CAMPASPE RIVER REACH 2 ENVIRONMENTAL WATERING PLAN

NORTH CENTRAL
Catchment Management Authority
Connecting Rivers, Landscapes, People

PREPARED FOR THE

GOULBURN-MURRAY WATER CONNECTIONS PROJECT

GOULBURN-MURRAY WATER

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Front cover photo: Campaspe River upstream of Runnymeade, Winter High Flow, 14 November 2011, Darren White, North Central CMA

The Campaspe River Reach 2 Environmental Watering Plan is a working document, compiled from the best available information. It will be subject to revision in the future as new information becomes available.

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EXECUTIVE SUMMARY

In 2010, an Environmental Watering Plan (EWP) was completed for the Campaspe River assessing and mitigating potential ecological impacts arising from outfall flow reductions into reaches three and four of the Campaspe River.

Challenges, including the prolonged drought and reduced allocations on the Campaspe System, have influenced nearly three quarters of irrigators to sell their water entitlements rather than modernising their farms as part of the Goulburn-Murray Water (G-MW) Connections Project. As a result the Campaspe Irrigation District (CID) has been decommissioned.

This Campaspe River Reach 2 EWP is a revision of the original Campaspe River EWP completed in 2010 and documents the approach to mitigating the potential impacts of decommissioning the CID on the Campaspe River. The closure of the CID will result in a significant hydrological change to Campaspe River flows in reach two between the Lake Eppalock and the Campaspe Weir north of Elmore.

The following components are the primary means by which the commitment of no net environmental impact for the Campaspe River will be achieved for the G-MW Connections Project. The main conclusions are summarised below.

Campaspe River Environmental Entitlement (EE) 2013

The Victorian Minister for Water announced on the 15th March 2013 that the Victorian Government will allocate 23 gigalitres from the G-MW Connections Project as a result of the decommissioning of the Campaspe Irrigation District to the environment. The Campaspe River Environmental Entitlement (EE) 2013 will be gazetted by 1 July 2013 granting the Victorian Environmental Water Holder (VEWH) this EE. The entitlement volume includes 15,052 ML of high reliability entitlement and 8,100 ML of long-term average entitlement.

Defining the environmental values of Campaspe River

The Campaspe River Reach 2 supports a range of environmental values (e.g. Murray Cod, *Maccullochella peelii peelii*). In describing the waterway values, the listed flora and fauna species, and vegetation communities followed by the environmental flow recommendation that support and sustain the river (e.g. spring freshes to cue native fish movement) have been identified.

The environmental values and environmental flow recommendations for Reaches 3 and 4 are defined in the Campaspe River EWP (North Central CMA 2010). It is also important to note that the provision of the environmental flow recommendations for Reach 2 will also affect Reaches 3 and 4. The Campaspe Weir has a small capacity of 2,624 ML and there is no reservoir at the intersection of Reaches 3 and 4 (Campaspe Siphon).

Assessment of mitigation water requirement

Mitigation water is defined as the volume of water required to ensure no net impacts on high environmental values resulting from the G-MW Connections Project. The assessment found that the environmental values of the Campaspe River Reach 2 are dependent on incidental water (delivery of the CID entitlement). Any changes that are likely to cause flows in Reach 2 to drop below the environmental flow recommendations should be considered a risk and water should be released from Lake Eppalock to ensure that the required flows are met. Significant species including Murray Cod and Golden Perch (Macquaria ambigua) are likely to be adversely impacted by a significant reduction in flows.

The Campaspe River EE 2013 grants the VEWH an environmental entitlement for water recovered from the decommissioning of the CID. The transfer of the full entitlement to the environment provides the source of the required mitigation water. The Campaspe River EE 2013 will provide the VEWH with water that will negate any risk to the Campaspe River.

Environmental Entitlement assessment

There is a total of approximately 28 GL/year (CID decommissioning and Commonwealth Environmental Water Holder (CEWH) entitlements) available on average to the environment from within the Campaspe River basin as a result of the closure of the CID and purchases by the Commonwealth. An assessment of the potential use of approximately 28GL on average each year in the Campaspe River basin to meet environmental objectives was undertaken. Overall, modelling has confirmed that the volume of water required to satisfy environmental requirements in each reach exceeds the 28 GL/year available.

Potential risks, limiting factors and adverse impacts associated with the recommended water regime

A number of potential risks, limiting factors and adverse impacts have been identified that may result from the provision of the EE as a portion of the recommended water regime. For example, Lake Eppalock releases may cause cold water pollution and anoxic conditions in the river.

Adaptive management framework

An adaptive management approach (assess, design, implement, monitor, evaluate and adjust) has been incorporated into the EWP to ensure that it is responsive to changing conditions.

Governance arrangements

A summary of the roles and responsibilities (e.g. land manager, environmental water manager, and system operator) relating to the development and implementation of the EWP has been defined.

Knowledge gaps and recommendations

A number of information and knowledge gaps exist which may impact on recommendations and/or information presented in the EWP. These relate to G-MW operations, implementation of the Campaspe River EE 2013, environmental flows and infrastructure.

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ACKNOWLEDGEMENTS

Acknowledgement of Country

The North Central Catchment Management Authority (North Central CMA) acknowledges Aboriginal Traditional Owners within the region, their rich culture and spiritual connection to Country. The North Central CMA also recognises and acknowledges the contribution and interest of Aboriginal people and organisations in land and natural resource management.

Contributions to the Campaspe River Reach 2 EWP

The information contained in the Campaspe River Reach 2 Environmental Watering Plan (EWP) has been sourced from a variety of reports and field inspections and from individual knowledge and expertise. The North Central CMA acknowledges the assistance of the following people in preparing this EWP:

- Chris Solum and Andrew Shields, Goulburn-Murray Water
- Environmental Technical Advisory Committee (TAC) (listed in Appendix A, Table A1)
- Bree Bisset, Darren White, Emer Campbell, Louissa Rogers, Lyndall Rowley and Rebecca Horsburgh, North Central CMA
- Paulo Lay and Bernie O'Kane, Department of Environment and Primary Industries (DEPI)
- Erin Murrihy, Sinclair Knight Merz
- Darcy Moar, Alluvium Consulting

ABBREVIATIONS

BE	Bulk Entitlement
BONN	Convention on the Conservation of Migratory Species
CAMBA	China–Australia Migratory Bird Agreement
CEWAG	Campaspe Environmental Water Advisory Group
CEWH	Commonwealth Environmental Water Holder
CID	Campaspe Irrigation District
DEWHA	Department of Environment, Water, Heritage and the Arts
DEPI	Department of Environment and Primary Industries
DPCD	Department of Planning and Community Development
EE	Environmental Entitlement
EPBC	Environmental Protection and Biodiversity Conservation Act 1999
ERP	Expert Review Panel
ETAC	Environmental Technical Advisory Committee
EVC	Ecological Vegetation Class
EWP	Environmental Watering Plan
FFG	Flora and Fauna Guarantee Act 1988
GIS	Geographic Information Systems
GL	Gigalitre (one billion litres)
GMID	Goulburn Murray Irrigation District
G-MW	Goulburn-Murray Water
G-MW CP	Goulburn-Murray Water Connections Project
HRWS	High Reliability Water Share
JAMBA	Japan–Australia Migratory Bird Agreement
LTCE	Long-term Cap Equivalent
MDB	Murray Darling Basin
North Central CMA	North Central Catchment Management Authority
NVIRP	Northern Victoria Irrigation Renewal Project
ROKAMBA	Republic of Korea–Australia Migratory Bird Agreement
VEAC	Victorian Environmental Assessment Council
VEFMAP	Victorian Environmental Flows Monitoring and Assessment Program
VEWH	Victorian Environmental Water Holder
WCMF	Water Change Management Framework
WWC	Western Waranga Channel

1. Goulburn-Murray Water Connections Project

The Goulburn-Murray Water (G-MW) Connections Project is a $2 billion works program to upgrade ageing irrigation infrastructure across the Goulburn Murray Irrigation District (GMID) and to reduce water lost through leakage, seepage, evaporation and system inefficiencies. Works include lining and automating channels, building pipelines and installing new, modern metering technology.

The GMID uses a number of natural carriers, rivers, lakes and wetlands for both storage and conveyance of water. While the water savings generated are from 'losses' within the irrigation system, in some cases the losses from the operating regime provides incidental benefits to environmental assets (SKM 2008).

Stage 1 of the G-MW Connections Project will implement water distribution and delivery efficiency improvements to deliver an estimated 225 GL/ yr Long Term Cap Equivalent (LTCE) water savings. This recovered water is returned as additional bulk water entitlement for use by irrigators, the environment and other funders.

Stage 2 of the Project is intended to recover an additional estimated 204 GL/ yr (LTCE) of water by 2017/18. The water recovered from Stage 2 is retained for environmental use (G-MW 2013a).

In July 2012 the Project was merged into G-MW and became the G-MW Connections Project: it had been previously the Northern Victoria Irrigation Renewal Project (NVIRP). The Project is scheduled for completion in 2018.

1.1. Decision under the Environment Effects Act 1978

On 14 April 2009, the G-MW Connections Project received a determination from the Victorian Minister for Planning that the Project did not require an Environmental Effects Statement under the *Environment Effect Act (EE Act) 1978*, subject to six conditions.

The conditions that apply to the protection of wetlands and waterways include:

Condition 3: "*development of a framework for protection of aquatic and riparian ecological values through management of water allocations and flows within the modified GMID system to the satisfaction of the Minister of Water*".

The G-MW Connections Project has developed a Water Change Management Framework (G-MW 2013) in response to this condition. The framework outlines the processes and methods for preparing Environmental Watering Plans (EWPs) to mitigate potential impacts on wetlands and waterways at risk from the implementation of the Connections Project through adaptive water management (G-MW 2013).

Condition 5: "*Environmental Watering Plans are required for 'at risk' waterways and wetlands before operation of the relevant NVIRP work commences*"

Environmental Watering Plans (EWPs) need to be prepared for at risk waterways and wetlands prior to modified irrigation infrastructure being operated that affect these sites. The plans need to be approved by the Victorian Minister for Water following advice from the Expert Review Panel. Plans affecting matters of national environmental significance also require Commonwealth approval (G-MW 2013b). EWPs have been prepared for four waterways and 10 wetlands to date.

1.2. Water Change Management Framework

The G-MW Connections Project developed a Water Change Management Framework (WCMF) in response to condition 3 of the *EE Act 1978* to describe protection and management measures. The framework outlines processes and methodologies for assessing potential ecological risks to wetlands, waterways and groundwater or seepage dependent ecosystems caused by hydrological changes associated with G-MW Connections Project.

The framework applies to how G-MW Connections Project:

- Develops operational requirements for managing the ecological consequences of hydrological changes arising from the implementation of G-MW Connections Project
- Establishes future operational requirements to achieve agreed environmental performance requirements, including transfer of responsibility to appropriate organisations
- Describes how the ecological consequences of hydrological changes arising from the implementation of G-MW Connections Project will be monitored, reported and adjusted through an adaptive management approach (G-MW 2013b).

The WCMF sets out the structure and contents of an EWP. It also provides the key principles and protocol for determining whether mitigation water is required and quantification the volumes to ensure the environmental values are maintained post G-MW Connections Project.

1.3. Shortlisting of Environmental Watering Plans

Following the preliminary list of waterways requiring further investigation (SKM, 2008a), Feehan Consulting (2009) undertook a validation process (confirmation of environmental values and water supply to the site) to short-list the waterways requiring EWPs. The following four waterways with significant environmental values were identified as potentially impacted by an 85% reduction in channel outfalls across the GMID:

1. Campaspe River (downstream of Campaspe Weir to Murray River)
2. Loddon River (downstream of Loddon Weir to Murray River)
3. Twelve Mile Creek (anabranch of the Loddon River)
4. Broken Creek (G-MW 2013b).

1.4. Campaspe River Environmental Watering Plan (2010)

The Campaspe River EWP was submitted to the Victorian Minister for Water and Commonwealth Minister for Environment Protection, Heritage and the Arts and approved in July 2010. It documents the approach to mitigating the potential impacts of the G-MW Connections Project due to significant reductions in channel outfalls to the waterway. The section of waterway assessed was the Campaspe River from Campaspe Weir to its confluence with the Murray River, or Reaches 3 and 4 of the environmental flow recommendations. It also included an assessment of the Campaspe Billabong and Unnamed Creek (Campaspe River Reach 4) (North Central CMA 2010).

1.5. Decommissioning of the Campaspe Irrigation District

The decommissioning of the CID resulted in almost all water shares being traded to the G-MW Connections Project and the CID was effectively closed (G-MW 2012).

The closure of the CID will result in a significant hydrological change to Campaspe River flows in Reach 2 between the Lake Eppalock outlet and Campaspe Weir north of Elmore. The Stage 1 project has resulted in water savings of approximately 8,100 ML Long Term Cap Equivalent (LTCE). This is comprised mainly of seepage, leakage, evaporation and outfall flow losses, as well as meter inaccuracy. This recovery of system losses will cause an equivalent reduction in flow in Reach 2, which would have been delivered throughout the irrigation season between 15 August and 15 May each year. The CID area is illustrated in Figure 1.

In addition to the above water savings the Connections Project secured 15,052 ML of High Reliability Water Share (HRWS) from farmers in the CID (G-MW 2012).

1.6. Risk Management 2012/13

Approval of an Environmental Watering Plan is required prior to the operation of the modified irrigation infrastructure that could affect ‘at risk’ waterways or wetlands (G-MW 2013b). However, no decision had

been made prior to the 2012/2013 irrigation season regarding the distribution of the water savings from the CID decommissioning.

The following risks were addressed for the 2012/13 irrigation season (prior to an EWP being prepared):

- *"The risk of harm being caused to the high environmental values of Reach 2 of the Campaspe River by not having an approved EWP to guide mitigation of the potential ecological impacts arising from hydrological changes due to the CID decommissioning*
- *The risk of harm being caused to the environmental values of Reach 2 of the Campaspe River by not releasing the 8020 ML (LTCE) of water recovered by the CID decommissioning" (G-MW 2012).*

It was found that the flow components most likely to be affected would be the low flow components, however the Seasonal Watering Plan for the Campaspe River (VEWH 2012) was scheduled to meet these low flow components and thus would negate any potential impact on high environmental values for the 2012/13 season. The relevant low flow components as outlined in the Seasonal Watering Plan were:

- Winter/Spring (June-November): 100 ML/day;
- Summer/Autumn (December-May): 10 ML/day.

The Victorian Environmental Water Holder (VEWH) managed the environmental water deliveries in 2012/13 in accordance with the Seasonal Watering Plan. A transfer of 8020 ML allocated water was provided to the VEWH for the provision of flows to manage the identified risk (G-MW 2012).

1.7. Ministerial decision to allocate CID water savings to the environment

The Victorian Minister for Water announced on the 15th March 2013 that the "*Victorian Government will allocate 23 gigalitres from the G-MW Connections Project as a result of the decommissioning of the Campaspe Irrigation District to the environment*" (VEWH 2013). The Campaspe River Environmental Entitlement (EE) 2013 was gazetted on 1 July 2013 granting the VEWH this environmental entitlement (Victorian Government 2013).

G-MW (2012, p4) suggested "*that the effect of this decision would be to negate any need for the Connections Project to mitigate ecological impacts because all water recovered would be fully available for delivery in accordance with existing environmental flow recommendations and would be controlled by the VEWH. If this recommendation is adopted, it will have substantial benefits for all reaches downstream of Lake Eppalock, as well as mitigating ecological impacts within the Campaspe River reaches two, three and four*".

1.8. Campaspe River Reach 2 Environmental Watering Plan

It is the G-MW Connections Project's preference to proceed with the development of an EWP even though the Minister decided the water will be designated to the environment. The EWP is required to demonstrate to the Victorian Minister for Planning (*Environment Effects Act 1978 (EE Act)*) and the Commonwealth Minister for Environmental Protection, Heritage and the Arts (*Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)*) that the environmental impacts of the CID closure have been assessed and mitigated (G-MW 2012).

