new approach presents considerable opportunity for coordinating the management of environmental water across catchments and waterway management boundaries.

The Victorian Water Holdings are a small but very important component of the overall Environmental Water Reserve. It is these entitlements that can be actively managed, in terms of when and how water is released, to get maximum environmental benefit. It is the intention of the VEWH to use its Water Holdings strategically to complement the other components of the Environmental Water Reserve and to work closely with the waterway managers and their partners to maximise environmental benefits.

The opportunity for coordination with other holders of environmental water entitlements, such as the Commonwealth Environmental Water Holder (CEWH) and partners in the Living Murray program, also means larger and more strategic environmental watering events are possible. Increased opportunities to trade environmental water entitlements and allocations, including through expansion of the water grid, provides greater flexibility to put environmental water to its highest value use.

Following an extended period of drought, Victoria's river systems received much needed rainfall and high flow conditions throughout 2010–11. Environmental watering priorities in 2011–12 will build upon the benefits provided by these wet conditions, promoting ecosystem recovery. Preliminary forecasts issued by the Bureau of Meteorology suggest slightly below average rainfall conditions for Victoria. However with most storages near capacity and wet catchments across most of the state, the outlook for the 2011–12 water year is positive.

The experiences of managing environmental water through the drought have not been forgotten however, and the VEWH intends to apply the lessons learned through this period to inform its decision making into the future.

This plan embraces an adaptive management framework, to guide decision-making under a range of seasonal conditions, based on scenarios from extremely dry to very wet. It is this framework that will allow the VEWH to make timely decisions and issue seasonal watering statements which authorise the use of water from its Water Holdings throughout the 2011–12 water year.

I, along with my fellow Commissioners, Geoff Hocking and Ian Penrose, look forward to the implementation of the *Seasonal Watering Plan 2011–12*, along with the challenges and opportunities the first operating year of the VEWH will undoubtedly present.

Denis Flett

Denis Flett
Chairperson, Victorian Environmental Water Holder

1 Overview

This Seasonal Watering Plan 2011–12 (the plan) is the first produced by the VEWH. It outlines the planned use of water from the Victorian Water Holdings (the Water Holdings), which comprise environmental water entitlements held within 13 source systems. Delivery of water from the Water Holdings to river reaches and wetlands throughout Victoria will help maintain important environmental values.

The plan considers how to coordinate delivery of water from the Victorian Water Holdings with environmental water managed by others, including the partners in the Living Murray program and the CEWH.

The plan has been prepared in collaboration with waterway managers (CMAs and Melbourne Water). It outlines priority environmental watering actions for 2011–12, provided there is sufficient water. The plan considers a range of scenarios, from very dry through to an extremely wet year, and is adaptive to changing water resource conditions and opportunities throughout the water year.

Seasonal watering proposals are developed by waterway managers to identify regional priorities for environmental water use. They provide a clear rationale to directly inform statewide priorities for environmental watering actions. The proposals are informed by relevant regional river health strategies, developed in consultation with the community and other partners. In addition, scientific studies into the timing, duration and frequency of environmental flows required for each river system (known as environmental flow studies), provide the scientific basis for seasonal watering proposals.

Understandably, there is variation in the approaches taken to developing these proposals; for example, in how the planning scenarios are identified, how priority flow components are defined and how risks have been assessed and described. In part, this reflects the varying hydrology of the systems and differences in water management arrangements. It may also be due to historical differences in terminology or the technical approaches used by waterway managers. In the future, it is intended that there will be more consistent approaches used in developing the seasonal watering plan.

Sections 13–15 outline the scope of planned watering actions during 2011–12 in southern, western and northern Victoria. These sections outline the expected environmental water use under a range of planning scenarios to achieve specific environmental objectives.

Seasonal watering statements will be issued to communicate decisions on environmental watering actions. A statement can be made at any time during the season. Statements will relate to specific systems and waterway managers. Depending on the nature of the system and the entitlement being used, there may be one or multiple statements made for a particular system, as conditions unfold and water becomes available (see section 6 for further information). In addition to communicating decisions on watering actions, the seasonal watering statements authorise waterway managers to order and deliver water from the Water Holdings on behalf of the VEWH.

Schedules 1–14 provide further detail about watering actions outlined in sections 13–15. Schedules 1–14 are available to download from www.vewh.vic.gov.au or hard copies are available from the VEWH office.

2 Environmental water in Victoria

The VEWH manages only the environmental water that is provided through environmental water entitlements or 'the Water Holdings' (see section 4 for more information). The Water Holdings can be actively managed, with discretion as to when, where and in what volumes water is delivered.

The volume of water from the Water Holdings actually available for use in any given year is subject to seasonal conditions, including rainfall and runoff in the catchments.

The Water Holdings form only one part of Victoria's broader Environmental Water Reserve (EWR). The EWR is the legal term used to describe the amount of water set aside to deliver environmental outcomes. In addition to the Water Holdings, the EWR includes water provided through:

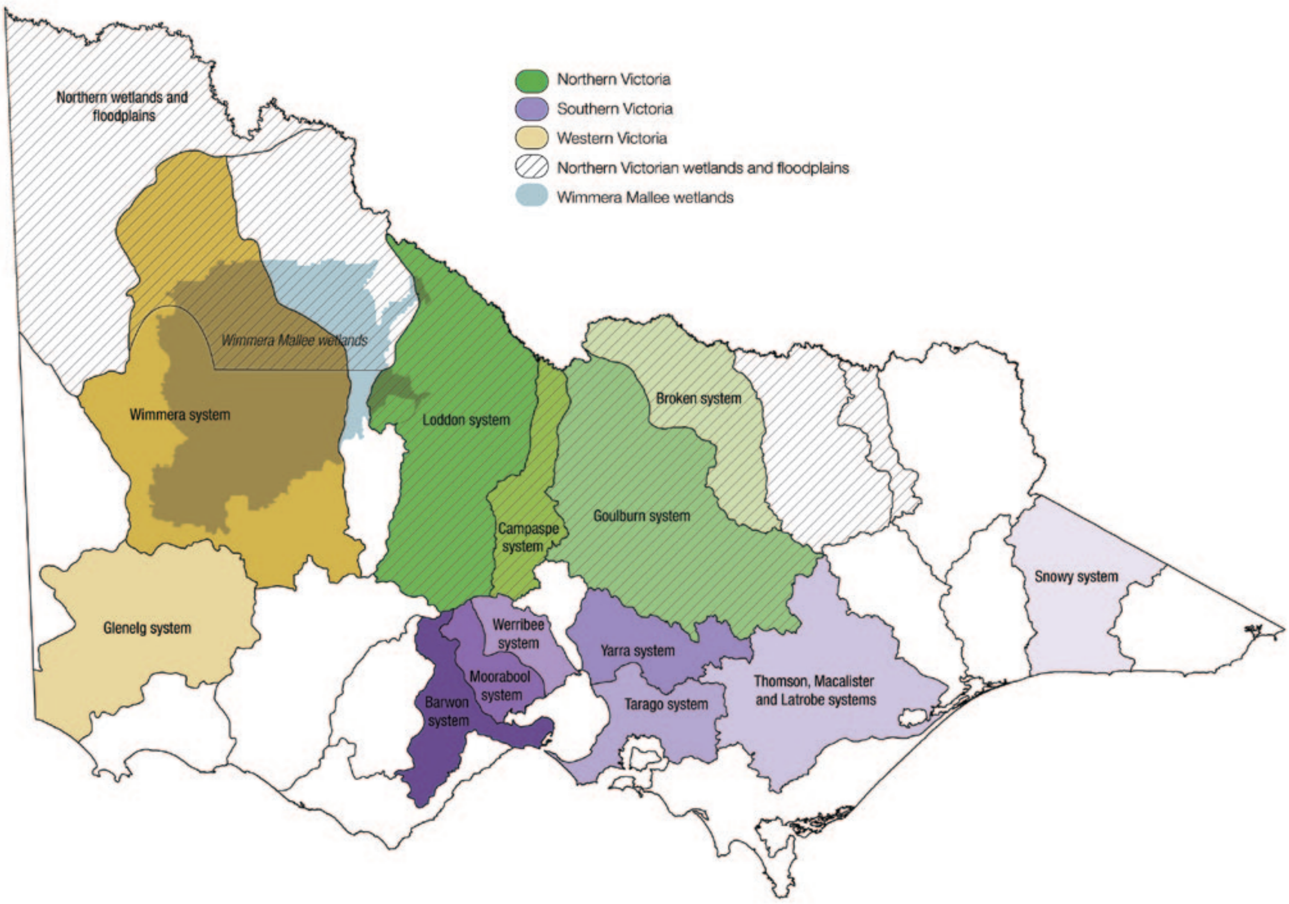
- water set aside for the environment as obligations on consumptive water entitlements held by urban and rural water corporations – these are usually called 'passing flows' that must be released from storages or provided at a particular point of a river
- 'above cap' water provided once limits on consumptive water use have been reached or due to unregulated flows and spills from storages, usually created by heavy rainfall.

Victorian river systems may also be allocated environmental water from other entitlement-holders, including partners in the Living Murray program, the CEWH and through donations from individuals, community groups and other organisations. It is the role of the VEWH to coordinate with other holders of environmental water entitlements to maximise the benefits to Victorian waterways, and to ensure that the delivery of this water will not have any adverse impacts in Victoria (see section 15 for more information).

River systems contain river reaches, floodplains and wetlands which can receive environmental water. Some of these systems connect naturally, some are connected by man-made structures, and others do not connect at all. Environmental entitlements are sourced from reservoirs in one river system but may be able to be delivered and used in a number of river reaches and wetlands, depending on the specific rules of the entitlement and the physical connectivity between systems. For example, an entitlement held in the Goulburn River may be available for use in River Murray wetlands. Figure 2.1 illustrates the systems where it is possible to deliver water from the Water Holdings.

Lindsay Island – Lake Wallawalla, Mallee Catchment Management Authority

Figure 2.1 Systems that can receive water from the Water Holdings



It is not only environmental water that is beneficial to waterways; other types of water can also provide environmental benefits, for example:

- consumptive water en route (that is, water on its way to being delivered to water users)
- system operating water (that is, water released down regulated rivers in order to deliver consumptive water to users).

Waterway managers consider these other types of water in developing their seasonal watering proposals. They are also considered in the development and implementation of the seasonal watering plan to ensure effective system operations, efficient use of water from the Water Holdings and to optimise environmental benefits.

3 The role of the Victorian Environmental Water Holder

The VEWH is an independent statutory body responsible for making decisions on the most efficient and effective use of Victoria's Water Holdings, thus helping to protect the environmental values of Victoria's rivers, wetlands and floodplains.

The VEWH is comprised of three part-time Commissioners, supported by a small operations team. The Commissioners act as a board of governance and consist of Denis Flett, Chairperson, Geoff Hocking, Deputy Chairperson, and Ian Penrose, Commissioner. The Commissioners are appointed by the Governor in Council on the recommendation of the Minister for Environment.

The VEWH works with CMAs and Melbourne Water. Its main responsibilities are to:

- hold and manage Victorian environmental water entitlements and allocations (the Water Holdings)
- coordinate the delivery of Victorian environmental water allocations with those of other environmental entitlement holders to maximise benefits to the environment
- ensure that environmental water management continues to become more efficient, optimising environmental benefits
- make adaptive, responsive and timely decisions about where and when environmental water is delivered
- examine opportunities to trade water allocations and entitlements, where this optimises environmental benefits
- draw on the environmental watering priorities identified by waterway managers in consultation with their local communities, to identify statewide priorities
- report on when, where, how and why environmental water entitlements have been used.

The objectives and functions of the VEWH are set out in sections 33DA–33DZA of the Water Act 1989. The VEWH is an independent statutory body that acts in accordance with State Government policy including:

- any rules issued by the Minister for Environment under section 33DZA of the Water Act
- sustainable water strategies
- the Victorian River Health Strategy (soon to be replaced by the Victorian Strategy for Healthy Rivers, Estuaries and Wetlands).

Denis Flett

Chairperson, Victorian Environmental Water Holder

Geoff Hocking

Deputy Chairperson, Victorian Environmental Water Holder

Ian Penrose

Commissioner, Victorian Environmental Water Holder

4 The Water Holdings

The Water Holdings are the environmental water entitlements held by the VEWH. Table 4.1 below outlines the environmental entitlements and bulk entitlements held by the VEWH (as of 30 June 2011), including those held in trust for the Living Murray.

Table 4.1 The Water Holdings

System	Entitlement	Volume (ML)	Reliability
Latrobe	Latrobe River Environmental Entitlement 2011	n/a[1]	n/a
Macalister	Macalister River Environmental Entitlement 2010	7,111 3,555	High Low
Thomson	Bulk Entitlement (Thomson River – Environment) Order 2005[2]	10,000[3]	n/a
Tarago	Tarago and Bunyip Rivers Environmental Entitlement 2009[2]	3,000[4]	n/a
Yarra	Yarra Environmental Entitlement 2006[2]	17,000[3] 55[5]	n/a
Werribee	Werribee River Environmental Entitlement 2011	n/a[6]	n/a
Moorabool	Moorabool River Environmental Entitlement 2010[2]	2,500[7]	n/a
Barwon	Barwon River Environmental Entitlement 2011	n/a[1]	n/a
Wimmera and Glenelg	Wimmera and Glenelg Rivers Environmental Entitlement 2010[2,8]	41,560	High
Loddon	Bulk Entitlement (Loddon River – Environmental Reserve) Order 2005[8]	2,000 7,490[9] 2,024	High n/a Low
	Environmental Entitlement (Birch Creek – Bullarook System) 2009[2]	100[9]	n/a
	Water Shares – Snowy River Environmental Reserve	470	High
Campaspe	Environmental Entitlement (Campaspe River – Living Murray Initiative) 2007	126 5,048	High Low
Goulburn	Environmental Entitlement (Goulburn System – Environmental Water Reserve) 2010	0[10]	n/a
	Goulburn River Environmental Entitlement 2010	1,432	High
	Environmental Entitlement (Goulburn System – Living Murray) 2007	39,625 156,980	High Low
	Bulk Entitlement (Goulburn System – Snowy Environmental Reserve) Order 2004	16,812	High
	Water Shares – Snowy River Environmental Reserve	6,121 17,852	High Low
	Silver and Wallaby Creeks Environmental Entitlement 2006	0[11]	n/a

River Murray, Alison Pouliot

Table 4.1 The Water Holdings (continued)

Source system	Entitlement	Volume (ML)	Reliability
Murray	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999	27,600 40,000[12]	High Unregulated entitlement
	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 – Barmah-Millewa Forest Environmental Water Allocation[13]	50,000 25,000	High Low
	Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 – Living Murray	5,710 101,850 34,300[12]	High Low Unregulated entitlement
	Environmental Entitlement (River Murray – Environmental Water Reserve) 2010	0[10]	n/a
	Bulk Entitlement (River Murray – Snowy Environmental Reserve) Conversion Order 2004	29,794	High
	Water Shares – Snowy River Environmental Reserve	10,544 6,415	High Low

1 Use of this entitlement is dependent upon suitable river heights, as specified in both the Latrobe and Barwon environmental entitlements.
2 In addition to the volumetric entitlement, the entitlement also includes passing flow obligations.
3 After making provision for passing flows, on the 1st July every year the first inflows into the Thomson basin (10,000 ML) and Yarra headworks system (17,000 ML) are allocated to the environment.
4 This volume represents the average annual entitlement volume. The entitlement consists of passing flows and a 10.3 per cent share of inflows into storage, with the actual volume available in any year varying depending upon inflow conditions.
5 55 ML of water was recovered through a Stream Flow Tender Pilot program in the catchments of Olinda Creek, Stringybark Creek and Pauls, Steels and Dixons Creeks, which is now available to supplement environmental flows in the Yarra River.
6 The Werribee environmental entitlement consists of a 10 per cent share of inflows into storage, with the actual volume available in any year varying depending upon inflow conditions.
7 This volume represents the average annual entitlement volume. The entitlement consists of a 11.9 per cent share of inflows into storage, with the actual volume available in any year varying depending upon inflow conditions.
8 In addition to volumetric entitlement, the entitlement also consists of above cap water.
9 Allocation of water against these entitlements is dependant upon the seasonal allocation of high-reliability water shares being greater than 1 % on the Goulburn system in April of the previous year (7,940 ML in the Loddon system), and greater than 20 % on the Bullarook system at the start of December in any year (100 ML in the Birch Creek – Bullarook system). Upon reaching these thresholds, the full entitlement volume is made available.
10 The volume available under this entitlement will be amended upon completion of water savings projects associated Stage 1 of the Northern Victoria Irrigation Renewal Program (NVIRP). In the interim period, the environment's 1/3 share of the annual water savings achieved from Stage 1 of NVIRP are provided under a supply agreement.
11 Entitlement consists of passing flows only.
12 Unregulated entitlement volume available only in declared periods of unregulated flow in the River Murray.
13 The Barmah-Millewa Forest Environmental Water Allocation is an obligation set out in Goulburn-Murray Water's entitlement, and this water is specifically for use in the Barmah-Millewa Forest, in accordance with specific rules. New South Wales hold an equivalent volume. Use of this water is approved by the VEWH and New South Wales Government, in consultation with the MDBA.

More detail about the above entitlements can be viewed online at the Victorian Water Register (www.waterregister.vic.gov.au)

5 Environmental watering partners

Environmental watering occurs through the collaboration of a range of agencies and individuals to ensure it is coordinated and effective, bringing about the best outcome for Victorian waterways.

Partners of the VEWH include:

Waterway managers (catchment management authorities and Melbourne Water)

engage communities to identify priority waterways and environmental values; submit seasonal watering proposals for VEWH consideration; and manage the physical delivery of environmental water, monitoring and reporting.

The Department of Sustainability and Environment

develops water resource policy for approval by the Victorian Government; creates and amends environmental entitlements on behalf of the Minister for Water; and manages Crown land (eg. state forests), some of which receives water through the environmental watering program

Storage operators (water corporations)

operate water storages; and work with waterway managers to deliver and measure environmental water.

Parks Victoria

manages state and national parks and other reserves across Victoria, many of which contain sites which receive water through the environmental watering program.

Murray-Darling Basin Authority

coordinates planning for and implementation of the Living Murray program (a multi-jurisdictional commitment to the health of the River Murray) including delivery of water from entitlements held in trust by the VEWH. Partners of the Living Murray program are the Murray-Darling Basin Authority and the Commonwealth, Victorian, New South Wales, South Australian and Australian Capital Territory governments.

Commonwealth Environmental Water Holder

(part of the Department of Sustainability, Environment, Water, Population and Communities) holds and manages the water entitlements purchased through the Restoring the Balance water recovery program.

Other stakeholders with an interest in environmental watering include environmental groups, local government, entitlement-holders, land-holders and communities.

6 Environmental water planning

Seasonal watering proposals put forward by waterway managers identify the regional priorities for environmental water use in each system under a range of planning scenarios. The proposals provide a clear rationale to directly inform the statewide priorities outlined in the seasonal watering plan.

The seasonal watering proposals are informed by relevant regional river health strategies, developed in consultation with the community and other partners. In addition, scientific studies into the timing, duration and frequency of environmental flows required for each system (known as environmental flow studies), provide the scientific basis for seasonal watering proposals. While not responsible for these strategies and studies, the VEWH will likely input to their development in the future.

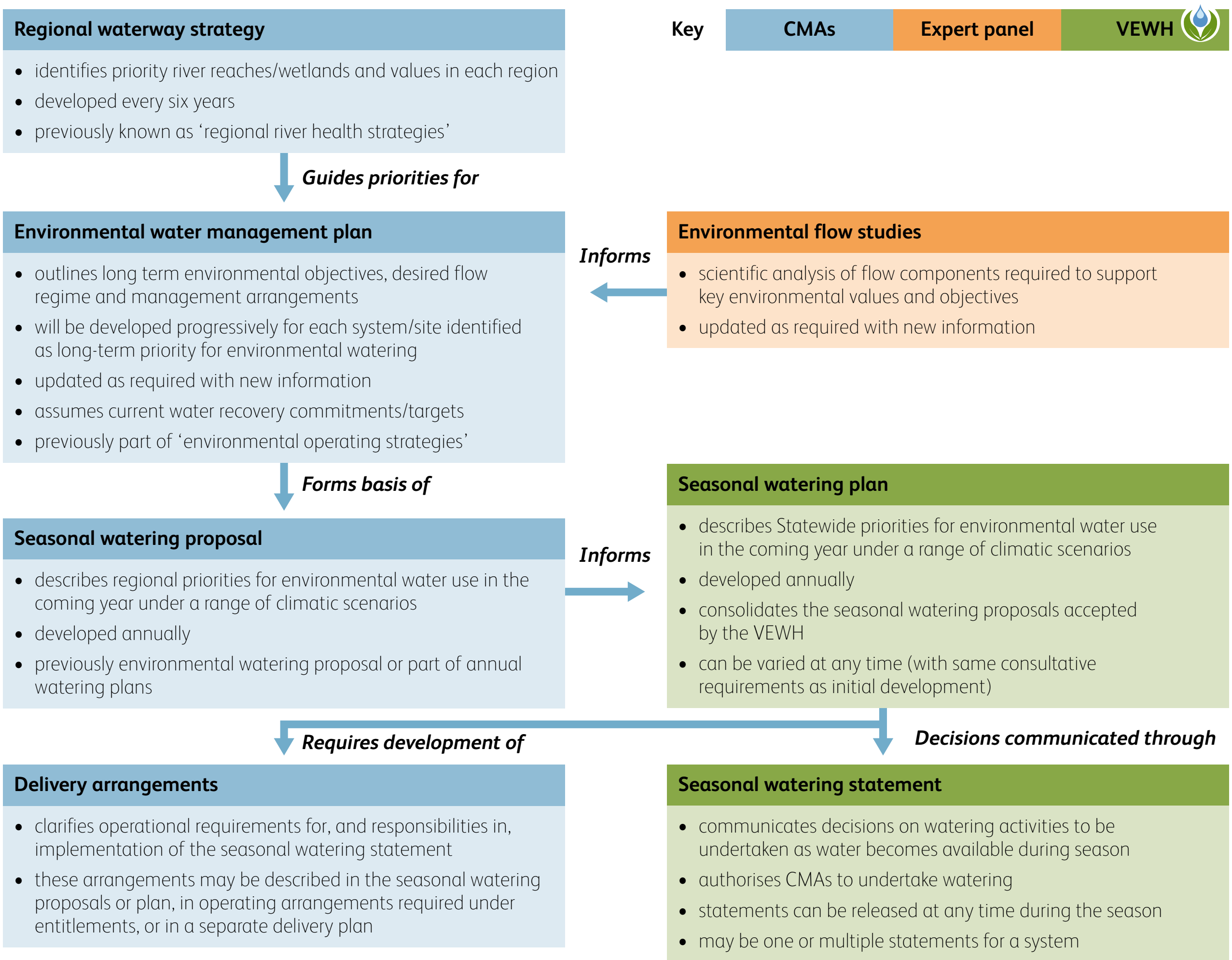
For this first seasonal watering plan, seasonal watering proposals put forward by waterway managers have been considered and accepted by the VEWH and now form part of the *Seasonal Watering Plan 2011–12* (see Schedules 1–14). They incorporate any changes resulting from feedback by the VEWH.

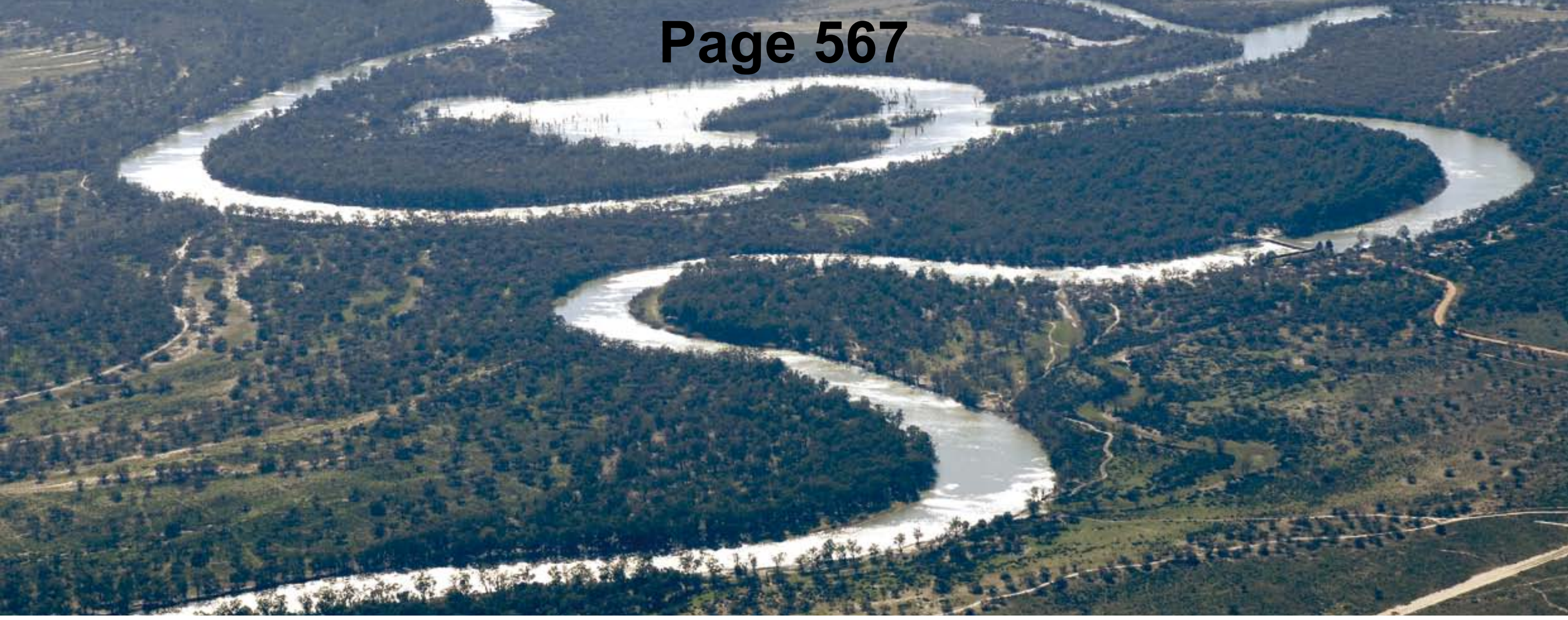
Seasonal watering statements will be issued to communicate decisions on environmental watering actions, including as water becomes available during the season. The statements authorise waterway managers to undertake watering actions; however, before any actions are performed, the VEWH must ensure that appropriate delivery arrangements are in place.

In developing seasonal watering statements, the VEWH will also negotiate with the CEWH and partners of the Living Murray program (see section 15 for more information).

The planning process is outlined in Figure 6.1. The elements of the planning framework, particularly regional waterway strategies and environmental water management plans, will be developed or refined over the next few years.

Figure 6.1 Planning for use of the Water Holdings





River Murray, Department of Sustainability and Environment

A flexible framework, called the *seasonally adaptive approach*, is used to guide decision-making. This approach looks at broad scenarios which range from very dry to very wet conditions. Scenarios incorporate the likely availability of environmental water based on recent climate history and outlook, and determine the priority environmental objectives as a result. In dry scenarios, watering actions are focused on protecting drought refuges and preventing critical or irreversible loss. In wetter scenarios, the aim is to improve resilience and restore floodplain linkages.

As a result of natural connectivity and man-made channels, it is often possible to deliver water from a particular reservoir to a range of river systems; northern Victoria is particularly interconnected. This interconnectivity provides the opportunity to prioritise environmental water use across systems and waterway manager boundaries; it is the role of the VEWH to do this prioritisation.

Determining priorities is most important when resources are constrained; for example, during drought periods or when there are limited funds for delivery charges.

In considering the seasonal watering proposals, developing the seasonal watering plan and prioritising the use of the Water Holdings, the following criteria are used:

- extent and significance of the environmental benefit expected from the watering (for example, the area watered, the size of the breeding event to be triggered, the conservation status of the species that will benefit etc)
- certainty of achieving the environmental benefit and ability to manage other threats (for example, a flow has been provided in the past with demonstrated benefits and relevant complementary works are being undertaken at the site)
- ability to provide ongoing benefits at the site (for example, where the management arrangements provide for watering in the long term)
- implications of not watering the site (for example, potential for critical or irreversible loss)
- risks associated with the watering (such as off-site salinity or water quality impacts)
- feasibility of the watering (including operational requirements and constraints and flexibility in delivery timing)
- cost-effectiveness of the watering (with regards to the amount of benefit for the volume of water and the associated delivery costs; includes the opportunity for return flows to provide downstream benefit)
- opportunity to maximise outcomes by integration with other sources of water and complementary works (for example, to build on a natural event or consumptive water en route)
- watering history (the length of time since a flow has occurred and the ecological implications of this).

7 Water delivery

The physical delivery of environmental water to sites in Victoria is guided by, and subject to a number of conditions, rules and in some cases fees and charges for the use of water delivery networks.

A seasonal watering statement must be issued by the VEWH before water delivery can commence.

Before issuing a seasonal watering statement to authorise a waterway manager to order and deliver water, the VEWH must be sure that delivery requirements have been met and that any costs to be met by VEWH are acceptable.

It is important that risks to the successful achievement of environmental outcomes and any risks to third parties are assessed and managed. Of particular note is the risk of damage to private property or personal injury. The VEWH and waterway managers will not flood private land. Risk management strategies will be implemented as necessary to address the risk of accidental or exacerbated flooding. These strategies are identified in sections 13A-I, 14A-C and 15A-E and each of the schedules.

Depending on the particular system and the entitlement being used, delivery arrangements might be outlined in any of the following:

- the seasonal watering plan
- operating arrangements required under some entitlements
- a separate delivery plan.

Delivery details include matters such as water source, delivery route, strategies to overcome delivery constraints, local site governance, mechanism, timing and triggers for watering, water ordering process, costs and funding sources and reporting and monitoring requirements.

A delivery plan must also be developed if water from entitlements of the CEWH or the Living Murray is approved for use at Victorian sites.

Once delivery arrangements have been confirmed, environmental watering can begin. This may be via a release from an upstream storage or by diverting directly from a river or channel.

Thomson Dam, Department of Sustainability and Environment

8 Accounting

Environmental water accounting provides information on the volume of water released, delivered and used at each of the environmental watering sites.

Allocation bank accounts (ABAs) are held for most of the entitlements held by the VEWH. As water is allocated to, or delivered from the entitlements, these amounts are recorded in the Victorian Water Register (www.waterregister.vic.gov.au/).

The VEWH will report its annual water use at the end of each water year in its annual report.

9 Carryover and trade

In certain circumstances, the VEWH can carry over allocation into the following water year and trade its water entitlements or allocation, consistent with the VEWH objectives – that is, the trade or carryover needs to benefit the environment. The mix of tools – water use, carryover and trade – will be used to optimise environmental benefits.

Water trading provides opportunities for more efficient use of environmental water in times of water scarcity. For example, revenue raised through trade may be used to purchase allocation at a different time or in a different system, fund small structural works to improve water use efficiency, or fund delivery costs.

Carryover provides opportunities for more flexibility and efficiency in environmental water planning and delivery by allowing entitlement holders to use environmental water when it is of greatest value to them.

All carryover and trade must be in line with any specific conditions in the entitlements or other relevant documents.

The VEWH must report annually on the use of the Water Holdings (including trade and carryover) to ensure transparency and accountability. All trading and carryover activity conducted by the VEWH will be recorded on the Victorian Water Register (www.waterregister.vic.gov.au/) and published in the VEWH annual report.

10 Consultation

This plan has been developed in a transitional phase, where responsibility for management of the Water Holdings has shifted largely from the Department of Sustainability and Environment to the VEWH. As such, the department has undertaken much of the consultation required with waterway managers. The VEWH will continue to consult thoroughly with waterway managers in the development of future plans.

CMAs and Melbourne Water are the waterway managers responsible for engaging with land managers, storage operators, regional communities and other stakeholders to identify environmental watering priorities and delivery arrangements. The consultation arrangements specific to each system are outlined in Schedules 1–14.

11 Monitoring and reporting

It is important to demonstrate that environmental water has been delivered, and that this water is delivering environmental outcomes.

The VEWH is required to report on when, where, how and why environmental water is used. There are also certain reporting obligations that must be undertaken by the VEWH in order to comply with each particular water entitlement.

The CMAs and Melbourne Water focus their monitoring efforts on actual water delivery but also conduct targeted ecological monitoring to improve future management decisions. The ecological objectives for watering and the proposed monitoring programs are outlined in Schedules 1–14.

Scientific environmental flow studies demonstrate the links between particular flow components (such as freshes or overbank flows) and a specific environmental objective (such as breeding of a priority fish species). In addition to these flow studies, the Victorian Government has developed and is undertaking the Victorian Environmental Flow Monitoring and Assessment Program (VEFMAP). This program will provide a sound scientific basis for the link between particular flow components and the ecological response.

In reporting on the watering actions that are implemented, the VEWH will rely on information provided by waterway managers. This information will be collated and made available in the VEWH annual report. The VEWH will also report on environmental watering outcomes through its website, media releases and other publications as required.

Information about the use of the broader EWR is available through the Monthly Water Report, (produced by the Department of Sustainability and Environment). The Monthly Water Report provides a summary of the status of Victoria's water resources and water supplies at the end of the reporting month (http://www.water.vic.gov.au/monitoring/monthly).

12 Planned watering actions

The following sections of the seasonal watering plan outline the scope of planned watering during 2011–12. They are described first for southern Victoria, starting in the east and moving across to western Victoria, and then for northern Victoria moving east to west.

These sections refer to the types of flows (flow components) which may be required to meet specific environmental objectives. Like the natural flow of rivers, different combinations of watering actions provide a different range of benefits for each ecosystem.

Flow components describe the different parts of a flow regime relevant to an ecosystem. They are characterised by their size, frequency, timing and duration. Freshes through summer, for instance, help to maintain or improve water quality; spring flooding replenishes a river channel and provides soil and nutrients for floodplains, as well as being vital for the breeding success of water birds and native fish. Figure 12.1 outlines the typical natural flow pattern of a Victorian river.

Wetlands and floodplains typically have wetting and drying phases, each important for ecological communities. For example, wetting phases are important in sustaining the health of river red gum forests and providing breeding habitat for waterbirds. Drying phases help to maintain an appropriate balance of aquatic and terrestrial plants, and ensure the wetting phase does not exceed the requirements of the relevant ecological community.