This EWP is assessing the Campaspe River Reach 2 (downstream of Lake Eppalock to the Campaspe Weir), it also includes downstream impacts to Reaches 3 and 4 (Figure 1). The Campaspe River EWP (North Central CMA 2010) should be referred to for further information on these reaches, for example, environmental values and environmental flow recommendations.

2. Campaspe River

2.1. Catchment setting

The Campaspe catchment lies to the east of the North Central CMA region. The Campaspe River rises in the Great Dividing Range near Woodend and flows 150 km northwards to the Murray River at Echuca (Figure 1). The major waterways of the catchment are the upper Campaspe River and the Coliban River (both upstream of Lake Eppalock), and the lower Campaspe River (downstream of Lake Eppalock). Major tributaries are Axe, McIvor, Mount Pleasant, Wild Duck and Pipers creeks (North Central CMA 2006).

Annual rainfall throughout the Campaspe River basin varies from 1080 mm on the Great Dividing Range in the south of the catchment to approximately 400-500 mm on the drier northern plains (Lorimer and Schoknecht 1987). The annual rainfall and modelled annual runoff averaged over the region are 594 mm and 69 mm over the 3961 km^2 catchment area, respectively. Rainfall is generally higher in the winter half of the year and most of the runoff occurs in winter and early spring. The Campaspe region covers 0.4 percent of the Murray Darling Basin (MDB) and contributes about 0.9 percent of the total runoff in the MDB (CSIRO 2008).

Flow throughout the catchment is regulated by water supply reservoirs, namely Lake Eppalock (downstream of the confluence of the Coliban and Campaspe rivers) and by the operation of the Campaspe Weir near Elmore. Water can also be released from the Waranga Western Channel (WWC) into the Campaspe River at the Campaspe Siphon (near Rochester), or pumped from the river into the channel at the same location (SKM 2006a).

2.1.1. River Characteristics

The Campaspe River is approximately 225 kilometres in length, Lake Eppalock delineates the upper and lower sections of the river. The Coliban River is the major tributary that joins the upper section of the Campaspe River just south of Lake Eppalock. Other creeks contributing to the upper Campaspe River include Wild Duck and Pipers creeks (North Central CMA 2005).

The lower, northern portion of the Campaspe River (downstream of Lake Eppalock) has Forest Creek and Mount Pleasant Creek entering from the east, and Axe Creek (which is fed by Sheepwash Creek) entering from the southwest near Axedale (North Central CMA 2006). Forest Creek and Mount Pleasant Creek are ephemeral, so the inflows from Axe Creek are the greatest natural input to the Campaspe River (SKM 2006b). The river downstream of Lake Eppalock is considered a lowland river with relatively flat gradients. The floodplain of the river is narrow, being approximately 1 km wide, until it approaches Echuca where it broadens out to more than 2 km (North Central CMA 2006). Figure 2 illustrates the main features of the Campaspe River.

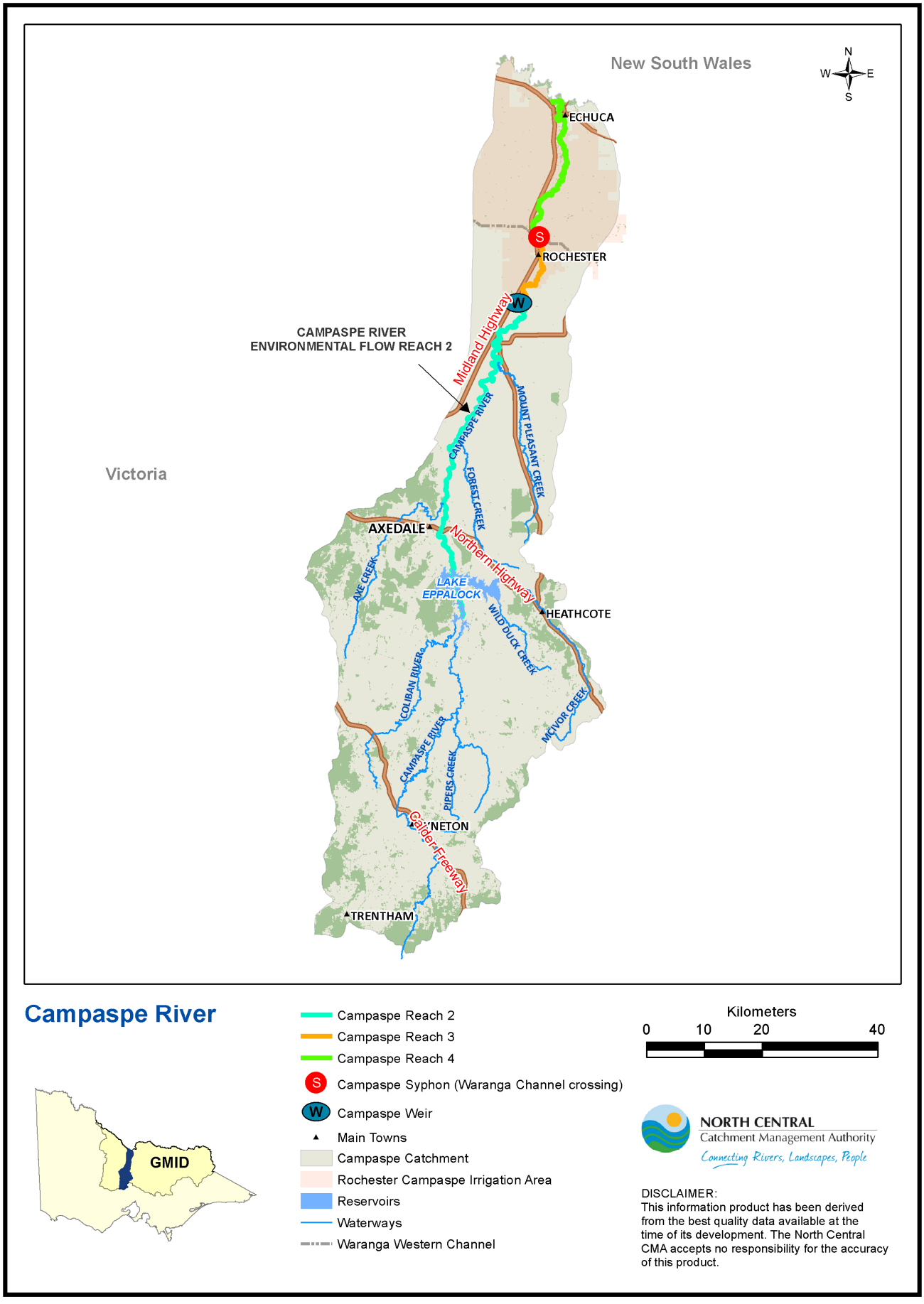

Figure 1: Campaspe River Catchment

2.1.2 Campaspe River Reach 2

The Campaspe River extends for approximately 85 km from the Lake Eppalock spillway to the Campaspe Weir. This section of the Campaspe River receives input from four major tributaries, the Native Gully, Mosquito, Axe and Forest creeks. The upper section of the Campaspe River downstream of the spillway flows approximately 6km through a deep gorge. It continues flowing north through narrow gorge-like areas and wide valleys with small alluvial flats to the Axe Creek confluence. The lower reaches meander across a broad alluvial floodplain to Elmore (North Central CMA 2006).

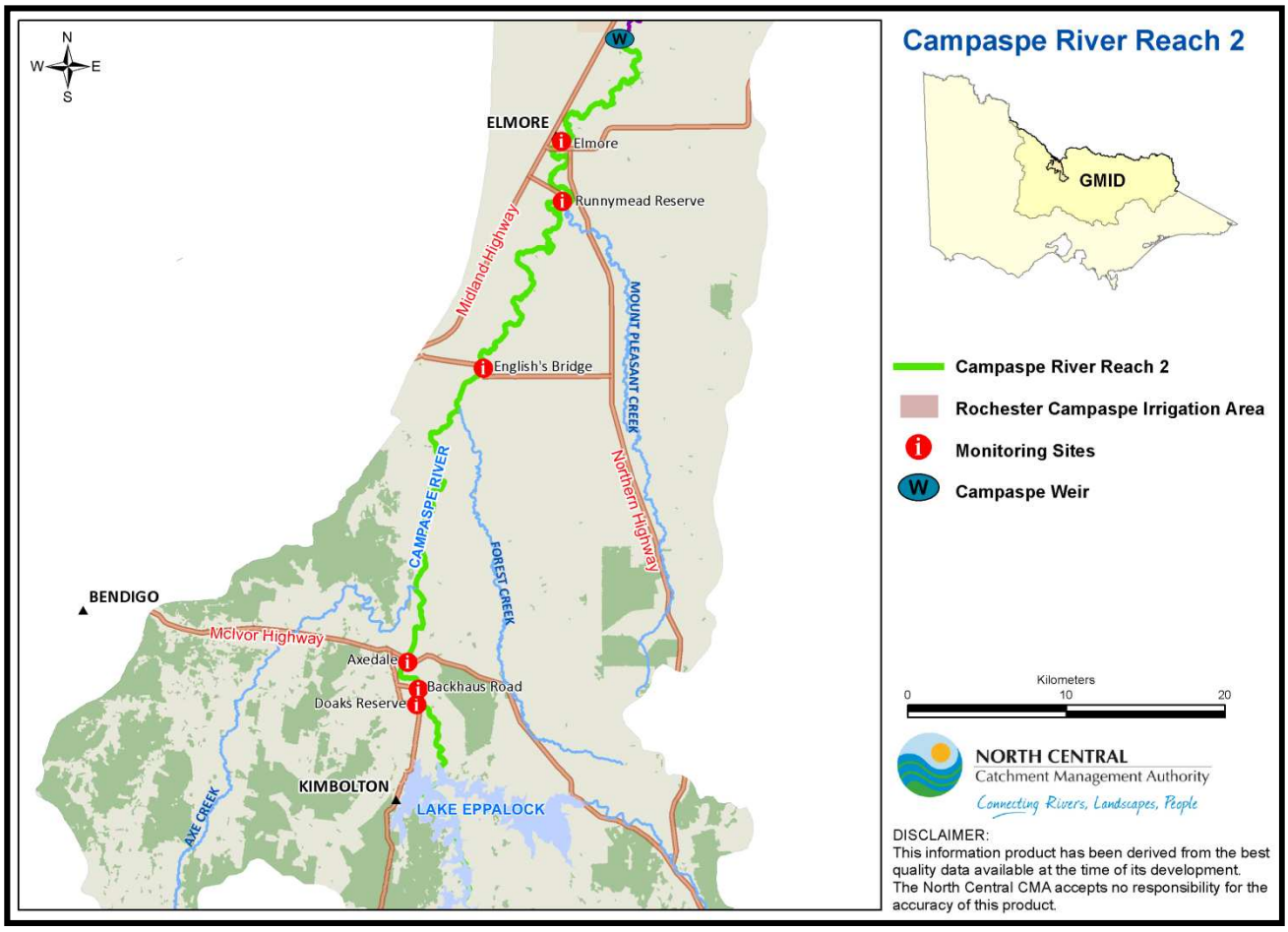

Figure 2: Campaspe River Reach 2

2.2. Recreation

The Campaspe River is a valuable recreation area in the North Central CMA region and has high passive recreation values. AVIRA (2013) rates camping as very high in Reach 2. Downstream of Elmore is extremely popular with caravans and motorhome tourists. The site has been listed in a number of touring guides and 40-50 caravans camp at the reserve during peak periods.

Recreational fishing is rated as very high for all reaches of the Campaspe River and this reach is stocked by the Department of Primary Industries (DPI) (Fisheries) with Murray Cod (*Maccullochella peelii peelii)* and Golden Perch (*Macquaria ambigua*) annually (DPI 2012). The Campaspe Weir is also considered to be one of the best fishing areas along the Campaspe River with anglers making catches of Golden Perch and Murray Cod (DPI 2010).

Other social values that are rated as very high include swimming, canoeing and riverside tracks. Non power boating and site-seeing also provide some value.

2.3. Cultural Heritage

Traditionally, Indigenous people have a strong affinity with waterways and water bodies, as a vital source of food, water and camping sites in traditional lifestyles. The alluvial plain of the Campaspe River was first inhabited by a number of Indigenous groups.

The Campaspe River has been occupied by the Dja Dja Wurung people on the west side of the river and Taungurung people on the east side. According to the Aboriginal Cultural Heritage sites register, there are 14 sites of cultural significance along the Campaspe River Reach 2. These sites include one burial, scarred trees and some artefact sites.

3. Management objectives

Management objectives have been set for the Campaspe River in relation to environmental flows. The ecological objectives for the Campaspe River system were developed under the 2006 Campaspe River Environmental FLOWS Assessment completed by Sinclair Knight and Merz (SKM 2006a). This flow assessment was developed using the Victorian state-wide FLOWS methodology and was completed in three stages (Appendix B).

Environmental flow objectives set the direction and target for the environmental water releases and are clear statements of what outcomes should be achieved in providing environmental flows. The environmental flow recommendations provide the environmental framework in which the water made available from the CID decommissioning will be deployed (Section 5.3).

The four environmental flow reaches are defined in Table 1 and shown in Figure 1.

Table 1: Campaspe River Environmental flow reaches (SKM 2006a)

Reach number	Description
Reach 1	Coliban River between Malmsbury Reservoir and Lake Eppalock
Reach 2	Campaspe River between Lake Eppalock and the Campaspe Weir
Reach 3	Campaspe River between Campaspe Weir and Campaspe Siphon
Reach 4	Campaspe River between Campaspe Siphon and the Murray River

3.1. Previous relevant studies, projects and groups

There are a number of river health related projects and programs being implemented along the Campaspe River by government agencies, non-profit environmental organisations and Landcare groups. A summary of these programs and projects specific to Reach 2 are documented below:

- **G-MW Management –** Bulk Entitlement (Campaspe System – Goulburn-Murray Water) Conversion Order 2005. Bulk entitlements define the amount, and the procedure by which, an authority is entitled to take and use water from a waterway.
- **Environmental Flow Management (2000 onwards) –** The right to water in the Campaspe River was defined in 2000 through the Bulk Entitlement (Campaspe System - Goulburn-Murray Water) Conversion Order. There are defined 'passing flows' within Goulburn-Murray Water's Bulk Entitlements for Reach 4 which is based upon recommendations by an environmental flows scientific panel (Marchant *et al.* 1997). There are no passing flow requirements for Reach 3 (between the Campaspe Weir and the Campaspe Siphon).

  In extreme dry years, the Minister for Water 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 specific Bulk Entitlement requirements aside (North Central CMA 2009). There have been two Qualification of Rights invoked by the Minister for Water for the Campaspe (including the Coliban) River system. The first Qualification of Rights covered the period July 2007 to June 2009. The second qualification covered the July 2009 to June 2011 period.

  In the 2010-11 season, well above average rainfall resulted in substantial increases of flow in the river and inflow to Lake Eppalock. As a result, Lake Eppalock spilled in November 2010 and has remained at high levels since, resulting in spills and pre-release flows to the Campaspe River.
- **Campaspe Environmental Water Advisory Group (CEWAG)** – the CEWAG consists of key stakeholders and community representatives who provide advice to the North Central CMA on the best use of environmental water for the Campaspe River.
- **Slackwater Review** – this study was commissioned to provide justification for the importance and protection of slackwater habitats in the Campaspe River. Flow versus velocity modelling was also performed at two sites to determine how specific flow magnitudes affected the availability of

slackwater habitats in the Campaspe River. Slackwater habitats are particularly important for spawning and recruitment of 'low-flow' specialist species. Based on this review, it was concluded that the summer low flow recommendation for the Campaspe River maximises the availability of ecologically significant slackwater habitats for riverine species and should not be changed (SKM 2007).

- **Deep Pools Assessment** – This study was completed in 2012 and aimed to characterise the deep pools that occur in Reach 2 and determine the flows that are required to maintain water quality and habitat quality and quantity within these pools. 24 deep pools were identified in the 35 km of river that was assessed, the deepest pool was located near Backhaus Lane (1.7 km long and 6.8 m deep). The study concluded that there was no requirement to increase the summer low flow, however it was recommended that continuous flows are delivered throughout the whole reach for most, if not all of summer (SKM 2012a).
- **Caring for the Campaspe Project** – The North Central CMA applied for Victorian Government funding to complement the delivery of environmental flows and achieve an improvement in river health. The project will work closely with land managers to deliver fencing, weed control and revegetation works along the river on both privately-owned and public land. This four year project was announced by the Minister for Water in March 2013.
- **Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP)** – the Campaspe River was selected for this statewide program. The monitoring programs implemented include physical habitat and geomorphology, water quality monitoring, fish surveys and aquatic and riparian vegetation assessments. The project commenced in 2006 and has funded yearly fish surveys, water quality monitoring, vegetation and physical habitat mapping for the Campaspe River. Figure 2 shows the locations of the monitoring sites used in this program for Reach 2.

4. Campaspe River Current Condition

The environmental flows study for the Campaspe River was completed in 2006 which calculated that the mean annual flow in Reach 2 has been reduced from 640 ML/day to 420 ML/day. The seasonal flow pattern has been reversed, with high flows during the summer irrigation season and low flows during winter.

Land clearing and unrestricted stock access have degraded the riparian zone along much of this reach and high summer flows have contributed to excessive Typha growth in the main channel. High summer flows have reduced the abundance of slackwater habitats that are important nurseries for native fish. Fish passage is restricted by both the Campaspe Weir and Lake Eppalock. High summer flows have altered the composition of the macroinvertebrate community in this reach.

The Campaspe River system experienced a drought for an extended period from the early 2000s to late 2010, during which time it was severely flow stressed. Environmental water management operated under a Ministerial Qualification of Rights, and flows within the river were significantly reduced. The 2010-11 floods delivered high flows including overbank flows, commencing its recovery from the drought.

While the floods caused immense damage to areas such as the township of Rochester, they also re-set the river system, scouring the river channel and removing the extensive beds of *Typha* sp. and Phragmites that had proliferated during the drought. The combination of unregulated flows and active management intervention through use of environmental water enabled the river to receive the important winter flow regime up to bank-full for the first time in 10 years. Environmental flow management during the 2012-13 year aimed to continue to build on recovery of the system (North Central CMA 2013).

Based on anecdotal evidence and the detailed Victorian Environmental Flows Monitoring and Assessment Program (VEFMAP) survey undertaken in 2012-13, the river appears to still be on a recovery trajectory following the severe drought and floods. Observations include fish movement during high flow events, the return of riparian ground cover to banks previously bare of vegetation and aquatic vegetation within deep pools has been maintained. Water quality has also remained within the acceptable limits, with no black water events during 2012-13 (North Central CMA 2013).

5. Environmental values

The environmental values associated with the lower Campaspe River have been documented and recorded in this report. All listed values are presented in this section with a full species list provided in Appendix C.

In describing the waterway values in the sections below, an emphasis has been placed on identifying significant flora and fauna species and vegetation communities, followed by the environmental flow recommendation that support and sustain the river.

5.1. Fauna

Six native fish species and seven exotic species have been recorded in Reach 2 of the Campaspe River (Appendix C). The list of native fish includes three significant species (Table 2), of which two (Murray Cod and Macquarie Perch, *Macquaria australasica*) are listed under the federal Environment Protection and Biodiversity Conservation (EPBC) Act 1999 and one (Golden Perch) listed for protection under the Victorian Flora and Fauna Guarantee (FFG) Act 1988. Golden Perch are stocked at Campaspe Weir (DPI 2009).

Table 2: Significant fish species recorded in Reach 2 of the Campaspe River

Common Name	Scientific Name	EPBC status	FFG status	DEPI Status
Golden Perch	*Macquaria ambigua*			VU
Macquarie Perch	*Macquaria australasica*	EN	L	EN
Murray Cod	*Maccullochella peelii peelii*	VU	L	EN
Conservation Status: *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999* Listed: EN – Endangered, VU – Vulnerable *Flora and Fauna Guarantee Act 1988* (FFG) listing: L – listed as threatened Victorian Rare or threatened Species (DSE status): EN – Endangered, VU – Vulnerable				

Fish surveys undertaken yearly since 2008 as part of the VEFMAP program at Reach 2 have recorded four native species, including Flathead Gudgeon (*Philypnodon grandiceps*), Australian Smelt (*Retropinna semoni*), Murray Cod and Golden Perch. Reach 2 is dominated by exotic species such as Common Carp (*Cyprinus carpio*), Redfin Perch (*Perca fluviatilis*) and Goldfish (*Carassius auratus*).

SKM (2006b) stated that "*macroinvertebrate communities appear to be most affected by flow regulation in the Campaspe River between Lake Eppalock and the Campaspe Weir*". The macroinvertebrate community is generally diverse and typical of a lowland system, however it supports a number of filter feeding species that are normally associated with cool, faster flowing upland streams: presumably this is a response to the summer irrigation releases from Lake Eppalock. The filter feeding community was numerically dominated by Fly Larvae (*Chironomidae*) and Water Boatmen (*Corixidae*), which is normally an indication of poor river health (SKM 2006b).

One hundred and twelve bird species have been recorded in Reach 2 (Appendix C), including seventeen significant species (Table 3). Eleven species in Table 3 below are considered to be flood-dependent (VEAC 2008).

Table 3: Significant bird species recorded in Reach 2 of the Campaspe River

Common Name	Scientific Name	EPBC status	Treaty	FFG status	DEPI status
Australasian Shoveler^	*Anas rhynchotis*				VU
Barking Owl	*Ninox connivens*			L	EN
Black-chinned Honeyeater^	*Melithreptus gularis*				NT
Brown Treecreeper (south-eastern ssp.)	*Climacteris picumnus victoriae*				NT
Diamond Firetail^	*Stagonopleura guttata*			L	VU
Eastern Great Egret^	*Ardea modesta*		C/J	L	VU

Common Name	Scientific Name	EPBC status	Treaty	FFG status	DEPI status
Fork-tailed Swift	*Apus pacificus*		C/J		
Grey-crowned Babbler^	*Pomatostomus temporalis temporalis*			L	EN
Hardhead^	*Aythya australis*				VU
Hooded Robin^	*Melanodryas cucullata cucullata*				NT
Musk Duck^	*Biziura lobata*				VU
Nankeen Night Heron^	*Nycticorax caledonicus hillii*				NT
Pied Cormorant^	*Phalacrocorax varius*				NT
Rainbow Bee-eater	*Merops ornatus*		J		
Regent Honeyeater	*Anthochaera phrygia*	EN		L	CR
Royal Spoonbill^	*Platalea regia*				VU
Swift Parrot	*Lathamus discolor*	EN		L	EN

Conservation Status:
EPBC status: EN – Endangered
J/C/R/B: JAMBA/CAMBA/ROKAMBA/Bonn international agreements
FFG listing: L – listed as threatened
DSE status: CR - Critically Endangered, EN – Endangered, VU – Vulnerable, NT – Near Threatened
^ - considered flood dependent (VEAC 2008)

5.2. Flora

The EVCs of Reach 2 demonstrate the transition of the Campaspe River from the upper Goldfields bioregion to the Victorian Riverina bioregion of the floodplain (Table 4). Reach 2 vegetation is dominated by Floodplain Riparian Woodland, which is the most extensive EVC in upper and lower Reach 2.

Table 4: EVCs at Campaspe River Reach 2

EVC Name	EVC #	Bioregional Conservation Status	Bioregion	Area (ha)	Flood depen-dent
Alluvial Terraces Herb-rich Woodland/Creekline Grassy Woodland Mosaic	81	Vulnerable	Goldfields	0.5	N
Box Ironbark Forest	61	Depleted	Goldfields	10.8	N
Creekline Grassy Woodland	68	Endangered	Goldfields	0.1	N
Floodplain Riparian Woodland	56	Endangered	Goldfields	154.1	Y
Grassy Woodland	175	Vulnerable	Goldfields	26.0	N
Plains Grassy Woodland	55	Endangered	Goldfields	25.0	N
Plains Woodland	803	Endangered	Goldfields	3.7	N
Stream Bank Shrubland	851	Endangered	Goldfields	38.9	Y
Creekline Grassy Woodland	68	Endangered	Victorian Riverina	0.1	N
Floodplain Riparian Woodland	56	Vulnerable	Victorian Riverina	629.2	Y
Grassy Woodland	175	Endangered	Victorian Riverina	0.1	N
Plains Grassy Woodland	55	Endangered	Victorian Riverina	0.9	N
Plains Woodland	803	Endangered	Victorian Riverina	70.7	N
Wetland Formation	74	Endangered	Victorian Riverina	3.9	Y

No flora species listed under the EPBC Act have been recorded in Reach 2 of the Campaspe River. One species is listed under the FFG Act 1988 (Table 5). Austral Trefoil (*Lotus australis*) is considered to be flood-dependent[1] and is also likely to respond to rainfall induced run-off (DNRE 2002; VEAC 2008).

Table 5: Significant flora species in Campaspe River Reach 2

Common Name	Scientific Name	EPBC status	FFG status	DSE Status
Austral Trefoil	*Lotus australis*			k
Blunt-leaf Pomaderris	*Pomaderris helianthemifolia* subsp. *minor*			r
Sand Rush	*Juncus psammophilus*			r
Southern Swainson-pea	*Swainsona behriana*			r
Velvet Daisy-bush	*Olearia pannosa* subsp. *cardiophylla*		L	v
Conservation Status: L = Listed under the *FFG Act 1988* DSE status: v- vulnerable in Victoria, r - rare in Victoria, k – poorly known in Victoria				

5.3. Environmental flow recommendations

Reach 2 of the Campaspe River contains a number of deep pools and riffles (SKM 2012). There are also distinct backwater and edge habitats that are filled with woody debris providing important habitat for macroinvertebrates, small fish and aquatic vegetation (SKM 2006b). Murray Cod and Golden Perch have been recorded in this reach and the presence of slackwater habitats provides spawning and recruitment opportunities for 'low-flow' specialist species (e.g. Australian Smelt have significant positive associations with backwater habitats and still littoral zones) (SKM 2007).

[1] A list of flood-dependent EVCs was distilled from the list of all EVCs in the VEAC (2006) investigation area. EVCs were classed as flood-dependent if likely to decline significantly in the region in the absence of flooding from adjoining rivers (as opposed to flooding or watering solely from local rainfall) (VEAC 2008).

Table 6 below outlines the environmental flow recommendations and associated ecological objectives for Reach 4 of the Campaspe River (SKM 2006b). Appendix B provides a summary of the method used to determine the environmental flow recommendations and how they relate to particular species and environmental values.

The flow components recommended include a cease to flow event which is intended to concentrate food resources for native fish and therefore enhance fish recruitment. The summer low flow will increase the abundance and diversity of slackwater habitats in the bottom of the channel, which are important nurseries for native fish. Summer freshes will allow longitudinal connectivity of fish movement throughout the reach. However, these freshes should occur between February and May to ensure slackwater habitats are not flushed out in early summer when larval and juvenile fish are abundant. The winter low flow will inundate the same areas as the summer fresh and will allow fish movement throughout the reach. Winter high flows will help suppress encroaching terrestrial vegetation and entrain organic matter, while the winter/spring bankfull flow will mobilise sediments and have sufficient velocity to scour stands of Typha as well as cue fish migration. The overbank flow aims to encourage some River Red Gum regeneration and deliver a large load of organic material to the river (SKM 2006b).

Table 6: Ecological objectives and recommended environmental flows for Campaspe River Reach 2 (SKM 2006b)

Ecological objectives	Flow component		Recommended release from Lake Eppalock (Magnitude, frequency, timing, duration)
• Increase food concentration for fish larvae and juveniles	Summer/Autumn (December to May)	Cease to flow*	One per year of 14 days duration *Not achievable due to G-MW operational requirements
• Maintain aquatic vegetation • Maintain fish habitat and reinstate slack waters • 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		Low flow	10 ML/day
• Maintain riparian and in channel recruitment vegetation • Provide longitudinal connectivity for fish during periods of low flow • Respond to Blackwater events as required		Fresh	100 ML/day for five days with managed rate of rise and fall. Three 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/Spring (June to November)	Low flow	100 ML/day
• Reduce encroachment of exotic and terrestrial vegetation • Enhance River Red Gum 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		High Flow	1,000 ML/day for four days with managed rate of rise and fall. Four 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		Bank-full Flow	10,000 ML/day for two days with managed rates of rise and fall. Four events or natural required each year
• Provide lateral connection to flood runners • Enhance River Red Gum recruitment		Over-bank Flow	12,000 ML/day with managed rates of rise and fall. One event required per year

*Note: The deep pools assessment recommended that the annual cease-to-flow should not be actively delivered, due to the additional stress these events can create (e.g. low dissolved oxygen), and they should only occur naturally (SKM 2012a).

The environmental values and environmental flow recommendations for reach 3 and 4 are defined in the Campaspe River EWP (North Central CMA 2010). The provision of the environmental flow recommendations for reach 2 will have a flow on effect for reaches 3 and 4. The Campaspe Weir has a small capacity of 2,624 ML and there is no reservoir at the intersection of reaches 3 and 4 (Campaspe Siphon).

6. Hydrology

6.1. Natural water regime

Prior to European settlement, streams in the middle and lower Campaspe River catchment would have had low energy, contained fine grained sediments and had occasional rocky outcrops. Most of the streams would have had incised channels, with deep pools, infrequent riffles over gravel, boulders or logs and an abundance of large woody debris (SKM 2006a).

Flows would have been seasonally variable, with high flows in winter and spring, and low or no flow in summer and autumn (McGuckin and Doeg 2001). Low flows in Reach 2 naturally occurred between January and May and high flows naturally occur between July and November (SKM 2006a).

6.2. Current water regime (prior to CID decommissioning)

The construction of reservoirs and weirs for potable supply and irrigation has substantially reduced flows throughout the catchment and reversed seasonal flow patterns in the lower reaches. The current flow regime is characterised by longer periods of low flow and shorter periods of high flow compared to natural (SKM 2006a).

The Campaspe River is now a regulated river, supplying water for irrigation and urban demands:

- In 1882, the Campaspe Weir was constructed 12 km south of Rochester with 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 Western Waranga Channel (WWC) crosses the river at this point and the siphon structure allows water from the Goulburn River to be diverted into the Campaspe River (SKM 2006a).
- The most significant structure on the Campaspe River is Lake Eppalock (completed in 1964 with a capacity of 312,000 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 (North Central CMA 2009).

The hydrological regime of the Campaspe River has changed markedly since the construction and operation of Lake Eppalock. Irrigation releases from the reservoir have substantially reversed seasonal flow patterns in the Campaspe River from Lake Eppalock downstream to the Campaspe Weir and the Campaspe Siphon (SKM 2006a). Prior to the 2005-06 change in river operations (drought response management) constant high flows occurred during the irrigation season (August to May).

Regulation throughout the Campaspe River catchment has diverted approximately 50% of mean annual discharge for irrigation, stock and domestic use. The Campaspe catchment experienced unprecedented dry conditions from 2001 to 2011, with years with zero allocation to Campaspe irrigators, and passing flows were suspended under the Qualification of Rights (North Central CMA 2009 and G-MW 2009).

The 2010-11 floods delivered high flows including overbank flows to the Campaspe River, commencing its recovery from the drought. Management following the floods has focused primarily on the recovery of the river. Despite high storage levels, the full suite of environmental flow recommendations have not been achieved to date: for example, although four winter high flow events are recommended each year, only one managed flow event of this magnitude was provided in the 2012/13 season.

6.3. Water regime (post CID decommissioning)

The 2012/13 season is the best indicator of how the Campaspe System will be operated post the decommissioning of the CID. With the introduction of carryover and spillable water accounts, removal of the CID and transfer of water to the environment, it is difficult to compare the operation of the river to previous years.