Further details on the scope of planned environmental watering actions can be found in Schedules 1–14 (these are listed in section 18).

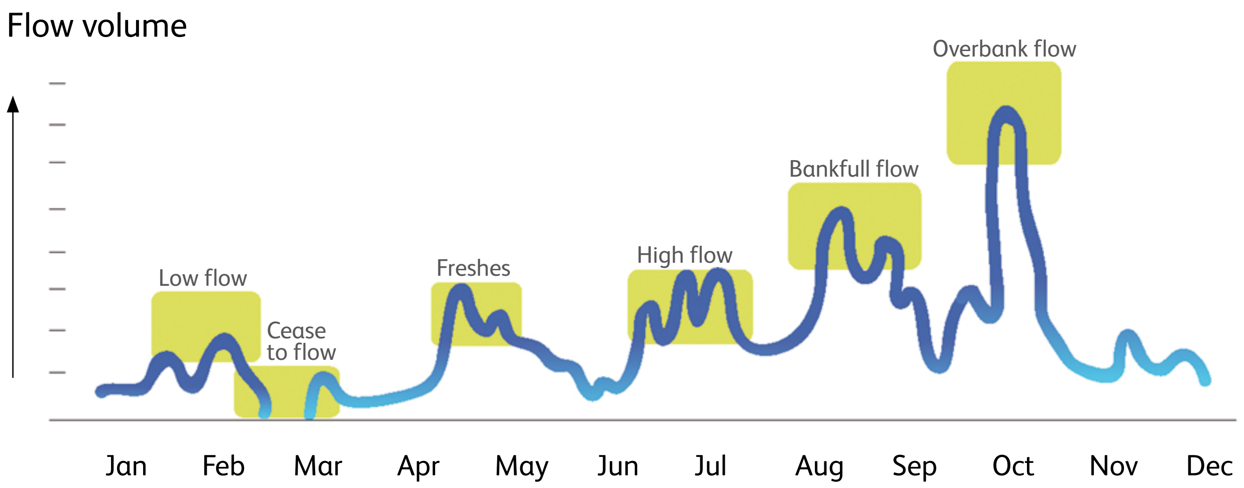
In addition to using water from the Victorian Water Holdings, the VEWH will also negotiate in relation to water from other holders where priorities are similar. For example, the VEWH coordinates the delivery of water held in Victoria by the CEWH and authorises the waterway managers to implement those watering actions. In doing so, the VEWH will seek to maximise the environmental benefits for Victoria's priority river reaches and wetlands. If priorities are not aligned, the VEWH will only authorise watering actions provided there are no adverse impacts on Victorian rivers and wetlands.

All watering actions will be authorised and communicated through seasonal watering statements, which will be issued as required.

In advance of the release of this plan, seasonal watering statements were issued for the Wimmera, Loddon and Campaspe systems. These statements authorised the continuation of watering actions that were approved in 2010–11 by the previous entitlement holder, the Minister for Environment and Climate Change. The continuation of these watering actions is in line with watering priorities in both 2010–11 and 2011–12.

The schedules and statements are available to download from www.vewh.vic.gov.au or hard copies are available by contacting the VEWH. In some instances, it may be appropriate for the VEWH to carry over into 2012–13 or to sell some water allocation, rather than using it in the current water year (see section 9). Likewise, it may be necessary to buy additional water allocation in order to complete a watering action in a particular system. While at this stage trade is not expected to be necessary in 2011–12, it may become so, depending on seasonal conditions. These opportunities will be assessed throughout the season and undertaken only where they optimise environmental outcomes.

Figure 12.1 Typical natural flow pattern of a Victorian river



13 Southern Victoria

Within southern Victoria, there are nine systems which can receive water from the Water Holdings (see sub-sections 13A–13I). These include the Snowy system in the far east, the Latrobe, Thomson and Macalister systems in Gippsland, the Tarago, the Yarra and Werribee systems around Greater Melbourne, and the Barwon and Moorabool systems around Greater Geelong and Greater Ballarat.

The Snowy River originates in New South Wales and is connected to the River Murray in northern Victoria via a series of tunnels, pipelines and aqueducts. Water Holdings are held in the Goulburn, Loddon and Murray systems and used to increase environmental flows in the Snowy River via substitution.

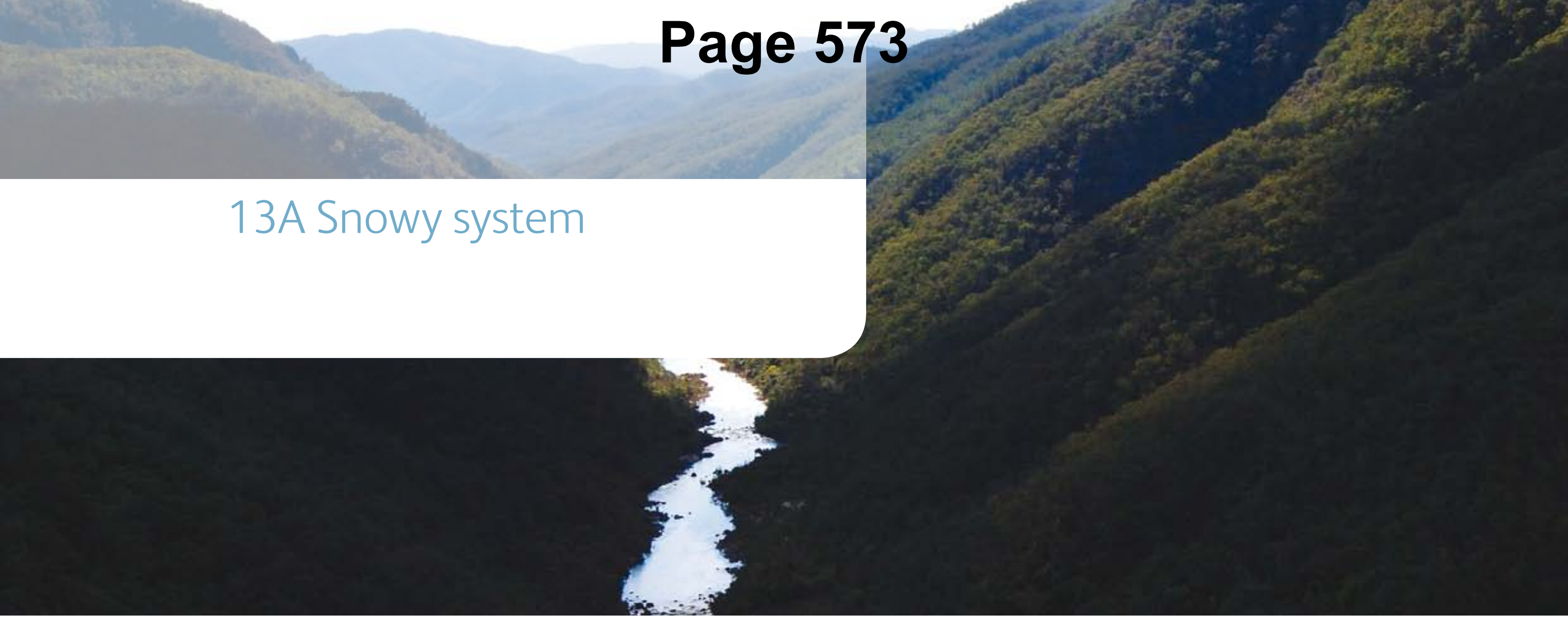
Northern Victoria is also connected to southern Victoria by the Goldfields Superpipe (supplying Central Highlands Water's urban customers from the Goulburn system) and the Sugarloaf Interconnector (providing a physical connection between the Goulburn system and Greater Melbourne's supply system). There is also a system of aqueducts and small weirs on the Silver and Wallaby Creeks in the Goulburn system, from which water has been harvested for Greater Melbourne since 1883.

Within southern Victoria, the systems are connected as a result of interconnections completed or being built to ensure urban water supply for Greater Melbourne and Greater Geelong. There is or soon will be the physical ability to move water between the Thomson and the Yarra, between the Yarra and the Barwon, and between the Barwon and Moorabool systems.

While these connections currently or soon will exist, providing the physical ability to move water between systems, the environmental water entitlements place some restrictions on such movement. Such inter-system transfers for environmental watering are not intended as part of this plan.

For the systems in which there are Water Holdings, the main storage operators in southern Victoria are Southern Rural Water, Melbourne Water and Central Highlands Water. In addition to being the storage operator, Melbourne Water is also the waterway manager for the systems around Greater Melbourne.

Planned watering actions for the Barwon system will be included as sub-section 13I of the *Seasonal Watering Plan 2011–12* at a later stage. Once the environmental flow study has been completed, the Corangamite Catchment Management Authority will prepare a seasonal watering proposal. This will then be considered by the VEWH and the agreed priority watering actions included in the plan.



13A Snowy system

Snowy River, Department of Sustainability and Environment

Waterway manager – East Gippsland Catchment Management Authority

The heritage-listed Snowy River originates on the slopes of Mount Kosciuszko, draining the eastern slopes of the Snowy Mountains in New South Wales, before flowing through the Snowy River National Park in Victoria and emptying into Bass Strait. Much of the Snowy valley and its remnant vegetation and wetlands continue to be important resting, feeding and breeding areas for migratory species from tropical rainforests in south-east Asia and wetland birds from Russia, China and Japan. The construction of the Snowy Mountains Hydro-electric Scheme between 1949 and 1974 resulted in the diversion of 99 per cent of the Snowy River's natural flow at Jindabyne Dam. While meeting critical demand for electricity generation and playing a vital irrigation role for farms in the west, flow diversion and other human activities have impacted on the river's health. The Victorian Government is working with the New South Wales and Commonwealth governments to restore health to this iconic river.

Planned environmental water use in 2011–12

The VEWH holds water entitlements in trust for the Snowy program, and manages the administrative requirements of these entitlements to ensure Victoria meets its commitments to provide water to the Snowy River.

Decisions about the preferred environmental water releases for the Snowy are made by the New South Wales Ministerial Corporation, on recommendation of the Snowy Scientific Committee. The VEWH does not have a direct role in planning for or delivering this water.

System overview

The Snowy Mountain Hydro-electric Scheme is a water and hydro-electric power facility located in Kosciuszko National Park in New South Wales. The Snowy Scheme can store up to 5,300,000 ML which is released to generate hydro-electricity. Under its licence, Snowy Hydro Limited has an obligation to release nominal annual volumes of 1,062,000 ML to the River Murray and 1,026,000 ML to the Murrumbidgee system.

Since 2000 the New South Wales, Victorian and Commonwealth governments have committed $425 million to recover 212,000 ML for the Snowy (21 per cent of average natural flows downstream of the Jindabyne Dam), plus 70,000 ML for the River Murray. In 2003, Water for Rivers was established as a joint government enterprise to undertake the water recovery. The water has been primarily recovered through irrigation modernisation projects, but also included some entitlement purchase.

A substitution arrangement is in place to Water Holdings in the Murray, Loddon and Goulburn systems to increase environmental flows in the Snowy system. Similar arrangements are in place for water recovered in New South Wales.

Water savings in the Murray and Goulburn provide additional water that can be supplied for consumptive use in northern Victoria. Similar arrangements apply on the New South Wales Murray and Murrumbidgee systems. This reduces the volume of water that must be supplied from the Snowy system (i.e. reduces the 1,062,000 ML per year) to the River Murray and Murrumbidgee River, thereby freeing up water for environmental flows in the Snowy.

The majority of the water recovery has now been undertaken and the subsequent environmental water entitlements created. As the water recovery is completed, the remaining Victorian component will be rolled into these entitlements. The entitlements are held by the VEWH in trust for the Snowy program. The VEWH manages the administrative requirements of these entitlements to ensure Victoria meets its commitments to provide water to the Snowy system but currently has no management role in the delivery of water to the Snowy. The VEWH oversees the substitution arrangements in the Victorian rivers, which are then reported to the New South Wales Ministerial Corporation that requests this volume of environmental water to be released by Snowy Hydro down the Snowy River.
The Snowy Scientific Committee, which includes two Victorian representatives, makes recommendations on the appropriate release pattern to maximise environmental benefits.

The Snowy system is shown in Figure 13A.1

Current situation

The Snowy River is set to receive 152,000 ML of water in 2011–12, with 84,000 ML planned to be released over 19 days in October to mimic the spring surge that used to occur annually under natural conditions. This will increase the environmental flows from the four per cent of natural flow at Jindabyne that has generally been released since the Snowy Agreement began, to 14 per cent. This is an improvement on the six per cent that was released in 2010–11. The health of the Snowy River will be improved, in particular by the removal of silt and algae from the river bed.

Priority watering actions

Managed environmental water releases in the Snowy River are undertaken on the advice of the Snowy Scientific Committee. More information on this committee and its recommendations can be found at www.snowyssc.org.

Further information

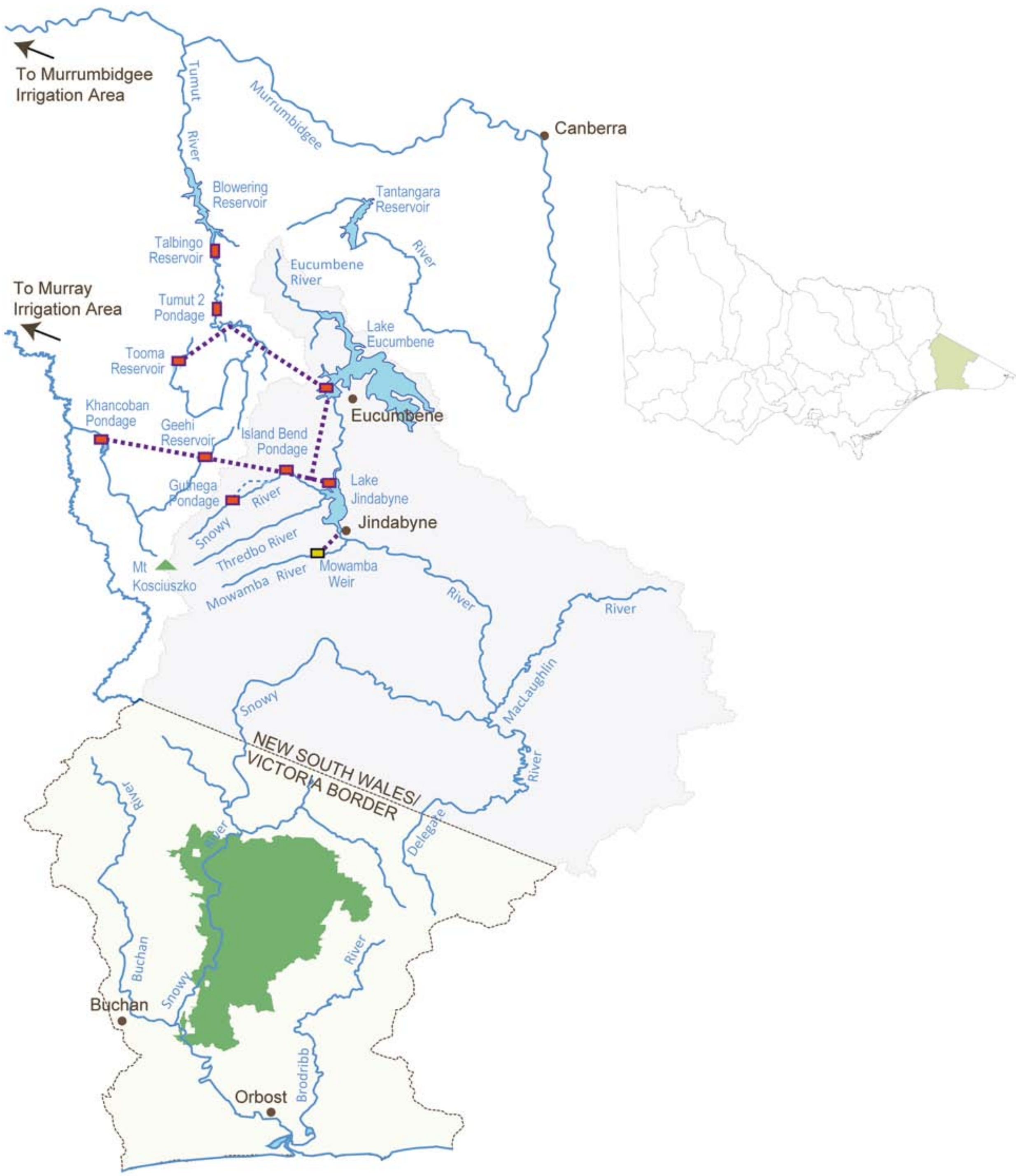
More information about the health of the Victorian part of the Snowy River can be found at www.egcma.com.au.

Table 13A.1 Water Holdings available for use in the Snowy system

Entitlement	Description
Bulk Entitlement (Goulburn System – Snowy Environmental Reserve) Order 2004	16,812 high-reliability entitlement
Bulk Entitlement (River Murray – Snowy Environmental Reserve) Order 2004	29,794 high-reliability entitlement
Water shares	6,121 ML Goulburn high-reliability water share 17,852 ML Goulburn low-reliability water share 10,544 ML Murray high-reliability water share 6,415 ML Murray low-reliability water share 470 ML Loddon high-reliability water share

Mouth of the Snowy River at Marlo, Department of Sustainability and Environment

Figure 13A.1 The Snowy system



13B Latrobe system

Heart Morass, Matt Bowler, West Gippsland Catchment Management Authority

Waterway manager – West Gippsland Catchment Management Authority

The lower Latrobe wetlands form part of the Gippsland Lakes wetland system which is listed as a 'wetland of international importance' under the Ramsar Convention. The wetlands include Sale Common, Heart Morass and Dowd Morass. Sale Common is one of only two remaining freshwater wetlands in the Gippsland Lakes system. Dowd Morass is a large, ecologically significant brackish wetland. Both wetlands provide important habitat for a range of waterbird species, and have supported species listed under Victoria's Flora and Fauna Guarantee Act 1988 and the Commonwealth's Environment Protection and Biodiversity Conservation Act 1999. Heart Morass is a large brackish wetland which is comprised of private land and some Crown land. It is estimated to be the largest private wetland restoration project in Australia.

Planned environmental water use in 2011–12

The priority environmental objectives in the lower Latrobe wetland system for 2011–12 are maintaining and enhancing the condition and extent of aquatic plants; limiting the extent of giant rush; maintaining waterbird breeding, recruitment and foraging opportunities; importing organic matter and nutrients; and managing water quality.

Priority watering actions are identified for all wetlands in the lower Latrobe wetland system, including Sale Common, Heart Morass and Dowd Morass.

It is anticipated that all priority watering actions for Sale Common, Heart Morass and Dowd Morass will be delivered in the 2011–12 water year, subject to the development of necessary agreements (refer to implementation section arrangements). River heights are likely to be sufficient to enable the manipulation of water control structures to maintain or increase wetland water levels as appropriate for each wetland.

System overview

The lower Latrobe wetlands are located on the floodplain of the Latrobe River between its confluence with the Thomson River and Lake Wellington, as shown in Figure 13B.1. The system consists of three wetlands: Sale Common; Heart Morass; and Dowd Morass.

Active environmental water management can now formally commence with the establishment of the *Latrobe River Environmental Entitlement 2010*, subject to the development of necessary agreements (refer to implementation arrangements section).

Water available under the Latrobe environmental entitlement does not consist of water held in storage. It allows for access to water from the Latrobe River, downstream of the Thomson River confluence, at any time for diversion into Sale Common, Heart Morass and Dowd Morass, subject to river levels.

Existing wetland water control infrastructure enables delivery of wetting flows, subject to suitable river conditions, and can facilitate drying phases. However, delivery of flushing flows is not possible with existing infrastructure and can only be achieved through natural events.

Figure 13B.1 The Latrobe system

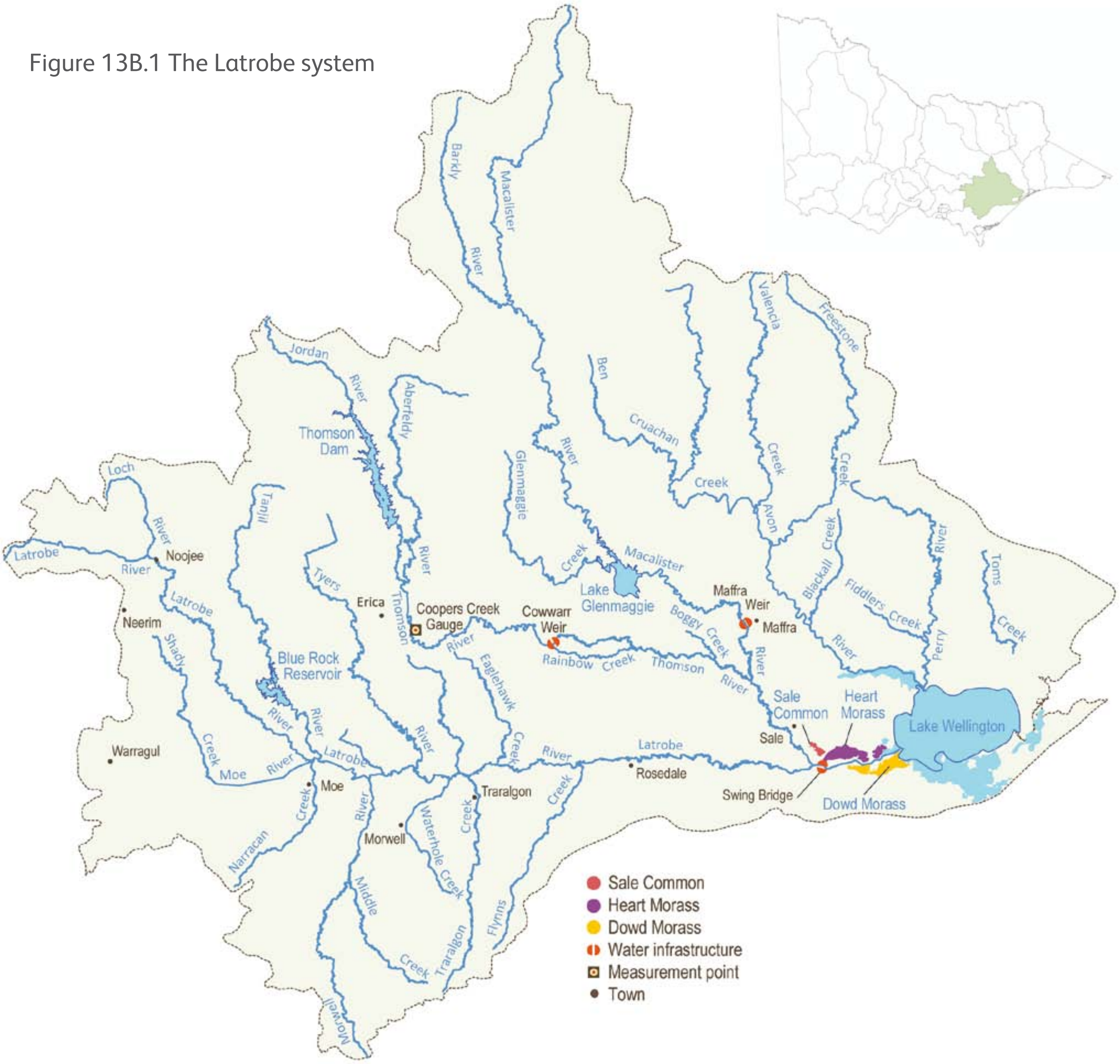


Table 13B.1 Water Holdings available for use in the Latrobe system

Entitlement	Description
Latrobe River Environmental Entitlement 2010	Access to water from the Latrobe River to inundate lower Latrobe wetlands when flows are above -0.7 m AHD at Swing Bridge gauging station

Current situation

The last 15 years in the region have been characterised by extended periods of relatively low rainfall and river flows, punctuated by two major floods in 1998 and 2007. This combination of circumstances has influenced the salinity levels of Dowd Morass and Heart Morass, due to inundation of these wetlands with saline water from Lake Wellington, and reduced frequencies of riverine flushing.

Good rainfall since spring 2007 has resulted in inundation of all lower Latrobe wetlands. This inundation was predominantly riverine flooding from the Latrobe River, resulting in the dilution of salinity levels. Winter flooding in the Thomson, Macalister and Latrobe systems in 2011 has resulted in further inundation of the wetlands, with all wetlands currently anticipated to be full, or close to full.

It is anticipated that all priority watering actions for Sale Common, Heart Morass and Dowd Morass will be delivered in the 2011–12 water year, subject to the development of necessary agreements (refer to implementation arrangements section). Under an average planning scenario, river heights are likely to be sufficient to enable the manipulation of water control structures to maintain or increase water levels in each wetland.

Table 13B.2 Priority watering actions under a range of planning scenarios in the Latrobe system

	DRY	AVERAGE	WET
Sale Common			
Environmental objectives	Provide opportunity for reproduction and growth of vegetation that requires reduced water levels and/or no surface water. Provide waterbird breeding, recruitment and foraging opportunities. Maximise recycling of nutrients. Maintain ecological functioning of refuge areas.	Promote persistence of submerged freshwater aquatic plants. Facilitate expansion of club rushes and tall spike rush. Limit or reduce extent, density and height of giant rush. Maintain waterbird breeding, recruitment and foraging opportunities. Import organic matter and nutrients. Import seed/propagules.	Promote persistence of submerged freshwater aquatic and riparian plants. Facilitate expansion of club rushes and tall spike rush. Limit or reduce extent, density and height of giant rush. Maximise waterbird breeding, recruitment and foraging opportunities. Maximise importation of organic matter and nutrients and export salt. Maximise seed/propagule dispersal. Facilitate movement of dwarf galaxias.
Environmental water priorities	Allow wetland water level to vary according to rainfall and evapotranspiration.	Wetting flow to maintain wetland water level at 0.49 m AHD.	Wetting flow to maintain wetland water level at 0.49 m AHD. Flushing flow (any time).
Possible volume required from the Water Holdings	0 ML*	850 ML	0 ML^
Heart Morass			
Environmental objectives	Provide opportunity for reproduction and growth of plants that require reduced water levels and/or no surface water. Provide waterbird breeding, recruitment and foraging opportunities. Maximise recycling of nutrients. Maintain ecological functioning of refuge areas. Avoid catastrophic events and critical loss resulting from inundation with saline water from Lake Wellington and/or Latrobe River, or activation of acid sulphate soils.	Promote recolonisation and expansion of emergent aquatic plants. Maintain/enhance condition and extent of structurally dominant plants. Maintain waterbird breeding, recruitment and foraging opportunities, particularly colonial nesting species. Import organic matter and nutrients and reduce salinity. Import seed/propagules. Mitigate acid sulphate soil risk.	Promote recolonisation and expansion of submerged freshwater aquatic plants. Maintain/enhance condition and extent of structurally dominant plants. Maximise waterbird breeding, recruitment and foraging opportunities, particularly colonial nesting species. Maximise importation of organic matter and nutrients and export salt. Maximise seed/propagule dispersal. Minimise acid sulphate soil risk.
Environmental watering priorities	Winter/spring wetting flow to fill the wetland to 0.11– 0.29 AHD. Allow wetland water level to vary according to river level, rainfall and evapotranspiration. Inundation based on salinity and acid sulphate soil risk.	Winter/spring wetting flow to fill the wetland to 0.11 – 0.29 AHD. Allow wetland water level to vary according to river level, rainfall and evapotranspiration.	Winter/spring wetting flow to fill the wetland to 0.11 – 0.29 AHD. Flushing flow (any time). Allow wetland water level to vary according to river level, rainfall and evapotranspiration.
Possible volume required from the Water Holdings	8,520 ML	6,390 ML	0 ML^

Table 13B.2 Priority watering actions under a range of planning scenarios in the Latrobe system (continued)

	DRY	AVERAGE	WET
Dowd Morass			
Environmental objectives	Provide opportunity for reproduction and growth of plants that require reduced water levels and/or no surface water. Provide waterbird breeding, recruitment and foraging opportunities. Maximise recycling of nutrients. Maintain ecological functioning of refuge areas. Avoid catastrophic events and critical losses resulting from inundation with saline water from Lake Wellington and/or Latrobe River, or activation of acid sulphate soils.	Promote recolonisation and expansion of emergent aquatic plants. Maintain/enhance condition and extent of structurally dominant plants. Maintain waterbird breeding, recruitment and foraging opportunities, particularly colonial nesting species. Import organic matter and nutrients and reduce salinity. Import seed/propagules. Mitigate acid sulphate soil risk.	Promote recolonisation and expansion of submerged freshwater aquatic plants. Maintain/enhance condition and extent of structurally dominant plants. Maximise waterbird breeding, recruitment and foraging opportunities, particularly colonial nesting species. Maximise importation of organic matter and nutrients and export salt. Maximise seed/propagule dispersal. Minimise acid sulphate soil risk.
Environmental watering priorities	Winter/spring wetting flow to fill wetland to 0.3 m AHD. Allow wetland water level to vary according to rainfall and evapotranspiration.	Winter/spring wetting flow to fill wetland to 0.3 m AHD. Autumn/winter wetting flow to fill wetland to 0.3 m AHD.	Winter/spring wetting flow to fill wetland to 0.3 m AHD. Autumn/winter wetting flow to fill wetland to 0.3 m AHD. Flushing flow (any time).
Possible volume required from the Water Holdings	5,800 ML	4,060 ML	0 ML^
Possible carryover into 2012–13#	N/A	N/A	N/A

* No environmental watering will be practically possible due to river levels being lower than the water level in the wetland.
^ Flow components will be met by natural inflows.
\# Entitlement consists of access to river flows only and no right to storage capacity, therefore no carryover is available.

Priority watering actions

Table 13B.2 outlines the priority objectives and watering actions under a range of planning scenarios. The priority watering actions are for:

- Sale Common: maintain high water levels at 0.49 m AHD all year
- Heart Morass: winter/spring wetting flow from August to October to fill the wetland to an average depth of 0.11 – 0.29 m AHD, then water level allowed to fluctuate in accordance with river levels
- Dowd Morass: winter/spring wetting flow from August to October to fill wetland to 0.3 m AHD and autumn/winter wetting flow from May to June to fill wetland to 0.3 m AHD

Adaptive management considerations

As watering actions in the lower Latrobe wetlands are dependent on river heights, the ability to manage environmental watering actions will be largely dependent on seasonal conditions in the 2011–12 water year.

The aim of environmental water management in Sale Common over the next few years is to maintain high levels to manage the growth and composition of aquatic plant communities. However, watering of Sale Common is not possible under dry conditions as river baseflows are approximately the same height as the base of the Common.

Water quality is another important factor influencing environmental watering decisions in the lower Latrobe wetlands, particularly Heart Morass and Dowd Morass, as river water quality can be influenced by saline water from Lake Wellington during extended periods of low flow. Emergency watering to maintain water quality may be necessary, particularly in dry conditions to prevent saline inundation and acid sulphate soils.

Under a wet scenario, no watering action is required for any of the lower Latrobe wetlands as it is expected that all priority flow components, including flushing flows, will be delivered naturally.

West Gippsland Catchment Management Authority will monitor the flows occurring naturally in the system, and assess the best time to make releases to provide the priority flow components most efficiently and with maximum environmental benefit.

Implementation arrangements

This plan outlines the watering actions that are a priority in the coming year, provided there is sufficient water. A seasonal watering statement will be issued to communicate decisions on the environmental watering actions that are to be undertaken and to authorise West Gippsland Catchment Management Authority to implement those decisions.

In the lower Latrobe wetlands, implementation arrangements are outlined in Schedule 1 of the *Seasonal Watering Plan 2011–12*. Implementation will also be guided by operating arrangements currently under development.

The inundation of Sale Common could impact upon upgrade works on the South Gippsland Highway. Agreement with Vic Roads will be sought by the West Gippsland Catchment Management Authority prior to any managed watering action occurring.

Watering actions identified for Heart Morass will inundate private land. Watering actions for Heart Morass will not be undertaken until agreements with affected landowners are successfully negotiated. The process for negotiating these agreements will be managed by the West Gippsland Catchment Management Authority.

There are no specific implementation issues associated with watering in Dowd Morass.

Reporting on the volume of water used under the Latrobe entitlement will be estimates only; it is not possible to measure the volumes as water is not being released from storage or pumped out of channel.

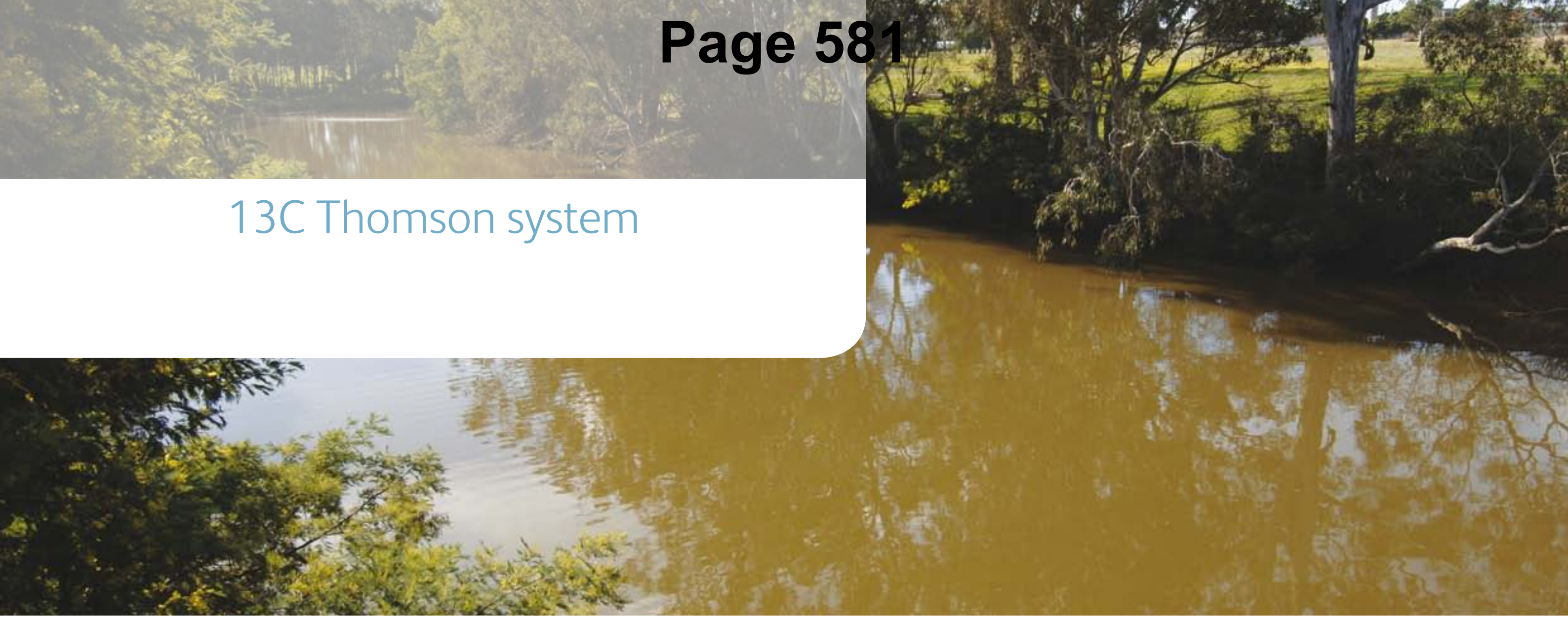
Risk assessment and management

Apart from those discussed in the implementation section above, there are no additional risks identified for third parties from the implementation of planned watering actions. Risks to successfully achieving the desired environmental outcomes from watering actions have been identified and can be found in Schedule 1.