Releases from Lake Eppalock will still need to be provided into Reach 2 to meet irrigation demand in Reaches 3 and 4 but the overall demand will be less, due to increased efficiencies (water savings in Stage 1, 7,058 ML) and de-commissioning of the CID. These could be expected to reduce discharge relative to Section 6.2, during the irrigation months but the inverted seasonal pattern would still prevail. Therefore, releases will continue to be higher than the summer low flow recommendation of 10 ML/day. There will be no change to the way Eppalock is managed during a flood. Pre-releases will only be made when the storage is close to full and if there is rain forecast.

This summary was provided by A. Shields G-MW Tatura, pers comm., 2013.

Environmental flow releases will continue to be made in accordance with recommendations of SKM 2006. However, the volume of environmental water available is now more (than prior to CID decommissioning, 23 GL). The water allocated to the environment from decommissioning of the CID will provide significant benefits to the river.

Figure 3 below provides an example of flows prior to the CID decommissioning (2000/01) compared to the 2012/13 season (first year post CID decommissioning). 7,058 ML was transferred to the VEWH from the G-MW Connections Project in 2012/13 to manage the risks prior to the EWP being developed (G-MW 2012). This enabled the provision of a winter fresh and three summer freshes to cue fish movement and provide longitudinal connectivity during periods of low flow.

Further analysis of the additional water for the Campaspe River (post CID decommissioning) is provided in the mitigation water assessment (Section 7).

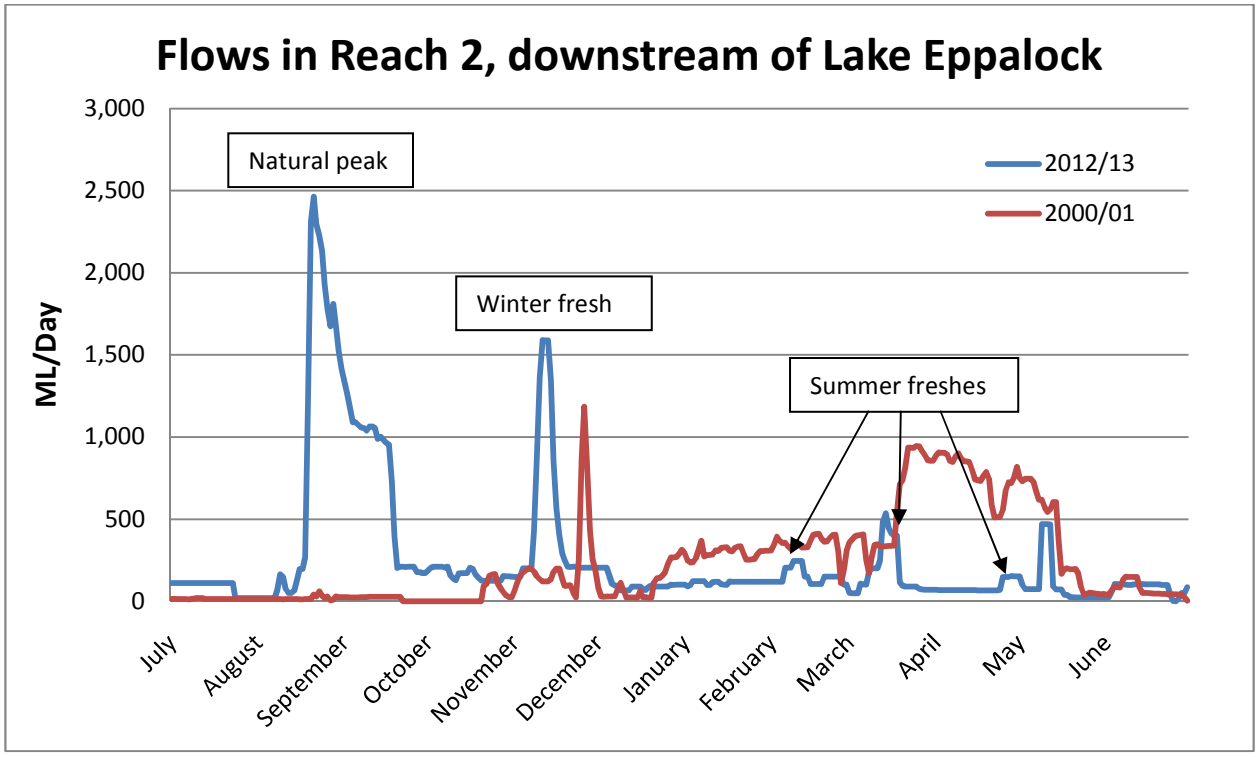

Figure 3: Reach 2 flow comparison (2012/13 and 2000/01)

Note: A detailed analysis of the post CID decommissioning flows within the river has not been undertaken. For the previous Campaspe River EWP (2010), an analysis of the change in flows caused by a reduction in outfalls was undertaken to determine the magnitude of change and therefore the risk to the river. However, due to the transfer of the CID water and losses to the VEWH as outlined in Section 7, this assessment is not considered necessary.

6.4. Streamflow measurement

Discharge in the Campaspe River is measured at four established gauging stations downstream of Lake Eppalock and in Axe Creek at Longlea (Table 7). Water levels are also measured in the Campaspe Weir.

Table 7: Victorian Water Quality Monitoring Network flow gauging stations

Gauging Station ID	Location	Period of Record
406207	Campaspe River at Lake Eppalock tail gauge	October 1976 to current
406201	Campaspe River at Barnadown	March 1881 to current
406202	Campaspe River at Campaspe Siphon	November 1976 to current
406214	Axe Creek at Longlea	November 1976 to current
406218	Campaspe Weir	January 1990 to current
406265	Campaspe River at Echuca	March 1992 to current

7. Mitigation water assessment

The volume of water that is required to offset the impact of the G-MW Connections Project on waterways that have become reliant on this water to support high environmental values is termed 'mitigation water'. The potential impact of the G-MW Connections Project considered in the Campaspe River Reach 2 EWP is related to the decommissioning of the CID in relation to the supply of the high reliability water shares (HRWS).

Other potential impacts to the waterway will be managed in accordance with the Water Change Management Framework and Site Environmental Management Plans. The key water savings principle, relevant to the Water Change Management Framework, identified in DSE's Water Savings Framework for the G-MW Connections Project is that:

> *"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"* (G-MW 2013, p53).

A process for calculating mitigation water based on the best available information has been developed and involves the application of a series of steps that are a series of analyses that support a reasoned judgement as to whether mitigation water is required. These steps are assessed below in relation to assessing the decommissioning of the CID.

Please note: The WCMF terminology used to describe the mitigation water assessment has been revised below to enable the assessment of the CID decommissioning. Previous EWPs have been assessed due to incidental water (e.g. outfalls) providing the hydrological watering regime and it was appropriate to update.

7.1. Step 1: Describe the desired environmental flow regime

The environmental flow recommendations for Reach 2 are described in Section 5.3, the flow components are outlined below:

1. **Summer low flow:**10 ML/day (or natural), 1 per year, duration 6 months
2. **Summer freshes:** 100 ML/day, 5 per year (Feb to May), duration 5 days
3. **Winter low flow:** 100 ML/day (or natural), 1 per year, duration 6 months
4. **Winter high flow:** 1,000 ML/day, 4 per year (or natural), duration 4 days
5. **Winter bank-full flow:** 10,000 ML/day, 1 per year (or natural), duration 2 days
6. **Winter Overbank flow:** 12,000 ML/day, 1 per year, duration 1 day (SKM 2006b).

SKM (2012) recommended that an annual cease-to-flow, although recommended, should not be actively delivered, due to the additional stress these events can create (e.g. low dissolved oxygen), and that these should only occur naturally. The calculated average annual environmental flow shortfall for Reach 2 was 58.6 GL (SKM 2012b).

Environmental flow shortfalls for Reach 2 have been calculated using monthly estimates for Environmental Water Demand along with current regime modelled flow data. The modelling highlighted that the environmental flow recommendations are rarely completely met. The least satisfied flow components are Bankfull and Overbank flows (refer to Appendix E, SKM 2012).

7.2. Step 2: Determine the baseline year incidental water contribution

This step determines the baseline year incidental water contribution from hydrological connections. As outlined in Section 1.5, this EWP is assessing the impact of decommissioning the CID. Only one hydrological connection (Lake Eppalock releases to provide the CID entitlement) exists for the Campaspe River Reach 2 (e.g. there are no outfalls).

The baseline year incidental water contribution is the amount of water received by the waterway from Lake Eppalock to enable the provision of the CID entitlement. The baseline year (2003/04) incidental water recorded was 7,058 ML, the portion of water that reached the waterway equates to 7,058 ML (refer to Table 8 below, G-MW 2012).

Table 8: Determination of the baseline year contribution at Campaspe River Reach 2

Hydrological connection	Baseline year incidental water at origin (Gross) (ML)	Estimated losses between origin (irrigation system) and waterway (for baseline year 2003/04) (ML)	Baseline year incidental water contribution at the waterway (Net) (ML)
Lake Eppalock releases - providing CID entitlement	7,058	0	7,058
TOTAL	**7,058 ML/year**	**0 ML/year**	**7,058 ML/year**

7.3. Step 3: Assess dependency on baseline incidental water contributions

The WCMF specifies the criteria to be applied in assessing whether mitigation water is required for a wetland or waterway with high environmental values. These criteria have been assessed for Campaspe River Reach 2 with the results presented in Table 9.

Table 9: Assessment of Reach 2 dependency on incidental water

Criteria by which mitigation water may be assessed as not required	Link between incidental water and environmental values
1. Mitigation water may be assessed as not required where:	
1.1 There is no hydraulic connection (direct or indirect) between the irrigation system and the wetland or waterway	There is a direct hydraulic connection between delivering the CID entitlement and Reach 2 of the Campaspe River. **Mitigation water may be required**.
1.2 The water does not reach the wetland or waterway with environmental values (e.g. the outfall is distant from the site and water is lost through seepage and evaporation before reaching the area with environmental values)	Water discharges directly into the waterway **Mitigation water may be required**.
2. Mitigation water may be assessed as not required where the wetland or waterway receives water intended for CID:	
2.1 That is surplus to the water required to support the environmental values (e.g. changing from a permanently wet to an intermittently wet or ephemeral regime is beneficial or has no impact)	Desired water regime for Campaspe River Reach 2 is to operate as a permanently flowing stream, therefore CID entitlement is not surplus. Any changes that are likely to cause flows in Reach 2 to drop below the recommended levels should be considered a risk and water should be released from Lake Eppalock to ensure that the required flows are met (SKM 2012). **Mitigation water may be required**.
2.2 That occurs at a time that is detrimental to the environmental values	No, however summer low flows are over and above 10ML/day due to the supply of irrigation through this natural carrier, this will continue post CID decommissioning.
2.3 That is of poor quality (or results in water of poor quality entering a site e.g. seepage resulting in saline groundwater intrusions to wetlands) and the removal of which would lead to an improvement in the environmental values	Water released into waterway from Lake Eppalock is of good quality, and its removal would not result in an improvement in water quality **Mitigation water may be required**.
3. Mitigation water may be assessed as not required where the environmental values:	
3.1 Do not directly benefit from the contribution from the irrigation system (e.g. river red gums around a lake may not directly benefit from an outfall and may be more dependent on rainfall or flooding)	Desired water regime for Campaspe River Reach 2 is to operate as a permanently flowing stream, therefore CID entitlement has provided a direct benefit and is not detrimental to environmental values.

Criteria by which mitigation water may be assessed as not required	Link between incidental water and environmental values
4. Mitigation water may be assessed as not required where the removal of water intended for the CID entitlement does not:	
4.1 Increase the risk of reducing the environmental values (e.g. outfalls form a very small proportion of the water required to support the environmental values and their removal will not increase the level of risk)	The provision of flow in the Campaspe River to provide the CID irrigators with their entitlements is a very large proportion of the water required to support the environmental values (Section 6.3). The CID contribution represents 40% of the average annual shortfall for the period of 1891 – 2008 (SKM 2012b).
4.2 Diminish the benefits of deploying any environmental water allocations (over and above the contribution from the irrigation system)	If the CID contribution to the water regime was removed, the benefits of the environmental flow recommendations would be diminished. For example, additional environmental water may be required to meet summer base-flow and spring and summer freshes.

The above assessment demonstrates that **the environmental values of the Campaspe River Reach 2 are dependent on incidental water (delivery of the CID entitlement).** Some potential impacts from not providing mitigation water are listed below. (Noting that an analysis and risk assessment was not undertaken):

- Flows over the irrigation season are likely to be affected over the whole flow range and particularly the summer low and freshening flows due to the reduction in volume of water being delivered.
- Any changes that are likely to cause flows in Reach 2 to drop below the environmental flow recommendations should be considered a risk and water should be released from Lake Eppalock to ensure that the required flows are met.
- Significant species including Murray Cod and Golden Perch are likely to be impacted by a significant reduction in flows. For example, reduced flows (increased occurrence in cease to flow) will reduce the amount of aquatic habitat, impact on water quality and persistence in permanent pools and therefore impact on fish species.
- The desired flow regime based on environmental flow recommendations is to meet summer fresh and summer low flows and operate Reach 2 as a permanently flowing stream to maintain aquatic habitat and water quality.
- The occurrence of summer cease-to-flow conditions would likely increase and additional environmental water would need to be sourced to manage the risk of water quality decline and fish deaths.

7.4. Step 4: Calculate the annualised baseline mitigation water volume (BMW)

The annualised BMW volume is expressed as the baseline incidental water contributions divided by the number of years in the cycle of the desired water regime. Mitigation water is required in the years that Campaspe River has an environmental flow recommendation (i.e. summer low flow). The desired flow regime for the Campaspe River Reach 2 is a permanently flowing stream (Step 1). Mitigation water is required every year, therefore the net annualised BMW is 7,058 ML.

7.5. Step 5: Calculate the mitigation water commitment (MWC)

The MWC expresses the BMW (Step 4) as a percentage of the annualised baseline incidental water contribution. It is used to calculate the share of annual water savings. These are calculated each year in accordance with the Water Savings Protocol and the associated Technical Manual and will become available in any following year. The mitigation water commitment has been calculated for the hydrological connection in Table 10 below.

Table 10: Determination of the mitigation water commitment at Campaspe River Reach 2

Hydrological connection	Baseline year incidental water contribution at origin (Gross) (ML)	Baseline year incidental water contribution at waterway (Net) (ML)	Annualised baseline mitigation water volume (ML)	Mitigation Water Commitment (%)
Lake Eppalock releases - providing CID entitlement	7,058	7,058	7,058	100%
TOTAL	**7,058 ML/year**	**7,058 ML/year**	**7,058 ML/year**	**100%**

The overall mitigation water commitment for Campaspe River Reach 2 is 100%.

MWC (%) = Gross BMW (Step 4) / Baseline incidental water contributions (Step 2)

= (7,058/7,058) x 100

= 100%

7.6. Step 6: Calculate the LTCE mitigation water volume

The LTCE mitigation water volume is used to account for mitigation water when reporting against the net savings target. This volume is calculated by multiplying the mitigation water commitment (Step 5) by the baseline mitigation water volume (Step 4) and the LTCE conversion factor.

Please note: calculation and confirmation on the LTCE conversion factor is provided in the Campaspe River EE 2013, refer to Section 7.7.

Source of Campaspe River Reach 2 mitigation water:

Campaspe River Environmental Entitlement 2013
The purpose of this gazetted document is to grant the VEWH an environmental entitlement for water recovered due to the decommissioning of the CID. The water recovered is made up of 15,052 ML of purchased high reliability water shares and 8,100 ML of long-term average loss savings (refer to section 7.7).

7.7. Environmental Entitlement assessment

The Northern Region Sustainable Water Strategy (NRSWS) (DSE 2010) background report identified that an additional volume of 30 GL/year in Reach 4 of the river (below Campaspe Siphon, see Figure 1), is required to be able to meet all of the minimum environmental flow recommendations (category 6 outcome). This includes the delivery of bankfull flows in Reach 4 which may be accompanied by overbank flows in Reach 3.

The Campaspe River EE 2013 grants the VEWH an environmental entitlement for water recovered due to the decommissioning of the CID. The transfer of the full entitlement to the environment provides the source of mitigation water. Table 11 defines the water available under this entitlement and specifies the reliability and allocation based rules for the use of this water.

Table 11: Environmental Entitlement components and allocation rules (Victorian Government 2013)

Source of entitlement	Maximum available volume (ML)	Allocation rules
Campaspe irrigation district (CID) fixed annual losses	1,656*	Full volume available at 1 July of any year.
CID variable delivery loss - high-reliability	3,944*	Full volume available at a seasonal determination of 100% for high-reliability water shares. Allocation against this component increases linearly with seasonal determination for high-reliability water shares.
CID variable delivery loss – low-reliability	2,966*	Full volume available at a seasonal determination of 100% low-reliability water shares. Allocation against this component increases linearly with seasonal determination for low-reliability water shares.
CID high-reliability entitlement	15,052	Full volume available at a seasonal determination of 100% for high-reliability water shares. Allocation against this component increases linearly with seasonal determination for high-reliability water shares.
Total	**23,152 ML**	Long-term average volume

*Note: Long-term average entitlement the combination of these three entitlements is not to exceed the 8,100 ML average.

There is a now a total of approximately 28 GL/year[2] available on average to the environment from within the Campaspe River basin as a result of the closure of the CID and purchases by the Commonwealth Environmental Water Holder (CEWH). SKM (2012b) undertook an assessment of the potential use of 28GL on average each year in the Campaspe River basin to meet environmental objectives (Summarised in Appendix E). This modelling showed that the volume of water required to satisfy environmental requirements in each reach exceeds the 28 GL/year available. Therefore, the transfer of water from decommissioning of the CID will provide significant benefits to the river.

Overall, the Campaspe River EE 2013 provides the VEWH with the ability to manage risks likely to arise from the removal of the losses and entitlement water from the Campaspe River, and to contribute to the long-term health of the river.

[2] With the closure of the CID, a long term average of 22 GL/yr of water savings has been made available in the Campaspe River basin. Also for consideration, the CEWH holds a little more than 6.2 GL of high reliability water share (HRWS) and 0.4 GL of low reliability water share within the basin from buybacks. Therefore 28 GL/yr was modelled as available on average for the environment in the catchment.

8. Environmental water sources

Campaspe River Environmental Entitlement 2013

The purpose of this Instrument is to grant the VEWH an environmental entitlement for water recovered due to the decommissioning of the CID as part of Stage 1 of the G-MW Connections Project. The water recovered is made up of 15,052 ML of purchased high-reliability water shares and 8,100 ML of long-term average loss savings. VEWH are responsible for paying storage and supply costs for the 15,052 ML entitlement. They do not have to pay storage and supply costs for the 8,100 ML, however this entitlement cannot be carried over. Within 12 months of the 1 July 2013, the VEWH, together with the Storage Manager, must develop operating arrangement for the supply of water under this entitlement. VEWH must also ensure that there is adequate metering within the Campaspe System to demonstrate compliance with this entitlement (Victorian Government 2013).

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 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). The 2012 BE amendment allows for the reduction and banking of passing flows in Lake Eppalock for later deployment. 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) (Victorian Government 2000).

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 14 March 2012, a total of 6,547 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 is held by the CEWH, which is 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 (Australian Government 2013).

Victorian Environmental Water Holder (VEWH)

The Victorian River Murray Flora and Fauna Bulk Entitlement provides a 27,600 ML entitlement of high reliability water in the Murray System. It is held by the VEWH 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 (Victorian Government 1999).

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 en-route 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 (Victorian Government 2007).

Table 12 below provides a summary of the environmental water that is available for the Campaspe River post CID decommissioning.

Table 12: Environmental water available for the Campaspe River post CID decommissioning

Water holder	Origin	Availability	HRWS (GL)	LRWS (GL)	Long term cap equivalent
CEWH	Buybacks	Current	6.4*	0.4*	~ 6 GL/year
VEWH	Living Murray	Current	0.12*	5.0*	~ 3.8 GL/year
G-MW	Bulk entitlement	Water is available to the environment under the BE as passing flows. This volume is not quantified as an average annual volume			
VEWH	CID closure	Proposed	20.0*	3.0*	23 GL/year
Total					33 GL/year

*Approximate volumes

9. Environmental water priorities

A Seasonal Watering Proposal (SWP) is developed by the North Central CMA each year and outlines the proposed priorities for use of environmental water, in the Campaspe River System downstream of Lake Eppalock. When delivering environmental flows to the Campaspe River system, the overarching priority is to provide flows to Reach 2, due to its high environmental values and the ability to deliver water. As identified in Section 5.3 management of flows in Reach 2 will also provide benefit to the downstream reaches. Once flows have been optimised in Reach 2, focus will shift to the lower reaches.

A set of 'hierarchical principles' have been established to manage the river during critical water shortages. The highest risk and stress period for the river is during the summer months with associated water quality issues and the inherent risk to the native fish populations. As management shifts down through the priority flow components, objectives shift from drought and avoiding catastrophic events, to recovery from drought, and finally to building permanent improvement in the ecological health of the river. The priority critical flows components are detailed below and illustrated in Figure 4 (North Central CMA 2013).

1. Summer low flows

Water quality decline, principally dissolved oxygen and salinity stratification of the pools in summer under low flow conditions, poses a significant risk to the native fish populations. Summer base flows, should be maintained at all times to reduce the possibility of water quality problems and fish deaths.

2. Underwrite next season's summer low flows

Management under extreme climatic conditions is focused on critical life support for the system. Once the current summer low flows have been secured, the next priority is to set water aside to underwrite the provision of summer low flows for the next season.

3. Reduced winter low flows

Provide a less than recommended winter low flow (reduced daily flow rate) principally for native fish and macroinvertebrate populations. This is to ensure that the native fish pools are at least maintained during the critical water shortage for later recovery. Water quality problems, while reduced in winter, still pose a threat. Therefore, a reduced low flow during the winter is preferred to maintain the fish populations and prevent water quality decline.

4. Winter high flow

Transitioning from drought survival to recovery, it is important to provide conditions for fish movement, to water riparian vegetation and maintain macroinvertebrate habitat. The provision of this flow allows fish to move to optimise their habitat and potentially breed. An objective of this flow is to flush the river channel and the higher benches of organic material during the cooler winter months to reduce the likelihood of blackwater events should there be high flows during the warmer months.

5. Full winter low flows

As more water becomes available the winter low flow recommendation should be implemented for as long as possible. This provides prolonged longitudinal connectivity along the river for fish. It also provides improved habitat for macroinvertebrates and maintains water quality in the river.

6. Summer freshes

Summer freshes should then be reintroduced once the winter base flows and at least one high flow have been provided. The objective of these freshes is for fish, during the high risk summer period. The flows also improve water quality and macroinvertebrate habitat.

7. Remaining winter high flows

As more water becomes available, more winter high flow components can be introduced with the aim of providing all four required under the flow recommendations. At this level, a more complete flow regime is being provided to the river with the exception of bank-full and over bank flows.

8. Lower reach targets

The delivery of the preceding seven priority flow components will have maximised the environmental conditions in Reach 2. The delivery of the flows however may not meet the flow magnitudes required in the lower reaches due to the higher flow volumes needed. As more water becomes available, flows should be increased to provide the necessary volumes required under the flow recommendations in reaches 3 and 4.

The above principles underpin environmental water management decisions and deployment each year. Depending upon the prevailing climatic conditions, unregulated flows and irrigation releases may provide these flows. The above principles will need to be adaptively managed and considered during scenario planning. Figure 4 shows the proposed delivery schedule for the Campaspe River system in 2013-14.

Information sourced from 2013-14 Campaspe River Seasonal Watering Proposal (North Central CMA 2013)

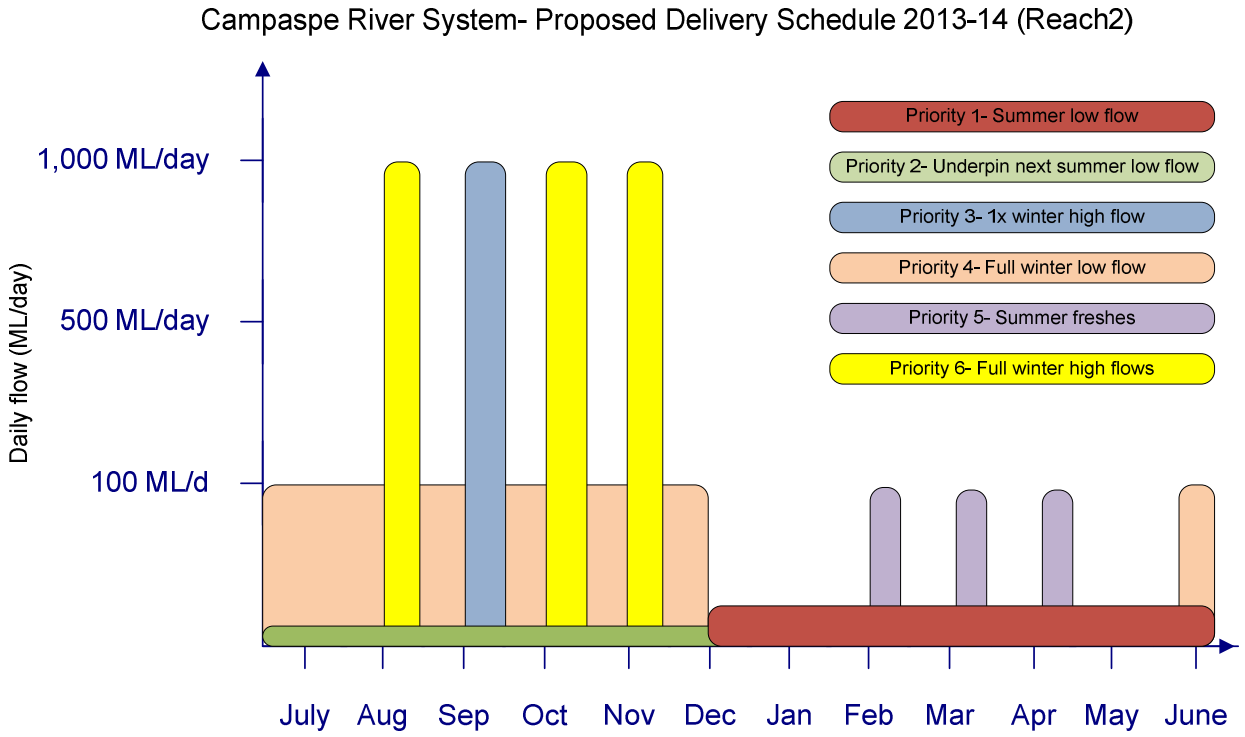

Figure 4: Priority watering actions for 2013-14 for the Campaspe River System (North Central CMA 2013)

Note: this schedule is from the 2013-14 Campaspe System SWP and is based on the best available knowledge as at February 2013. It should be used as a guide only as priorities may change throughout a season.

As identified in Section 8, there are several sources of water available to provide the priority flow components identified above. Decisions will need to made by the environmental water manager as to which entitlement will be used for each priority flow component. For example, as the 8,100 ML entitlement becomes available (allocation granted to the system) from the Campaspe River EE 2013, this entitlement would be allocated to the first priority summer low flow as it cannot be carried over. Entitlements that can be carried over would be allocated to underwriting next season's summer low flows (priority 2).

Also, as outlined in Section 8, some of the Campaspe River EE 2013 can be used in other systems (e.g. Boort District Wetlands) to achieve the maximum environmental benefit with the available water within operational constraints.

10. Opportunities to deliver water

The following section outlines the opportunities to deliver water including any infrastructure requirements to deliver environmental water in the Campaspe River (downstream of Lake Eppalock to the Murray River).

Campaspe River Reach 2

The following implications exist for Reach 2:

1. Bankfull flow: to achieve 8,000 ML/day at Rochester, the flow rate required at Barnadown is 9,600 ML/day. This assumes 30% flow contribution from Mt Pleasant Creek at Barnadown which is close to the bankfull capacity in Reach 2 (10,000 ML/day). If it was attempted to achieve this flow from Lake Eppalock, a much higher flow rate would be required to allow for flow attenuation, which could result in overbank flows in some locations along Reach 2 (SKM 2012b). Therefore, it is recommended to make use of a naturally occurring event to release a smaller volume from Lake Eppalock and allow for some inflow to occur from Axe Creek and Mt Pleasant Creek. This is recognised to potentially be very difficult and further studies are required to provide the best sequencing for such a release.
2. Water quality

   Cold water pollution: temperature impacts downstream of Lake Eppalock should be managed by adjusting the water release level. This may be feasible given that Lake Eppalock already has a multi-level offtake tower, however OH&S issues exist when changing the outlet level.

   Anoxic water conditions: similar to cold water pollution, anoxic water can be released from Lake Eppalock. Thermal stratification resulting in low dissolved oxygen levels have been experienced in the Campaspe River. A cone valve exists that potentially reoxygenates releases, however there is anoxic conditions have occurred in the 201/13 season immediately downstream of Lake Eppalock when releases from the outlet tower are lower than eight metres.

   End-of-Valley Salinity Target: end-of-valley salinity targets are set for each tributary catchment in the Murray Darling Basin. The Campaspe Weir is the compliance point for the Campaspe River, and an annual median (50 %ile) target of 412 µS/cm has been set (Commonwealth Government 2007). Environmental flow releases delivered as part of the Campaspe River EE 2013 will need to ensure that this target is still achieved.

Campaspe River Reach 3

Environmental flow recommendations in Campaspe River Reach 3 are delivered via the Campaspe Weir, however the following recommendations would enhance the delivery of the desired flow regime:

1. Campaspe Weir investigations undertaken by G-MW have recommended a remediation option to strengthen the Campaspe Weir and extend its life for a further 20 years. Any works undertaken will need to consider environmental water uses both upstream and downstream of the weir (e.g. the weir pool is an important environmental refuge).
2. To provide the winter bankfull flow component to Campaspe River Reach 3 there is a constraint at the Lake Eppalock outlet capacity at less than FSL (maximum 1,850 ML/day). Recommendations to modify Eppalock releases and piggyback on high tributary inflows have been made (SKM 2006d) for consideration by the Environmental Water Manager.

Campaspe River Reach 4

There are two main issues that constrain the delivery of bankfull flows to Reach 4 by means of an in-stream release:

1. Longitudinal variations in channel capacity mean that the bankfull requirements of Reach 4 cannot be achieved without overbank flows in Reach 3. These overbank flows are likely to flood private property, see Section 8.

2. To provide the winter bankfull flow component to Campaspe River Reach 4 the same constraint at the Lake Eppalock outlet capacity as described for reach 3 applies. Furthermore, the revised bankfull requirements of Reach 4 cannot be solely achieved from a Lake Eppalock release. As the maximum release rate from Lake Eppalock is 1,850 ML/day, a flow rate of 10,000 ML/day can only be achieved in Reach 3 if there is significant tributary contribution, or this release is made in conjunction with a high flow event (SKM 2012b).

   As the maximum that can be achieved in Reach 4 from in-stream flows without flooding Reach 3 is around 6,400 ML/day (Section 8.2), this leaves about 2,600 ML/day being required from the WWC. While this flow rate is within the conveyance capability of the WWC (up to 3,500 ML/day), the capability to release such a volume from the WWC into the Campaspe River is limited by outlet capacity (estimated at 2,300 ML/day), the irrigation requirements at that time, and could be affected by high flows in the Campaspe (SKM 2006c). This needs to be investigated in more detail.

11. Potential risks or adverse impacts

An important component of the EWPs is the identification of potential risks, limiting factors and adverse impacts associated with the delivery of the desired watering regime. Table 13 outlines the risks, limiting factors and potential impacts associated with the provision of mitigation water as a component of the desired watering regime that need to be considered by G-MW in conjunction with the environmental water manager. Mitigation measures have been recommended to minimise the likelihood or the risk occurring and/or its potential impact.