Further information

More detail about the planned watering actions in the lower Latrobe wetlands can be found by downloading Schedule 1 of the *Seasonal Watering Plan 2011–12* at www.vewh.vic.gov.au.

13C Thomson system



Thomson River at Sale, Department of Sustainability and Environment

Waterway manager – West Gippsland Catchment Management Authority

The Thomson system is vitally important for the Gippsland region, supplying towns and farms with water and providing social and cultural amenities to local communities. The Thomson River and associated dam are integral to Melbourne's water supply, and provide fresh water flows into the lower Latrobe River and to the Gippsland Lakes and surrounding wetlands. The Thomson River is most notably home to a threatened native fish species, the Australian grayling.

Planned environmental water use in 2011–12

The priority environmental objectives in the Thomson system for 2011–12 are improving habitat for aquatic species; maintaining fish passage; assisting spawning and migration of priority fish species, in particular Australian grayling; and avoiding deterioration of water quality.

The priority river reach is reach 3 (Aberfeldy to Cowwarr Weir). Environmental watering will focus, in priority order, on autumn freshes; winter baseflows; and summer freshes.

The outlook for the 2011–12 watering season is positive, with full allocation available and a wet catchment coming into spring. It is expected that there will be sufficient water in the Water Holdings to provide all planned priority flow components under the dry and average planning scenario. It is possible that all flow components could be provided under the wet scenario, except some summer and autumn freshes, depending on the volume and timing of unregulated flows.

System overview

The environmental flow reaches for the Thomson system are shown in Figure 13C.1. The priority river reach is reach 3, because it can receive managed environmental water and because it is high value (heritage river status, the presence of the threatened Australian grayling and significant riparian vegetation). The measurement point for target flows at reach 3 is at Coopers Creek gauge. Reach 2 also benefits from flows being passed to the priority reach 3. At Cowwarr Weir the Thomson splits into two, with water able to be passed down the Old Thomson course (reach 4a), or the New Thomson course (reach 4b).

The preference is to pass environmental water down reach 4a to allow for fish migration as Cowwarr Weir is a barrier to fish passage into reach 4b. While reaches 5 and 6 both have important ecological values, it is difficult for managed environmental flow releases to reach them due to the distance and inability to manipulate significant flow volumes at Cowwarr Weir. Water provided through reaches 3 and 4 will still have some benefits to the lower reaches 5 and 6.

Figure 13C.1 The Thomson system

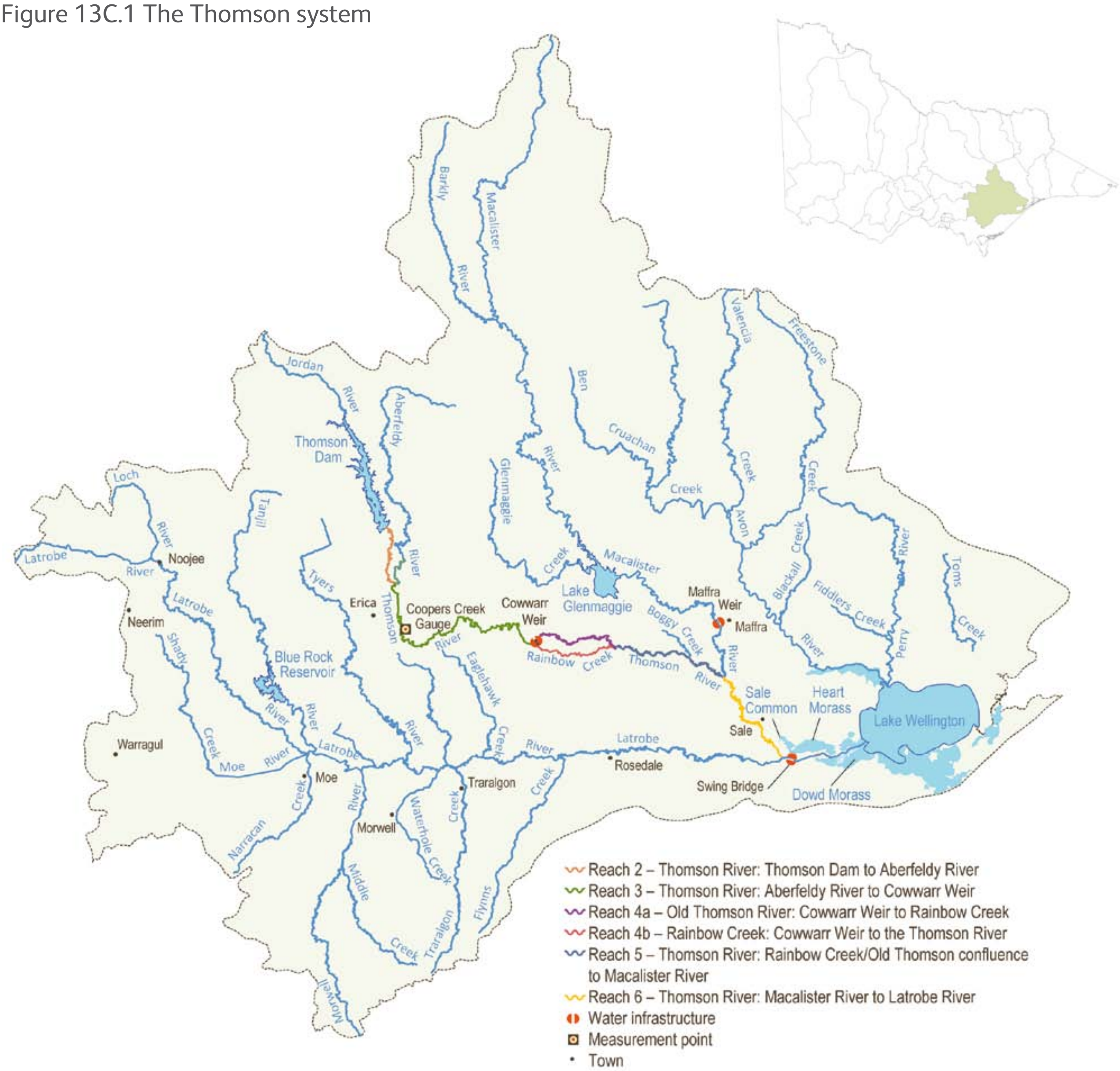


Table 13C.1 Water Holdings available for use in the Thomson system

Entitlement	Description
Bulk Entitlement (Thomson River – Environment) Order 2005	• 10,000 ML per year and share of reservoir storage space • minimum passing flows at various weirs and gauges throughout the Thomson system

Current situation

The prolonged drought from 1997 saw decreased Australian grayling populations in the Thomson system. Spawning flows over the last two years have seen a small increase in the population; however these flows continue to be important to the recovery of grayling populations.

Rainfall at the start of the 2010–11 water year was below average, but improved during the year to above average during summer and autumn. This provided significant flows down the Thomson and increased Thomson Dam levels.

The outlook for the 2011–12 watering season is positive, with full allocation available and a wet catchment coming into spring. It is expected that there will be sufficient water in the Water Holdings to provide all planned priority flow components under the dry and average planning scenario. It is possible that all flow components could be provided under the wet scenario, except some summer and autumn freshes, depending on the volume and timing of unregulated flows.

Priority watering actions

Table 13C.2 outlines the priority objectives and watering actions under a range of planning scenarios. The priority watering actions, in priority order, are for:

- autumn freshes (one to three freshes of 800 ML per day for four days each between April and May)
- winter baseflows (230 ML per day from May to June and from October to November)
- summer freshes (one to seven freshes of 230 ML per day for three days each between December and April).

Table 13C.2 Priority watering actions under a range of planning scenarios in the Thomson system

	Planning scenario		
	DRY	AVERAGE	WET
Expected availability of Water Holdings	10,000 ML 2,700 ML carryover	10,000 ML 2,700 ML carryover	10,000 ML 2,700 ML carryover
Environmental objectives	Provide habitat and migration opportunities for native fish.	Provide habitat and migration opportunities for native fish. Provide spawning opportunities for Australian grayling.	Provide habitat and migration opportunities for native fish. Provide spawning opportunities for Australian grayling. Provide opportunities for fish movement and maintain stream substrate condition.
Flow components	Winter baseflow.	Autumn freshes. Winter baseflow.	Autumn freshes. Winter baseflow.
Possible volume required from the Water Holdings*	5,100 ML	9,900 ML	14,900 ML
Possible carryover into 2012–13#	7,600 ML	2,800 ML	0 ML

^ Figures assume no unregulated flows occur, and are therefore an upper limit of the volume required from the Water Holdings.
* The amount of carryover available in 2012–13 will be limited by the available reservoir storage capacity; however this is unlikely to be an issue in 2012–13 as storage are currently only half full.

Adaptive management considerations

The delivery of flow components will change depending on seasonal condition (catchment inflows and the consequent impact on storage levels and unregulated flows in the river). If conditions are dry, storage levels will be low and there will be minimal unregulated flows. In this case, the priority flow component is winter baseflows from October to November 2011 and May to June 2012. If dry conditions persisted, water not used would be carried over into 2012–13 for winter baseflows and an autumn fresh next year. An autumn fresh would not be a priority this year, since this flow component occurred in 2010–11. Since Australian grayling require a minimum of two spawning events every three years, this would not be a priority in 2011–12 if dry conditions occurred.

If conditions are average, storage levels will improve and unregulated flows will increase. In this case, the priority for winter baseflows from October to November 2011 stays the same but not in May and June 2012. The West Gippsland Catchment Management Authority would instead seek to provide autumn freshes to enhance spawning opportunities in April and May 2012. Remaining water would then be used to meet winter baseflows in May and June 2012.

Under wet conditions, storage levels will be high and significant unregulated flows would occur, likely providing some of the winter baseflows in October and November 2011 naturally. In this case, as many of the summer and autumn freshes would be provided as possible, between December 2011 and May 2012. This will depend on the amount and timing of unregulated flows occurring and the volume of water available in the Water Holdings. If unregulated flows do not occur at the right time, it is possible that not all the summer and autumn freshes would be provided.

West Gippsland Catchment Management Authority will monitor the flows occurring naturally in the system, and assess the best time to make releases to provide the priority flow components most efficiently and with maximum environmental benefit.

Implementation arrangements

This plan outlines the watering actions that are a priority in the coming year, provided there is sufficient water. A seasonal watering statement will be issued to communicate decisions on the environmental watering actions that are to be undertaken and to authorise West Gippsland Catchment Management Authority to implement those decisions.

In the Thomson system, implementation arrangements are outlined in Schedule 1 of the *Seasonal Watering Plan 2011–12* and will also be guided by the draft Thomson River Operating Arrangements.

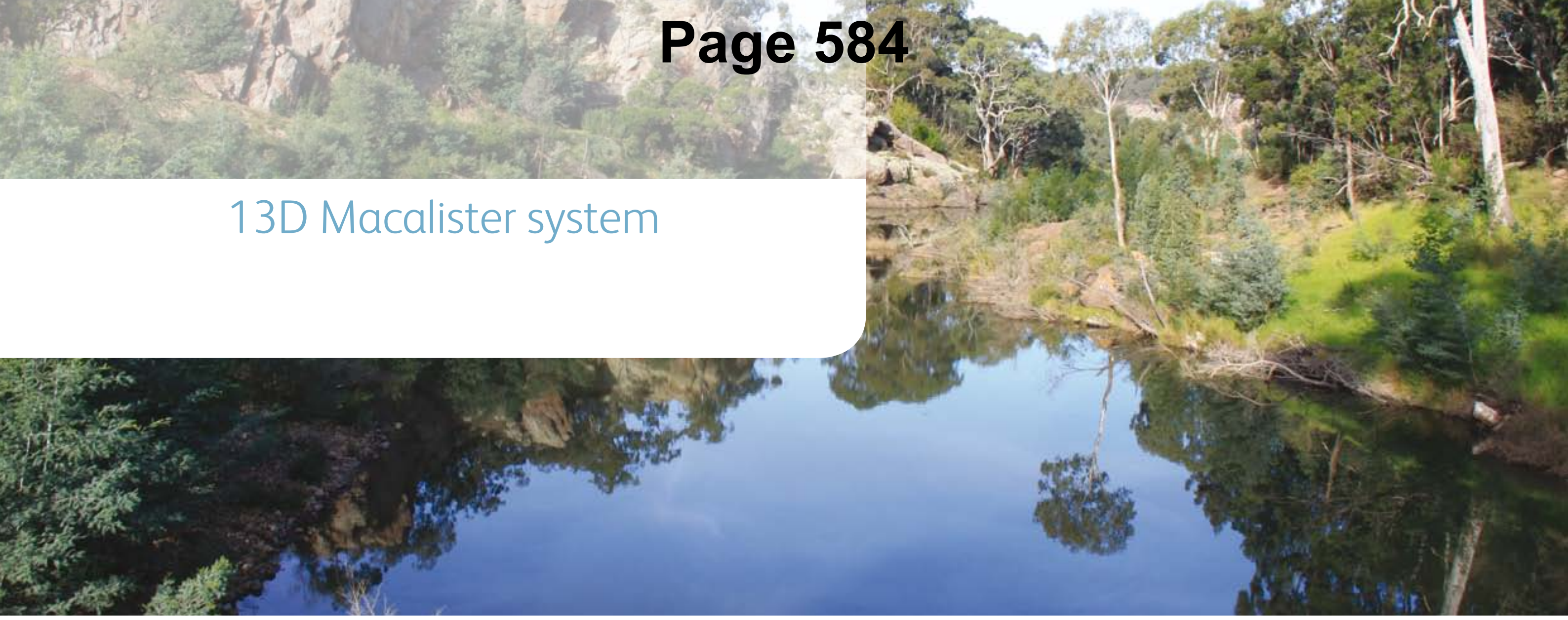
Risk assessment and management

Risks associated with the implementation of priority watering actions include flooding of private land and personal injury to river users. However, these risks are assessed as low. Management strategies include consideration of historic release limits, ongoing dialogue between West Gippsland Catchment Management Authority and Southern Rural Water; and adequate communication of planned releases to key stakeholders.

Also important are risks to successfully achieving the desired environmental outcomes from watering actions. Details on these can be found in Schedule 1.

Further information

More detail about the planned watering actions in the Thomson system can be found by downloading Schedule 1 of the *Seasonal Watering Plan 2011–12* at www.vewh.vic.gov.au.



13D Macalister system

Macalister River, West Gippsland Catchment Management Authority

Waterway manager – West Gippsland Catchment Management Authority

The Macalister system is extremely important for the Gippsland region, supplying towns and farms with water and providing social and cultural amenities to local communities. Like its sister river, the Thomson, the Macalister River also provides fresh water flows into the lower Latrobe River and to the Gippsland Lakes and surrounding wetlands. The river is also home to a threatened fish species, the Australian grayling.

Planned environmental water use in 2011–12

The priority environmental objectives in the Macalister system for 2011–12 are improving habitat for aquatic species; maintaining fish passage; assisting spawning and migration of priority fish species, in particular the Australian grayling.

The priority river reach is reach 2 (Maffra Weir to Thomson River confluence). Environmental watering will focus, in priority order, on an autumn fresh and early winter baseflows. It is intended to reduce passing flows where possible to provide optimum flows; this water would then be saved up to provide water to the winter baseflow and autumn fresh priorities.

With full allocation likely to be available for the Macalister in 2011–12, it is expected that the priority autumn freshes will be delivered with the ability to meet the majority of the autumn baseflow requirements. The ability to reduce summer passing flows will depend on system operations.

System overview

The environmental flow reaches for the Macalister system are shown in Figure 13D.1. The priority river reach for environmental watering is reach 2 (Maffra Weir to Thomson River confluence); in particular, flows for fish spawning are targeted at reach 2 because Maffra Weir is a barrier to fish movement. The associated measurement point at Maffra Weir has measurement inaccuracies; therefore, flows are measured in reach 1 (Lake Glenmaggie to Maffra Weir), downstream of Lake Glenmaggie. As the reaches are relatively short and the Macalister River typically gains water from tributary inflow and run-off, releases measured downstream of Lake Glenmaggie will provide the required flows in reach 2.

Current situation

The prolonged drought from 1997 saw decreased Australian grayling populations in the Macalister system. Spawning flows over the last two years have seen a small increase in the population; however, these flows continue to be important to the recovery of grayling populations.

Rainfall at the start of the 2010–11 water year was below average, but improved during the year to above average during summer and autumn. This provided significant flows down the Macalister, including several spills from Lake Glenmaggie.

With full allocation likely to be available for the Macalister in 2011–12, it is expected that the priority autumn freshes will be delivered with the ability to meet the majority of the autumn baseflow requirements. The ability to reduce summer passing flows will depend on system operations.

Figure 13D.1. The Macalister system

Table 13D.1 Water Holdings available for use in the Macalister system

Entitlement	Description
Macalister River Environmental Entitlement 2009	• 7,111 ML high-reliability entitlement • 3,555 ML low-reliability entitlement • Passing flows

Priority watering actions

Table 13D.2 outlines the priority objectives and watering actions under a range of planning scenarios. The priority watering actions, in priority order, are for:

- autumn freshes (one to two freshes of 350–1,500 ML per day for seven days each between April and May)
- winter baseflows (320 ML per day from May to June)
- summer baseflows (35 ML per day from December to April).

Adaptive management considerations

The Macalister bulk entitlement held by Southern Rural Water allows for the specified passing flows to be reduced on advice from the West Gippsland Catchment Management Authority. These flows can be retained in storage if there is spare capacity in Lake Glenmaggie; however, it is the first water to be lost if the storage physically spills. The summer passing flows set out in the entitlement are higher than those required, therefore it is desirable to retain these in storage to ensure sufficient water for other priority flow components. This will be dependent on inflows and the available capacity in Lake Glenmaggie (for example, if it is close to full, it is likely that any stored volume would be spilt before autumn). As Lake Glenmaggie spills in the spring of most years, the ability to store water for the priority autumn fresh component by reducing passing flows is limited. The West Gippsland Catchment Management Authority will assess the benefits of reducing passing flows during the year to provide high priority components.

The key objective for the autumn fresh is for spawning of Australian grayling. While the scientific flow study recommends 1,500 ML per day, without unregulated flows there would be insufficient water in the Water Holdings to provide this. A flow of 350 ML per day would meet other ecological objectives, such as fish connectivity, and potentially provide spawning opportunities. Environmental water will be released to build on natural events where possible, to meet the higher flow target. The West Gippsland Catchment Management Authority will be seeking to provide one or two freshes between April and May 2012.

It is possible that there will be less water available in the Water Holdings than is required to provide the priority flow components. If this occurs, all available water would be used to provide as many flow components as possible, as there is little ability to carry water over in storage for use in 2012–13 as storages are likely to spill.

West Gippsland Catchment Management Authority will monitor the flows occurring naturally in the system, and assess the best time to make releases to provide the priority flow components most efficiently and with maximum environmental benefit.

Implementation arrangements

This plan outlines the watering activities that are a priority in the coming year, provided there is sufficient water. A seasonal watering statement will be issued to communicate decisions on the environmental watering actions that are to be undertaken and to authorise West Gippsland Catchment Management Authority to implement those decisions.

In the Macalister system, implementation arrangements are outlined in Schedule 1 of the *Seasonal Watering Plan 2011–12* and will also be guided by the draft Macalister River Operating Arrangements.

Risk assessment and management

Risks associated with the implementation of priority watering actions include flooding of private land and personal injury to river users. However, these risks are assessed as low. Management strategies include consideration of historic release limits, ongoing dialogue between West Gippsland Catchment Management Authority and Southern Rural Water; and adequate communication of planned releases to key stakeholders.

Also important are risks to successfully achieving the desired environmental outcomes from watering actions. Details on these can be found in Schedule 1.

Further information

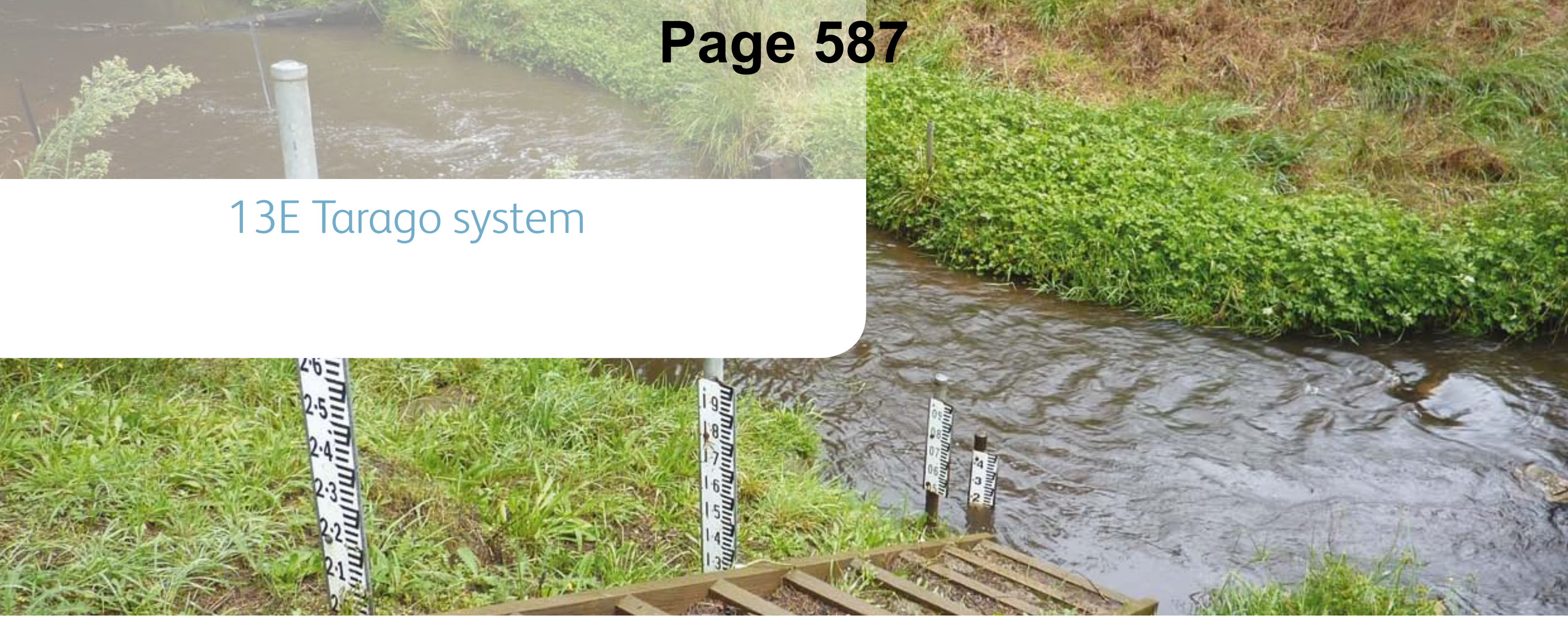
More detail about the planned watering activities in the Macalister system can be found by downloading Schedule 1 of the *Seasonal Watering Plan 2011–12* at www.vewh.vic.gov.au.

Table 13D.2 Priority watering actions under a range of planning scenarios in the Macalister system

	Planning scenario		
	DRY	**AVERAGE**	**WET**
Expected availability of Water Holdings	7,111 ML	8,149 ML	10,666 ML
Environmental objectives	Provide habitat and migration opportunities for native fish. Provide spawning opportunities for Australian grayling.	Provide habitat and migration opportunities for native fish. Provide spawning opportunities for Australian grayling.	Provide habitat and migration opportunities for native fish. Provide spawning opportunities for Australian grayling.
Flow components	Autumn fresh. Winter baseflow. Summer baseflow.^	Autumn fresh. Winter baseflow. Summer baseflow.^	Two autumn freshes. Winter baseflow. Summer baseflow.^
Possible volume required from the Water Holdings*	12,900 ML	12,900 ML	14,800 ML
Possible carryover into 2012–13	0 ML	0 ML	0 ML

^ Provision of this flow component does not require water from the Water Holdings; rather it requires water that would have been released as passing flows to be retained in storage.
* Figures assume no unregulated flows occur, and are therefore an upper limit of the volume required from the Water Holdings.

13E Tarago system



Tarago River, Melbourne Water

Waterway manager – Melbourne Water

The Tarago River is a major tributary of the Bunyip River. Its headwaters are within the Tarago State Forest and flow into the Tarago Reservoir at Neerim. Downstream of the reservoir, the Tarago flows through the towns of Rokeby and Robin Hood before meeting the Bunyip River at Longwarry North, supplying many irrigators in the catchment. The Tarago system is home to many native fish species such as the Australian grayling and river blackfish, along with one of Australia's most iconic marsupials, the platypus. Threatened vegetation species such as long pink-bells, tree geebung, and swamp bush-pea can be found along some river reaches.

Planned environmental water use in 2011–12

The priority environmental objectives in the Tarago system for 2011–12 are improving habitat for aquatic species; maintaining habitat connectivity; assisting spawning and migration of priority fish species; increasing the spread of flood-tolerant vegetation; maintaining channel form; and avoiding deterioration of water quality.

The priority river reaches are reach 2 (around Drouin West – downstream of Tarago reservoir) and reach 6 (around Iona – downstream of the Bunyip and Tarago rivers confluence). Environmental watering will focus, in priority order, on summer freshes; summer and winter high flows; and a winter fresh.

Based on existing knowledge, the outlook for the 2011–12 watering season is positive with a wet scenario likely. It is expected that there will be sufficient water, through both regulated and unregulated flows, to provide all priority flow components.

System overview

Water available under the Tarago and Bunyip environmental entitlement is stored in and released from Tarago Reservoir.

The environmental flow reaches are shown in Figure 13E.1. The priority river reaches are reach 2, the Tarago River from Tarago Reservoir to the Bunyip River confluence, and reach 6, the Bunyip Main Drain. These reaches have the priority ecological values and can also practically have water delivered from Tarago Reservoir at low cost. Some benefit is also provided to reach 7, as the final reach of the system. The measurement points for target flows are at Drouin West in reach 2 and Iona in reach 6.

Current situation

Flows in the Tarago River have been well below average over the last couple of years. However, in 2010–11, stream flows were above average in winter, spring and summer. Unregulated flows and passing flows resulted in some planned priority flow components being met, including winter high flows and winter freshes. No environmental water was released in the Tarago system during 2010–11 due to operational works on Tarago Reservoir and clarification of operational arrangements.

Based on existing knowledge, the outlook for the 2011–12 watering season is positive with a wet scenario likely. It is expected that there will be sufficient water, through both regulated and unregulated flows, to provide all priority flow components.

Figure 13E.1 The Tarago system

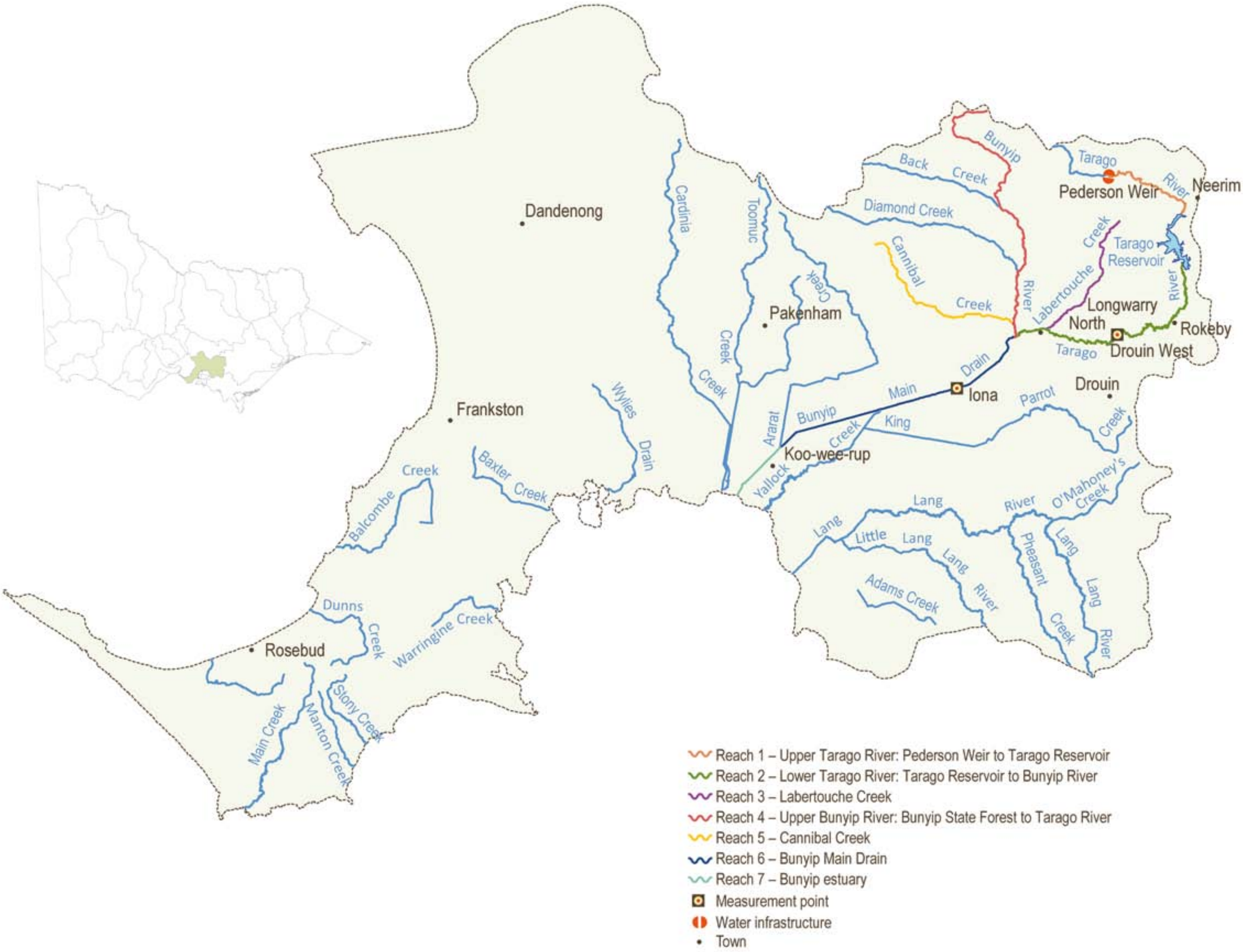


Table 13E.1 Water Holdings available for use in the Tarago system

Entitlement	Description
Tarago and Bunyip Rivers Environmental Entitlement 2009	• 10.3 % of inflows, after passing flows have been provided • 3,000 ML of storage space • Passing flows of 12 ML per day or natural flow at Drouin West gauging station

Priority watering actions

Table 13E.2 outlines the priority objectives and watering actions under a range of planning scenarios. The priority watering actions are for:

- summer freshes in reach 2 (five freshes of 100 ML per day for four days each between December and May)
- summer freshes in reach 6 (three freshes of 120 ML per day for seven days each between December and May)
- summer high flows in reach 2 (one event of 200 ML per day for one day between December and May)
- winter high flows in reach 2 (280 ML per day for one day between October and November)
- winter high flows in reach 6 (70 ML per day between October and November)
- winter freshes in reach 2 (three freshes of 120 ML per day for two days each between June and November)
- winter freshes in reach 6 (three freshes of 170 ML per day for two days each between June and November, with one in November).

Summer low flows are also a priority flow component; however these are provided year round by passing flows. Melbourne Water, as the storage operator, is required to maintain the passing flows specified in the *Tarago and Bunyip Rivers Environmental Entitlement 2009*. Due to potential flooding risks and infrastructure limitations, bankfull and overbank flows will not be actively managed, but may occur naturally.

Adaptive management considerations

Decisions to release water from the Tarago and Bunyip environmental entitlement will mainly be influenced by the amount of unregulated flows experienced in the system throughout the year. With passing flows providing low flow requirements, summer freshes are the highest priority in the Tarago system. As inflows and unregulated flows increase, the focus will move to the delivery of summer and winter high flows, and a winter fresh. Delivery of winter flow components may occur early in the season (August 2011) if Melbourne Water determines that there is sufficient water available in the system to achieve priority summer flow components later in the year.

After providing all of these components, any water still available under the entitlement would be carried over into 2012–13.

Melbourne Water will monitor the flows occurring naturally in the system, and assess the best time to make releases to provide the priority flow components most efficiently and with maximum environmental benefit. Close working relationships with Southern Rural Water will help in timing environmental releases to build on irrigation releases.

Implementation arrangements

This plan outlines the watering actions that are a priority in the coming year, provided there is sufficient water. A seasonal watering statement will be issued to communicate decisions on the environmental watering actions that are actually to be undertaken. The seasonal watering statement will authorise Melbourne Water to implement those decisions.

In the Tarago system, implementation arrangements are outlined in Schedule 2 of the *Seasonal Watering Plan 2011–12*. Implementation will also be guided by the draft Tarago and Bunyip Operating Arrangements 2011.

Risk assessment and management

Risks associated with the implementation of priority watering actions include flooding of private land and personal injury to river users; however this risk is assessed as low. Management strategies include consideration of historic release limits, ongoing dialogue between environmental water reserve officers and storage operation officers within Melbourne Water, and adequate communication of planned releases to key stakeholders.

Also important are risks to successfully achieving the desired environmental outcomes from watering actions. Details on these can be found in Schedule 2.