Table 13: Potential risks, impacts and mitigation measures

Risk/limiting factors	Impacts	Mitigation measures
G-MW		
Storage Operator maintenance works affects ability to deliver water.	Environmental flow objectives not met. Potential for water quality decline leading to fish deaths.	Ongoing dialogue with G-MW (resource manager) regarding maintenance schedule, to assist in timing releases when there is available capacity to meet desired flow rates.
Resource Manager cannot deliver required volume or flow rate (outlet/capacity constraints, insufficient storage volume).	Environmental flow objectives not met. Potential for water quality decline leading to fish deaths.	Ongoing dialogue with G-MW (resource manager) regarding consumptive demand in the system, to assist in timing releases when there is available capacity to meet desired flow rates.
Opportunistic diversion licenses (unregulated) and entitlements from river.	Artificial lowering of water level threatening environmental flow objectives.	Ongoing dialogue with G-MW (resource manager) regarding consumptive demand in the system and monitoring of deep pools to ensure water quality and habitat in the river is sufficient.
Lake Eppalock releases from below eight metres cause cold water pollution and anoxic conditions in the river.	Water quality decline, potential for fish deaths and poor river health.	Work with G-MW to improve operation (OH&S issues) of multi-level offtake tower.
Continued irrigation releases that are more than the summer low flow recommendation have a negative consequence for the river.	Ecological objectives not achieved.	Continue to work with G-MW to seek opportunities to improve releases (closer to environmental flow recommendations) for consumptive use.
Campaspe Weir fails	Catastrophic sedimentation into Reach 3. Weir pool drought refuge lost	Long-term goal to connect the river and investigate options for Campaspe Weir.
VEWH		
Modelled End-of-Valley salinity target exceeded	Costs to State Government for each EC over target level.	Report to DEPI on environmental water management and End-of-Valley salinity levels.
Cost of delivery exceeds available funding.	Environmental water cannot be delivered.	Secure adequate funding for Campaspe River EE 2013.
North Central CMA		
Current environmental flow recommendations are inaccurate.	Ecological objectives not achieved.	• Undertake ongoing ecological monitoring of releases to assist in refining flow recommendations over time • Use annual operation monitoring to inform annual priority flow components. • Source funding to establish baseline and use of the additional environmental entitlements.
Environmental releases cause flooding of private land.	• Damage to private and public land. • Loss of private and public assets.	• Maximum regulated release volume of 1,500 ML/day, which is within normal system operations. • Ensure on ground monitoring of water levels is undertaken for every high flow event. • Work closely with storage manager and cease regulated release if high catchment runoff flows are predicted. • Engage the community and undertake local media prior to releases. • Work with local G-MW office to reduce potential flooding of diverters' infrastructure.
Environmental release cause flooding to public infrastructure.		
Environmental releases causes flooding of Crown land.		
Key stakeholders not supportive of environmental water release.	Negative response from community and key stakeholders.	• Engage the community in the development of SWPs. • Undertake local media prior to releases.

12. Adaptive management framework

The G-MW Connections Project is established to implement the modernization of irrigation, and its role in the operation of the modified GMID or environmental management in the region is both temporary (bounded by the life-span of the Connections project) and limited to quite specific areas, as given in the WCM. Therefore G-MW Connections Project needs to establish effective management arrangements to ensure that any management or mitigation measures are implemented on an ongoing basis, particularly in the EWPs.

A key G-MW Connections Project principle is that an adaptive management approach is adopted to ensure an appropriate response to changing conditions (Section 9.4, G-MW 2013). Adaptive management is a continuous management cycle of assessment and design, implementation, monitoring, review and adjustment. Table 14 shows how the adaptive management approach will be applied in the context of this EWP.

Table 14: Adaptive management framework

Adaptive management phase	Application to this EWP (Responsible agency)	When (Sections 15 and 19, G-MW 2013)
Assessment and design	Assessment identifies environmental values, their water dependencies, and the potential role of Campaspe River EE 2013. Design determines the desired water regime to support environmental values and determines any mitigation water commitment. Details of both these phases are documented in this EWP. (G-MW Connections Project)	2013
Implementation	Implementation is the active management of environmental water, of which mitigation water may form a portion, consistent with this EWP. (Agencies as appropriate)	Continuous
Monitoring (and reporting)	Monitoring is gathering relevant information to facilitate review and enable any reporting obligations to be met. Two types of monitoring are required. Compliance monitoring is checking that the intended water regime is applied. Performance monitoring is used to inform the review of the effectiveness of the interim mitigation water contribution to achieving the water management goal. Other agencies – monitoring to inform assessment of achievement of environmental objectives)	Annual
Review	Review is evaluating actual results against objectives and identifying any improvement opportunities which may be needed. (G-MW Connections Project, until responsibilities transferred to other Agencies)	2015, 2020, 2025, etc
Adjustment	Adjustment is determining whether changes are required following review or after considering any new information or scientific knowledge and making any design changes in an updated version of the EWP. (G-MW Connections Project, until responsibilities transferred to other Agencies)	2015, 2020, 2025, etc

12.1 Monitoring and reporting

It is assumed that if mitigation water is supplied in accordance with the environmental flow recommendations and hierarchical principles defined in Section 10 then environmental values potentially impacted by the decommissioning of the CID will be maintained. The G-MW Connections Project will report, annually, on the contribution, or provision, of the Campaspe River EE 2013 towards achieving the water regime (Section 18, G-MW 2013). This will be done through liaison with other agencies in relation to monitoring and reporting on:

- Proportion of Campaspe River EE 2013 that was available for the Campaspe River.
- The Campaspe River EE 2013 was delivered to the waterway in accordance with the environmental flow recommendations.
- Decisions made on how the water was deployed to the waterway for that year.
- The ecological objectives were achieved or are being achieved.

The reporting of delivery of environmental water other than environmental entitlement is also required because it is impossible to partition the achievement of ecological objectives between each source of environmental water.

It is expected the VEWH will fund the monitoring of environmental water delivery (i.e. quantity, timing, duration and frequency) and in some cases DEPI will fund detailed monitoring program to enable assessment of ecological condition. The G-MW Connections Project will not implement a detailed monitoring program. It is beyond the scope of this EWP to provide a detailed monitoring program to determine the effectiveness of the recommended water regime in achieving ecological objectives and the overall environmental flow regime.

G-MW (2013, p95) states that "*monitoring requirements will be designed to be consistent with the Catchment Management Authorities' existing monitoring programs*". There is already an ongoing environmental flow, water resource planning and water quality monitoring program for the Campaspe River conducted by the North Central CMA and Goulburn-Murray Water. This monitoring program is seen as sufficient and will be used to inform the outcomes of the use of the Campaspe River EE 2013 (refer to Appendix D). The recommendations within this EWP will be regularly reviewed as outlined in Table 14.

12.2 Review

Periodic reviews provide the opportunity to evaluate monitoring results in terms of compliance, ecological objectives and to learn from implementation. It is expected this EWP will be reviewed in 2015, 2020 and every five years thereafter, or at any time, if requested by the Victorian Minister for Water or Commonwealth Minister for Environment Protection, Heritage and the Arts (Sections 15 and 19, G-MW 2013).

12.3 Adjustment

Adjustments may be made to:

- operational management
- management hypotheses and, perhaps, to ecological objectives
- cope with unexpected issues.

These adjustments will be incorporated into the EWP by the environmental water manager.

13. Management and governance arrangements

A summary of the roles and responsibilities of the various bodies relating to the delivery and review of management and mitigation measures is provided in Table 15 (G-MW 2013). The table outlines the roles and responsibilities before and during the implementation of the G-MW Connections Project in the modified GMID.

Table 15: Roles and Responsibilities

Agency	Assess and develop management and mitigation measures	Deliver and review management and mitigation measures during G-MW Connections Project implementation
G-MW Connections Project	• Identify and account for water savings, subject to audit by DEPI accredited auditor. • Lead the assessment and development processes for management and mitigation measures including developing and gaining approval for the WCMF (which guides the development of EWPs and the assessment of mitigation water). • Maintain short-list of all wetlands, waterways and groundwater dependent ecosystems for mitigation. • Identify and source mitigation water required implementing management and mitigation measures including the adaptive development of EWPs. • Retain or provide infrastructure to deliver water to waterways and wetlands. • Convene and chair the Technical Advisory Committee. • Convene the Expert Review Panel	• Apply, review and, as necessary, develop amendments and gain approval to updated versions of the WCMF. • Provides resources to enable monitoring and review of management and mitigation measures. • Establish protocols for transfer of responsibility to relevant agencies. • Coordinate with other agencies to improve management and mitigation measures. • Arrange for the provision of delivery and measurement infrastructure including capacity and operational flexibility for mitigation water • Work closely with system operator.
Catchment Management Authority	• Identify and inform G-MW Connections Project of opportunities for best practice. • Inform G-MW Connections Project of its infrastructure requirements to deliver environmental water. • Participate in Technical Advisory Committee. • Agree to implement relevant components of Environmental Watering Plans. • Agree to implement other relevant regional management and mitigation measures required due to the implementation of the G-MW Connections Project.	• Advise Environmental Water Holder and system operator on priorities for use of environmental entitlements (including mitigation water) in line with recommendations outlined in the EWPs • Implement the relevant components of Environmental Watering Plans. • Operate, maintain and replace, as agreed, the infrastructure required for delivery of mitigation water, where the infrastructure is not part of the G-MW irrigation delivery system. • Report on environmental outcomes (e.g. wetland or waterway condition) from the delivery of the water, in the course of normal reporting on catchment condition. • Where agreed conduct the periodic review of EWPs and report results to G-MW Connections Project.

Agency	Assess and develop management and mitigation measures	Deliver and review management and mitigation measures during G-MW Connections Project implementation
		• Manage and report on other relevant catchment management and mitigation measures required due to the implementation of the G-MW Connections Project.
Land Manager (Public and private as relevant)	• Identify and inform G-MW Connections Project of opportunities for best practice. • Participate in Technical Advisory Committee. • Agree to implement relevant components of Environmental Watering Plans. • Agree to implement other relevant regional management and mitigation measures required due to the implementation of the G-MW Connections Project.	• Implement the relevant components of Environmental Watering Plans. • Operate, maintain and replace, as agreed, the infrastructure required for delivery of mitigation water, where the infrastructure is not part of the G-MW irrigation delivery system. • Where agreed, participate in the periodic review of relevant EWPs. • Manage and report on other relevant catchment management and mitigation measures required due to the implementation of the G-MW Connections Project.
System Operator	• Identify and inform G-MW Connections Project of opportunities for best practice. • Participate in Technical Advisory Committee. • Agree to implement relevant components of Environmental Watering Plans. • Administer management and operational arrangements.	• Implement the relevant components of Environmental Watering Plans, namely delivery of mitigation water. • Operate, maintain and replace, as needed, the infrastructure required for delivery of mitigation, or other, water, where the infrastructure is part of the G-MW irrigation delivery system. • May negotiate transfer of ownership of infrastructure to the environmental water/land manager for provision of mitigation water if it is no longer required for the public distribution system. • Where the infrastructure assets are due for renewal or refurbishment, the water corporation will undertake the upgrade to the best environmental practice, including any requirements to better provide Environmental Water Reserve. • Report annually on the availability and delivery of water for mitigating environmental impacts as part of reporting upon meeting obligations under its bulk entitlement. In some instances, it will be appropriate to measure mitigation flows to ensure mitigation volumes of water are delivered. • Work closely with G-MW Connections Project
DEPI	• Identify and inform G-MW Connections Project of opportunities for best practice. • Participate in Technical Advisory Committee. • Arrange funding to enable environmental water manager, catchment manager and land manager to deliver agreed measures.	• Participate in the periodic review of the Water Change Management Framework and relevant EWPs. • Conduct review as part of the long-term water resource management; a requirement specified in Section 22L of the Water Act 1989. The process will allow:

Agency	Assess and develop management and mitigation measures	Deliver and review management and mitigation measures during G-MW Connections Project implementation
	• Develop policies to address relevant issues (assuming that other agencies will participate in policy development).	- the balance of the environmental obligations and consumptive water to be assessed and restored based on certain conditions. - the need for the obligation reviewed based on the environmental values at the time of the review.
Environmental Water Holder	• Identify and inform G-MW Connections Project of opportunities to enhance environmental water delivery infrastructure • Ensure that environmental and mitigation water management continues to become more efficient; while optimising benefits to the environment • Make adaptive, responsive and timely decisions about where and when environmental water is delivered – keep G-MW Connections Project informed of process. • Examine opportunities within GMID to trade water allocations and entitlements, where this optimises environmental benefits	• Hold and manage environmental entitlements, including mitigation water that becomes a defined entitlement. • Consult with CMAs in identifying priority wetlands, waterways and groundwater systems for environmental watering. Plan and report on the use of environmental entitlements. • Participate in the periodic review of relevant EWPs. • Negotiate with Commonwealth Environmental Water Holder to arrange delivery of Commonwealth environmental water.

14. Knowledge gaps and recommendations

The Campaspe River Reach 2 EWP has been developed using the best available information. However, a number of information and knowledge gaps exist which may impact on recommendations and/or information presented in the EWP. These are summarised below.

14.1 G-MW operations

Supply of irrigation entitlements from the river

Further information and the location of the G-MW customers that will remain on and new customers that will divert from the river need to be confirmed. This will allow assessment of the potential impacts on the waterway and inclusion in the monitoring program.

14.2 Campaspe River Environmental Entitlement 2013

Operating arrangements

The operating arrangements for the supply of water under this entitlement have not been established. The Campaspe EE 2013 requires them to be developed and agreed on by VEWH and the Storage Manager within 12 months of 1 July 2013.

14.3 Environmental flows

Risks and tolerances

The 2013-14 Campaspe River SWP identified that a major knowledge gap involving the management of environmental water is the lack of information regarding optimal frequencies, durations and timing of flow components to achieve the ecological objectives. The lack of information regarding tolerances and risks reduces the ability for informed critical analysis to be undertaken regarding the degree to which the flow component achieved the ecological objective.

The environmental flow recommendations only specify an annual flow regime and do not consider inter-annual variations and tolerances. For example, the risk the river is being subjected to if the summer fresh if the is run at 80 ML/day for three days instead of 100 ML/day for five days needs to be determined.

Summer low flow

Reach 2 has some of the highest environmental values, however this reach carries all irrigation demands for downstream reaches, which dominates river flows during the irrigation season. The recommended summer low flow will continue to be exceeded in the majority of days due to irrigation releases from Lake Eppalock. This continued higher than recommended flow rate for the summer low flow needs to be reviewed.

Cease to flow

SKM (2012) recommended that the annual cease-to-flow should not be actively delivered, due to the additional stress these events can create (e.g. low dissolved oxygen). It is recommended that this flow component should be added to the risks and tolerances assessment identified above.

Native fish

Exotic fish species, including Carp, have become dominant in the Campaspe River. Further investigations into the flows that benefit native fish are required, monitoring has found that they are spawning but not recruiting (*Darren White, North Central CMA pers comm., 6 May 2013*).

14.4 Infrastructure

Lake Eppalock releases

- Water quality impacts downstream of Lake Eppalock could be managed by adjusting the water release level. This may be feasible given that Lake Eppalock already has a multi-level offtake tower, however OH&S issues exist when changing the outlet level.
- To provide the winter bankfull flow components to all reaches, recommendations to modify Eppalock releases and piggyback on high tributary inflows have been made. SKM (2012b) acknowledged that it could be difficult for releases from Lake Eppalock to be managed for perfect timing without tributary inflows. Further floodplain hydraulic studies have been recommended for determining the optimal timing of release under a variety of conditions.

  SKM (2012b) also found that 6,400 ML/day was the highest flow rate that can be delivered at Echuca along the Campaspe River channel without flooding Reach 3, where the bankfull flow rate of 8,000 ML/day would occur.