Further information

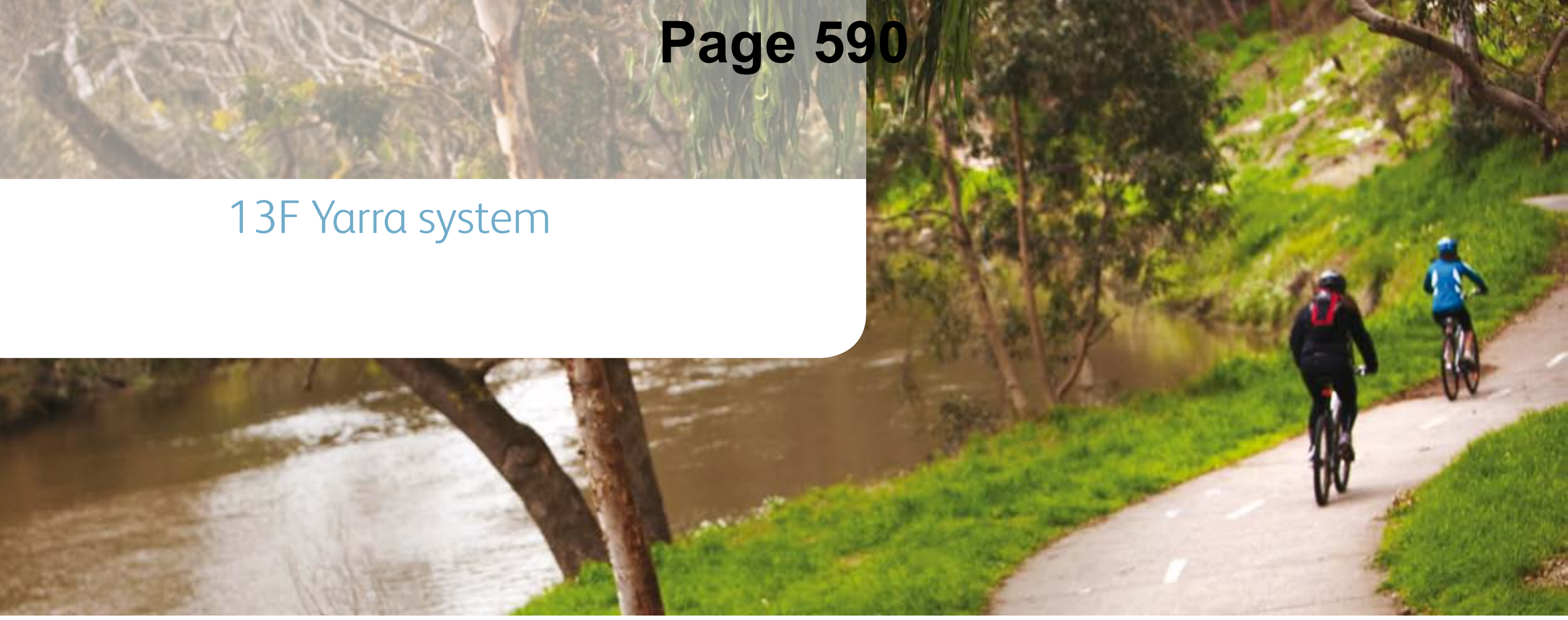
More detail about the planned watering actions in the Tarago system can be found by downloading Schedule 2 of the *Seasonal Watering Plan 2011–12* at www.vewh.vic.gov.au

Table 13E.2 Priority watering actions under a range of planning scenarios in the Tarago system

	Planning scenario			
	DROUGHT (protect)	**DRY (maintain)**	**AVERAGE (recover)**	**WET (enhance)**
Expected availability of Water Holdings^	3,000 ML	3,000 ML	3,000 ML	3,000 ML
Environmental objectives	Protect priority species and critical refuge habitat. Avoid catastrophic events (eg. fish deaths or algal blooms). Protect water quality for priority species and habitats.	Protect priority species and critical refuge habitat. Avoid catastrophic events (eg. fish deaths or algal blooms). Protect water quality for priority species and habitats.	Improve habitat access for aquatic species. Avoid deterioration of water quality. Maintain habitat connectivity. Increase the spread of flood-tolerant vegetation. Assist spawning and migration of priority fish species.	Improve habitat access for aquatic species. Maintain habitat connectivity. Increase the spread of flood-tolerant vegetation. Assist spawning and migration of priority fish species. Maintain channel form.
Flow components#	Summer fresh if water quality deteriorates.	Summer freshes. Summer and winter high flows.	Summer freshes. Summer and winter high flows. Winter fresh.	Summer freshes. Summer and winter high flows. Winter fresh.
Possible volume required from the Water Holdings*	1,000 ML	1,000–2,000 ML	2,000–3,000 ML	500 ML
Possible carryover into 2012–13	2,000 ML	1,000–2,000 ML	0–1,000 ML	2,500 ML

^ The *Tarago and Bunyip Rivers Environmental Entitlement 2009* entitles the environment to 3,000 ML of storage space in Tarago Reservoir. Where total inflows exceed 3,000 ML, access to storage airspace is currently being discussed.
# Bankfull and overbank flows may occur naturally but will not be provided through the Water Holdings due to the risk of flooding private land.
* Estimated volumes depend on the amount of unregulated flows experienced throughout the year.

13F Yarra system



Yarra River, David Hannah

Waterway manager – Melbourne Water

The Yarra River is one of Victoria's most significant waterways. The pristine upper reaches of the river are important water supply catchments, while the lower reaches provide social and recreational opportunities for more than four million people who live in Greater Melbourne and surrounds. The waterways of the Yarra River are generally of high ecological value, supporting platypus and a number of nationally significant species of fish (such as the Australian grayling and the Macquarie perch).

Planned environmental water use in 2011–12

The priority environmental objectives in the Yarra system for 2011–12 are improving habitat for aquatic species; maintaining fish passage; assisting spawning and migration of priority fish species, including Australian grayling and Macquarie perch; increasing the spread of flood-tolerant vegetation; maintaining channel form; and avoiding deterioration of water quality.

The priority river reaches are reach 2 (around Warburton) and reach 5 (around Warrandyte). Environmental watering will focus, in priority order, on summer freshes; winter freshes; summer high flows; and winter high flows.

Based on existing knowledge, the seasonal outlook for 2011–12 is positive with a wet scenario likely. There is a good chance that summer freshes will be provided naturally and there will be sufficient water in the Water Holdings to provide all planned priority flow components, with water left to carry over into 2012–13.

System overview

The 17,000 ML of water available under the Yarra environmental entitlement can be released from the Upper Yarra, Maroondah and O'Shannassy reservoirs. It can be provided to reaches 1–8.

The environmental flow reaches for the Yarra system are shown in Figure 13F.1. The priority river reaches are reach 2, from Armstrong Creek to Millgrove, and reach 5, from the top of Yering Gorge to Mullum Mullum Creek, due to their high environmental values. The measurement points for target flows are at Millgrove in reach 2 and Warrandyte in reach 5.

The environmental entitlement held in storage adds to the significant benefits already provided by unregulated flows in the Yarra system.

Current situation

Flows in the Yarra River have been well below average over the last 13 years. However, in 2010–11, increased rainfall resulted in above-average stream flows during the summer and winter months. As a result, the majority of planned priority flow components were met naturally, including summer and winter low flows, high flows, and freshes. In addition, bankfull flows were met naturally. Therefore no delivery of environmental water was required during 2010–11. As such, there will be about 18,000 ML of carryover available for use, in addition to the 17,000 ML expected to be allocated in 2011–12.

Based on existing knowledge, the seasonal outlook for 2011–12 is positive with a wet scenario likely. Under a wet scenario, summer freshes will be provided naturally and there will be sufficient water in the Water Holdings to provide all planned priority flow components, with water left to carry over into 2012–13.

Figure 13F.1 The Yarra system

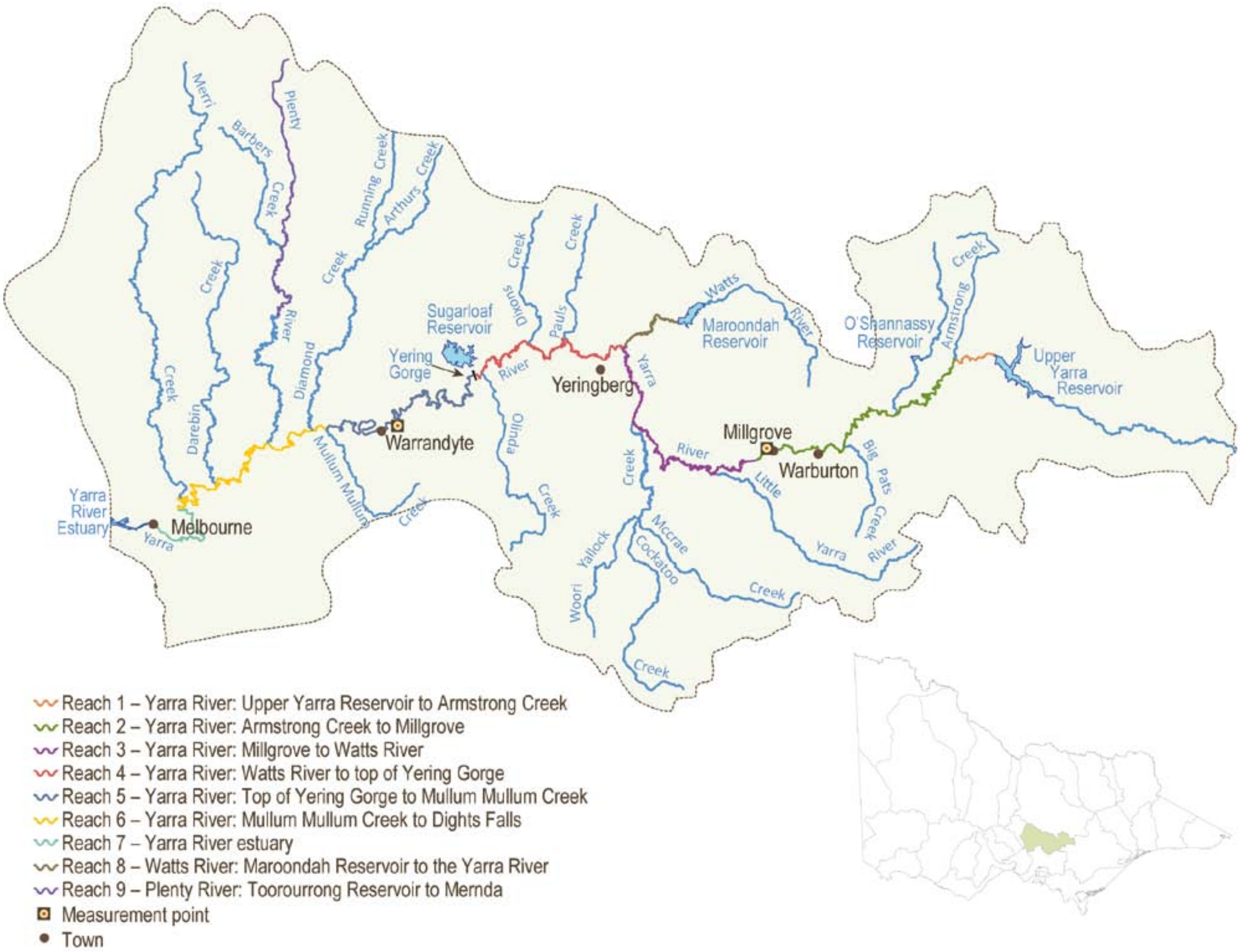


Table 13F.1 Water Holdings available for use in the Yarra system

Entitlement	Description
Yarra Environmental Entitlement 2006	• 17,000 ML per year and share of reservoir storage space • minimum passing flows at various weirs and gauges throughout the Yarra system • 55 ML per year in the Yarra River downstream of the confluence with Olinda Creek

Priority watering actions

Table 13F.2 outlines the priority objectives and watering actions under a range of planning or climatic scenarios. The priority watering actions are for:

- summer freshes in reach 2 (three freshes of 350 ML per day for two days each between December and May)
- summer freshes in reach 5 (three freshes of 750 ML per day for two days between December and May)
- winter freshes in reach 2 (two freshes of 700 ML per day for seven days each between June and November)
- winter freshes in reach 5 (two freshes of 2,000 ML per day for seven days between June and November)
- summer high flows in reach 2 (560 ML per day for seven days between April and May)
- summer high flows in reach 5 (1,500 ML per day for seven days between April and May)
- winter high flows in reach 2 (700 ML per day for 14 days between October and November)
- winter high flows in reach 5 (2,000 ML per day for 14 days between October and November).

Winter and summer low flows are also a priority flow component. These are provided year round by passing flows required under the *Yarra River Environmental Entitlement 2006*. Melbourne Water, as the storage operator, is required to maintain flows as specified in Schedule 1 of the entitlement.

Bankfull and overbank flows are important to the heath of the Yarra River, as identified in the scientific flow study. However, the environmental entitlement specifies that these cannot be met through managed flows.

Table 13F.2 Priority watering actions under a range of planning scenarios in the Yarra system

	Planning scenario			
	DROUGHT (protect)	**DRY (maintain)**	**AVERAGE (recover)**	**WET (enhance)**
Expected availability of Water Holdings	8,000 ML carryover 17,000 ML allocation	18,000 ML carryover 17,000 ML allocation	18,000 ML carryover 17,000 ML allocation	18,000 ML carryover 17,000 ML allocation
Environmental objectives	Avoid localised extinction of, and provide refuge habitat for, aquatic species. Avoid catastrophic events (eg. fish deaths or algal blooms). Avoid deterioration of water quality.	Avoid localised extinction of and provide refuge habitat for aquatic species. Avoid catastrophic events (eg. fish deaths or algal blooms). Avoid deterioration of water quality.	Improve habitat access for aquatic species. Maintain fish passage. Assist spawning and migration of priority fish species. Increase the spread of flood-tolerant vegetation. Avoid deterioration of water quality.	Improve habitat access for aquatic species. Maintain fish passage. Assist spawning and migration of priority fish species. Increase the spread of flood-tolerant vegetation. Maintain channel form.
Flow components	Summer fresh if water quality deteriorates.	Three summer freshes. Winter fresh. Summer high flows.	Three summer freshes. One winter fresh. Summer high flows.	Three summer freshes. Two winter freshes. Summer high flows. Winter high flows.^
Possible volume required from the Water Holdings*	10,000 ML	10,000–33,000 ML	10,000–34,000 ML	10,000 ML
Possible carryover into 2012/13#	25,000 ML	2,000–25,000 ML	1,000–25,000 ML	25,000 ML

^ Subject to high unregulated stream flows, the winter high flow component will be delivered through reach 1 to mobilise sediment, as per the Upper Yarra Dam flow release strategy.
* Estimated volumes depend on the amount of unregulated flows experienced throughout the year.
# The amount of carryover available in 2012–13 will be limited by the available reservoir storage capacity.

Yarra River, Alison Pouliot

Adaptive management considerations

Decisions to release water from the Yarra entitlement will be mainly influenced by the amount of unregulated flows experienced in the system throughout the year.

Summer freshes are the highest priority in the Yarra system. As the season progresses, and if the catchment remains wet, it is expected that summer freshes will be met naturally and the priority will move to the provision of winter freshes, and summer high flows. The delivery of winter high flows may occur in 2011, depending upon the occurrence of a natural high flow event to assist in mobilising sediment in reach 1.

After providing all of these components, water still available under the entitlement is to be carried over into 2012–13 to meet similar objectives as those for this year.

The 55 ML available downstream of the confluence with Olinda Creek will likely be left instream to supplement unregulated flows, as it is unlikely to be required for billabong watering. Most priority billabongs were inundated in 2010–11.

Melbourne Water, as the waterway manager, will monitor the flows occurring naturally in the system, and assess the best time to make releases to provide the priority flow components most efficiently and with maximum environmental benefit.

Environmental flow requirements may also be met through cease to harvest at Yering Pumping Station or through operational transfers within the Melbourne Water headworks system. This is subject to agreement with Melbourne Water storage operators. Where these arrangements occur, any additional losses will be deducted from the Water Holdings.

Implementation arrangements

This plan outlines the watering actions that are a priority in the coming year, provided there is sufficient water. A seasonal watering statement will be issued to communicate decisions on the environmental watering actions that are to be undertaken and to authorise Melbourne Water to implement those decisions.

In the Yarra system, implementation arrangements are outlined in Schedule 3 of the *Seasonal Watering Plan 2011–12*. In the future, implementation will also be guided by operating arrangements due for development by June 2012

Risk assessment and management

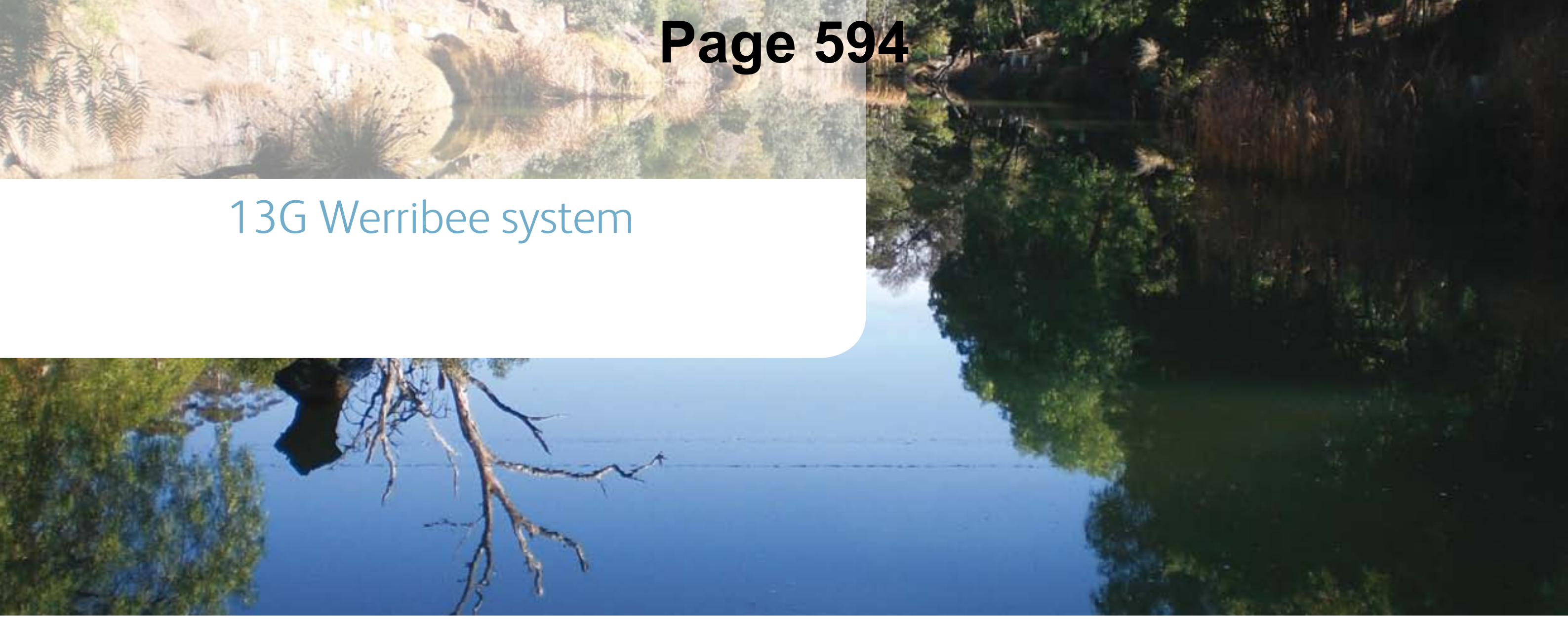
Risks associated with the implementation of these watering actions include flooding of private land and personal injury to river users. However, these risks are assessed as low. Management strategies include consideration of historic release limits, ongoing dialogue between environmental water reserve officers and storage operation staff within Melbourne Water, and adequate communication of planned releases to key stakeholders.

Additional risks associated with the delivery of high flows through reach 1, including mobilisation of sediment and organic matter, are addressed in the Upper Yarra Dam flow release strategy. These risks will be managed by timing the release to coincide with high unregulated flows in the Yarra system, minimising downstream impacts.

Also important are risks to successfully achieving the desired environmental outcomes from watering actions. Details on these can be found in Schedule 3.

Further information

More detail about the planned watering actions in the Yarra system can be found by downloading Schedule 3 of the *Seasonal Watering Plan 2011–12* at www.vewh.vic.gov.au.



13G Werribee system

Werribee River, Melbourne Water

Waterway manager – Melbourne Water

The Werribee system, located 40 kilometres south-west of Melbourne, flows from the Wombat State Forest south east to the undulating plains of basalt soils north of Ballan before flowing into Port Phillip Bay. The upper Werribee River contains areas of relatively intact streamside vegetation and is an important habitat for native fish, platypus and invertebrates. The middle reaches of the Werribee River provide good habitat for fish, including short-finned eel, pygmy perch, and tupong, and a significant platypus population. The lower reaches of the river are home to migratory wading birds and numerous fish species, and are lined with highly valued river red gums.

Planned environmental water use in 2011–12

The priority environmental objectives in the Werribee system for 2011–12 are maintaining pool habitat and connectivity for platypus and priority fish species, including pygmy perch; maintaining instream and riparian vegetation growth; mobilising sediment; and maintaining riffle sites and channel form.

The priority river reaches are reach 6 (below Lake Merrimu) and reach 8 (below Melton Reservoir). Environmental watering will focus, in priority order, on cease to flow events; low flows; low flow freshes; baseflows; small high flow freshes; and large high flow freshes.

Based on existing knowledge, the outlook for the Werribee system is positive with a wet scenario likely. It is expected that there will be sufficient water available to provide all priority flow components.

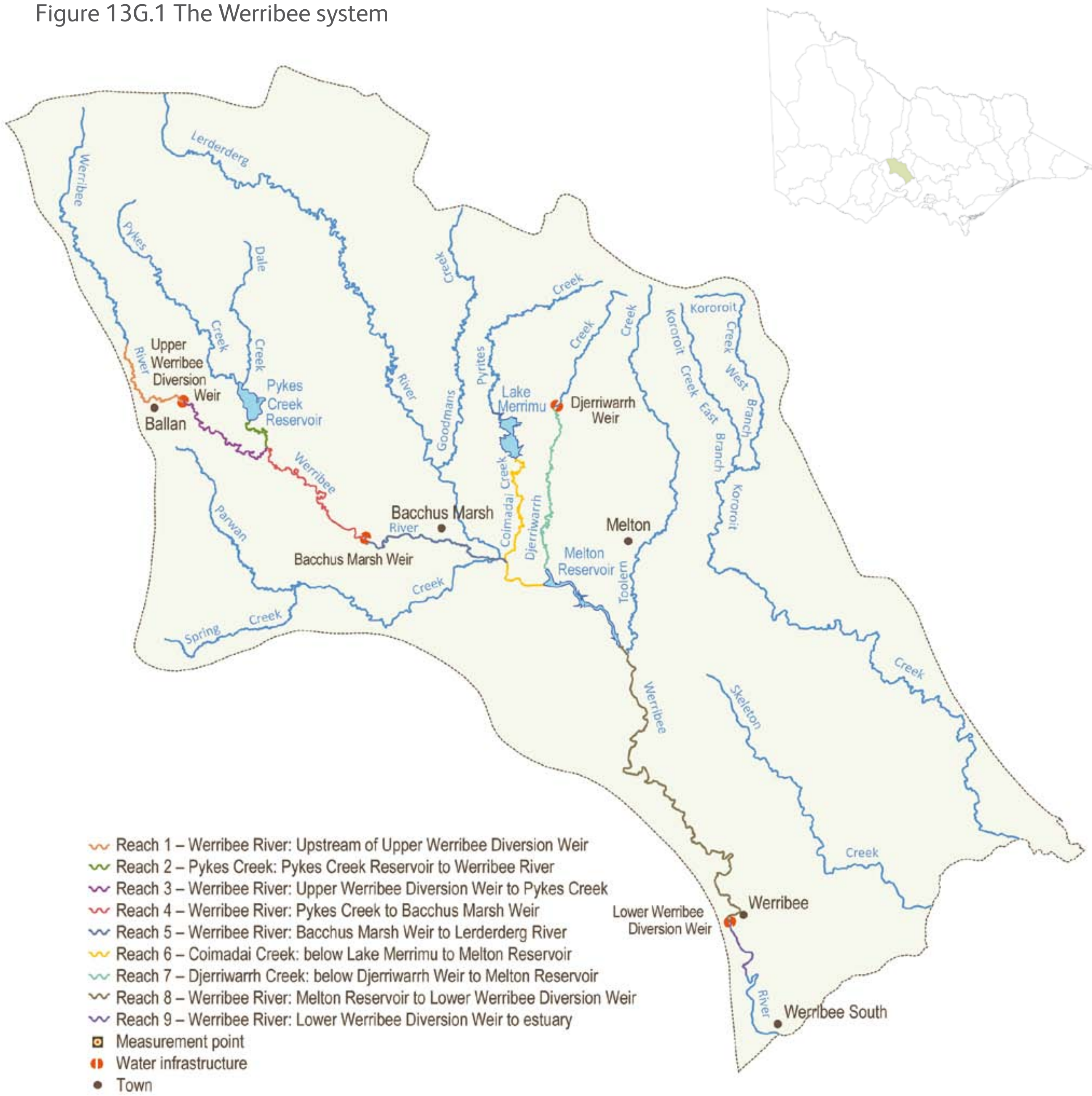
System overview

Environmental water available under the *Werribee River Environmental Entitlement 2011* can be released to the Werribee system from Lake Merrimu and Melton Reservoir.

The environmental flow reaches in the Werribee system are shown in Figure 13G.1. Environmental water can only be managed in the reaches below the reservoirs. Therefore, the priority reaches for environmental watering are reach 6, downstream of Lake Merrimu, and reach 8, downstream of Melton Reservoir. The measurement points for target flows are below Lake Merrimu in reach 6 and below Melton Reservoir in reach 8. It is anticipated that some benefit will be provided to reach 9, the lowest reach, below the Werribee Diversion Weir to the estuary.

The Werribee system is highly regulated, providing water to support urban and industrial customers, private diverters and irrigation districts at Bacchus Marsh and Werribee. As a result, the natural flow regime of the river has been significantly altered. Environmental water in the Werribee system will assist in restoring some degree of natural seasonality to the flow regime of the river.

Figure 13G.1 The Werribee system



Current situation

The flow regime of the Werribee River has been highly modified, resulting in reversal of the natural flow seasonality of the system. While passing flows are provided at numerous locations in the Werribee system, no active management of environmental water has occurred to date as the environmental entitlement was only created in May 2011. Whilst passing flows have provided some environmental benefit, environmental water now available under the Werribee entitlement will greatly improve the ability to achieve desired environmental objectives in the system.

The Werribee system has experienced prolonged low flow conditions up until 2010–11 when good spring and winter rainfall filled both Lake Merrimu and Melton Reservoir, causing Melton Reservoir to spill for the first time since 2005. Bankfull flows occurred naturally in reach 8, with some achievement of baseflows, low flows and high flow freshes during 2010–11. Low flow freshes did not occur.

Operational leakage from Lake Merrimu is believed to be the cause of a persistent trickle flow in reach 6. This is thought to be reducing the occurrence of cease to flow events, but requires further investigation. Additionally, the capture of flow in Lake Merrimu has significantly reduced the occurrence of freshes, with no achievement of bankfull and overbank flows in recent years.

Based on existing knowledge, the outlook for the Werribee system is positive with a wet scenario likely. It is expected that there will be sufficient water available to provide all priority flow components.

Table 13G.1 Water Holdings available for use in the Werribee system

Entitlement	Description
Werribee River Environmental Entitlement 2011	• 10 per cent of share of inflows, after passing flows have been provided • some ability to bank passing flows in Lake Merrimu (subject to a number of conditions) • air space storage in Lake Merrimu and Melton Reservoir (first to spill)

Priority watering actions

Table 13G.2 outlines the priority objectives and watering actions under a range of planning scenarios. The priority watering actions for the Werribee system are:

- cease to flow in reach 6 (0 ML per day for 30 days, or natural, between December and January and March and June)
- low flows in reach 8 (10 ML per day, or natural flow, between December and May, in all years but extreme drought)
- low flow fresh in reach 8 (5–167 ML per day, or natural, for one to three days between December and June)
- baseflow in reach 6 (0.5 ML per day, or natural, between July and December)
- baseflow in reach 8 (36 ML per day, or natural, between June and December)
- small high flow freshes in reach 6 (10 freshes of 10 ML per day for five days each between July and November)
- large high flow freshes in reach 6 (two freshes of 93 ML per day, or natural, for two days each between July and November)
- large high flow freshes in reach 8 (seven freshes of 350 ML per day or natural, for seven days each between June and December).

Adaptive management considerations

As inflows improve, more flow components will be delivered in the water year. Under wetter conditions the delivery of baseflows becomes a higher priority than low flows and low flow freshes, as there is increased water available under the environmental entitlement to maintain baseflows.

To maximise the benefits of the environmental water available in the Werribee system, Melbourne Water will work closely with Southern Rural Water to time releases, where possible, to build on irrigation releases. This is a key method for efficiently achieving flow components, particularly summer freshes.

After providing these flow components, either managed or natural, any water still available under the entitlement will be carried over to meet similar objectives in 2012–13.

Melbourne Water, as the waterway manager, will monitor the flows occurring naturally in the system, and assess the best time to make releases to provide the priority flow components most efficiently and with maximum environmental benefit.

Implementation arrangements

This plan outlines the watering actions that are a priority in the coming year, provided there is sufficient water. As conditions unfold and water becomes available throughout the year, seasonal watering statements will be issued to communicate decisions on the environmental watering actions that are to be undertaken. The seasonal watering statements authorise Melbourne Water to implement those decisions.

In the Werribee system, implementation arrangements are outlined in Schedule 4 of the *Seasonal Watering Plan 2011–12*, with operating arrangements for the system currently under development. These arrangements outline the water source, delivery constraints, timing and triggers for watering, water ordering process, costs, reporting and monitoring requirements.

Risk assessment and management

Risks associated with the implementation of priority watering actions include flooding of private land and risk of personal injury. However, these risks are assessed as low. Management strategies include ongoing dialogue between environmental water reserve officers and storage operators, and adequate communication of planned releases to key stakeholders.

Additional risks associated with water quality, particularly during the summer periods, have also been identified. This risk will be managed through ongoing water quality monitoring and use of triggers to inform the timing of environmental releases.

Also important are risks to successfully achieving the desired environmental outcomes from watering actions. Details on these can be found in Schedule 4.

Further information

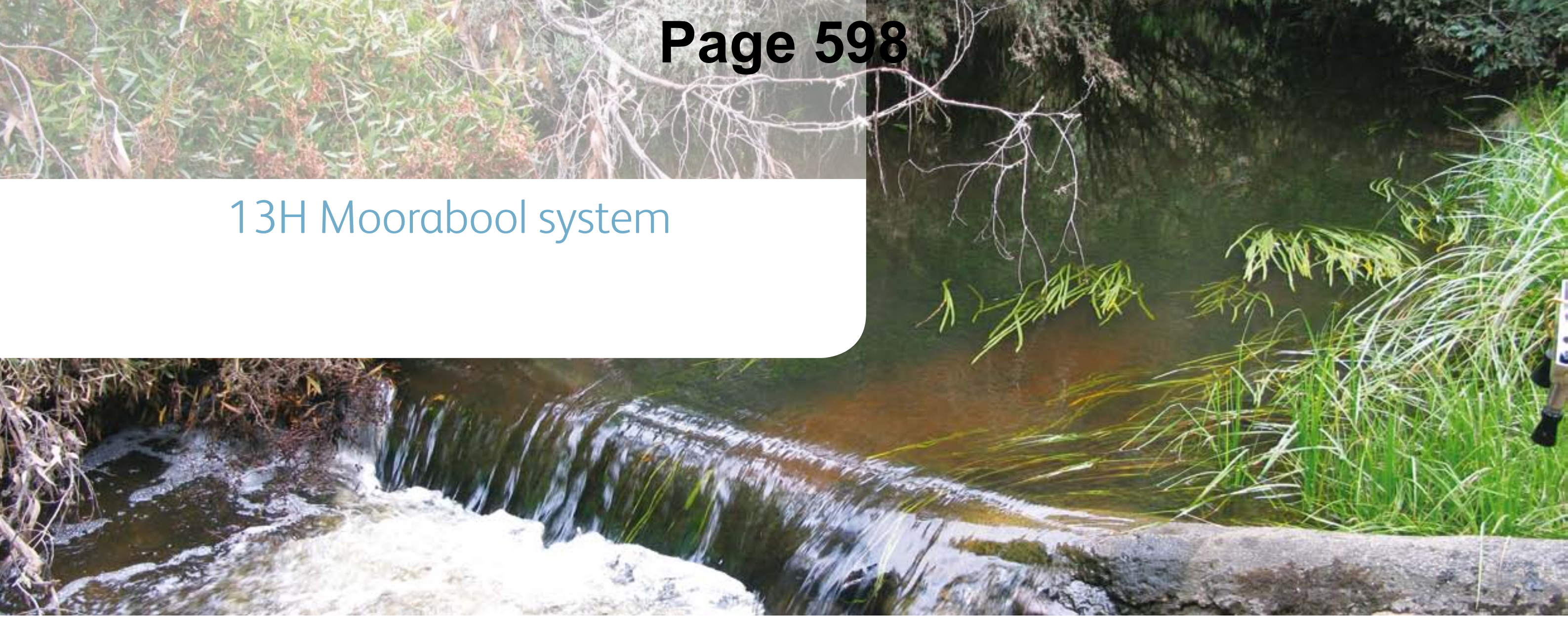
More detail about the planned watering actions in the Werribee system can be found by downloading Schedule 4 of the *Seasonal Watering Plan 2011–12* at www.vewh.vic.gov.au.