Lake Eppalock capacity

The recommended winter bankfull and overbank flows to the Campaspe River downstream of Eppalock, which range from 8,000 to 12,000 ML/day, are constrained by the available outlet capacity of Lake Eppalock. At less than fully supply level, Eppalock outlet capacity is 1,850 ML/day. The capacity of Lake Eppalock outlet works could be increased to 12,000 ML/day, however the cost of doing this is estimated at $AUD 25 million (SKM 2006d).

Campaspe Weir

Any modification to the Campaspe Weir will need to consider environmental water values both upstream and downstream of the weir (e.g. the weir pool is an important environmental refuge).

Campaspe Siphon

Downstream of Campaspe siphon, part of the recommended winter bankfull and overbank flow could also be delivered from the Waranga Western Channel. However, this is constrained by outfall capacity (1,470 to 2,300 ML/day), and off-season maintenance requirements. This needs to be investigated in more detail.

15. References

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Appendix A: G-MW Connections Project ETAC

Table A1: ETAC members and observers

Name	Organisation and Job title
Members	
Anne Graesser	Manager – Water Systems Health Goulburn-Murray Water
Emer Campbell	Executive Manager – Murray Campaspe Avon Richardson Catchments North Central CMA
Jen Pagon	Catchment and Ecosystem Service Team Leader Department of Primary Industries
Andrea Keleher	Manager Sunraysia Department of Sustainability and Environment
Carl Walters	Shepparton Irrigation Region Executive Officer Goulburn Broken CMA
Ross Plunkett	Executive Manager Planning Goulburn-Murray Water
Tamara Boyd	State Parks and Environmental Water Coordinator Parks Victoria
Observers	
Paulo Lay	A/Director, Environmental Water Reserve Sustainable Water Environments Department of Environment and Primary Industries
Chris Solum	Environmental Program Manager Goulburn-Murray Water
Mark Paganini	Connections Manager Planning Goulburn-Murray Water
Karen Weaver	Senior Policy Officer Department of Environment and Primary Industries
Pat Feehan	Consultant Feehan Consulting
Bruce Wehner	Ranger Parks Victoria

Appendix B: Flows method

The environmental flow recommendations provided in section 5.3 outline the desired watering regime for the Campaspe River Reach 2 and are used as part of the calculations for mitigation water (Section 7).

The FLOWS method which has been specifically developed for determining environmental water requirements in Victoria was used to determine environmental flow requirements for the Campaspe River, including reach 2.

The FLOWS method is based on the concept that key components of the natural flow regime influence various biological, geomorphological and physico-chemical processes in waterways. It involves the collection of information through desktop studies, field assessments and stakeholder consultation (Figure A1) (DNRE 2002).

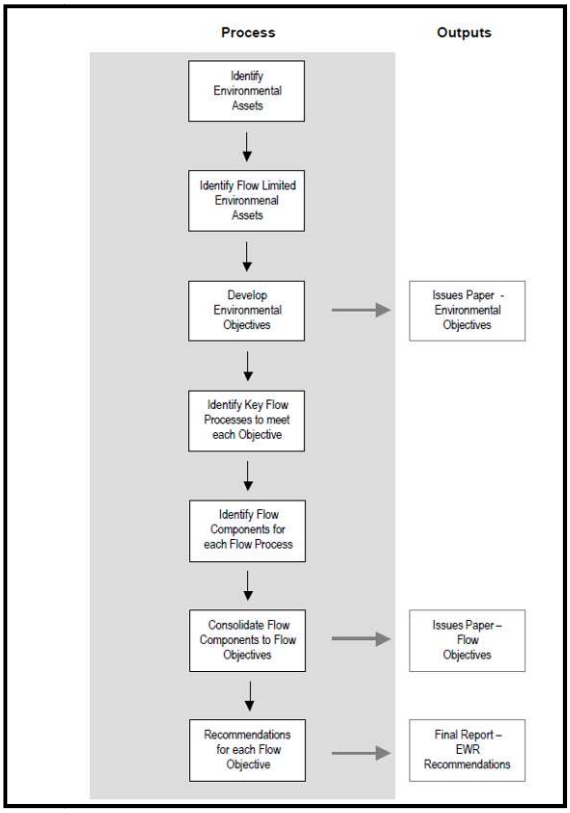


Figure A1: Outline of the process for the determination of environmental and flow objectives

The intent of an environmental flows study (FLOWS method) is to state objectives that would, if met, mean that the flow could sustain an ecologically healthy river. Therefore the objectives are developed not only to protect current conditions or environmental assets of concern, such as threatened species, but also to sustain natural communities and processes that are essential for river health (DNRE 2002). The steps below summarise the process undertaken in the FLOWS method:

Step 1: Identify current environmental assets

A list of current environmental assets (species and communities) is collated. While this list is not restricted to threatened biota it is critical that the flow recommendations do describe conditions required for their protection:

- *Particular species and communities*
  - Species: threatened aquatic invertebrates, all fish, all frogs, all aquatic reptiles, all aquatic mammals, colonial water birds, threatened water birds, threatened aquatic and riparian plants
  - Communities: Riparian Ecological Vegetation Classes, Wetlands of significance (Ramsar, DIWA, Bioregion), AusRivAS score for the aquatic invertebrate community
- *Flagship/locally significant species/communities*
- *Habitats*
  - Channel morphology (pools, benches, riffles etc.)

- Instream habitat: large woody debris, aquatic vegetation
- Wetlands

- *Ecological processes*
  - Linkages/connectivity
  - Geomorphic processes
  - Nutrient cycling

Step 2: Identify assets expected to be associated with a "healthy" waterway

The environmental assets that need to be reinstated or improved in order to achieve the 'ecological healthy state' are identified.

Step 3: Develop environmental objectives

From steps 1 and 2, a group of assets are selected which are flow dependent and for which there is good understanding of their flow requirements. Environmental objectives are developed for each environmental asset.

Step 4: Identify key flow related events and flow components to meet each environmental objective

For each environmental asset, the flow-related events or processes that are critical in order to meet the environmental objectives are identified. There may be a number of these for each asset. The flow related events may be to meet a biological need, such as a trigger for spawning, or to provide physical habitat, such as inundation of snags or maintenance of suitable water quality in pools. An example is provide in Table A1 below.

Table A1: Example of flow processes and components for Murray Cod

Ecological asset	Objective	Flow related events	Flow component
Murray Cod	Self sustaining populations of Murray Cod	1. Movement 2. Recruitment 3. Habitat availability in summer 4. Water quality in summer	1. High flow(winter) 2. Freshes (winter/spring) 3. Low flow (summer) 4. Freshes (summer)

Step 5: Develop flow objectives

Each flow component is described in terms of timing, frequency or duration required to meet the environmental objectives. The flow objectives must meet the requirements of the environmental objectives.

Step 6: Develop recommendations to meet each flow objective

The environmental water recommendations are developed to provide the described flow objectives (Hydraulic modelling).

Adapted from DNRE 2002

Appendix C: Flora and Fauna Species List for Campaspe River Reach 2

Compiled: April 2013

Sources:

Data Source: *Biodiversity Interactive Map*. Department of Sustainability and Environment http://mapshare2.dse.vic.gov.au/MapShare2EXT/imf.jsp?site=bim (Accessed December 2012).

Data Source: 'Threatened Fauna 100' © The State of Victoria, Department of Sustainability and Environment.

Data Source: 'Threatened Flora 100' © The State of Victoria, Department of Sustainability and Environment.

Data Source: 'Aquatic Fauna Database', Copyright - The State of Victoria, Department of Sustainability and Environment.

Flora

Key

- Conservation status: L = listed under the *Flora and Fauna Guarantee Act 1988*; r = rare; v = vulnerable in Victoria; k = poorly known in Victoria.
- NS – not specified
- * = introduced

Common Name	Scientific Name	EPBC status	FFG status	DSE Status	Last record
Flora					
African Box-thorn*	*Lycium ferocissimum*				09/03/1999
Arabian Grass *	*Schismus sp.*				21/01/1999
Artichoke Thistle *	*Cynara cardunculus*				04/07/1991
Austral Trefoil	*Lotus australis*			k	NS
Barley-grass *	*Hordeum leporinum*				08/12/1999
Bearded Oat *	*Avena barbata*				08/12/1999
Blunt-leaf Pomaderris	*Pomaderris helianthemifolia* subsp. *minor*			r	
Bristly Wallaby-grass	*Austrodanthonia setacea*				21/01/1999
Broad-leaf Cumbungi	*Typha orientalis*				03/07/2002
Broom Rush	*Juncus sarophorus*				02/07/2002
Brush Wire-grass	*Aristida behriana*				21/01/1999
Burr Medic *	*Medicago polymorpha*				08/12/1999
Cape Weed *	*Arctotheca calendula*				08/12/1999
Chilean Needle-grass *	*Nassella neesiana*				01/03/2002
Cluster Clover *	*Trifolium glomeratum*				21/01/1999
Common Blown-grass	*Lachnagrostis filiformis* s.l.				21/01/1999
Common Wallaby-grass	*Austrodanthonia caespitosa*				21/01/1999
Couch	*Cynodon dactylon*				08/12/1999
Creeping Knotweed	*Persicaria prostrata*				08/12/1999
Curled Dock *	*Rumex crispus*				03/07/2002
Desmazeria *	*Tribolium acutiflorum* s.l.				21/01/1999
Drain Flat-sedge *	*Cyperus eragrostis*				02/07/2002
Fennel *	*Foeniculum vulgare*				08/12/1999
Fiddle Dock *	*Rumex pulcher subsp. pulcher*				08/12/1999
Finger Rush	*Juncus subsecundus*				08/12/1999
Flatweed *	*Hypochaeris radicata*				21/01/1999
Floating Pondweed	*Potamogeton tricarinatus* s.l.				03/07/2002

Common Name	Scientific Name	EPBC status	FFG status	DSE Status	Last record
Golden Thistle *	*Scolymus hispanicus*				15/08/1991
Grassland Wood-sorrel	*Oxalis perennans*				21/01/1999
Great Brome *	*Bromus diandrus*				08/12/1999
Grey Willow-herb	*Epilobium billardierianum* subsp. *cinereum*				21/01/1999
Hairy Willow-herb	*Epilobium hirtigerum*				02/07/2002
Heron's Bill	*Erodium sp.*				08/12/1999
Hollow Rush	*Juncus amabilis*				03/07/2002
Hop Clover *	*Trifolium campestre* var. *campestre*				21/01/1999
Horehound *	*Marrubium vulgare*				02/07/2002
Narrow-leaf Clover *	*Trifolium angustifolium* var. *angustifolium*				21/01/1999
Onion Grass *	*Romulea rosea*				21/01/1999
Ox-tongue *	*Helminthotheca echioides*				03/07/2002
Pacific Azolla	*Azolla filiculoides*				02/07/2002
Paspalum *	*Paspalum dilatatum*				03/07/2002
Paterson's Curse *	*Echium plantagineum*				08/12/1999
Pepper Tree *	*Schinus molle*				02/07/2002
Poong'ort	*Carex tereticaulis*				02/07/2002
Prostrate Knotweed *	*Polygonum aviculare* s.l.				08/12/1999
Rat's-tail Fescue *	*Vulpia myuros*				21/01/1999
Ribwort *	*Plantago lanceolata*				03/07/2002
River Red-gum	*Eucalyptus camaldulensis*				03/07/2002
Rough Sow-thistle *	*Sonchus asper* s.l.				08/12/1999
Sand Rush	*Juncus psammophilus*			r	
Slender Dock	*Rumex brownii*				03/07/2002
Slender Wallaby-grass	*Austrodanthonia racemosa* var. *racemosa*				21/01/1999
Small St John's Wort	*Hypericum gramineum*				21/01/1999
Small-flower Mallow *	*Malva parviflora*				08/12/1999
Soft Brome *	*Bromus hordeaceus* subsp. *hordeaceus*				08/12/1999
Southern Swainson-pea	*Swainsona behriana*			r	
Spear Grass	*Austrostipa sp.*				21/01/1999
Squirrel-tail Fescue *	*Vulpia bromoides*				08/12/1999
Sweet Melilot *	*Melilotus indicus*				08/12/1999
Tall Sedge	*Carex appressa*				02/07/2002
Thread Rush	*Juncus filicaulis*				21/01/1999
Toowoomba Canary-grass *	*Phalaris aquatica*				08/12/1999
Variable Willow-herb	*Epilobium billardierianum*				08/12/1999
Velvet Daisy-bush	*Olearia pannosa* subsp. *cardiophylla*		L	v	
Water Couch *	*Paspalum distichum*				03/07/2002
Water Ribbons	*Triglochin procera* s.l.				03/07/2002

Common Name	Scientific Name	EPBC status	FFG status	DSE Status	Last record
Willow *	*Salix sp.*				02/07/2002
Wimmera Rye-grass *	*Lolium rigidum*				08/12/1999
Windmill Grass	*Chloris truncata*				21/01/1999
Wiry Dock	*Rumex dumosus*				21/01/1999

Fauna

Key

- Conservation status: CR = Critically endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; DD = Data deficient; L = listed under the *Flora and Fauna Guarantee Act 1988;* J/C/R/B = listed under JAMBA, CAMBA, ROKAMBA, &/or Bonn.
- * = introduced

Common Name	Scientific Name	EPBC	FFG	DSE adv list	FFG comm-unity
Fish					
Australian Smelt	*Retropinna semoni*				
Brown Trout *	*Salmo trutta*				
Carp Gudgeon	*Hypseleotris compressa*				Y
Common Carp *	*Cyprinus carpio*				
Flat-headed Gudgeon	*Philypnodon grandiceps*				Y
Gambusia *	*Gambusia holbrooki*				
Golden Perch	*Macquaria ambigua*			VU	Y
Goldfish *	*Carassius auratus*				
Macquarie Perch	*Macquaria australasica*	EN	L	EN	Y
Murray Cod	*Maccullochella peelii peelii*	VU	L	EN	Y
Rainbow Trout *	*Oncorhynchus mykiss*				
Redfin Perch *	*Perca fluviatilis*				
Tench *	*Tinca tinca*				
Amphibians					
Plains Froglet	*Crinia parinsignifera*				
Common Froglet	*Crinia signifera*				
Southern Bullfrog (ssp. unknown)	*Limnodynastes dumerilii*				
Reptiles					
Bougainville's Skink	*Lerista bougainvillii*				
Boulenger's Skink	*Morethia boulengeri*				
Eastern Brown Snake	*Pseudonaja textilis*				
Long Neck Tortoise	*Chelodina longicollis*				
Olive Legless Lizard	*Delma inornata*				
Turtle					
Mammals					
bat - Unidentified	Ord. Chiroptera				
Black Wallaby	*Wallabia bicolor*				
Common Brushtail Possum	*Trichosurus vulpecula*				
Common Ringtail Possum	*Pseudocheirus peregrinus*				
European Hare *	*Lepus europeaus*				
European Rabbit *	*Oryctolagus cuniculus*				

Common Name	Scientific Name	EPBC	FFG	DSE adv list	FFG comm-unity
House Mouse *	*Mus musculus*				
Platypus	*Ornithorhynchus anatinus*				