Table 13G.2 Priority watering actions under a range of planning scenarios in the Werribee system

	Planning scenario			
	DROUGHT (protect)	**DRY (maintain)**	**AVERAGE (recover)**	**WET (enhance)**
Expected availability of Water Holdings[1]	3,000 ML carryover <1,000 ML allocation	3,000 ML carryover 1,000 ML allocation	3,000 ML carryover 1,000–2,000 ML allocation	3,000 ML carryover 3,000 ML allocation
Environmental objectives	Maintain habitat for platypus populations. Maintain refuge for fish. Allow passage of river blackfish. Inundate instream macroinvertebrate riffle habitat. Maintain pool water quality. Curtail growing season of in-channel emergent macrophytes	Maintain habitat for platypus populations. Maintain refuge for fish. Allow passage of river blackfish. Inundate instream macroinvertebrate riffle habitat. Maintain pool water quality. Curtail growing season of in-channel emergent macrophytes.	Manage instream vegetation growth. Manage pygmy perch access stream bed vegetation. Mobilise sand and silt from riffle sites and pools. Maintain channel form. Mobilise gravels and disturb macrophytes. Disturb shrubby vegetations.	Manage instream vegetation growth. Manage pygmy perch access stream bed vegetation. Mobilise sand and silt from riffle sites and pools. Maintain channel form. Mobilise gravels and disturb macrophytes. Disturb shrubby vegetations.
Flow components	Cease to flow (reach 6).[2] Low flows (reach 8). Low flow freshes (one per reach).	Cease to flow (reach 6).[2] Low flows (reach 8). Low flow freshes (two per reach). Baseflow (reach 8).	Baseflow.[3,4] Low flows[3] (reach 8). Low flow freshes (three per reach). Small high flow freshes (10 events in reach 6). Large high flow fresh (reach 6).	Baseflow.[3,4] Low flows[3] (reach 8). Low flow freshes (four events in reach 6; three events in reach 8). Small high flow freshes. Large high flow fresh (reach 6). Large high flow fresh (one event in reach 8). Bankfull.[5] Overbank.[5]
Possible volume required from the Water Holdings[6]	1,000 ML	1,600 ML	3,300 ML	8,300 ML
Possible carryover into 2012/13[1]	Up to 3,000 ML	Up to 3,400 ML	Up to 3,300 ML	0 ML

1 The *Werribee River Environmental Entitlement 2011* allows environmental water to be stored in storage space not being used by other entitlement holders in Lake Merrimu and Melton Reservoir. When either of the storages spill, environmental water is the first to spill.
2 Cease to flow components are provided by ensuring water from the Water Holdings is not released.
3 Baseflow requirements are provided through passing flows requirements in reach 6.
4 Baseflows cannot currently be provided in reach 8 due to outlet constraints.
5 Bankfull and overbank flows will not be provided through managed environmental water releases due to the potential flooding of private land and infrastructure, however these flows are expected to occur naturally under an 'enhance' scenario.
6 Figures assume no unregulated flows occur, and are therefore an upper limit of the volume required from the Water Holdings.

13H Moorabool system



Moorabool River in flood, 2011, Corangamite Catchment Management Authority

Waterway manager – Corangamite Catchment Management Authority

The Moorabool system is an important catchment for the major urban areas of Geelong and Ballarat. The river also sustains economic values through its contribution to extensive agriculture in the region. Despite years of drought and water extraction, the river still retains some significant environmental values, particularly the mid to lower reaches around She Oaks Weir. These values include native fish of high conservation value and areas of significant remnant vegetation. The river maintains populations of native aquatic species such as tupong, river blackfish, southern pygmy perch, Australian smelt and the short-finned eel.

Planned environmental water use in 2011–12

The priority environmental objectives in the Moorabool system for 2011–12 are maintaining water quality; maintaining diversity of macroinvertebrate and instream aquatic plant communities; limiting encroachment of instream vegetation; maintaining snag habitat; restoring or maintaining self-sustaining population of priority fish species; and maintaining riparian vegetation communities.

The priority river reach is reach 3 between Lal Lal Reservoir and She Oaks Weir. Environmental watering will focus, in priority order, on summer freshes; summer low flow; cease to flow (if natural conditions are appropriate); winter freshes; and winter low flow.

Based on existing knowledge, the outlook for the 2011–12 watering season is positive, with an average scenario most likely. It is expected that there will be sufficient water, through both regulated and unregulated flows, to meet all priority summer flow requirements and some achievement of winter freshes.

System overview

Water available under the Moorabool environmental entitlement is stored and released from Lal Lal Reservoir, the main storage on the Moorabool system.

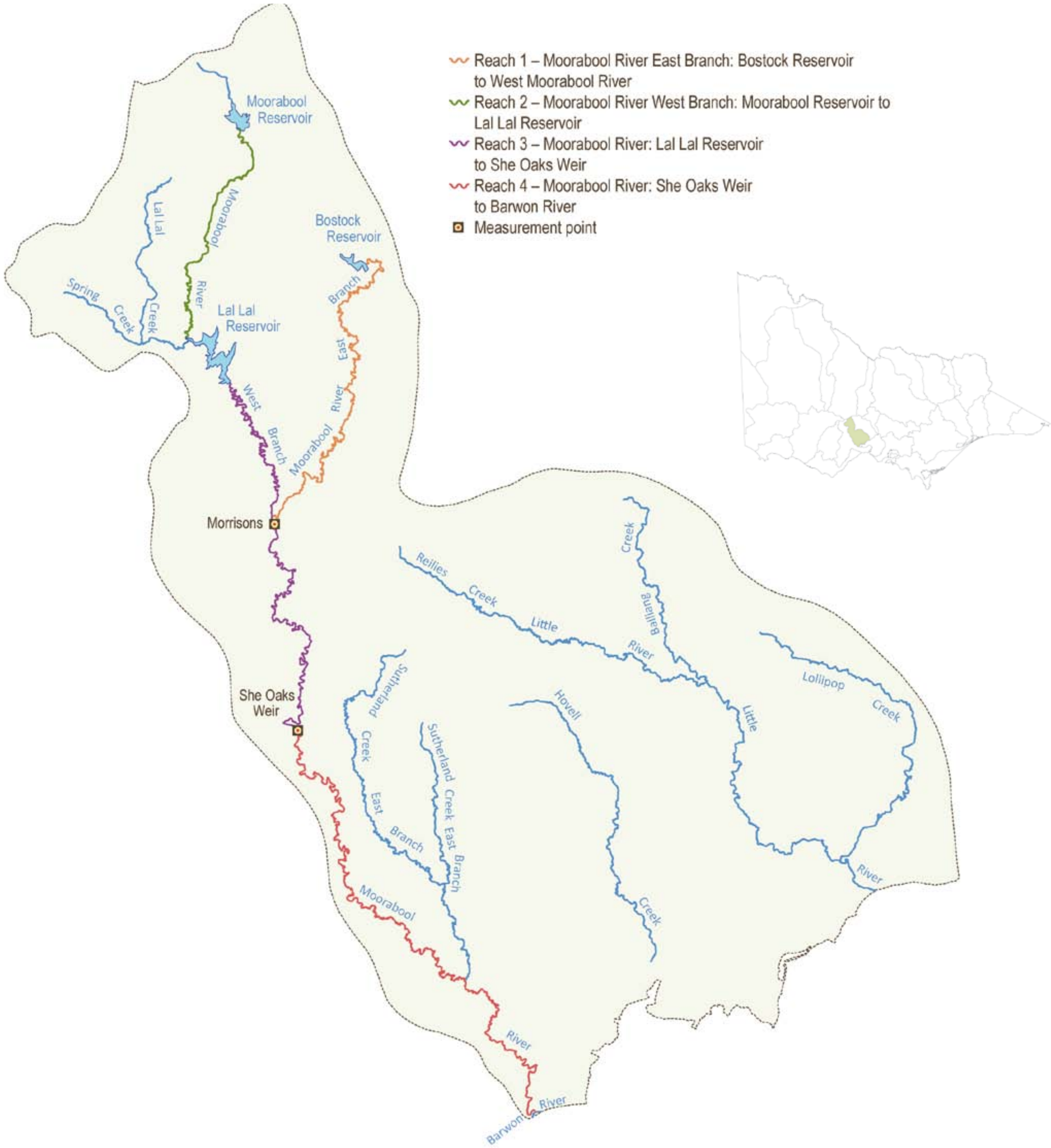
The environmental flow reaches are shown in Figure 13H.1. The priority reach in the Moorabool system is reach 3, between Lal Lal Reservoir and She Oaks Weir. This reach has the priority ecological values and is most influenced by water released from Lal Lal Reservoir. Some benefit may be provided to reach 4, as the final reach of the Moorabool system which flows into the Barwon River, although this reach is not an environmental watering priority. The measurement points for target flows in the Moorabool system are at Morrisons and She Oaks Weir.

Current situation

Seasonal flow patterns have been reversed in the Moorabool system in the majority of the past 10 years, with high summer flows and little or no winter flows occurring. This is a result of the transfer of consumptive water from Lal Lal Reservoir, and environmental releases to protect refuge habitat.

Since 2005, the Moorabool River has experienced prolonged drought conditions and 'cease to flow' events. During this time, the Corangamite Catchment Management Authority operated under emergency management conditions, using small volumes of water to maintain key drought refuges and avoid critical loss of species. Significant and sustained flows were then experienced in 2010–11 with most priority flow components partially or fully achieved through a combination of natural unregulated flows, consumptive water releases and managed environmental releases.

Figure 13H.1 The Moorabool system



The extent to which priority flow components will be met in the 2011–12 water year will largely depend on the amount of unregulated flows in the system and opportunities to build upon other releases, such as consumptive water deliveries. Based on existing knowledge, the outlook for the 2011–12 watering season is positive with an average scenario most likely. It is expected that there will be sufficient water, through both regulated and unregulated flows, to meet all priority summer flow requirements and potentially winter freshes.

Table 13G.1 Water Holdings available for use in the Moorabool system

Entitlement	Description
Moorabool River Environmental Entitlement 2010	• 11.9 per cent (7,086 ML) of storage capacity • 11.9 per cent of inflows, after passing flows have been set aside • a maximum use of 7,500 ML of VEWH water in any consecutive three year period

Priority watering actions

Table 13H.2 outlines the priority objectives and watering actions under a range of planning scenarios. The priority watering actions, in priority order, for reach 3 are for:

- summer fresh (three freshes of 31 ML per day for 10 days between December and May)
- summer low flow (20 ML per day from December to May)
- cease to flow (one event of 0 ML per day for 10 days between December and May)
- winter fresh (one fresh of at least 146 ML per day for five days between June and November)
- winter low flow (83 ML per day from June to November).

Depending on inflows into Lal Lal Reservoir, a portion of summer low flows will be provided to the system through passing flows specified under the *Moorabool River Environmental Entitlement 2010* and managed by Central Highlands Water. However, these flows often require top-up with environmental water to reach desired flow rates.

Winter high flows are also an important flow component in the Moorabool system, aiding in deepening pools, removing organic matter, fish breeding and movement, and wetting riparian communities such as tea tree; however, it is not possible to actively manage these flows due to capacity constraints at Lal Lal Reservoir. In addition, there is insufficient water available under the existing entitlement to provide these flows without jeopardising other critical flow components or watering actions in future years. As such, winter high flows will not be sought using the environmental entitlement, but may occur naturally.

Adaptive management considerations

Decisions to release water from the Moorabool environmental entitlement will be mainly influenced by the amount of unregulated flows and water corporation transfers occurring in the system throughout the year. Given the small volume available for use under the environmental entitlement and the need to protect refuge pools and water quality from December 2011 to May 2012, the delivery of summer flow components is the highest priority.

The second priority will be to provide winter flows in 2012, to restore some balance to the reversal of seasonal flow pattern typically seen in the system.

Water available under the Moorabool environmental entitlement is restricted by a maximum use of 7,500 ML over any three-year consecutive period. Corangamite Catchment Management Authority plans to use 2,500 ML in 2011–12, retaining flexibility for future years through carryover.

Corangamite Catchment Management Authority will monitor the inflows and water quality, assessing the best time to make releases to provide the priority flow components most efficiently and with maximum environmental benefit. Close working relationships with Barwon Water and Central Highlands Water will be important in timing environmental releases to coincide with deliveries of consumptive volumes, thereby sharing any losses and maximising flow rates.

Implementation arrangements

This plan outlines the watering actions that are a priority in the coming year. A seasonal watering statement will be issued to communicate decisions on the environmental watering actions that are to be undertaken and authorise Corangamite Catchment Management Authority to implement these decisions.

In the Moorabool system, implementation arrangements are outlined in Schedule 5 of the *Seasonal Watering Plan 2011–12*.

Risk assessment and management

Risks associated with the implementation of these watering actions include flooding of private land and personal injury to river users; however, these risks are assessed as low. Management strategies include monitoring of release levels, ongoing dialogue between Corangamite Catchment Management Authority and storage operators at Central Highlands Water and adequate communication of planned releases to key stakeholders.

Also important are risks to successfully achieving the desired environmental outcomes from watering actions. Details on these can be found in Schedule 5.

Further information

More detail about the planned watering actions in the Moorabool system can be found by downloading Schedule 5 of the *Seasonal Watering Plan 2011–12* at www.vewh.vic.gov.au.

Table 13H.2 Priority watering actions under a range of planning scenarios in the Moorabool system

	Planning scenario			
	DROUGHT	DRY	AVERAGE	WET
Expected availability of Water Holdings	0–1,475 ML allocation 6,300 ML carryover	1,500–2,350 ML allocation 6,300 ML carryover	2,375–2,625 ML allocation 6,300 ML carryover	>2,650 ML allocation 6,300 ML carryover
Environmental objectives	Manage salinity and dissolved oxygen levels. Maintain diverse macroinvertebrate communities. Maintain instream aquatic plant species diversity. Limit encroachment of instream vegetation. Restore riffles.	Manage salinity, dissolved oxygen and total nitrogen concentrations. Maintain diverse macroinvertebrate communities. Maintain instream aquatic plant species diversity. Limit encroachment of instream vegetation. Provide adequate fish habitat. Maintain snag habitat. Restore riffles.	Manage salinity, dissolved oxygen and total nitrogen concentrations. Maintain diverse macroinvertebrate communities. Maintain instream aquatic plant species diversity. Limit encroachment of instream vegetation. Maintain snag habitat. Restore or maintain self-sustaining populations of tupong, river blackfish, southern pygmy perch, Australian smelt, and short-finned eel. Maintain physical processes through organic matter transport. Maintain riparian vegetation communities. Maintain channel form.	Manage salinity, dissolved oxygen and total nitrogen concentrations. Maintain diverse macroinvertebrate communities. Maintain instream aquatic plant species diversity. Limit encroachment of instream vegetation. Maintain snag habitat. Restore or maintain self-sustaining populations of tupong, river blackfish, southern pygmy perch, Australian smelt, and short-finned eel. Maintain physical processes through organic matter transport. Maintain riparian vegetation communities. Maintain channel form.
Flow components	Trigger-based freshes. Summer freshes. Summer low flow.	Cease to flow. Summer freshes. Summer low flow. Late winter fresh.	Cease to flow. Summer freshes. Summer low flow. Winter freshes. Winter low flow.	Summer freshes. Summer low flow. Winter freshes. Winter low flow. Winter high flow (natural event).
Possible volume required from the Water Holdings	2,500 ML	2,500 ML	2,500 ML	2,500 ML
Possible carryover into 2012–13	3,800–5,275 ML	5,300–6,150 ML	6,175–6,425 ML	>6,450 ML

13I Barwon system

Hospital Swamp, Donna Smithyman, Corangamite Catchment Management Authority

Planned watering actions for the Barwon system will be included as sub-section 13I in the Seasonal Watering Plan 2011–12 at a later stage. Once the environmental flow study has been completed, the Corangamite Catchment Management Authority will prepare a seasonal watering proposal. This will then be considered by the VEWH and the agreed priority watering actions included in the plan.

14 Western Victoria

The Wimmera-Glenelg is a single, highly connected, regulated source system and the only system within western Victoria in which there are Water Holdings. This source system supplies both the Glenelg and the Wimmera regulated river systems (see sub-sections 14A and 14B), as well as wetlands connected to the Wimmera-Mallee pipeline (see sub-section 14C).

The Wimmera-Glenelg environmental water entitlement was originally created in 2004 as part of the process of converting loosely defined rights to water into secure entitlements, including the water savings from the Northern Mallee pipeline project. It has been progressively updated as further water savings have been realised. In 2010, the entitlement was reissued to reflect the water recovery undertaken as part of the Wimmera-Mallee pipeline project.

The Wimmera–Glenelg supply system is complex, with many rivers, streams and pipelines, multiple storages, channels connecting storages, and numerous passing flow requirements. The system is operated by Grampians Wimmera Mallee Water, which is currently developing storage management rules in consultation with entitlement holders (including the VEWH) and other key stakeholders.

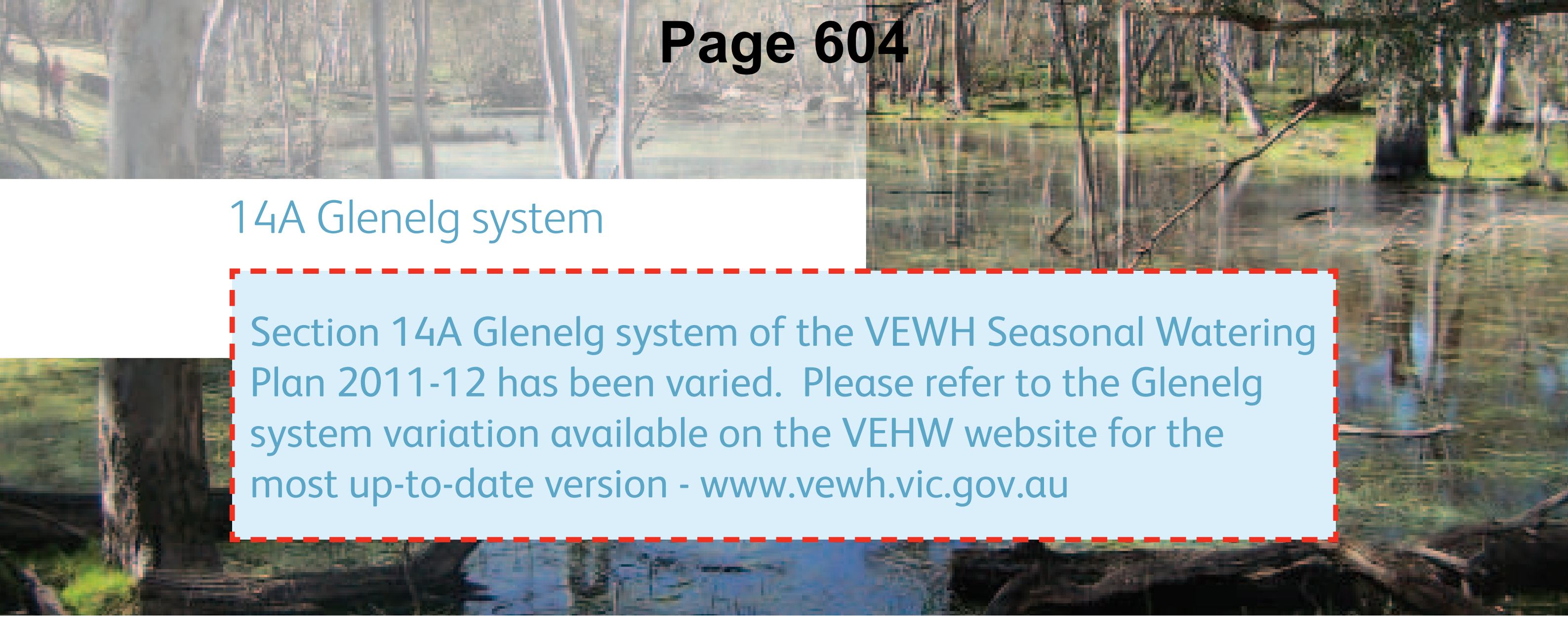
Due to this complexity, planning for use of the Water Holdings in western Victoria is undertaken conjunctively for the Wimmera and Glenelg systems. Sub-sections 14A and 14B, which address the two systems separately, are complementary to each other.

The priority watering actions for the Glenelg and Wimmera systems have been proposed by the Glenelg Hopkins and Wimmera catchment management authorities on advice from the Inter-Catchment Advisory Group, which includes community representatives of both CMAs. The priority actions have since been agreed to by the VEWH and included in the seasonal watering plan.

Planned watering actions for the Wimmera-Mallee wetlands will be included in the *Seasonal Watering Plan 2011–12* at a later stage. Once planning and infrastructure works to connect further wetlands to the pipeline are completed, the Mallee Catchment Management Authority will prepare a seasonal watering proposal, in consultation with Wimmera and North Central CMAs. This will then be considered by the VEWH and the agreed priority watering actions included in the plan.

14A Glenelg system

Section 14A Glenelg system of the VEWH Seasonal Watering Plan 2011-12 has been varied. Please refer to the Glenelg system variation available on the VEHW website for the most up-to-date version - www.vewh.vic.gov.au



Frazer Swamp on the Glenelg River, Glenelg-Hopkins Catchment Management Authority

Waterway manager – Glenelg Hopkins Catchment Management Authority

The Glenelg River, in south-western Victoria, starts in the Grampian Ranges and runs for over 350 kilometres, making it the longest river in south-west Victoria. A short stretch of the lower end winds through South Australia before returning to Victoria to enter the sea at Nelson. The Glenelg River is a central feature of the Lower Glenelg National Park and is valued for its high social, economic and environmental attributes. In recent history the Glenelg River has been seriously affected by prolonged drought and is now experiencing improved flows for the first time in many years. The Glenelg River is listed as a heritage river due to the high-value aquatic life it supports, including the Glenelg freshwater mussel and Glenelg spiny crayfish.

Planned environmental water use in 2011–12

The priority environmental objectives in the Glenelg system for 2011–12 include maintaining and improving instream habitat and water quality, and providing connectivity between reaches to support native fish movement.

The priority river reach in the Glenelg system is reach 1, from Rocklands Reservoir to upstream of Burkes Bridge. Environmental watering will focus, in priority order, on summer baseflows; a summer fresh; and a spring fresh. If there is sufficient environmental water to provide all flow components in reach 1, the focus will shift to providing additional flows to meet baseflow targets in reach 2.

Based on existing knowledge, the seasonal outlook for 2011–12 is positive, with an average scenario likely. It is likely that allocations in 2011–12 and water carried over from last year will provide sufficient water for all priority flow components in the Glenelg system.

System overview

The Glenelg system has two main storages which can capture water from the Glenelg River: the Moora Moora and Rocklands reservoirs. Moora Moora Reservoir is a relatively small dam in the headwaters of the Glenelg. Rocklands Reservoir is the largest storage in the Wimmera-Glenelg headwork system and captures all inflows from seven creeks and rivers including the Glenelg River. Environmental water in the Glenelg system is released from Rocklands Reservoir through carp screens and enters reach 1 via the dam outlet, and 5 mile and 12 mile outlets which provide water to reach 1 progressively downstream.

In the Glenelg River the priority reaches for environmental watering are reaches 1 and 2. Reach 3 will benefit from environmental watering releases; however reach 1 and 2 are the only reaches in which environmental water can be adequately released to meet desired flow targets. The measurement points for target flows are at Harrow for reach 1 and Dergholm for reach 2.

Figure 14A.1 The Glenelg system

Table 14A.1 Water Holdings available for use in the Glenelg system

Entitlement	Description
Wimmera and Glenelg Rivers Environmental Entitlement 2010	• 40,560 ML of regulated entitlement with the allocations based on inflow into storage (to be shared between the Wimmera system and Glenelg system) • fixed passing flows in Wannon River • passing flows with some ability to vary rates in the Glenelg River

Current situation

The 2010–11 water year marked a drastic shift in water resource condition in the Glenelg system, moving from drought conditions which have dominated the region since 1997, to large-scale flooding. These flows provided significant benefit to riparian vegetation and have improved water quality and macroinvertebrate diversity. Fish response has been mixed, with the diversity of native species increasing. All planned priority flow components occurred naturally or were provided, including summer baseflows and freshes, winter baseflows and winter spring freshes.

Based on existing knowledge, the seasonal outlook for 2011–12 is positive, with an average scenario likely. It is likely that allocations in 2011–12 and water carried over from last year will provide sufficient water for all priority flow components in the Glenelg system.

Passing flows occur during winter to meet the winter baseflow requirements.

Priority watering actions

Table 14A.2 outlines the priority objectives and watering actions under a range of planning scenarios. The priority watering actions are based on what can be feasibly released within operational constraints. The primary focus is on:

- summer base flows in reaches 1 and 2 (minimum of 75 ML per day between November and May)
- summer freshes in reach 1 (five freshes of 65 ML per day for six days each between December and May)
- winter/spring freshes in reach 1 (two freshes of 350 ML per day for four days each between July and October).

Adaptive management considerations

Environmental water will first be reserved to provide summer baseflows and freshes from November 2011. If there is sufficient water available, winter/spring freshes will be provided up to October 2011.

The Wimmera-Glenelg headwork system is highly regulated with numerous storages. A number of factors influence the management of environmental releases in the Glenelg system, including reservoir capacity constraints, storage levels, and other water resource management activities. Glenelg Hopkins Catchment Management Authority will work closely with Grampians-Wimmera-Mallee Water to ensure there is maximum benefit from the use of environmental water in the system.

Water available after providing priority flow components in both the Glenelg and Wimmera systems is to be carried over into 2012–13.

Glenelg Hopkins Catchment Management Authority will monitor the flows occurring naturally in the system, and assess the best time to make releases to provide the priority flow components most efficiently and with maximum environmental benefit.

The Glenelg-Hopkins Catchment Management Authority and Wimmera Catchment Management Authority will work together to provide the priority watering actions in both the Glenelg and Wimmera systems, considering water availability and system constraints. They will communicate regularly to ensure sufficient water in the Water Holdings before ordering. In the unlikely event there is insufficient water to meet priority watering actions in both the Glenelg and Wimmera systems, prioritisation will be agreed by both CMAs and based on the effectiveness of flows in minimising risks to key ecological assets. If shortfalls are identified, the CMAs will work together to allocate the remaining water to the priority flow components across systems, involving the VEWH in final decision making as necessary.

Implementation arrangements

This plan outlines the watering actions that are a priority in the coming year, provided there is sufficient water. A seasonal watering statement will be issued to communicate decisions on the environmental watering actions that are actually to be undertaken and to authorise Glenelg Hopkins Catchment Management Authority to implement those decisions.

In the Glenelg system, implementation arrangements are outlined in Schedule 7 of the *Seasonal Watering Plan 2011–12*. In the future, implementation will also be guided by storage management rules due for development by October 2011 and operating arrangements also to be developed.

Risk assessment and management

While unlikely, there is a risk that in an extremely wet year, flooding impacts could be exacerbated. In order to manage this risk, the Glenelg Hopkins Catchment Management Authority will monitor releases and upstream flows and if there is a risk, immediately order releases to cease.

Also important are risks to successfully achieving the desired environmental outcomes from watering actions. Details on these can be found in Schedule 7. Of note is an emerging risk related to water quality issues in Taylors Lake in the Wimmera system. In response, Grampians Wimmera Mallee Water has modified its normal operational practice as a mitigation measure. This has the potential to impact on water available from the Water Holdings. The VEWH, together with Wimmera and Glenelg-Hopkins catchment management authorities, will work closely with Grampians Wimmera Mallee Water to manage the water quality issues while minimising the risk to the Water Holdings.

Further information

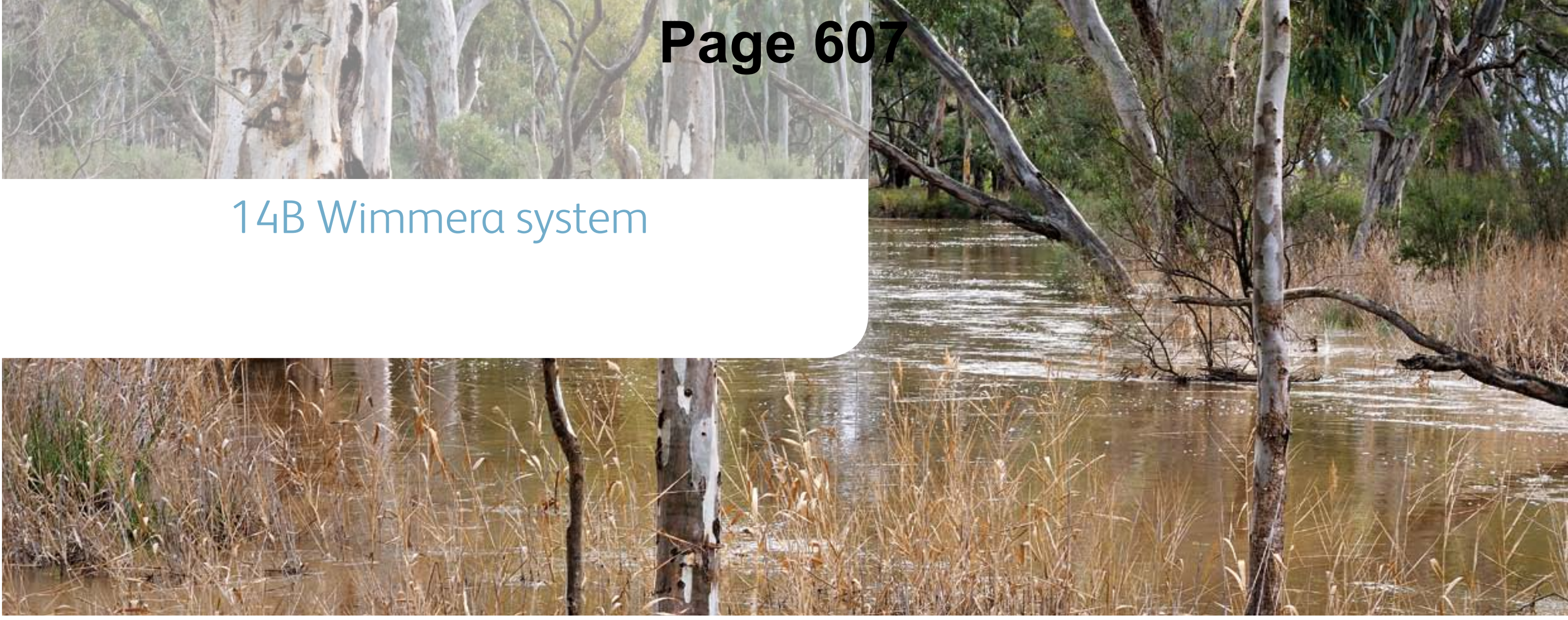
More detail about the planned watering activities in the Glenelg system can be found by downloading Schedule 7 of the *Seasonal Watering Plan 2011–12* at www.vewh.vic.gov.au.

Table 14A.2 Priority watering actions under a range of planning scenarios in the Glenelg system

	Planning scenario			
	DROUGHT	**DRY**	**AVERAGE**	**WET**
Expected availability of Water Holdings^	27,651 ML carryover 29,500 ML allocation	27,651 ML carryover 40,500 ML allocation	27,651 ML carryover 40,500 ML allocation	27,651 ML carryover 40,500 ML allocation
Environmental objectives	Maintain pool habitat for fish. Increase flow disturbance for macroinvertebrates. Improve fish movement potential.	Maintain pool habitat for fish. Minimise low dissolved oxygen risks (especially hot summer months) for fish. Increase flow disturbance for macroinvertebrates. Improve fish movement potential. Carbon/nutrient cycling and vegetation.	Maintain pool habitat for fish. Minimise low dissolved oxygen risks (especially hot summer months) for fish. Increase flow disturbance for macroinvertebrates. Improve fish movement potential. Spring flood for macroinvertebrates, fish and wetlands.	Maintain pool habitat for fish. Minimise low dissolved oxygen risks (especially hot summer months) for fish. Increase flow disturbance for macroinvertebrates. Improve fish movement potential Spring flood for macroinvertebrates, fish and wetlands.
Flow components	Summer baseflow.	Summer baseflow.	Summer baseflow. Summer freshes. Winter/spring freshes.	Summer baseflow. Summer freshes. Winter/spring freshes.
Possible volume required from the Water Holdings*	5,300 ML	7,475 ML	20,125 ML	20,125 ML
Possible carryover into 2012–13#	33,251 ML	30,076 ML	2,526 ML	2,526 ML

^ Water Holdings are shared across the Glenelg and Wimmera systems and indicate the total amount for both systems.
* Figures are estimates of the volume required in the Glenelg system only and not the Wimmera system. Figures assume no unregulated flows occur, and are therefore an upper limit of the volume required from the Water Holdings.
# Figures take account of the possible volume required in both the Glenelg and Wimmera systems. The amount of carryover into 2012–13 will be determined not only by the volume of unused water but the possibility that the storage spills and carryover is forfeited. Figures assume full usage from the required volumes and that the storage does not spill.

14B Wimmera system



Wimmera River, Melissa Powell

Waterway manager – Wimmera Catchment Management Authority

The Wimmera River lies in western Victoria, beginning in the Pyrenees, and flowing into Lake Hindmarsh and Lake Albacutya. In recent years, the Wimmera River has been seriously affected by drought, but is now experiencing improved flows for the first time in many years. The Wimmera River is known for its high social, economic and environmental values and is listed as a heritage river. The Wimmera system is home to many threatened species such as the Wimmera bottlebrush, located along the MacKenzie River and to Victoria's only self-sustaining population of freshwater catfish.

Planned environmental water use in 2011–12

The priority environmental objectives in the Wimmera system for 2011–12 are maintaining pool habitat and water quality for fish populations; improving potential for fish movement; increasing macroinvertebrate populations; carbon/nutrient cycling and bench vegetation; and limiting saline groundwater impacts on banks and deep pools.

The priority river reaches for environmental watering are the regulated sections of the Wimmera River where releases can be made: reach 4 and then reaches 2 and 3. Priorities in the MacKenzie River are reaches 2 and 3, with reach 1 benefiting from flows passed to the lower reaches. Environmental watering in both rivers will focus, in priority order, on summer base flows; summer freshes; winter/spring baseflows; and spring freshes.

Based on existing knowledge, the seasonal outlook for 2011–12 is positive, with an average scenario most likely. It is likely that allocations in 2011–12 and water carried over from last year will provide sufficient water for priority flow components in the MacKenzie and Wimmera rivers.

System overview

Water in the Wimmera system is stored in three on-stream reservoirs: Lake Wartook on the MacKenzie River; Lake Lonsdale on Mount William Creek; and Lake Bellfield on Fyans Creek. Off-stream storages can harvest water via channels from the Wimmera River and Mount William Creek (Taylor's Lake) and Fyan Creek (Lake Fyans). The channel system enables water to be shifted between some of the storages and between the Wimmera and Glenelg systems. Environmental water can be called out of any storage, dependent on constraints and system losses. This complexity provides significant opportunities and flexibility in environmental water management.

The environmental flow reaches are shown in Figure 14B.1. In the Wimmera system, the priority reaches for environmental watering are the heritage-listed reach 4 and then the lower section of reach 2 and all of reach 3 of the Wimmera River. These are the only reaches for which stored environmental water can be released, with the upper reaches being mostly unregulated. Flows are targeted at Lochiel downstream of Dimboola, however day to day management will use the metering point at Wail as flow data can be accessed daily. The priority reaches in the MacKenzie River are reaches 2 and 3, with reach 1 receiving consumptive water year-round to supply Horsham's water supply. The measurement points for target flows are at Dad and Dave Weir for reach 2 and Mackenzie Creek Reserve gauging station for reach 3. Water flowing through reach 3 of the MacKenzie will provide benefit to the Wimmera River below Horsham.

Figure 14B.1 The Wimmera system

Table 14B.1 Water Holdings available for use in the Wimmera system

Entitlement	Description
Wimmera and Glenelg Rivers Environmental Entitlement 2010	• 40,560 ML of regulated entitlement with the allocations based on inflow into storage • Fixed passing flows in Fyans Creek • Passing flows with some ability to vary rates in the Wimmera River and Mount William Creek

Current situation

In the 2010–11 water year, there was a drastic shift from the drought conditions that dominated the region since 1997 to large-scale flooding across the whole system. Three flood events, of varying magnitude, in September and December 2010 and January 2011 met the environmental flow objectives not able to be met by regulated releases due to capacity constraints. The most recent flood resulted in significant overbank flooding and large inflows into Lake Hindmarsh, which was completely empty six months earlier.

While the start of the 2010–11 water year was focused on providing drought refuge, after the floods the focus shifted to maintaining baseflows in the Wimmera and MacKenzie rivers. The majority of planned priority flow components were provided or occurred naturally, including winter/spring (baseflows occurred after August), spring freshes (freshes occurred in late spring early summer), summer baseflows and summer freshes. In addition, bankfull flows occurred through spring and summer.

Based on existing knowledge, the seasonal outlook for 2011–12 is positive, with an average scenario likely. It is likely that allocations in 2011–12 and water carried over from last year will provide sufficient water for all priority planned flow components in the MacKenzie and Wimmera rivers.

Priority watering actions

Table 14B.2 outlines the priority objectives and watering actions under a range of planning scenarios, with estimated volumes required to meet ecological objectives. The priority watering actions are:

- MacKenzie River summer baseflows (2 ML per day from December to February, with a maximum of five cease to flow events of seven days each)
- MacKenzie River summer freshes (five freshes of 5 ML per day for seven days each between December and February)
- Wimmera River summer baseflows (5 ML per day from December to February, with a cease to flow event of 5–25 days)
- Wimmera River summer freshes (four freshes of 20 ML per day for 7–15 days each between December and February)
- MacKenzie River winter baseflows (37 ML per day from June to August)
- MacKenzie River spring baseflows (37 ML per day from September to November)
- Wimmera River winter baseflows (37 ML per day from June to August)
- Wimmera River spring baseflows (37 ML per day from September to December)
- MacKenzie River spring freshes (three freshes of 100 ML per day for seven days each between September and November)
- Wimmera River spring freshes (up to five freshes of 334 ML per day for at least 16 days each between September and November).

The priority environmental watering actions in the MacKenzie and Wimmera rivers are based on the baseflows and freshes that can be feasibly released, with the magnitude of freshes constrained by storage and outlet capacity.

Adaptive management considerations

The Wimmera-Glenelg is a highly regulated system, with the ability to move water to various locations. The ability of the waterway manager to access water from its preferred storages and at desired rates will be dependent on inflows into the six river/creek sources, storage levels and other water deliveries. This will be continuously assessed during the year by the Wimmera Catchment Management Authority and Grampians-Wimmera-Mallee Water. Opportunities will be sought where possible to provide volumes to other regulated waterways such as Mount William Creek and Burnt Creek in the delivery of water to priority reaches of the Wimmera River.

Summer flow components have been identified as the highest priority in the MacKenzie and Wimmera rivers, with the MacKenzie the highest priority to receive environmental water. Volumes for the summer flow components in both systems will be reserved before winter/spring flows are released from August 2011 and again in June 2012, with the MacKenzie the highest priority to receive these components, followed by the Wimmera if there is sufficient water. The carryover volume and predicted allocations means that there will likely be sufficient water to meet the priority planned flow components.

In general, considerations in adaptive management include balancing the immediate need for environmental water versus future, potentially drier, years. In making this decision, it is necessary to think about the 15 per cent deduction that is associated with carryover in the Wimmera system and the risk of losing carryover altogether if storages spill.

Wimmera Catchment Management Authority will monitor the flows occurring naturally in the system, and assess the best time to make releases to provide the priority flow components most efficiently and with maximum environmental benefit.

The Wimmera Catchment Management Authority and Glenelg-Hopkins Catchment Management Authority will work together to provide the priority watering actions in both the Wimmera and Glenelg systems, considering water availability and system constraints. They will communicate regularly to ensure sufficient water in the Water Holdings before ordering. In the unlikely event there is insufficient water to meet priority watering actions in both the Wimmera and Glenelg systems, prioritisation will be agreed by both CMAs and based on the effectiveness of flows in minimising risks to key ecological assets. If shortfalls are identified, the CMAs will work together to allocate the remaining water to the priority flow components across systems, involving the VEWH in final decision making as necessary.

Implementation arrangements

This plan outlines the watering actions that are a priority in the coming year, provided there is sufficient water. A seasonal watering statement will be issued to communicate decisions on the environmental watering actions that are to be undertaken and to authorise Wimmera Catchment Management Authority to implement those decisions. A transitional watering statement was released on 1 July 2011 to authorise the continuation of watering actions that were approved in 2010–11 by the previous entitlement holder, the Minister for Environment and Climate Change. This will be superseded when a new seasonal watering statement is issued.

In the Wimmera system, implementation arrangements are outlined in Schedule 7 of the *Seasonal Watering Plan 2011–12*. In the future, implementation will also be guided by storage management rules due for development by October 2011 and operating arrangements also to be developed.

Risk assessment and management

While unlikely, there is a risk that in an extremely wet year, flooding impacts could be marginally exacerbated. In order to manage this risk, the Wimmera Catchment Management Authority will monitor releases and upstream flows and if there is a risk, immediately order releases to cease. An additional risk is that the delivery of environmental water will turn over saline pools and mix salt-stratified water, with the resulting high salinity and low dissolved oxygen levels causing death of instream biota. All releases will be monitored to assess stratification, with the highest risk in summer when the stratification is most strongly defined. In the event of mixing, flows will be reduced to prevent further mixing of saline water.

Also important are risks to successfully achieving the desired environmental outcomes from watering actions. Details on these can be found in Schedule 7. Of note is an emerging risk related to water quality issues in Taylors Lake in the Wimmera system. In response, Grampians Wimmera Mallee Water has modified its normal operational practice as a mitigation measure. This in turn has the potential to impact on water available from the Water Holdings. The VEWH, together with Wimmera and Glenelg-Hopkins catchment management authorities, will work closely with Grampians Wimmera Mallee Water to manage the water quality issues while minimising the risk to the Water Holdings.

Further information

More detail about the planned watering actions in the Wimmera system can be found by downloading Schedule 7 of the *Seasonal Watering Plan 2011–12* at www.vewh.vic.gov.au.

Wimmera River, Melissa Powell

Table 14B.2 Priority watering actions under a range of planning scenarios in the Wimmera system

	Planning scenario			
	DROUGHT	DRY	AVERAGE	WET
Expected availability of Water Holdings^	27,651 ML carryover 29,500 ML allocation	27,651 ML carryover 40,500 ML allocation	27,651 ML carryover 40,500 ML allocation	27,651 ML carryover 40,500 ML allocation
Wimmera River (reaches 2–4)				
Environmental objectives	Maintain pool habitat and water quality for fish populations. Improve fish movement potential. Increase macroinvertebrate populations.	Maintain pool habitat and water quality for fish populations. Improve fish movement potential. Increase macroinvertebrate populations. Carbon/nutrient cycling & bench vegetation.	Maintain pool habitat and water quality for fish populations. Improve fish movement potential. Increase macroinvertebrate populations. Limit saline groundwater impacts on banks.	Maintain pool habitat and water quality for fish populations. Improve fish movement potential. Increase macroinvertebrate populations. Provide cues for native fish for migration and spawning.
Flow components	Year round baseflows. Summer freshes.	Year round baseflows. Summer freshes.	Year round baseflows. Summer freshes. Spring fresh.	Year round baseflows. Summer freshes. Spring fresh.
Possible volume required from the Water Holdings	17,000 ML	17,000 ML	30,000 ML	30,000 ML
Mackenzie River (reaches 2–3)				
Environmental objectives	Habitat for fish (reach 2). Maintain health of Wimmera bottlebrush.	Habitat for fish (reach 2). Maintain health of Wimmera bottlebrush. Promote chances of Wimmera bottlebrush recruitment.	Habitat for fish (all reaches). Maintain health of Wimmera bottlebrush. Promote chances of Wimmera bottlebrush recruitment. Improve potential for fish/platypus movement.	Habitat for fish (all reaches). Maintain health of Wimmera bottlebrush. Promote chances of Wimmera bottlebrush recruitment. Improve fish/platypus movement potential. Inundate emergent aquatic vegetation.
Flow components	Summer baseflows (reach 2). Summer freshes (reach 2). Spring baseflow and freshes (reach 3).	Summer baseflows (reach 2). Summer freshes (reach 2). Spring baseflow and freshes (reach 3).	Summer baseflows (reach 2). Summer freshes (reach 2). Spring baseflow and freshes (reach 3). Winter baseflow.	Summer baseflows (reach 2). Summer freshes (reach 2). Spring baseflow and freshes (reach 3). Winter baseflow.
Possible volume required from the Water Holdings	1,600 ML	2,600 ML	4,500 ML	4,500 ML
Total possible volume required from the Water Holdings*	18,600 ML	19,600 ML	34,500 ML	34,500 ML
Possible carryover into 2012/13#	33,251 ML	30,076 ML	2,526 ML	2,526 ML

^ Water Holdings are shared across the Glenelg and Wimmera systems and indicate the total amount for both systems.
* Use figures do not assume unregulated flows are meeting any of the flow demands and are therefore are an upper limit of flow requirement.
\# The amount of carryover into 2012–13 will be determined not only by water use but the possibility that the storage spills and the use of water from this shared entitlement in the Glenelg system. The carryover volumes account for expected water use in the Glenelg system, and assume the full amount is required from the required Water Holdings and that the storage does not spill.

14C Wimmera-Mallee wetlands

Barbers environmental dam, Mallee Catchment Management Authority

Planned watering actions for the Wimmera-Mallee wetlands will be included in the Seasonal Watering Plan 2011–12 at a later stage. Once planning and infrastructure works to connect further wetlands to the pipeline are completed, the Mallee Catchment Management Authority will prepare a seasonal watering proposal, in consultation with Wimmera and North Central catchment management authorities. This will then be considered by the VEWH and the agreed priority watering actions included in the plan.

15 Northern Victoria

Northern Victoria includes the tributaries that flow north into the River Murray. In addition to the Kiewa and Ovens, in which there are no Water Holdings, these systems include the Broken, Goulburn, Campaspe and Loddon (see sub-sections 15A–15D). There are also significant wetlands and floodplains which are supplied by these systems (see sub-section 15E).

Northern Victoria is part of the Murray-Darling Basin, in which water sharing is governed by the *Murray-Darling Basin Agreement*. This agreement guides how much water is allocated to each state (Victoria, New South Wales and South Australia). Each state then has its own entitlement framework for allocating its share of water to water users.

Northern Victoria is renowned for its irrigated agricultural production and has been significantly developed over the past 100 years. The water systems in northern Victoria are highly connected, allowing water to move between systems.

The storage operator in northern Victoria is Goulburn-Murray Water, and for the storages subject to interstate sharing arrangements, the Murray-Darling Basin Authority.

Over the last 10 years, there has been significant investment to return water to the environment. In addition to Victorian projects, water recovery has been undertaken by partners of the Living Murray program and separately by the Commonwealth Government. The VEWH will liaise with these other water holders to coordinate delivery of their water with the Victorian Water Holdings and optimise the benefits for Victorian systems.

The Living Murray program

The Living Murray program began in 2002 as a partnership between the Commonwealth, New South Wales, Victorian, South Australian and Australian Capital Territory governments. The long-term goal of this program is to achieve a healthy working River Murray system for the benefit of all Australians.

In 2004, under the Living Murray 'First Step' decision, ministers from the partner governments committed to recover a long-term average of 500,000 ML of water to improve environmental outcomes at six 'icon sites': the River Murray channel; Barmah-Millewa Forest; Gunbower-Koondrook-Perricoota Forest; Hattah Lakes; Chowilla Floodplain and Lindsay-Wallpolla Islands; and the Lower Lakes, Coorong and Murray Mouth. The Murray-Darling Basin Authority also participated in water recovery in its own right.

The allocation of Living Murray water is overseen by the Murray-Darling Basin Authority. The Authority takes advice from the Environmental Watering Group which includes representatives from each of the partner jurisdictions. Decisions are made in line with the *Living Murray Annual Watering Plan* (http://www.mdba.gov.au/programs/tlm/programs_to_deliver/environmental_delivery). The VEWH is now a member of the Environmental Watering Group, and is responsible for submitting proposals for the use of Living Murray water in Victoria.

Commonwealth Environmental Water Holder

The *Commonwealth Water Act 2007* established the CEWH to manage the Commonwealth's environmental water holdings. The purpose of the Commonwealth Water Holdings is to protect or restore the environmental assets of the Murray-Darling Basin, and of other areas outside the Basin where the Commonwealth holds water, so as to give effect to relevant international agreements.

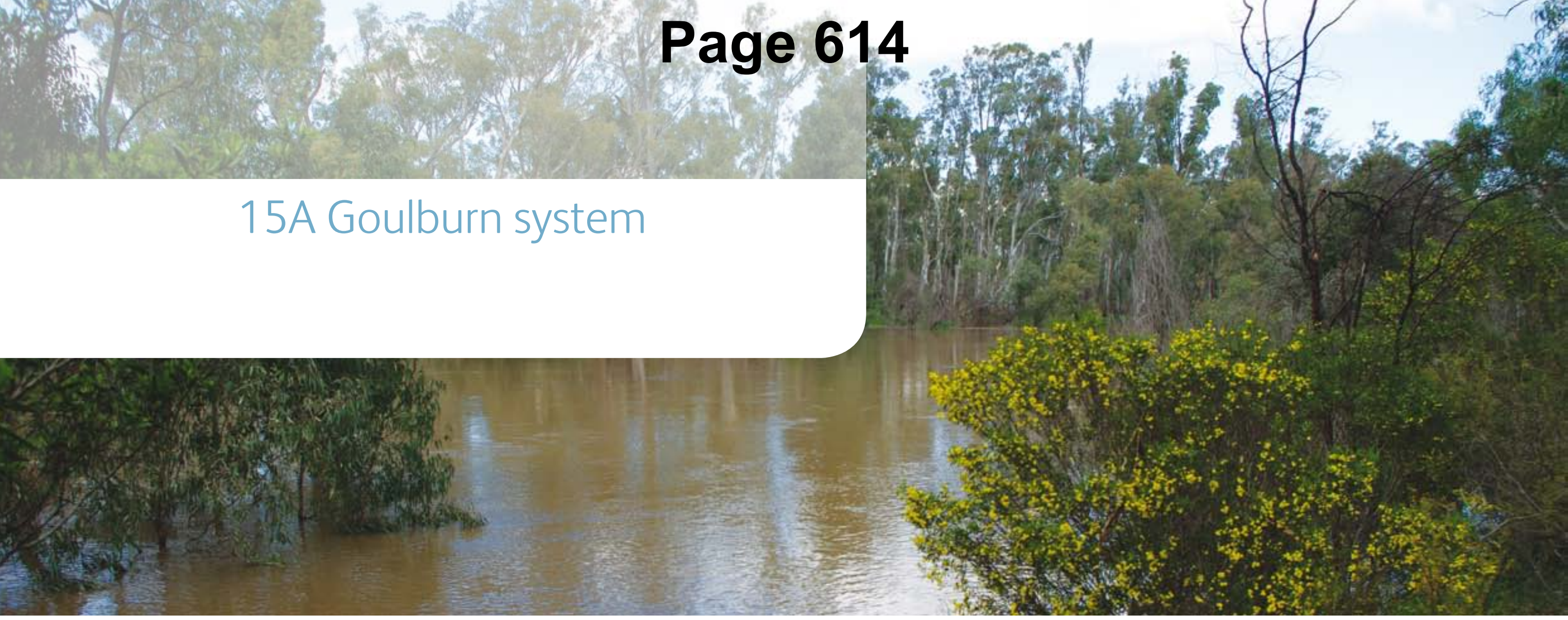
Water held by the CEWH is required to be managed in accordance with the environmental watering plan in the Basin Plan, currently being developed by the Murray-Darling Basin Authority.

Decisions on watering actions are made by the CEWH in consultation with its scientific advisory committee. The VEWH will submit proposals to the CEWH for the use of CEWH water for Victoria's priority river reaches and wetlands. In some cases, the CEWH may want water delivered via Victorian rivers for priority sites elsewhere in the Murray Darling Basin (for example, in South Australia). The VEWH will coordinate the delivery of this water and authorise waterway managers to undertake it, provided there are no adverse impacts on Victorian rivers and wetlands.

The Snowy River water recovery package

Water recovery has been undertaken in the Goulburn, Loddon and Murray systems to return water, via substitution, to the Snowy system, including in southern Victoria (see sub-section 13A for a full explanation).

15A Goulburn system



Goulburn River at Shepparton, Keith Ward, Goulburn Broken Catchment Management Authority

Waterway manager – Goulburn Broken Catchment Management Authority

The Goulburn river basin is Victoria's largest, covering over 1.6 million hectares or 7.1 per cent of the state's total area. The Goulburn River is an iconic heritage river due to its high environmental values. It supports areas of intact river red gum forest, and provides habitat for threatened and endangered species such as the barking marsh frog, Murray cod and Macquarie perch. It also contains many important cultural heritage sites, as well as providing water for agriculture and supporting recreational activities such as fishing and canoeing.

Planned environmental water use in 2011–12

The priority environmental objectives in the Goulburn system in 2011–12 are maximising fish habitat; improving and expanding macroinvertebrate habitat; carbon/nutrient cycling and bench vegetation; and stimulating golden perch breeding.

The priority reaches for environmental watering are reaches 4 and 5, from Goulburn Weir to the River Murray, as they have the largest water demands. Reaches 1 to 3, between Lake Eildon and Goulburn Weir, benefit from the flows being passed to the lower reaches or are not adversely impacted by them.

Environmental watering will focus, in priority order, on winter/spring baseflows; a spring fresh; and autumn/winter baseflows. If additional water is available or catchment runoff conditions are average to wet, environmental watering will also focus on increased winter/spring baseflows; a winter fresh; summer baseflows; and summer freshes.

With full use of all available Water Holdings, it is likely that the first-tier priority components can be provided under drier climatic conditions and second-tier priority flow components could be provided under average to wet climatic conditions.

System overview

The environmental flow reaches are shown in Figure 15A.1. Water Holdings in the Goulburn system are released from Lake Eildon into reach 1 or Goulburn Weir into reach 4.

The priority river reaches are reaches 4 and 5, from Goulburn Weir to the River Murray, with reaches 1, 2 and 3, between Lake Eildon and Goulburn Weir, benefiting from the flows being passed to the lower reaches or being unaffected by them. The measurement points for target flows are at Murchison for reach 4 and McCoys Bridge for reach 5.

In addition to the Water Holdings, passing flows are provided under Goulburn-Murray Water's bulk entitlements and consumptive water is delivered down the Goulburn en route to the River Murray. These can provide significant environmental benefits if delivered during the right time of year. High flows in summer can have a detrimental effect on the system and need to be managed where possible; the larger and longer the flow, the more potential for ecological damage. Goulburn Broken Catchment Management Authority will work with Goulburn-Murray Water to maximise the environmental outcomes of consumptive water delivery while preventing ecological damage where possible.

Figure 15A.1 The Goulburn system

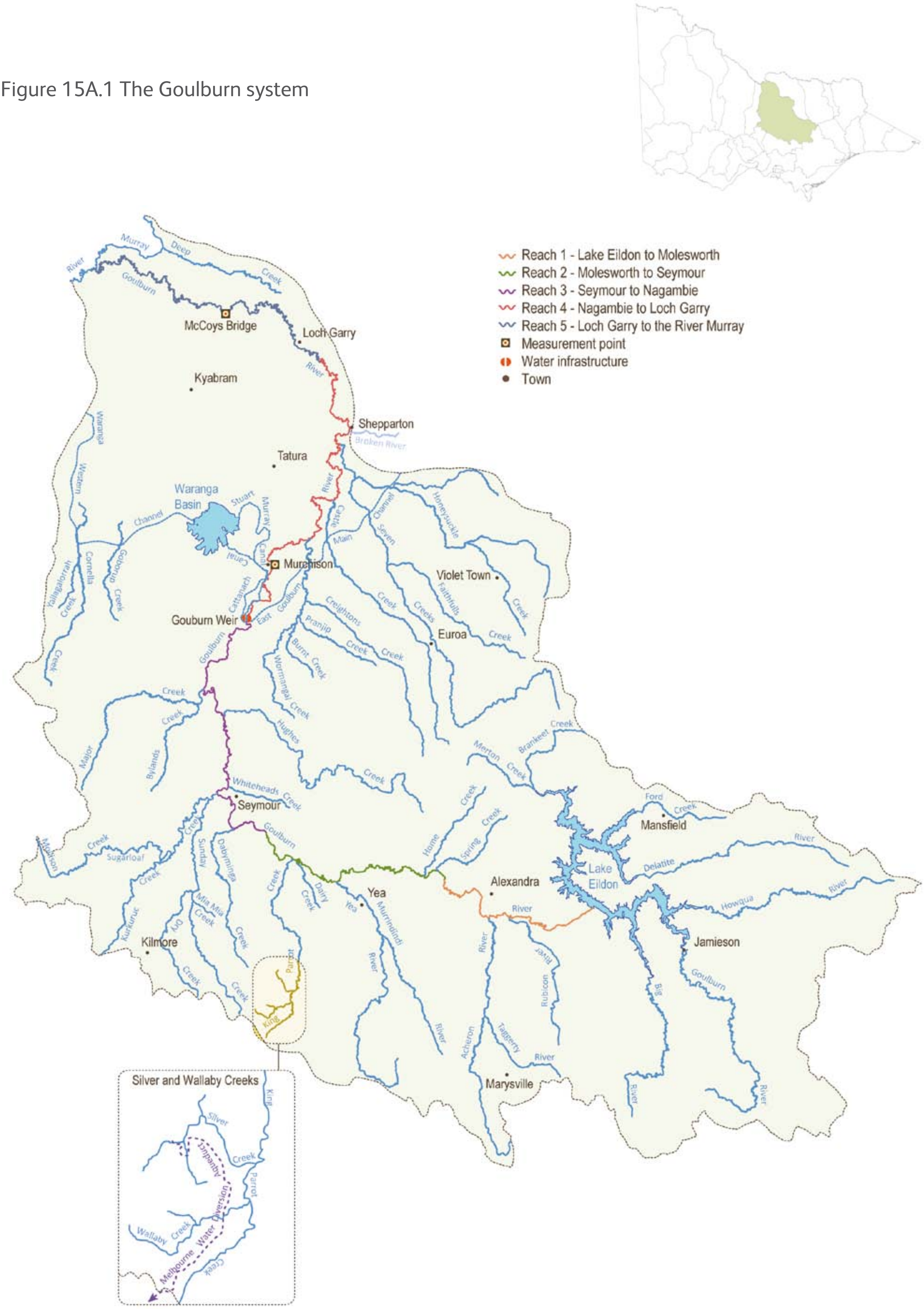


Table 15A.1 Water Holdings available for use in the Goulburn system

Entitlement	Description
Victorian Water Holdings	
Victorian River Murray Flora and Fauna Entitlement	27,600 ML high reliability entitlement
Goulburn Environmental Water Savings Supply Deed	One-third of water savings created in the Goulburn system as a result of modernisation works completed as part of Stage 1 of the Northern Victoria Irrigation Renewal Project Mitigation water reserve (water which was deemed required to mitigate against impacts of reduced outfalls into environmental sites resulting from modernisation)
Shepparton Modernisation Project[1]	1,500 high-reliability entitlement 7,600 ML low-reliability entitlement
Environmental Entitlement (Goulburn System – Living Murray) 2007[2]	49,625 ML high reliability entitlement 156,980 ML low reliability entitlement
Silver and Wallaby Creeks Environmental Entitlement 2006[3]	Passing flows
Other Water Holdings	
Commonwealth Environmental Water Holdings[4]	100,455 ML Goulburn high-reliability water share 10,527 ML Goulburn low-reliability water share

1 Entitlement does not yet exist, but is expected to be finalised in 2011–12.
2 Water allocated to this entitlement must be used for the Living Murray 'icon sites'. However, this water is released down and can provide environmental benefits in the Goulburn River en route to the River Murray.
3 Entitlement provides passing flows only and not a volume in storage, therefore no management action is necessary.
4 Decisions about the use of Commonwealth Water Holdings are the responsibility of the CEWH. The VEWH will submit proposals for the use of CEWH water for Victoria's priority rivers and wetlands.

Current situation

Leading into 2011–12, there were several years of drought with low river flows, particularly in the Goulburn River between Goulburn Weir and the River Murray. This was followed by extremely wet conditions in 2010–11 where all environmental flow objectives were met naturally. With the prolonged drought causing river health degradation, the wet 2010–11 has started the ecological recovery of the Goulburn River. It is important to continue this recovery in the 2011–12 water year. With significant volumes of environmental and operational water available, good environmental improvement should be possible.

Priority watering actions

Table 15A.2 outlines the priority objectives and watering actions and how these vary for different planning scenarios. The priority watering actions are for the following flows at Murchison or McCoys Bridge:

- winter/spring baseflows (540 ML per day at Murchison between July and November)
- a spring fresh (5,600 ML per day at Murchison for 14 days between October and November)
- autumn/winter baseflows (540 ML per day at Murchison between April and June).

If additional water is available, environmental watering will also focus on these second tier priorities:

- higher winter/spring baseflows (830 ML per day at Murchison between July and December)
- a winter fresh (5,600 ML per day at Murchison for 14 days between June and August).
- summer baseflows (940 ML per day at McCoys Bridge between December and May)
- summer freshes (5,600 ML per day at MCCoys Bridge for two days between December and April)

While bankfull and overbank flows are recommended in the scientific flow study, they are not priority flow components at this stage, due to the risk of flooding private land.

The VEWH will also coordinate the delivery of CEWH water and authorise waterway managers to implement CEWH priority watering actions, provided there are no adverse impacts on Victorian rivers and wetlands.

Table 15A.2 Priority watering actions under a range of planning scenarios in the Goulburn system

	Planning scenario					
	WORST DROUGHT	**VERY DRY**	**DRY**	**AVERAGE**	**WET**	**VERY WET**
Expected availability of Water Holdings#	1,000 ML Victorian Water Holdings 88,500 ML Living Murray Water Holdings 88,000 ML Commonwealth Environmental Water Holdings	1,500 ML Victorian Water Holdings 97,500 ML Living Murray 117,000 ML Commonwealth Environmental Water Holdings	1,500 ML Victorian Water Holdings 112,500 ML Living Murray 160,000 ML Commonwealth Environmental Water Holdings	3,000 ML Victorian Water Holdings 112,500 ML Living Murray Water Holdings 150,000 ML Commonwealth Environmental Water Holdings	9,100 ML Victorian Water Holdings 112,500 ML Living Murray Water Holdings 130,000 ML Commonwealth Environmental Water Holdings	9,100 ML Victorian Water Holdings 197,000 ML Living Murray Water Holdings 130,000 ML Commonwealth Environmental Water Holdings
Environmental objectives	Maintain pool depth and maximise fish habitat. Improve and expand macroinvertebrate habitat. Bench inundation for carbon/nutrient cycling and vegetation. Stimulate golden perch breeding.	Maintain pool depth and maximise fish habitat. Improve and expand macroinvertebrate habitat. Bench inundation for carbon/nutrient cycling and vegetation. Stimulate golden perch breeding.	Maintain pool depth and maximise fish habitat. Improve and expand macroinvertebrate habitat. Bench inundation for carbon/ nutrient cycling and vegetation. Stimulate golden perch breeding.	Maintain pool depth and maximise fish habitat. Improve and expand macroinvertebrate habitat. Bench inundation for carbon/nutrient cycling and vegetation.	Maintain pool depth and maximise fish habitat. Improve and expand macroinvertebrate habitat. Bench inundation for carbon/nutrient cycling and vegetation.	Maintain pool depth and maximise fish habitat. Improve and expand macroinvertebrate habitat. Bench inundation for carbon/nutrient cycling and vegetation.
Flow components	Winter/spring baseflows. Spring fresh. Autumn/winter baseflows.	Winter/spring baseflows. Spring fresh. Extend duration of natural freshes. Autumn/winter baseflows.	Winter/spring baseflows. Spring fresh. Extend duration of natural freshes. Autumn/winter baseflows.	Winter/spring baseflows. Summer fresh. Autumn/winter baseflows.	Winter/spring baseflows. Summer baseflows. Summer fresh. Autumn/winter baseflows.	Winter/spring baseflows. Summer baseflows. Summer fresh. Autumn/winter baseflows.
Possible volume required from the Water Holdings*	113,000 ML (plus additional 97,000 ML if available)	151,000 ML (plus additional 63,000 ML if available)	210,000 ML (plus additional 34,000 ML if available)	137,000 ML (no additional water required)	155,000 ML (no additional water required)	172,000 ML (no additional water required)
Possible carryover into 2012–13	0 ML	9,500 ML	38,500 ML	135,500 ML	97,500 ML	172,000 ML

This is an estimate of the water which is available from the Goulburn system and does not include water which can be traded into the Goulburn from other systems. In addition, these volumes can be traded out of the Goulburn for use in other systems. Estimates assume some spills from spillable water accounts. Figures available from the Commonwealth Environmental Water Holdings assume an estimate of carryover only and depend upon decisions by the CEWH.

* Outlines the range of water required from the Water Holdings, dependent on the amount of natural flows that occur. The additional volumes indicated in brackets are those that would enable delivery of flow components that are lower priority but which would still provide significant environmental benefit.

Adaptive management considerations

Decisions about the watering actions that will take place in the Goulburn system are largely dependent on the amount of water assigned by the CEWH, and the ability to release Living Murray water at times beneficial to the Goulburn River. Table 15A.2 outlines the plan for full use of the entitlements in Table 15A.1, including all allocations made in 2011–12 and an estimate of carryover from 2010–11.

Under the drier scenarios, environmental watering focuses on winter/spring flow objectives, while the delivery of consumptive water meets summer/autumn flow objectives. Even if there were less consumptive water available than assumed here, the priority for environmental watering would still be on winter/spring flows. Under the wetter scenarios, environmental watering focuses on summer/autumn objectives because less consumptive water is likely to be delivered and natural flows would be meeting winter/spring objectives.

Climatic conditions are not certain at this stage. Depending on water availability and decisions of the CEWH, the following prioritisation would apply in the Goulburn system.

Winter baseflows of 540 ML per day would be provided from July to November 2011. Additional water would first be saved to provide the spring fresh of 4,600–5,600 ML per day between October and November 2011, then the winter baseflows beginning April 2012 to June 2012. Continuation of these flows into July/August 2012 would require water to be carried over into next water year.

Following this, winter baseflows in 2011 would be increased to 830 ML per day. In October 2011, the decision to release water for the spring fresh would depend on water temperatures and whether it was being provided naturally or whether there was sufficient water in the Water Holdings to provide it. If so, a decision must be made on whether to release it in October or November (or even December). Goulburn Broken Catchment Management Authority would seek to provide the flow with maximum environmental benefit while using the Water Holdings as efficiently as possible.

Depending on the climatic conditions, Goulburn Broken Catchment Management Authority would start working with Goulburn-Murray Water between October and December 2011 to plan for the delivery of consumptive water. If there was limited consumptive water being delivered and available water from the Water Holdings, summer baseflows of 940 ML per day would be provided from December 2011 to March 2012, with a fresh of 5,600 ML per day at some stage in that period. Releases for autumn/winter baseflows of 540-830 ML per day would begin in March or April 2012.

Goulburn Broken Catchment Management Authority will monitor the flows occurring naturally in the system, and assess the best time to make releases to provide the priority flow components most efficiently and with maximum environmental benefit.

Implementation arrangements

This plan outlines the watering actions that are a priority in the coming year, provided there is sufficient water. As conditions unfold and water becomes available throughout the year, seasonal watering statements will be issued to communicate decisions on the environmental watering actions that are to be undertaken. The seasonal watering statements authorise Goulburn Broken Catchment Management Authority to implement those decisions.

Implementation arrangements for the Goulburn system are outlined in Schedule 9. In the future, implementation will also be guided by operating arrangements due for development by June 2012.