Common Name	Scientific Name	EPBC	Treaty	FFG	DEPI adv list	Colonial nesting
Birds						
Australasian Grebe	*Tachybaptus novaehollandiae*					
Australasian Shoveler	*Anas rhynchotis*				VU	
Australian Hobby	*Falco longipennis*					
Australian King-Parrot	*Alisterus scapularis*					
Australian Magpie	*Gymnorhina tibicen*					
Australian Pelican	*Pelecanus conspicillatus*					Y
Australian Raven	*Corvus coronoides*					
Australian Shelduck	*Tadorna tadornoides*					
Australian White Ibis	*Threskiornis molucca*					Y
Australian Wood Duck	*Chenonetta jubata*					
Barking Owl	*Ninox connivens*			L	EN	
Black Kite	*Milvus migrans*					
Black Swan	*Cygnus atratus*					
Black-chinned Honeyeater	*Melithreptus gularis*				NT	
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*					
Black-fronted Dotterel	*Elseyornis melanops*					
Black-shouldered Kite	*Elanus axillaris*					
Blue-faced Honeyeater	*Entomyzon cyanotis*					
Blue-winged Parrot	*Neophema chrysostoma*					
Brown Goshawk	*Accipiter fasciatus*					
Brown Treecreeper	*Climacteris picumnus*				NT	
Brown-headed Honeyeater	*Melithreptus brevirostris*					
Buff-banded Rail	*Gallirallus philippensis*					
Clamorous Reed Warbler	*Acrocephalus stentoreus*					
Cockatiel	*Nymphicus hollandicus*					
Collared Sparrowhawk	*Accipiter cirrhocephalus*					
Common Blackbird *	*Turdus merula*					
Common Bronzewing	*Phaps chalcoptera*					
Common Myna *	*Acridotheres tristis*					
Common Starling *	*Sturnus vulgaris*					
Crested Pigeon	*Ocyphaps lophotes*					
Crested Shrike-tit	*Falcunculus frontatus*					
Crimson Rosella	*Platycercus elegans*					
Darter	*Anhinga novaehollandiae*					Y
Diamond Firetail	Stagonopleura guttata			L	VU	

Common Name	Scientific Name	EPBC	Treaty	FFG	DEPI adv list	Colonial nesting
Dollarbird	*Eurystomus orientalis*					
Dusky Moorhen	*Gallinula tenebrosa*					
Dusky Woodswallow	*Artamus cyanopterus*					
Eastern Great Egret	*Ardea modesta*		C/J	L	VU	Y
Eastern Rosella	*Platycercus eximius*					
Eurasian Coot	*Fulica atra*					
European Goldfinch *	*Carduelis carduelis*					
Flame Robin	*Petroica phoenicea*					
Fork-tailed Swift	*Apus pacificus*		C/J			
Fuscous Honeyeater	*Lichenostomus fuscus*					
Galah	*Cacatua roseicapilla*					
Golden Whistler	*Pachycephala pectoralis*					
Great Cormorant	*Phalacrocorax carbo*					
Grey Butcherbird	*Cracticus torquatus*					
Grey Fantail	*Rhipidura albiscarpa*					
Grey Shrike-thrush	*Colluricincla harmonica*					
Grey Teal	*Anas gracilis*					
Grey-crowned Babbler	*Pomatostomus temporalis temporalis*			L	EN	
Hardhead	*Aythya australis*				VU	
Hooded Robin	Melanodryas cucullata cucullata			L	NT	
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*					
House Sparrow *	*Passer domesticus*					
Laughing Kookaburra	*Dacelo novaeguineae*					
Little Black Cormorant	*Phalacrocorax sulcirostris*					
Little Corella	*Cacatua sanguinea*					
Little Friarbird	*Philemon citreogularis*					
Little Grassbird	*Megalurus gramineus*					
Little Lorikeet	*Glossopsitta pusilla*					
Little Pied Cormorant	*Phalacrocorax melanoleucos*					
Little Raven	*Corvus mellori*					
Long-billed Corella	*Cacatua tenuirostris*					
Magpie-lark	*Grallina cyanoleuca*					
Masked Lapwing	*Vanellus miles*					
Musk Duck	*Biziura lobata*				VU	
Musk Lorikeet	*Glossopsitta concinna*					
Nankeen Night Heron	*Nycticorax caledonicus hillii*				NT	Y
Noisy Friarbird	*Philemon corniculatus*					
Noisy Miner	*Manorina melanocephala*					
Olive-backed Oriole	*Oriolus sagittatus*					
Pacific Black Duck	*Anas superciliosa*					
Pallid Cuckoo	*Cuculus pallidus*					
Peaceful Dove	*Geopelia striata*					

Common Name	Scientific Name	EPBC	Treaty	FFG	DEPI adv list	Colonial nesting
Peregrine Falcon	*Falco peregrinus*					
Pied Cormorant	*Phalacrocorax varius*				NT	Y
Purple Swamphen	*Porphyrio porphyrio*					
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*					
Rainbow Bee-eater	*Merops ornatus*					
Red Wattlebird	*Anthochaera carunculata*					
Red-rumped Parrot	*Psephotus haematonotus*					
Regent Honeyeater	*Anthochaera phrygia*	EN		L	CR	
Restless Flycatcher	*Myiagra inquieta*					
Royal Spoonbill	*Platalea regia*				VU	Y
Rufous Songlark	*Cincloramphus mathewsi*					
Sacred Kingfisher	*Todiramphus sanctus*					
Silver Gull	*Chroicocephalus novaehollandiae*					Y
Southern Boobook	*Ninox novaeseelandiae*					
Spotted Pardalote	*Pardalotus punctatus*					
Straw-necked Ibis	*Threskiornis spinicollis*					Y
Striated Pardalote	*Pardalotus striatus*					
Sulphur-crested Cockatoo	*Cacatua galerita*					
Superb Fairy-wren	*Malurus cyaneus*					
Swamp Harrier	*Circus approximans*					
Swift Parrot	*Lathamus discolor*	EN		L	EN	
Tawny Frogmouth	*Podargus strigoides*					
Tree Martin	*Hirundo nigricans*					
Varied Sittella	*Daphoenositta chrysoptera*					
Wedge-tailed Eagle	*Aquila audax*					
Welcome Swallow	*Hirundo neoxena*					
Whistling Kite	*Haliastur sphenurus*					
White-bellied Cuckoo-shrike	*Coracina papuensis*					
White-browed Scrubwren	*Sericornis frontalis*					
White-browed Woodswallow	*Artamus superciliosus*					
White-faced Heron	*Egretta novaehollandiae*					
White-naped Honeyeater	*Melithreptus lunatus*					
White-necked Heron	*Ardea pacifica*					Y
White-plumed Honeyeater	*Lichenostomus penicillatus*					
White-winged Chough	*Corcorax melanorhamphos*					
White-winged Triller	*Lalage sueurii*					
Willie Wagtail	*Rhipidura leucophrys*					
Yellow-billed Spoonbill	*Platalea flavipes*					Y
Yellow-faced Honeyeater	*Lichenostomus chrysops*					
Zebra Finch	*Taeniopygia guttata*					

Appendix D: Monitoring

There is already an ongoing environmental flow, water resource planning and water quality monitoring program for the Campaspe River conducted by the North Central CMA and Goulburn-Murray Water. This monitoring program is seen as sufficient and will be used to inform the outcomes of the use of the Campaspe River EE 2013.

D.1. Long-term condition Monitoring - VEFMAP

The Victorian environmental flows monitoring and assessment program (VEFMAP) is aimed to:
"Evaluate ecosystem responses to environmental flows in the eight high-priority regulated rivers that are to receive enhancements to their flow regime".

The Campaspe River was selected for this statewide program. The monitoring programs implemented include:

- Physical habitat and geomorphology
- Water quality monitoring
- Fish, aquatic and riparian vegetation assessments.

D.2. Intervention Monitoring

The management of environmental flows is highly adaptive and dynamic in response to environmental conditions and system operation constraints. Refer to Table D1 for site locations and monitoring techniques undertaken.

Table D1: Water quality monitoring sites - location and rationale

Reach 2	Site location	Features / Rationale	Monitoring Technique
Lake Eppalock to Campaspe Weir	**1.** Doaks Reserve	• Upstream of Axe Creek • Shallow-medium depth • Cumbungi & Woody habitat around island area • Identified as environmental flows monitoring site for state program	• Continuous probe (DO, EC and temperature) • North Central CMA and G-MW water quality monitoring
	2. Axedale	• Downstream of Axe Creek • Large deep pool • Good drought refuge	• North Central CMA and G-MW water quality monitoring
	3. Backhaus Road	• Existing monitoring site	• Continuous probe (DO, EC and temperature) • North Central CMA and G-MW water quality monitoring
	4. English's Bridge	• Existing monitoring site	• North Central CMA and G-MW water quality monitoring
	5. Runnymead Reserve	• Existing monitoring site	• North Central CMA and G-MW water quality monitoring
	6. Elmore	• Existing monitoring site • Deep pool - backed up from the Campaspe Weir • Important refuge for fish	• North Central CMA and G-MW water quality monitoring

Appendix E: Environmental Entitlement assessment

Adapted from Campaspe Irrigation District – Opportunity of 22 GL recovery for environmental flows (SKM 2012b).

There is a total of approximately 28 GL/year[3] available on average to the environment from within the Campaspe River basin as a result of the closure of the CID and purchases by the Commonwealth. SKM (2012b) undertook an assessment of the potential use of approximately 28GL on average each year in the Campaspe River basin to meet environmental objectives. The following sections provide a summary of the assessment undertaken by SKM. Overall, modelling has confirmed that the volume of water required to satisfy environmental requirements in each reach exceeds the 28 GL/year available.

E.1. Confirmation of shortfalls to full environmental demands in Campaspe River reaches 2, 3 and 4.

Environmental flow shortfalls for Reaches 2, 3 and 4 of the system were calculated using monthly estimates for Environmental Water Demand along with current regime modelled flow data from each reach (Table E1). The shortfall represents the additional volume of water the environment would need to receive the minimum recommended environmental flows in reaches 2, 3 and 4 of the Campaspe River.

Table E1: Average annual shortfalls (GL/year) by flow component, average across 1891 – 2008

Component	Reach 2	Reach 3	Reach 4
Summer Low	0.0	0.1	0.1
Summer Fresh	0.1	0.4	0.4
Winter Low	3.3	6.7	7.3
Winter High	7.5	8.3	6.2
Bankfull	38.6	10.9	18.2
Overbank	8.1	24.5	-
Total	**57.6**	**50.8**	**32.2**

Average values do not adequately describe the pattern and size of shortfalls, especially when there are many years with small or zero shortfalls. To resolve this, the average annual shortfall was re-calculated using only years when the shortfall was greater than zero. The results of this process are summarised below in Table E2.

Table E2: Average annual shortfalls (GL/year) by flow component, averaged across years with a shortfall only (along with the number of years in which there was a shortfall) for 1891 – 2008

Component	Reach 2	Reach 3	Reach 4
Summer Low	0.23 (10 years)	0.34 (28 years)	0.34 (36 years)
Summer Fresh	0.55 (24 years)	0.76 (56 years)	0.79 (62 years)
Winter Low	3.51 (112 years)	7.04 (112 years)	7.73 (112 years)
Winter High	9.32 (95 years)	11.41 (86 years)	10.80 (68 years)
Bankfull	44.62 (102 years)	26.26 (49 years)	34.03 (63 years)
Overbank	31.78 (30 years)	33.18 (87 years)	-

3 With the closure of the CID, a long term average of 22 GL/yr of water savings has been made available in the Campaspe River basin. Also for consideration, the CEWH holds a little more than 6.2 GL of high reliability water share (HRWS) and 0.4 GL of low reliability water share within the basin from buybacks. Therefore 28 GL/yr was modelled as available on average for the environment in the catchment.

Total	**58.6 (116 years)**	**51.2 (117 years)**	**32.4 (117 years)**

The results confirmed that the volume of water required to satisfy environmental requirements in each reach exceeds the 28 GL/year available.

E.2. Assess flooding implications

For delivery of the bankfull recommendation (flow rate of 9,000 ML/day in Reach 4) the flow required in Reach 3 is seen to exceed the channel capacity at that location of 8,000 ML/day. It was therefore necessary to estimate the flow rate that could be expected in Reach 4 if flooding were to be avoided in Reach 3. Please note, further floodplain hydraulic studies are recommended for determining the optimal timing of release under a variety of conditions.

It was found that 6,400 ML/day was the highest flow rate that can be delivered at Echuca along the Campaspe River channel without flooding Reach 3, where the bankfull flow rate of 8,000 ML/day would occur. If 6,400 ML/day is used as a revised (constrained) bankfull target in Reach 4, it is clear that this volume would be achieved more frequently than the previous requirement of 9,000 ML/day. Therefore, it is expected to reduce the environmental flow shortfalls that were calculated earlier.

The shortfall in Reach 4 was again computed giving a revised bankfull value of 37,173 ML/month (previously this was 46,930 ML/month). The results for the new shortfall analysis for Reach 4, is summarised below in Table E3.

Table E3: Recalculated average annual shortfalls (GL/year) for Reach 4

Component	Reach 4
Summer Low	0.1
Summer Fresh	0.4
Winter Low	7.3
Winter High	6.2
Bankfull	11.2
Total	**25.2**

The total requirement to meet the environmental flow requirement with a reduced bank full target is 25.2 GL/year. This would leave 2.8 GL/year for other purposes. The following section will discuss potential alternatives for the distribution of this amount.

E.3. Options to use up remaining 2.8 GL/year

Two options are readily available for usage of the extra 2.8 GL/year:

1. Vary Low Flows

There are shortfalls in the lower flow components that can use this water. Flows naturally vary and more recent environmental flow studies have specifically recommended that such variability be incorporated into low flow recommendations. There would therefore be value using the available water to vary low flows.

It was estimated that an average low flow of 263 ML/day rather than a constant 200 ML/day could be provided with the available water. Thus, with the objective of providing variability in low flows, it may be feasible to vary the low flows with an average of 263 ML/day and a lower limit of 200 ML/day.

Winter fresh shortfalls in Reach 3 are greater than in Reach 4 due to the requirement for four freshes in Reach 3 and only two in reach 4. The extra water available could also therefore go towards the delivery of an extra fresh in Reach 3 without negative impacts on Reach 4. The average annual requirement for a winter fresh is 6.2 GL/year. This means that an extra fresh could be delivered every 2-3 years.

2. Using the available water to deliver supplementary environmental flows at downstream locations. Five examples are provided:

    i. **Delivery to Boort District Wetlands via release into the Waranga Western Channel (WWC):** this delivery would be possible when the WWC offers sufficient capacity to transfer the water and there is a requirement for watering the Boort District Wetlands.

    ii. **Delivery to the Kerang Wetlands in the Torrumbarry system via the Murray River:** the Kerang Wetlands Ramsar site comprises 23 marshes, lakes and swamps that range from freshwater to hypersaline. Delivery to this system would be possible when there is a requirement for watering the Kerang Wetlands.

    iii. **Delivery to Reach 4 of the Loddon River via release into the WWC:** this reach has a shortfall of 7.7 GL/year on average.

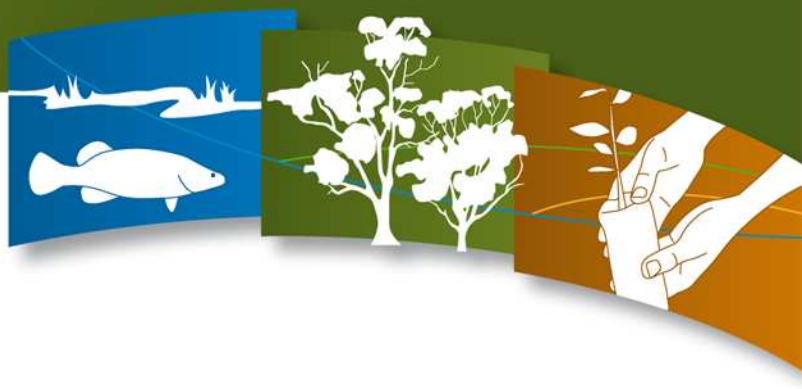
    iv. **Delivery to other sites on the Murray River.**

    v. **Transfer back to the Goulburn River.**

It is likely that these four options can be considered at any time to achieve the maximum environmental benefit of the available water within operational constraints.

E.4. The implications for the Goulburn and Murray Systems

It was concluded that the 23 GL/year relinquished from the Goulburn/Murray system would prove very beneficial to the Campaspe and would only have small impacts on the capability of delivering environmental water in the Goulburn and Murray Rivers in the short term. In the longer term, it is probable that the CEWH's targeted acquisition of entitlement in the southern basin would be able to compensate for this loss.



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