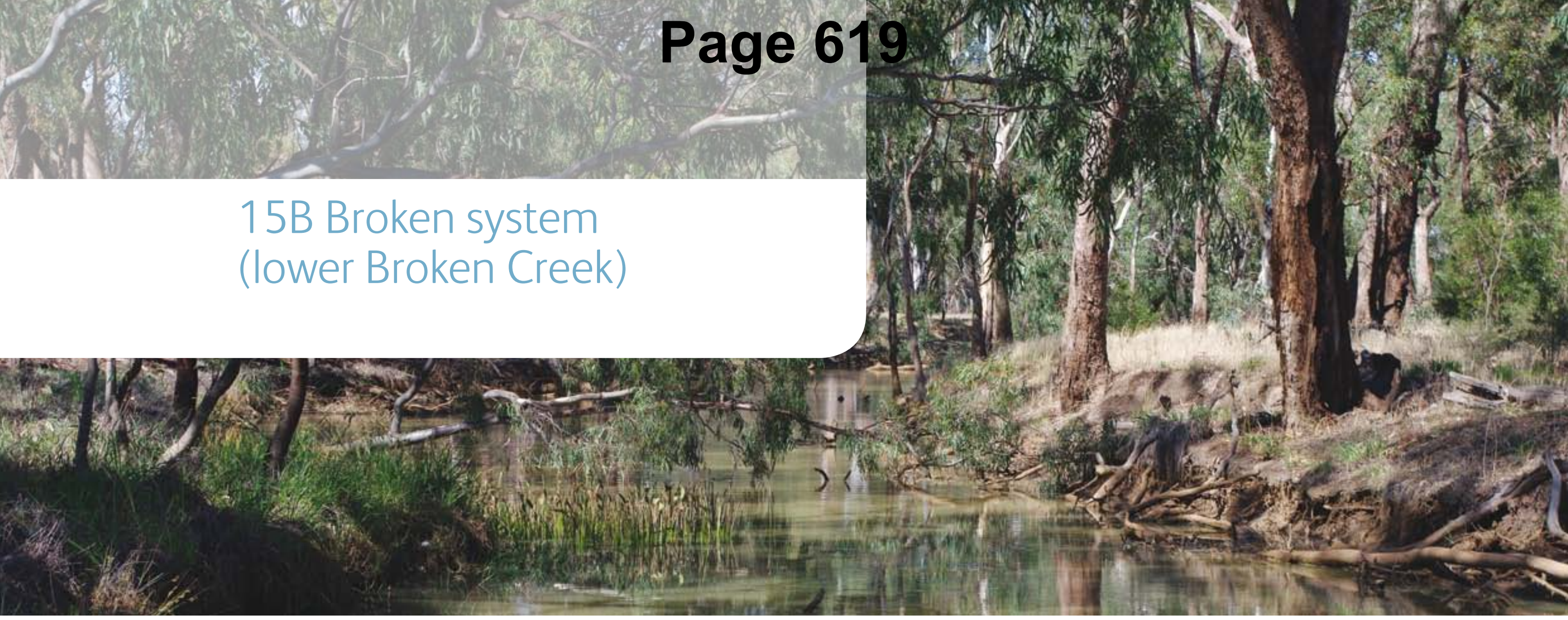
Risk assessment and management

Risks associated with the implementation of these watering actions include flooding of private land and personal injury to river users. However, these risks are assessed as low, given the planned flows are well below bankfull level. Public advice of watering events will be undertaken by the Goulburn Broken Catchment Management Authority where required. An increased abundance of carp resulting from the improved habitat availability provided for native fish is possible. There is currently no strategy available to manage this risk. If natural overbank flows occur, there is a risk of a blackwater event; water may be released to mitigate the effect of the blackwater.

Also important are risks to successfully achieving the desired environmental outcomes from watering actions. Details on these can be found in Schedule 9.

Further information

More detail about the planned watering activities in the Goulburn system can be found by downloading Schedule 9 of the *Seasonal Watering Plan 2011–12* at www.vewh.vic.gov.au.



15B Broken system (lower Broken Creek)

Broken Creek downstream of outfall at Katamatite, Keith Ward, Goulburn-Broken Catchment Management Authority

Waterway manager – Goulburn Broken Catchment Management Authority

The Broken Creek, in northern Victoria, flows from the Broken River north into the River Murray, just downstream of Barmah Forest. It supports threatened plant and animal species, including up to six native fish species of state and national conservation significance, and icon species such as the Murray cod. The Broken Creek also supports riparian vegetation, especially in the lower reaches, which provides important habitat for threatened waterbirds, such as the brolga and bush-stone curlew.

Planned environmental water use in 2011–12

The priority environmental objectives in the lower Broken Creek for 2011–12 are providing native fish passage; providing suitable water quality conditions for native fish; and providing fish habitat during migration and breeding seasons.

While all reaches are important, environmental watering is targeted to reach 3 (from Nathalia Weir Pool to the River Murray), with flows providing benefits to reaches 1 and 2 on the way. Environmental watering will focus, in priority order, on year-round low flows; winter/spring medium flows; summer/autumn medium flows; summer/autumn high flows; winter/spring flushes; and winter/spring high flows.

The outlook for 2011–12 does not greatly influence the flow requirements for the creek as it is such a highly regulated system. Of greater importance is the ability to get the required flows through the irrigation channel system to the creek. The ability to use consumptive water en route will determine the amount of environmental water required to provide priority flow components.

System overview

The Broken Creek flows from the Broken River at Casey's Weir north-west to the River Murray. Water can be released from the Goulburn system through the East Goulburn Main Channel and from the Murray system through the Yarrawonga Main Channel. Water from the Goulburn and Murray can only be delivered to the lower Broken Creek and not the upper reaches.

The environmental flow reaches in the lower Broken Creek are shown in Figure 15B.1. While all reaches are important, environmental watering is targeted to reach 3 (from Nathalia Weir Pool to the River Murray), with flows providing benefits to reaches 1 and 2 on the way. The measurement point for target flows for reach 3 is at Rices Weir. The upper Broken Creek from Waggarandall Weir to Katamatite is now largely unregulated and ephemeral in nature.

In addition to the Water Holdings, consumptive water can be diverted through the channel system en route to irrigators to provide flows in the lower Broken Creek in spring, summer and autumn. Goulburn-Murray Water's bulk entitlement also includes 30,000 ML that can be released if required to mitigate water quality issues. Goulburn Broken Catchment Management Authority will work with Goulburn-Murray Water and the Murray-Darling Basin Authority to maximise the environmental outcomes of consumptive water delivery, and the water quality reserve if required.

Figure 15B.1 The Broken Creek system

Table 15B.1 Water Holdings available for use in the Broken system (lower Broken Creek)

Entitlement	Description
Victorian Water Holdings	
Bulk Entitlements (River Murray Flora & Fauna) Conversion Order 1999	27,600 ML high reliability entitlement
Goulburn Environmental Water Savings Supply Deed	One third of water savings created as a result of modernisation works completed as part of stage 1 of the Northern Victoria Irrigation Renewal Project Mitigation water reserve (water which was deemed required to mitigate against impacts of reduced outfalls into environmental sites resulting from modernisation)
Other Water Holdings	
Commonwealth Environmental Water Holdings#	100,455 ML Goulburn high-reliability water share 10,527 ML Goulburn low-reliability water share
	140,076 ML Murray high-reliability water share 11,125 ML Murray low-reliability water share
	47 ML Broken high-reliability water share* 4 ML Broken low-reliability water share*

* Water is held in Lake Nillahcootie on the Broken River. As part of the upper Broken Creek is unregulated, the losses to provide this water would be too great to effectively use these Water Holdings in the lower Broken Creek. The Goulburn Broken Catchment Management Authority and the VEWH will work with the CEWH on delivery of these water shares in the Broken River.

\# Decisions about the use of Commonwealth Water Holdings are the responsibility of the CEWH. The VEWH will submit proposals for the use of CEWH water for Victoria's priority rivers and wetlands.

Current situation

The 2010–11 water year resulted in extensive flood flows after several years of drought. Most of the lower Broken Creek's environmental water needs were met naturally; however, these natural flows resulted in an extensive blackwater event during November to February, with very low dissolved oxygen levels and some fish deaths. Environmental water was released to manage these impacts.

The focus in 2011–12 is to continue to provide flow components that maximise the native fish populations in the lower Broken Creek. The outlook for 2011–12 does not greatly influence the flow requirements for the creek as it is such a highly regulated system. Of greater importance is the ability to get the required flows through the irrigation channel system to the creek. This limitation creates a high risk of fish deaths in the lower Broken Creek. The ability to use consumptive water en route will determine the amount of environmental water required to provide priority flow components.

Priority watering actions

Table 15B.2 outlines the priority objectives and watering actions and how these vary for different planning scenarios. The priority watering actions are for the following flows at Rice's Weir:

- year-round low flow (40 ML per day from August to May)
- winter/spring medium flow (120 ML per day from August to November)
- summer/autumn medium flow (150 ML per day from December to May)
- summer/autumn high flow (250 ML per day for 30–60 days between December and mid March)
- winter/spring flush (two flushes of 250 ML per day for 14 days between August and November)
- winter/spring high flow (250 ML per day from September to December).

The VEWH will also coordinate the delivery of CEWH water and authorise waterway managers to implement CEWH priority watering actions, provided there are no adverse impacts on Victorian rivers and wetlands.

Adaptive management considerations

Decisions about the watering actions that will take place in the lower Broken Creek largely depend on the ability to use consumptive water en route. The key issue for water delivery is the likely difficulty in gaining access to enough channel capacity to provide the required flow rates at different times of the year. This means that Water Holdings in both the both Goulburn and Murray, which are delivered via different channels, may be required.

When irrigation demand increases significantly in spring, it is more difficult to access the channel system to deliver water to the creek. Before this occurs, a flush should be provided to reduce azolla build up in the creek.

Goulburn Broken Catchment Management Authority will monitor the flows occurring naturally in the system, and assess the best time to make releases to provide the priority flow components most efficiently and with maximum environmental benefit.

Implementation arrangements

This plan outlines the watering actions that are a priority in the coming year, provided there is sufficient water. As conditions unfold and water becomes available throughout the year, seasonal watering statements will be issued to communicate decisions on the environmental watering activities that are to be undertaken. The seasonal watering statements will authorise Goulburn Broken Catchment Management Authority to implement those decisions.

Implementation arrangements for the lower Broken Creek are outlined in Schedule 10 of the *Seasonal Watering Plan 2011–12*. In the future, implementation will also be guided by operating arrangements due for development by June 2012.

Risk assessment and management

Risks associated with implementation of these watering actions include flooding of private land and personal injury to river users. However, these risks are assessed as low, given the planned flows are well below bankfull level. An increased abundance of carp is possible, due to the improved habitat availability provided for native fish. There is currently no strategy available to manage this risk. A blackwater event is not likely to occur from these watering actions but releases are a good tool to mitigate their effect if they occur from upstream catchment runoff.

Also important are risks to successfully achieving the desired environmental outcomes from watering actions. In particular, there is a high risk associated with the inability to manage water quality in the creek due to restrictions on delivery of water through the channel systems, which has the potential to result in fish deaths. Details on these risks can be found in Schedule 10.

Further information

More detail about the planned watering actions in the lower Broken Creek can be found by downloading Schedule 10 of the *Seasonal Watering Plan 2011–12* at www.vewh.vic.gov.au.

Table 15B.2 Priority watering actions under a range of planning scenarios in the Broken system

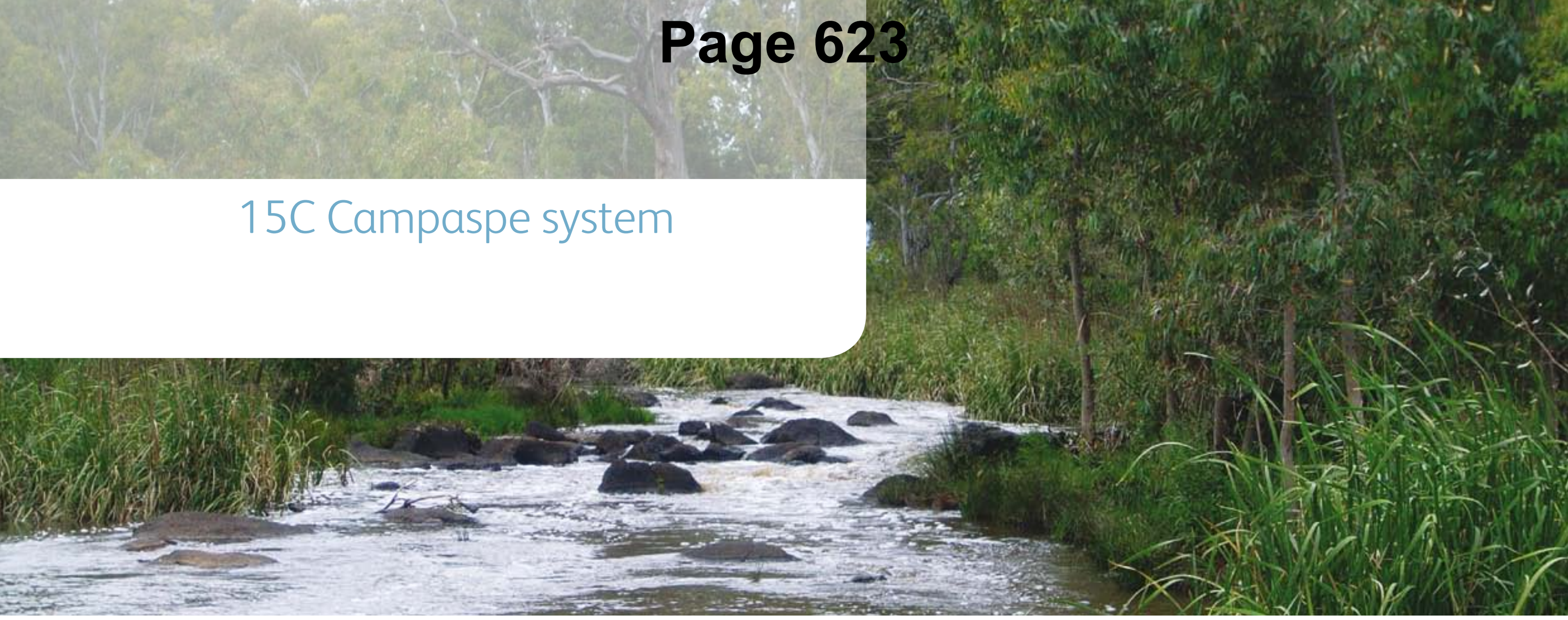
	Planning scenario		
	VERY DRY	**AVERAGE**	**WET**
Expected availability of Water Holdings	34,000 ML Victorian Water Holdings 207,000 ML Commonwealth Environmental Water Holdings (in Goulburn and Murray)	34,000 ML Victorian Water Holdings 207,000 ML Commonwealth Environmental Water Holdings (in Goulburn and Murray)	34,000 ML Victorian Water Holdings 207,000 ML Commonwealth Environmental Water Holdings (in Goulburn and Murray)
Environmental objectives	Provide native fish passage. Provide suitable water quality conditions for native fish. Provide fish habitat during migration and breeding seasons.	Provide native fish passage. Provide suitable water quality conditions for native fish. Provide fish habitat during migration and breeding seasons.	Provide native fish passage. Provide suitable water quality conditions for native fish. Provide fish habitat during migration and breeding seasons.
Flow components	Year-round low flow.^ Winter/spring medium flow. Summer/autumn medium flow. Summer/autumn high flow. Winter/spring flush. Winter/spring high flow.	Year-round low flow.^ Winter/spring medium flow. Summer/autumn medium flow. Summer/autumn high flow. Winter/spring flush. Winter/spring high flow.	Year-round low flow.^ Winter/spring medium flow. Summer/autumn medium flow. Summer/autumn high flow. Winter/spring flush. Winter/spring high flow.
Possible volume required from the Water Holdings*	0–12,000 ML	0–17,000 ML	0–21,000 ML
Possible carryover into 2012–13	N/A	N/A	N/A

* Assumes reasonable access to consumptive water en route from the Goulburn and Murray systems, with more consumptive water being delivered in the drier scenarios.

\# Decisions to carry over will be driven by the environmental water demands of other VEWH and CEWH priorities, rather than the needs of the Broken system in 2012–13. It is likely that water requirements for the lower Broken Creek in 2012–13 will be similar to 2011–12 requirements.

^ While the preference is to provide this flow component all year round, the channel system closes for repairs and limits the ability to provide these flows in winter.

15C Campaspe system



Campaspe River, North Central Catchment Management Authority

Waterway manager – North Central Catchment Management Authority

The Campaspe system, which flows to its confluence with the River Murray at Echuca, lies in north-central Victoria. The Campaspe River provides irrigation water to an agriculturally diverse catchment, including dryland, dairy and intensive horticultural farming. The Campaspe River has high environmental values because of its connection to the River Murray, its banks of river red gums and its relatively healthy native fish populations, including Murray cod, golden and silver perch. It also supports a range of significant bird species, such as the near-threatened brown treecreeper.

Planned environmental water use in 2011–12

The priority environmental objectives in the Campaspe system for 2011–12 are maintaining pool habitat and water quality for fish populations; improving the potential for fish movement; maintaining macroinvertebrate populations; reducing encroachment of terrestrial vegetation instream; and enhancing river red gum recruitment.

While all river reaches are a priority, environmental watering is targeted at reaches 2 and 4. Reach 3 will also benefit from environmental water releases if these are made from Lake Eppalock rather than the Campaspe Siphon.

Environmental watering will focus, in priority order, on winter low flows and winter high flows in reach 2; summer low flows and summer freshes in reach 4; and then winter low flows and winter high flows in reach 4.

Based on existing knowledge, the seasonal outlook for 2011–12 is positive; allocations on 1 July 2011 in the Campaspe system were 100 per cent for high reliability entitlements and 47 per cent for low reliability entitlements. It is possible to provide all the priority flow components; however, this is dependent on access to water from the Commonwealth Environmental Water Holder and the Living Murray.

System overview

Water Holdings in the Campaspe system can be delivered from two locations: Lake Eppalock and the Campaspe Siphon. Releases from Lake Eppalock flow through reaches 2 to 4 en route to the River Murray. Releases can be made from the Goulburn system through the Western Waranga Channel to the Campaspe Siphon and into reach 4.

The environmental flow reaches are shown in Figure 15C.1. While all river reaches are important, environmental watering is targeted at reach 2 (Lake Eppalock to the Campaspe Weir) and reach 4 (Campaspe Siphon to the River Murray confluence). It is at the top of these reaches that there is an ability to provide releases to meet downstream needs. The measurement points for target flows are at Barnadown in reach 2 and Echuca in reach 4. Reach 3 will also benefit from environmental water releases if these are made from Lake Eppalock rather than the Campaspe Siphon.

In addition to the Water Holdings, passing flows are provided under Goulburn-Murray Water's bulk entitlement and consumptive water is delivered down the Campaspe to meet consumptive users' needs (reaches 1 to 3). There are also opportunities to provide environmental benefit from consumptive water from the Goulburn through the lower Campaspe (reach 4) en route to meeting irrigation needs in the River Murray. This requires agreement with Goulburn Murray Water and the Murray-Darling Basin Authority.

Figure 15C.1 The Campaspe system

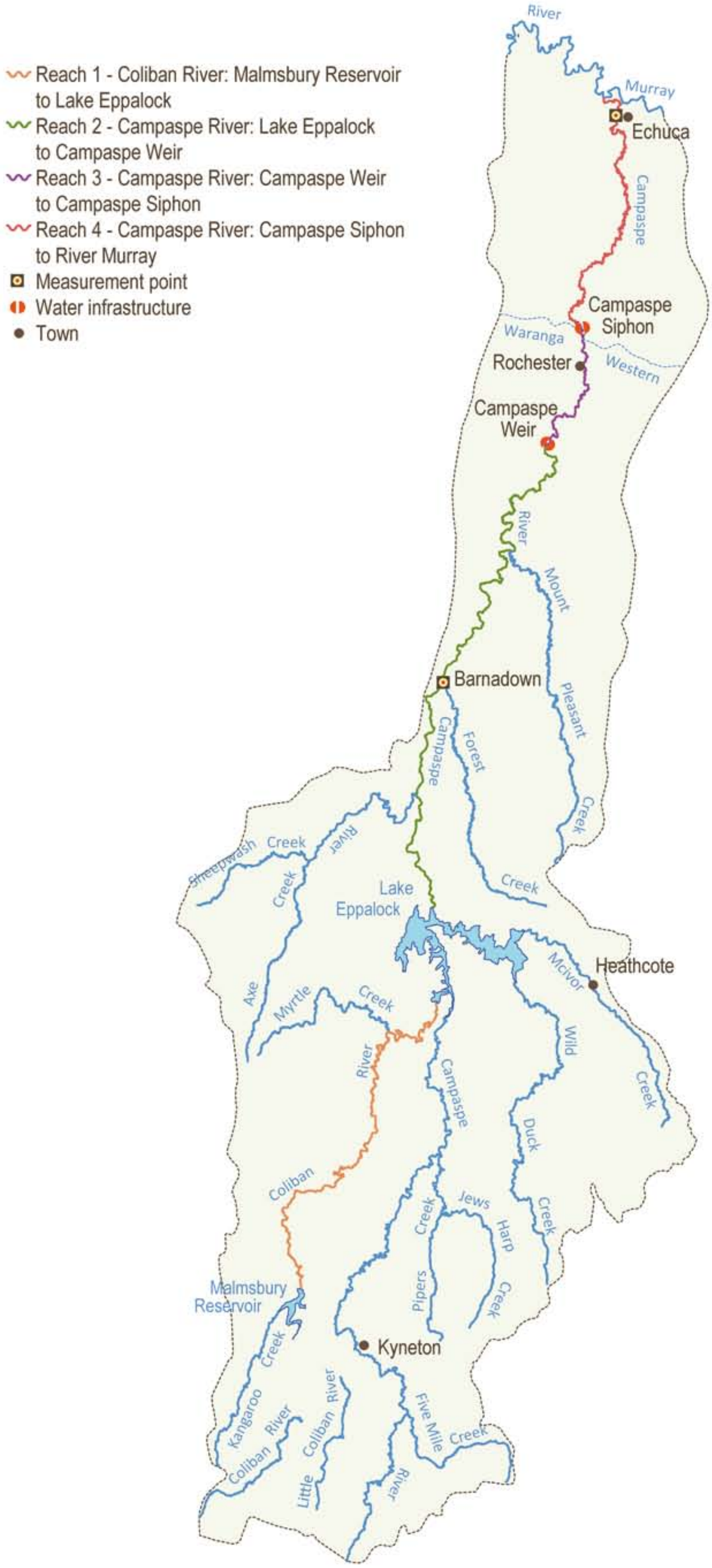


Table 15C.1 Water Holdings available for use in the Campaspe system

Entitlement	Description
Victorian Water Holdings	
Environment Entitlement (Campaspe River – Living Murray Initiative) 2007*	126 ML high-reliability entitlement 5,048 ML low-reliability entitlement
Bulk Entitlement (River Murray Flora and Fauna) 1999#	27,600 ML high-reliability entitlement
Other Water Holdings	
Commonwealth Environmental Water Holdings^	5,783 ML Campaspe high-reliability water share 395 ML Campaspe low-reliability water share Potential to transfer Water Holdings from other systems in the southern connected Murray-Darling Basin dependent of trade restrictions

* Water allocated to this entitlement must be used for Living Murray 'icon sites'. However, this water must be released from the Campaspe system, environmental benefits to the Campaspe River en route.
\# Sourced from the Murray system but can be transferred for use in the Campaspe system.
^ Decisions about the use of Commonwealth Water Holdings are the responsibility of the CEWH. The VEWH will submit proposals for the use of CEWH water for Victoria's priority rivers and wetlands.

Current situation

Following an extended drought, the Campaspe system received well above average rainfall in the 2010–11 water year, and milder than average temperatures. This resulted in substantial river flows and volumes in storage.

Summer baseflows and freshes and winter bankfull and overbank flows occurred in reach 2. Because high flows did not start until spring, not all the winter high flows were met; in addition, the wet summer meant that no 'cease to flow' occurred. In reach 4, summer freshes and winter low flows, high flows and bankfull flows occurred. Summer flows were higher than the required summer baseflow, therefore this flow component is not considered to have been provided. The system is starting to recover with improved water quality; however, long-term ecological benefits will take a few years to be observed. Winter baseflows have been provided since June 2011 to aid in the system's recovery.

Priority watering actions

Table 15C.2 outlines the priority objectives and watering actions under a range of planning scenarios, with estimated volumes required to meet ecological objectives. The priority watering actions are:

- winter low flows in reach 2 (100-125 ML per day or natural flows from June to November)
- winter high flows in reach 2 (fours events of 1,000-1,200 ML per day for four days each between June and November)
- summer low flows in reach 4 (10-20 ML per day from December to May)
- summer freshes in reach 4 (three freshes of 100 ML per day for six days between February and May)
- winter low flows in reach 4 (200 ML per day or natural flows from June to November)
- winter high flows in reach 4 (two events of 1,500 ML per day for four days between June to November).

The VEWH will also coordinate the delivery of CEWH water and authorise waterway managers to implement CEWH priority watering actions, provided there are no adverse impacts on Victorian rivers and wetlands.

Adaptive management considerations

Water for priority winter watering actions will need to be released out of Lake Eppalock, because they are aimed at reach 2 which cannot receive water from the Campaspe Siphon. It is also preferable that water for priority summer watering actions be released from Lake Eppalock rather than the Campaspe Siphon, because this will provide benefit in all reaches, rather than just reach 4. The ability to release water from Lake Eppalock is dependent on system operations and other water demands. North Central Catchment Management Authority will work with Goulburn-Murray Water to maximise the environmental benefits in delivering the Water Holdings.

Winter low flows have been identified as the highest priority in the Campaspe and are focused on reach 2. If the catchment receives good rainfall, the majority of these low flows will be met by natural runoff and the priority moves to providing winter high flows in reach 2. These winter high flows will provide benefit to downstream reaches after they pass through reach 2. If additional water is available, summer low flows and summer freshes are to be provided to reach 4. If additional water is available, the priority shifts to providing winter low flows and winter high flows in reach 4.

Releases can be made from the Goulburn system through the Western Waranga Channel into the Campaspe Siphon, watering reach 4. Where these arrangements occur, any associated losses will be deducted from the environmental water account.

There are Water Holdings in the Campaspe system held in trust for the Living Murray. Any water carried over under these entitlements must be used by 1 January 2011. This water must be delivered down the Campaspe but the timing of delivery is dependent on the needs of the Living Murray icon sites. The VEWH will liaise with the Murray-Darling Basin Authority to maximise the environmental benefits of this water delivery.

North Central Catchment Management Authority will monitor the flows occurring naturally in the system, and assess the best time to make releases to provide the priority flow components most efficiently and with maximum environmental benefit.

Implementation arrangements

This plan outlines the watering actions that are a priority in the coming year, provided there is sufficient water. As conditions unfold and water becomes available throughout the year, seasonal watering statements will be issued to communicate decisions on the environmental watering actions that are to be undertaken. The seasonal watering statements authorise North Central Management Authority to implement those decisions. A transitional watering statement was released on 1 July 2011 to authorise the continued delivery of CEWH water approved in 2010–11 by the previous entitlement holder, the Minister for Environment and Climate Change. This may be complemented by or superseded by new seasonal watering statements when they are issued.

In the Campaspe system, implementation arrangements are outlined in Schedule 11 of the *Seasonal Watering Plan 2011–12*. In the future, implementation will also be guided by operating arrangements due for development by June 2012.

Risk assessment and management

Risks associated with the implementation of these watering actions include flooding of private land; however, this risk is considered low as the high winter flows targeted are well within channel capacity right along the system. In the event of a natural flood, environmental water will not be required to provide priority flow components and environmental water releases will be ceased.

Blackwater events are naturally occurring in the Campaspe system. There is a lower risk of this occurring in 2011–12 due to the 2011 summer floods which flushed organic material through the system. As winter low flows and freshes are the priority in the system, they will flush any further organics before the higher-risk period of summer. Monitoring of releases will be undertaken and summer freshes will only be initiated if there is sufficient water for a follow up fresh to mitigate any blackwater issues.

Also important are risks to successfully achieving the desired environmental outcomes from watering actions. Details on these can be found in Schedule 11.

Further information

More detail about the planned watering actions in the Campaspe system can be found by downloading Schedule 11 of the *Seasonal Watering Plan 2011–12* at www.vewh.vic.gov.au.

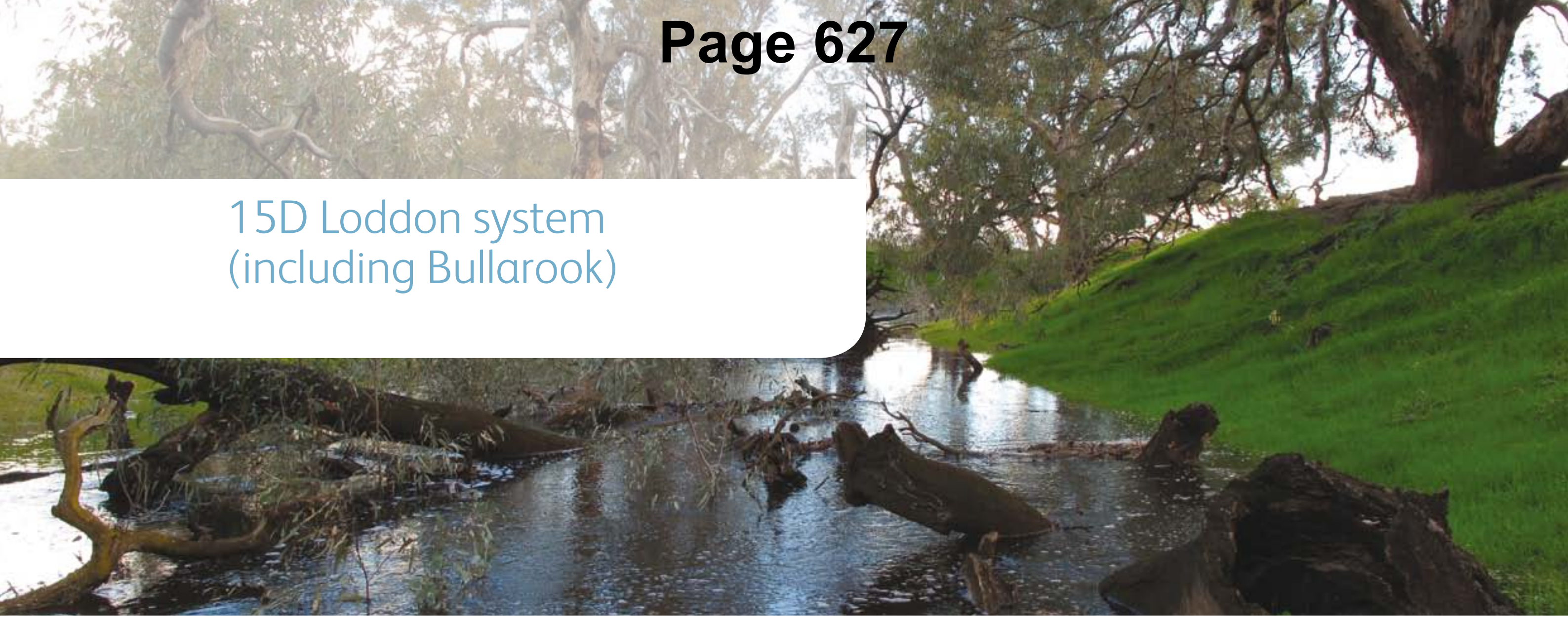
Table 15C.2 Priority watering actions under a range of planning scenarios in the Campaspe system

	Planning scenario		
	DROUGHT	**DRY**	**AVERAGE/WET**
Expected availability of Water Holdings*	21,200 ML	15,600 ML	10,600 ML
Environmental objectives	Maintain pool habitat and water quality for fish populations. Improve potential for fish movement. Maintain macroinvertebrate populations. Reduce encroachment of terrestrial vegetation instream. Enhance river red gum recruitment.	Maintain pool habitat and water quality for fish populations. Improve potential for fish movement. Maintain macroinvertebrate populations. Reduce encroachment of terrestrial vegetation instream. Enhance river red gum recruitment.	Maintain pool habitat and water quality for fish populations. Improve potential for fish movement. Maintain macroinvertebrate populations. Reduce encroachment of terrestrial vegetation instream. Enhance river red gum recruitment.
Flow components	Winter low flows (reach 2). Winter high flows (reach 2). Summer low flows (reach 4). Summer freshes (reach 4). Winter low flows (reach 4). Winter high flows (reach 4).	Winter low flows (reach 2). Winter high flows (reach 2). Summer low flows (reach 4). Summer freshes (reach 4). Winter low flows (reach 4). Winter high flows (reach 4).	Winter low flows (reach 2). Winter high flows (reach 2). Summer low flows (reach 4). Summer freshes (reach 4). Winter low flows (reach 4). Winter high flows (reach 4).
Possible volume required from the Water Holdings	13,500 ML	7,900 ML	3,000 ML
Possible carryover into 2012/13#	N/A	N/A	N/A

* Comprises water held in trust for the Living Murray and the Commonwealth Environmental Water Holdings. Assumes some water was carried over into the 2011–12 water year and if the season is wet, water will be lost due to storage spill. The River Murray Flora and Fauna entitlement can be traded into the system depending on trade restrictions. Reconfiguration of the Campaspe system means it is not currently possible to assess trade options; therefore the volume is not included in the available volume.

\# Decisions to carry over will be driven by the environmental water demands of the Living Murray icon sites and Commonwealth Environmental Water Holder priorities, rather than the needs of the Campaspe River in 2012–13.

15D Loddon system (including Bullarook)



Loddon River downstream of Boort – Durham Road, North Central Catchment Management Authority

Waterway manager – North Central Catchment Management Authority

The Loddon system is located in north-central Victoria, and includes the ecologically important Boort wetlands. The Boort wetlands, consisting of a system of freshwater lakes, are known for their abundant bird life and ecologically productive wetlands. The wetlands provide breeding grounds for bird species such as ibis, herons, ducks and egrets. The Loddon River is also home to native fish species such as the river blackfish, Murray cod, golden perch and silver perch, and supports an active tourism industry due to its intact forests and high value vegetation. Also part of the Loddon system is the smaller Bullarook system, including Birch Creek. The Bullarook system has its own entitlement; planned use of this entitlement is described on page 75.

Planned environmental water use in 2011–12

The priority environmental objectives in the Loddon system for 2011–12 are maintaining channel form; maintaining instream and riparian vegetation; reducing encroachment of terrestrial vegetation; and maintaining water quality.

The priority river reach is reach 4 from Loddon Weir to Kerang Weir, as it has the largest water demands. Reaches 1 to 3 and reach 5 benefit from the flows being passed from the upper storages to Loddon Weir, and also from Kerang Weir to the River Murray.

Environmental watering will focus, in priority order, on winter low flows; a spring fresh; and summer freshes.

With full use of all available Water Holdings, it is likely that the majority of priority flow components can be provided under all planning scenarios.

System overview

The environmental flow reaches are shown in Figure 15D.1. Water Holdings in the Loddon system are released from Cairn Curran (reach 1), Tullaroop (reach 2) and Lannecoorie (reaches 3 to 5). Water in the Goulburn system can be delivered through the Western Waranga Channel to the Loddon Weir and delivered to reach 4.

While all reaches in the Loddon are important, environmental watering is targeted at reach 4 as it has the largest environmental water demand. The measurement point for target flows is downstream of Loddon Weir. Environmental water releases from Tullaroop or Cairn Curran Reservoirs also benefit reaches 1 and 2, while releases from Lannecoorie will benefit reach 3.

In addition to the Water Holdings, passing flows are provided under Goulburn-Murray Water's bulk entitlement and consumptive water is delivered down the Loddon to meet downstream irrigation needs, which together with unregulated flows provide significant environmental benefit.

Figure 15D.1 The Loddon system

Table 15D.1 Water Holdings available for use in the Loddon system

Entitlement	Description
Victorian Water Holdings	
Bulk Entitlement (Loddon River – Environmental Reserve) 2005	• 2,000 ML high-reliability entitlement for Boort wetlands • 2,024 ML low-reliability entitlement • 7,490 ML high-reliability entitlement for use below Loddon Weir • Passing flows, including withheld flows account[1] • Access to surplus flows (flows which cannot be captured in the regulated system and pass downstream)
Goulburn River Environmental Entitlement 2010	• 1,432 ML high-reliability entitlement from Goulburn-Wimmera-Mallee Pipeline savings
Bulk Entitlement (River Murray Flora & Fauna) 1999[2]	• 27,600 ML high-reliability entitlement
Environmental Entitlement (Birch Creek – Bullarook System) 2009	• 100 ML entitlement (available when allocations for Bullarook high-reliability water shares are at 20%)[3] • Passing flows • Above cap water (i.e. all water not allocated to other entitlement holders)
Other Water Holdings	
Commonwealth Environmental Water Holdings[4]	• 1,700 ML Loddon high-reliability water share • 527 ML Loddon low-reliability water share

1 Passing flows can be withheld in storage and released at a time that provides maximum environmental benefit.
2 Sourced from the Murray system but can be transferred for use in the Loddon system.
3 Available from December of any year to November of the following year.
4 Decisions about the use of Commonwealth Water Holdings are the responsibility of the CEWH.
The VEWH will submit proposals for the use of CEWH water for Victoria's priority rivers and wetlands.

Current situation

Following an extended drought, the Loddon system received a sequence of high rainfall and high flow events, including three major floods in September and December 2010 and January 2011. Flow components recommended in the scientific flow study, including bankfull and overbank flows, were largely provided naturally. The only flows that did not occur were early winter baseflows and freshes as it was early in the water year and water was not available. All wetlands in the Boort District received significant inflows after the September flood. Wetlands from Lake Boort through to Little Lake Meran were linked for the first time in many years.

As a result of 2010–11 flows, there was opportunistic fish migration through the Kerang fishway and terrestrial vegetation was cleared from the channel. A range of bird species made use of the wetlands early in the flood period and some species were observed to have two breeding events. Watering in 2011–12 will be focused on continuing the recovery of the system from last year's flows. With significant volumes of environmental water available it should be possible to provide most priority planned flow components.

Priority watering actions

Table 15D.2 outlines the priority objectives and watering actions under a range of planning scenarios. The priority watering actions are for reach 4 and comprise:

- winter low flows (100 ML per day from May to October)
- spring fresh (750 ML per day for 6–10 days between September and November)
- summer fresh (two freshes of 100 ML per day for 10–14 days each between December and February).

Winter and summer low flows in reaches 1 to 3 are also priority flow components; however these are provided year round by passing flows required under the Bulk Entitlement (Loddon River – Environmental Reserve) Order 2005. No management action is required to provide these flows. Environmental flow requirements were determined for bankfull flows in reach 4 of the Loddon; however these were provided naturally in 2010–11 and are thus not a priority in the next two to three years.

The VEWH will also coordinate the delivery of CEWH water and authorise waterway managers to implement CEWH priority watering actions, provided there are no adverse impacts on Victorian rivers and wetlands.

Table 15D.2 Priority watering actions under a range of planning scenarios in the Loddon system

	Planning scenario			
	DROUGHT	**DRY**	**AVERAGE**	**WET**
Expected availability of Water Holdings*	14,005 ML Victorian Water Holdings 880 ML Commonwealth Environmental Water Holdings	15,000 ML Victorian Water Holdings 1,373 ML Commonwealth Environmental Water Holdings	13,139 ML Victorian Water Holdings 1,700 ML Commonwealth Environmental Water Holdings	11,338 ML Victorian Water Holdings 1,700 ML Commonwealth Environmental Water Holdings
Environmental objectives	Maintain channel form. Maintain instream and riparian vegetation. Reduce encroachment of terrestrial vegetation. Maintain water quality.	Maintain channel form. Maintain instream and riparian vegetation. Reduce encroachment of terrestrial vegetation. Maintain water quality.	Maintain channel form. Maintain instream and riparian vegetation. Reduce encroachment of terrestrial vegetation. Maintain water quality.	Maintain channel form. Maintain instream and riparian vegetation. Reduce encroachment of terrestrial vegetation. Maintain water quality.
Flow components	Winter low flows. Spring fresh.	Winter low flows. Spring fresh.	Winter low flows. Spring fresh. Summer fresh.	Winter low flows. Spring fresh. Summer fresh.
Possible volume required from the Water Holdings^	12,900 ML for instream 0–1,500 ML for Boort wetlands	12,900 ML for instream 0–1,500 ML for Boort wetlands	16,000 ML for instream 0–1,500 ML for Boort wetlands	16,000 ML for instream 0–1,500 ML for Boort wetlands
Possible carryover into 2012/13#	5,632–7,132 ML	7,120–8,620 ML	5,147–6,647 ML	5,147–6,647 ML

* Includes water available only for the Boort wetlands (2,000 ML entitlement). Does not include water available from the Bulk Entitlement (River Murray Flora & Fauna) 1999, which could be traded into the system if required.
^ Assumes passing flows are provided, but no unregulated volumes above passing flows, therefore volumes are upper limits of water required from the Water Holdings.
\# Decisions to carry over will depend on the environmental water demands of other VEWH and CEWH priorities in 2011–12. Carryover includes passing flows that are assumed to be kept in storage rather than being released under all planning scenarios (estimated to be an additional 5,147 ML).

Adaptive management considerations

The preference is for environmental water to be released from Tullaroop or Cairn Curran reservoirs to provide environmental benefit to all reaches if required. This is dependent on system operations. The North Central Catchment Management Authority will work closely with Goulburn-Murray Water to provide the preferred pattern of release from the upper storages to meet the targeted flows at reach 4 below Loddon Weir.

Under the *Bulk Entitlement (Loddon River – Environmental Reserve) 2005*, there is 2,000 ML of entitlement that can only be used in the Boort wetlands: Lake Leaghur; Lake Yando; Lake Meran; Little Lake Meran; Big Boort; and other Boort wetlands identified as priorities by North Central Catchment Management Authority. Water available under this entitlement ranges from 700 ML under a drought scenario to 4,000 ML under a wet scenario (includes 2,000 ML carryover, assuming storage does not spill). All the wetlands were filled in 2010–11 and the majority will be allowed to draw down and dry out. Watering is only planned for Big Lake Boort, and this would only be required under a drought or dry scenario (1,000–1,500 ML required). Big Lake Boort may be filled by unregulated flows under an average or wet scenario. In this case, no water would be required from the Water Holdings and since this water can only be used in the Boort wetlands, the full 4,000 ML would be carried over into 2012–13; however this would be lost if Cairn Curran or Tullaroop Reservoirs spill.

Instream environmental watering actions are targeted on reach 4 of the Loddon system, and will focus in priority order on winter low flows from July 2011 to October 2011; a spring fresh between September and November 2011; then summer freshes between December 2011 and February 2012. Summer passing flows are provided for under the entitlement, however these are not the priority for this year and are likely to be withheld to deliver priority flow components in 2012–13.

North Central Catchment Management Authority will monitor the flows occurring naturally in the system, and assess the best time to make releases to provide the priority flow components most efficiently and with maximum environmental benefit.

Implementation arrangements

This plan outlines the watering actions that are a priority in the coming year, provided there is sufficient water. As conditions unfold and water becomes available throughout the year, seasonal watering statements will be issued to communicate decisions on the environmental watering actions that are to be undertaken. The seasonal watering statements will also authorise North Central Catchment Management Authority to implement those decisions. A transitional watering statement was released on 1 July 2011 to authorise the continuation of watering actions that were approved in 2010–11 by the previous entitlement holder, the Minister for Environment and Climate Change. This may be complemented by or superseded by new seasonal watering statements when they are issued.

In the Loddon system, implementation arrangements are outlined in Schedule 12 (Loddon River) and Schedule 13 (Bullarook system) of the *Seasonal Watering Plan 2011–12*. The Loddon River bulk entitlement is guided by the environmental operating strategy agreed by the North Central Catchment Management Authority and Goulburn-Murray Water in 2005. Operating arrangements will be reviewed by June 2012 and will include the Bullarook system.

Risk assessment and management

Risks associated with the implementation of these watering actions include flooding of private land; however the likelihood of this is low. This will be managed by delivering environmental flows in line with flow recommendations and investigating potential changes to channel form following the recent floods. For the Boort wetlands, no environmental water would be released except under a drought or dry scenario. There is also a risk that environmental watering could cause water quality issues, such as:

- blackwater events (reduced dissolved oxygen levels resulting from leaf litter and other organic matter being washed instream)
- sulphate generation and low pH (from acid sulphate soils being exposed and then rewet)
- blue-green algal blooms (from nutrient-rich water being flushed instream from the floodplain).

These risks are assessed as low, and will be managed by avoiding low flows during summer and providing freshes to dilute water if necessary.

Also important are risks to successfully achieving the desired environmental outcomes from watering actions. Details on these can be found in Schedules 12 and 13.

Further information

More detail about the planned watering actions in the Loddon system can be found by downloading Schedules 12 and 13 of the *Seasonal Watering Plan 2011–12* at www.vewh.vic.gov.au.

Planned environmental water use in 2011–12 in the Bullarook system

The Bullarook system is a tributary of the Loddon River and includes Birch Creek which rises on the northern slopes of the Great Dividing Range. The area is highly developed from mining which continued after the gold rush, broad acre agriculture and dairy farming. However, Birch Creek still supports some significant environmental values, including important habitat for the endangered river blackfish.

The environmental flow reaches in the Bullarook system are shown in Figure 15D.1. The Bullarook environmental entitlement includes passing flow requirements for each of the reaches. The 100 ML that can be actively managed can be released from Newlyn Reservoir or Hepburn Lagoon and provided to all reaches. The environmental objectives in 2011–12 are to maintain river blackfish populations; flush sediments; allow fish movement; reinstate instream and riparian vegetation diversity; and minimise low dissolved oxygen risks. The full 100 ML will be used if required to provide:

- summer baseflows in reach 3 (8 ML per day between December and May)
- summer freshes in reach 3 (four freshes of 15 ML per day for three days each between December and February.

Water under the Bullarook environmental entitlement cannot be carried over.

15E Northern wetlands and floodplains

Hattah Lakes, Bob Merlin, Mallee Catchment Management Authority

Waterway manager – Mallee Catchment Management Authority, North Central Catchment Management Authority and Goulburn Broken Catchment Management Authority

The Northern Victorian wetlands and floodplains are numerous and cover three catchment management authority boundaries: Mallee; North Central; and Goulburn Broken. Included within the area are four Living Murray 'icon sites': Barmah Forest; Gunbower Forest; Hattah Lakes; and Lindsay-Wallpolla Islands. Barmah Forest and Gunbower Forest are Australia's largest river red gum forests. These forests together with Hattah, Lindsay-Wallpolla and Kerang wetlands are recognised as wetlands of international importance under the Ramsar Convention. There are other significant wetlands and floodplains in the Goulburn Broken area, around Boort and Kerang and along the River Murray.

Planned environmental water use in 2011–12

The priority environmental objectives for northern Victorian wetlands and floodplains in 2011–12 are to improve ecological resilience and, where appropriate, initiate drying regimes, returning these systems to a more natural flow regime.

The systems which require environmental water in 2011–12 include Boort wetlands; Kerang wetlands; Mallee-River Murray wetlands; Barmah Forest; Gunbower Forest; and Lindsay-Wallpolla Islands. Other systems, including the Goulburn Broken wetlands, are sufficiently full or currently in a drying phase.

Environmental watering will focus on ensuring resilience of the systems, providing habitat and breeding opportunities for water-dependent species, such as frogs and waterbirds, and increasing the opportunity for recruitment of vegetation.

The seasonal outlook for 2011–12 is positive, with good allocations likely in the Murray and Goulburn systems. The suite of Water Holdings in northern Victoria provides a good opportunity to meet the majority of ecological objectives across the priority northern Victorian wetlands and floodplains. Decisions on use of the Victorian Water Holdings will be influenced by seasonal opportunities and the allocation of water by other water holders.

System overview

The northern Victorian wetlands and floodplains are part of the southern connected Murray-Darling Basin. The southern connected Basin is highly regulated and can deliver water from a number of storages including Lake Victoria, Hume and Dartmouth Dams on the Murray; Lake Eildon on the Goulburn; Lake Eppalock on the Campaspe, Cairn Curran and Tullaroop Reservoirs on the Loddon and the mid-Murray storages in Kerang.

Victoria has priority wetlands in the majority of these systems, in addition to a number of Living Murray icon sites: Barmah-Millewa Forest; Gunbower-Koondrook-Perricoota Forest; Hattah Lakes and Chowilla Floodplain, Lindsay and Wallpolla Islands.

The Ovens and Kiewa systems are also included in the southern connected basin. They are less regulated than the other systems, with relatively small storages. They currently contain no wetlands or floodplains which can receive regulated environmental water.

The highly connected and regulated nature of northern Victoria also provides opportunities to use environmental water to build on consumptive water en route and unregulated flows to enhance the environmental benefit.

Figure 15E.1 The northern wetlands and floodplains

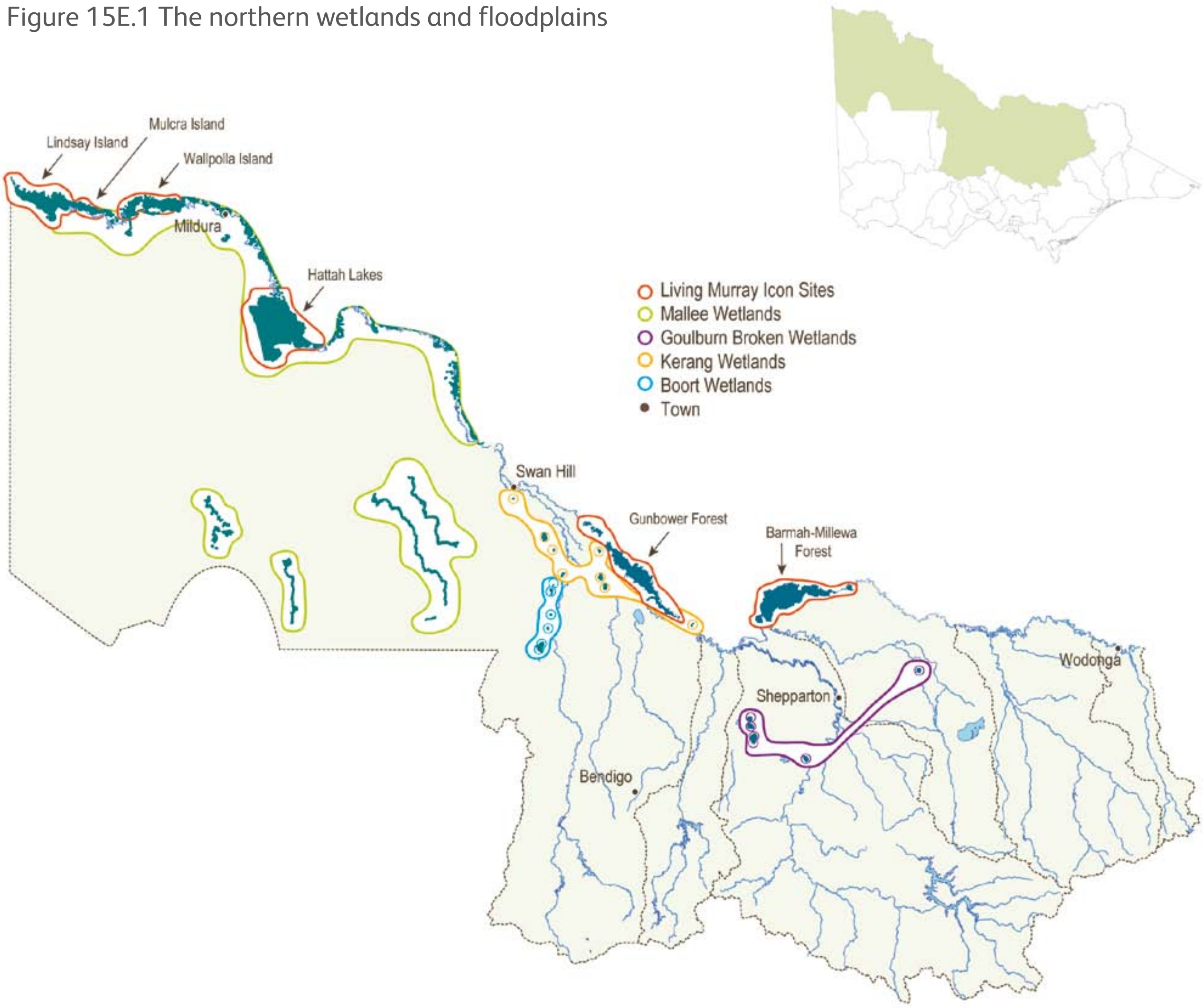


Table 15E.1 Water Holdings available for use in northern Victorian wetlands and floodplains

Entitlement	Description
Victorian Water Holdings	
Bulk Entitlement (River Murray Flora & Fauna) 1999	27,600 ML high-reliability entitlement 40,000 ML unregulated entitlement 50,000 ML high-reliability Barmah-Millewa Environmental Water Allocation 25,000 ML low-reliability Barmah-Millewa Environmental Water Allocation
River Murray Environmental Water Savings Supply Deed	One-third of water savings created in the Murray system as a result of modernisation works completed as part of Stage 1 of the Northern Victoria Irrigation Renewal Project Mitigation water reserve (water which was deemed required to mitigate against impacts of reduced outfalls into environmental sites resulting from modernisation)
Goulburn Environmental Water Savings Supply Deed	One-third of water savings created in the Goulburn system as a result of modernisation works completed as part of Stage 1 of the Northern Victoria Irrigation Renewal Project Mitigation water reserve (water which was deemed required to mitigate against impacts of reduced outfalls into environmental sites resulting from modernisation)
Goulburn River Environmental Entitlement 2010	1,432 ML high-reliability entitlement (for use in the Loddon system)
Bulk Entitlement (Loddon River Environmental Reserve) Order 2005	2,000 ML high-reliability entitlement for Boort wetlands 2,024 ML low-reliability entitlement 7,490 ML high-reliability entitlement for use at or below Loddon Weir
Environment Entitlement (Campaspe River – Living Murray Initiative) 2007*	126 ML high-reliability entitlement 5,048 ML low-reliability entitlement
Environmental Entitlement (Goulburn System – Living Murray) 2007*	39,625 ML high-reliability entitlement 156,980 ML low-reliability entitlement
Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999* – Living Murray	5,710 ML high-reliability entitlement 101,850 ML low-reliability entitlement 34,300 ML unregulated entitlement
Other Water Holdings	
Other Living Murray entitlements*	17,518 ML high-reliability water shares in Victoria 1,887 ML of high-security entitlement in New South Wales 212,127 ML of general-security entitlement in New South Wales 12,965 ML of unregulated entitlement in New South Wales 350,000 ML of supplementary entitlement in New South Wales 43,765 ML water licence entitlement in South Australia
Commonwealth Environmental Water Holdings#	129,946 ML Murray high-reliability water shares 11,125 ML Murray low-reliability water shares 95,705 ML Goulburn high-reliability water shares 10,526 ML Goulburn low-reliability water shares 47 ML Broken high-reliability water shares 4 ML Broken low-reliability water shares 5,783 ML Campaspe high-reliability water shares 395 ML Campaspe low-reliability water shares 1,564 ML Loddon high-reliability water shares 527 ML Loddon low-reliability water shares

* Water allocated to this entitlement must be used for the Living Murray 'icon sites'.
# Decisions about the use of Commonwealth Water Holdings are the responsibility of the CEWH. The VEWH will submit proposals for the use of CEWH water for Victoria's priority rivers and wetlands. Current as at 31 May 2011. Does not include Commonwealth Environmental Water Holdings in other states.

Current situation

In 2010–11, much of northern Victoria experienced above average rainfall. Significant flooding occurred in the Murray, Goulburn, Broken, Campaspe and Loddon systems.

During the start of 2010–11, environmental water was being delivered to a number of priority wetlands. However, as a result of the wet conditions across the state over summer, rainfall and catchment runoff has filled many wetlands to capacity and generated high natural river flows in a number of systems. These natural events filled many wetlands and floodplains, with relatively small amounts of managed environmental water used to build on these events.

Flooding along the River Murray provided water to many wetlands and floodplains including the Hattah Lakes, Lindsay, Wallpolla and Mulcra islands and many smaller wetlands along the River Murray floodplain. Large-scale flooding around Boort and Kerang connected a number of significant wetlands and floodplains. Wetlands in the Goulburn Broken area also received significant inundation. A large portion of these wetlands and floodplains are still full or retaining water, and may require only small top-ups or in some cases no managed environmental water in 2011–12.

The seasonal outlook for 2011–12 is positive, with good allocations likely in the Murray and Goulburn systems. The suite of Water Holdings in northern Victoria provides a good opportunity to meet the majority of ecological objectives across the priority northern Victorian wetlands and floodplains. Decisions on use of the Victorian Water Holdings will be influenced by seasonal opportunities and the decisions of other water holders.

Priority watering actions

The majority of wetlands and floodplains in northern Victoria have wetting and drying cycles, reflecting the requirements of important ecological communities. For example, the optimum flow regime in some wetlands is one year of full inundation, followed by two years with no active water management allowing the wetland to dry. Other wetlands may require three years of inundation, with only one dry year between.

Wetting cycles are important in maintaining environmental values, such as sustaining the health of river red gum forests, or providing breeding habitat for waterbirds. Equally important is the drying cycle, to ensure that wetting does not exceed the requirements of the relevant ecological community. Maintaining the balance between wetting and drying is important in maintaining the diversity and health of the wetland system.

Table 15E.2 outlines the priority watering actions for wetlands and floodplains across northern Victoria, and how watering requirements vary under different planning scenarios. This table does not show the priority wetlands which do not require watering in 2011–12 as they require a drying phase.

The VEWH will also coordinate the delivery of CEWH water and authorise waterway managers to implement CEWH priority watering actions, provided there are no adverse impacts on Victorian rivers and wetlands.

Adaptive management considerations

Decisions on priority watering actions for northern Victorian wetlands and floodplains will be influenced by the amount of water available for use, the watering history (wetting and drying cycle) of the wetland or floodplain system, and local rainfall or catchment runoff that may influence the watering requirements of wetland or floodplain system as the water year progresses.

The Northern Victorian Environmental Watering Project Control Board, consisting of Mallee, North Central and Goulburn Broken catchment management authorities and Parks Victoria, assists in the prioritisation process throughout the year, making recommendations to the VEWH on environmental water requirements of northern Victorian wetland and floodplain systems. This group will continue to review the volumes and management actions required for the sites as seasonal conditions unfold and allocation progressively becomes available for use.

The CEWH and partners in the Living Murray Program have varying interests in northern Victorian wetlands and floodplains, reflecting their different objectives. The ability to meet the water requirements of northern Victorian wetlands and floodplains is dependent on decisions by other water holders and seasonal conditions.

Implementation arrangements

This plan outlines the watering actions that are a priority in the coming year, provided there is sufficient water. As conditions unfold and water becomes available throughout the year, seasonal watering statements will be issued to communicate decisions on the environmental watering actions that are to be undertaken. The seasonal watering statements will authorise Mallee, North Central or Goulburn Broken catchment management authorities (as appropriate) to implement priority actions for particular wetlands and floodplains. There will be many statements released for the northern Victorian wetlands and floodplains, reflecting the complexity associated with different water holders, progressive water allocations, and multiple catchment management authorities.

Large-scale watering actions require inter-jurisdictional planning and coordination. The VEWH and relevant waterway managers will participate in planning and implementation meetings as required.

Implementation arrangements for northern Victorian wetlands and floodplains are outlined in Schedule 14. More specific arrangements, including costs and funding sources, will be confirmed through the development of a delivery plan before each watering action is authorised.

Risk assessment and management

Risks associated with the implementation of priority watering actions include flooding of private land and personal injury to river and wetland users. A broad risk assessment has been undertaken for each system and is included in Schedule 14. The assessment looks at risks to operational delivery, third parties such as if there is a risk of flooding private land, and risks of not communicating the rationale for undertaking the management action.. More detailed risk assessments will be completed by the relevant waterway manager as part of the delivery plan for each watering action.

Further information

More detail about priority watering actions in the northern Victorian wetland system can be found by downloading Schedule 14 of the *Seasonal Watering Plan 2011–12* at www.vewh.vic.gov.au.

Table 15E.2 Priority watering actions under a range of planning scenarios in the northern wetlands and floodplains

Sites other than Living Murray icon sites

	DROUGHT		DRY		AVERAGE		WET	
Wetlands and floodplains	**Priority sites to receive environmental water in 2011–12**	**Total volume (ML)**	**Priority sites to receive environmental water in 2011–12**	**Total volume (ML)**	**Priority sites to receive environmental water in 2011–12**	**Total volume (ML)**	**Priority sites to receive environmental water in 2011–12**	**Total volume (ML)**
Goulburn Broken wetlands	N/A	0	N/A	0	N/A	0	N/A	0
Boort wetlands*	Lake Boort	1,000	Lake Boort	1,500	Lake Boort	1,500	N/A	0
Kerang wetlands	Round Lake Lake Elizabeth Hirds Swamp Johnson's Swamp Richardson's Lagoon	3,900	Round Lake Lake Elizabeth Hirds Swamp Johnson's Swamp Richardson's Lagoon	3,900	Round Lake Lake Elizabeth Hirds Swamp Johnson's Swamp Richardson's Lagoon	3,500	Round Lake Lake Elizabeth Hirds Swamp Johnson's Swamp Richardson's Lagoon	2,000
Mallee River Murray wetlands	Nurrang wetlands Merbein Common Liparoo Ned's Corner Cardross Lakes Lake Koorlong	2,970	Heywoods Lake Nurrang wetlands Lakes Powell and Carpul Merbein Common Sandilong Creek Liparoo Cardross Lakes Lake Koorlong	10,520	Heywoods Lake Nurrang wetlands Lakes Powell and Carpul Merbein Common Sandilong Creek Liparoo Cardross Lakes Lake Koorlong	10,920	Heywoods Lake Lake Hawthorn Cardross Lakes Lake Koorlong	7,900
Total	7,870		15,920		15,920		9,900	

* The Boort wetlands are part of the Loddon system, which have their own water entitlement (as part of the *Bulk Entitlement (Loddon Environmental Reserve) 2005*). If there is insufficient water available under this entitlement, additional water could be sourced from other entitlements, such as the *Bulk Entitlement (River Murray Flora and Fauna) 1999*.

Table 15E.2 Priority watering actions under a range of planning scenarios in the northern wetlands and floodplains (continued)

Living Murray icon sites								
	DROUGHT		DRY		AVERAGE		WET	
Wetlands and floodplains	**Priority sites to receive environmental water in 2011–12**	**Total volume (ML)**	**Priority sites to receive environmental water in 2011–12**	**Total**	**Priority sites to receive environmental water in 2011–12**	**Total**	**Priority sites to receive environmental water in 2011–12**	**Total**
Barmah Forest	Top Island Boals Deadwoods Gooses Swamp Gulf Creek Smiths Creek Unregulated creeks which receive water (under 15,000 ML/day)	273,000	Top Island Boals Deadwoods Gooses Swamp Gulf Creek Smiths Creek Unregulated creeks which receive water (under 15,000 ML/day)	273,000–450,000	Top Island Boals Deadwoods Gooses Swamp Gulf Creek Smiths Creek Unregulated creeks which receive water (under 15,000 ML/day)	273,000–450,000	Top up natural inflow in whole of Barmah Forest	600,000
Gunbower Forest	Black Charlie Lagoon Little Gunbower Creek complex Little Reedy complex Reedy Lagoon Gunbower Creek	58,300	Black Charlie Lagoon Little Gunbower Creek complex Little Reedy complex Reedy Lagoon Gunbower Creek	72,000	Black Charlie Lagoon Little Gunbower Creek complex Little Reedy complex Reedy Lagoon Gunbower Creek	91,800	Top up natural inflows in whole of Gunbower Forest	97,000
Hattah Lakes	N/A	0	N/A	0	N/A	0	Lake Kramen	3,000
Lindsay Island	Lindsay Island	1,500	Lindsay Island Lake Wallawalla	3,500	Lindsay Island Lake Wallawalla	8,700	N/A	0
Mulcra Island	Mulcra Island (TLM works)	1,000	Mulcra Island (TLM works)	1,000	Mulcra Island (TLM works)	2,000	N/A	0
Wallpolla Island	Wallpolla Island	2,000	Wallpolla Island	1,500	Wallpolla Island	700	N/A	0
Total	335,800		351,000–528,000		376,20–553,200		700,000	

16. Glossary

Allocation bank account – water share owners hold allocation bank accounts (ABAs), which are credited as water allocations are made throughout the season

Carryover – allows entitlement-holders to retain ownership of unused water into the following season (according to specified rules)

Catchment management authority – statutory authorities established to manage regional and catchment planning, waterways, floodplains, salinity and water quality

Commonwealth Environmental Water Holder – (part of the Department of Sustainability, Environment, Water, Populations and Communities) holds and manages the water entitlements purchased through the Restoring the Balance water recovery program

Environmental flow regime – the timing, frequency, duration and magnitude of flows for the environment

Environmental flow study – a scientific study of the flow requirements of a particular basin's river and wetlands systems used to inform decisions on the management and allocation of water resources

Environmental water entitlement – an entitlement to water to achieve environmental objectives in waterways (could be an environmental entitlement, environmental bulk entitlement, water share, section 51 licence or supply agreement)

Flow component – components of a river system's flow regime that can be described by timing, seasonality, frequency and duration (for example, cease to flow and overbank flows)

Gigalitre (GL) – one billion (1,000,000,000) litres

High-reliability entitlement – legally recognised, secure entitlement to a defined share of water, as governed by the reserve policy (full allocations are expected in most years)

Low-reliability entitlement – legally recognised, secure entitlement to a defined share of water, as governed by the reserve policy (full allocations are expected only in some years)

Megalitre (ML) – one million (1,000,000) litres

Monthly Water Report – a report produced by the Department of Sustainability and Environment, which provides a summary of the status of Victoria's water resources and water supplies at the end of the reporting month

Northern Victoria Irrigation Renewal Program – an irrigation modernisation project, involving upgrading irrigation infrastructure in the Goulburn Murray Irrigation District, which will provide water to irrigators, Melbourne and the environment

Passing flow – water released out of storages to operate river and distribution systems (to deliver water to end users), provide for riparian rights and maintain environmental values and other community benefits

Permanent trade – transfer of ownership of a water share or licence

Restoring the Balance water recovery program – a Commonwealth Government program to return water to the environment through the purchase of water entitlements from irrigators

Seasonally adaptive approach – a planning approach which incorporates the likely availability of environmental water based on recent climate history and outlook, and determines the priority environmental objectives as a result

Seasonal allocation – the volume of water allocated to a water share in a given season, expressed as a percentage of total entitlement volume

Temporary trade – transfer of a seasonal allocation

The Living Murray – an intergovernmental program, which holds an average of 500,000 ML of environmental water per year, for use at six icon sites along the River Murray

Unregulated entitlement – an entitlement to water declared during periods of unregulated flow in a river system, that is, flows that are unable to be captured in storages

Victorian Environmental Flow Monitoring and Assessment Program – assesses the effectiveness of environmental flows in delivering ecological outcomes

Victorian Environmental Water Holder – an independent statutory body responsible for holding and managing Victorian environmental water entitlements and allocations (Victorian Water Holdings)

Victorian Water Register – a public register of water-related entitlements in Victoria

Waterways – can include rivers, wetlands, creeks, floodplains and estuaries

Water entitlement – the right to a volume of water that can (usually) be stored in reservoirs and taken and used under specific conditions

Water Holdings – environmental water entitlements held by the Victorian Environmental Water Holder

Waterway manager – agency responsible for the environmental management of waterways (includes catchment management authorities and Melbourne Water)

17. List of acronyms

ABA – allocation bank account

CEWH – Commonwealth Environmental Water Holder

CMA – catchment management authority

EWR –Environmental Water Reserve

NVIRP – Northern Victoria Irrigation Renewal Project

VEFMAP – Victorian Environmental Flow Monitoring and Assessment Program

VEWH – Victorian Environmental Water Holder

18. Schedules

Sections 13–15 outline the scope of planned watering actions during 2011–12 in southern, western and northern Victoria. The schedules provide further detail about these watering actions (see list below). They are available either by downloading from www.vewh.vic.gov.au or in hard copy from the VEWH office.

The schedules are the seasonal watering proposals prepared by the waterway managers. They have been accepted by the VEWH and now form part of the *Seasonal Watering Plan 2011–12*. As such, these schedules incorporate any changes resulting from feedback from the VEWH.

- Schedule 1: Latrobe, Thomson and Macalister systems
- Schedule 2: Tarago system
- Schedule 3: Yarra system
- Schedule 4: Werribee system
- Schedule 5: Moorabool system
- Schedule 6: Barwon system*
- Schedule 7: Wimmera-Glenelg system
- Schedule 8: Wimmera-Mallee wetlands*
- Schedule 9: Goulburn system
- Schedule 10: Broken system
- Schedule 11: Campaspe system
- Schedule 12: Loddon system
- Schedule 13: Bullarook system
- Schedule 14: Northern wetlands and floodplains

* These schedules will be added to the seasonal watering plan at a later date, following the finalisation of the Barwon environmental flow study, and planning and infrastructure works to connect further Wimmera-Mallee wetlands to the Wimmera-Mallee Pipeline.