

LODDON RIVER

INTERIM ENVIRONMENTAL WATERING PLAN



PREPARED FOR THE
NORTHERN VICTORIA IRRIGATION RENEWAL PROJECT



AUGUST 2009

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Front cover photo: Loddon River Reach 5, Channel No. 1 McKnight Outfall, North Central CMA, 22 June 2009.

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EXECUTIVE SUMMARY

This Loddon River Interim Environmental Watering Plan (EWP) documents the approach to mitigating the potential short-term impacts of the Northern Victoria Irrigation Renewal Project (NVIRP). It is focused on the channel outfalls that will be modernised by the NVIRP 2009 winter works. A Long-term Loddon River EWP is required to assess the impacts of NVIRP modernisation measures, including reduced outfalls, beyond this timeframe (NVIRP, 2009).

The Northern Victoria Irrigation Renewal Project (NVIRP) is a \$2 billion works program to upgrade ageing irrigation infrastructure across the Goulburn-Murray Irrigation District (GMID) and to save water lost through leakage, evaporation and system inefficiencies. Works will include lining and automating channels, building pipelines and installing new, modern metering technology.

On the 14 April 2009 the Minister for Planning made a decision that an Environment Effects Statement (EES) is not required for the NVIRP project, although it is subject to several conditions. Condition 5 requires the development of Environmental Watering Plans (EWPs) for 'at risk' waterways and wetlands before the relevant NVIRP work are operated.

The Loddon River has been identified as requiring an EWP due to its significant environmental values that may be impacted by an 85% reduction in channel outfalls from the NVIRP.

The Loddon River Interim EWP focuses on changes in operation of the No. 1 channel which outfall into the Loddon River Reach 5 (downstream of Kerang Weir to Murray River). A risk assessment of significant environmental values and drought refuge was undertaken to identify the short-term risk from these reduced outfalls. The results and main recommendations are summarised below:

- the short-term risk (2009/10) from the reduction in the No. 1 channel outfall to the Loddon River is considered to be **low** for both significant species and drought refuge.
- it is recommended that a monitoring program is implemented during the 2009/10 irrigation season to monitor any changes in risk during this period. The monitoring program will include a late spring site assessment to monitor spring ecological processes and/or values more likely to be present during this period.
- no mitigation actions are required for the 2009-10 irrigation season.

The Interim EWP and risk assessment do not negate the need for the Long-term EWP. This will clarify the future risk of the NVIRP works program on the Loddon River.

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- NVIRP Technical Advisory Committee (TAC) (listed in Appendix A, Table A1)
- North Central CMA working group (listed in Appendix A, Table A2)
- Michelle Bills, Rohan Hogan, Lyndall Rowley, Emer Campbell, Rebecca Horsburgh, Bianca Huider, Melissa Donaldson and Wendy Shea (North Central CMA).

ABBREVIATIONS

AUSRIVAS	Australian River Assessment System
BE	Bulk Entitlement
Bonn	Convention on the Conservation of Migratory Species
CAMBA	China–Australia Migratory Bird Agreement
DO	Dissolved Oxygen
DPCD	Department of Planning and Community Development
DSE	Department of Sustainability and Environment
EC	Electrical Conductivity
EES	Environment Effects Statement
EPBC	Environment
EVC	Ecological Vegetation Class
EWP	Environmental Watering Plan
FFG	Flora and Fauna Guarantee
GIS	Geographic Information Systems
GL	Gigalitre (one billion litres)
GMID	Goulburn-Murray Irrigation District
G-MW	Goulburn–Murray Water
ISC	Index of Stream Condition
JAMBA	Japan–Australia Migratory Bird Agreement
LREFSP	Loddon River Environmental Flows Scientific Panel
LWD	Large Woody Debris
ML	Megalitre (one million litres)
North Central CMA	North Central Catchment Management Authority
NVIRP	Northern Victoria Irrigation Renewal Project
RHS	River Health Strategy
ROKAMBA	Republic of Korea–Australia Migratory Bird Agreement
SEPP	State Environment Planning Policies
TAC	Technical Advisory Committee
TIS	Torrumbarry Irrigation System
VROTS	Victorian rare or threatened species
WMEMF	Water Management Environmental Management Framework
WoV	Waters of Victoria
WWC	Waranga Western Channel

1. Northern Victoria Irrigation Renewal Project

The Northern Victoria Irrigation Renewal Project (NVIRP) is a \$2 billion works program to upgrade ageing irrigation infrastructure across the Goulburn-Murray Irrigation District (GMID) and to save water lost through leakage, evaporation and system inefficiencies. Works will include lining and automating channels, building pipelines and installing new, modern metering technology. These combined works will improve the irrigation system's delivery efficiency and recover an average 425 GL of water per year.

The GMID uses a number of natural carriers, rivers, lakes and wetlands for both storage and conveyance of water. While the water savings generated from the NVIRP are considered a 'loss' to the irrigation system, in some cases this operating regime provides incidental benefits to environmental assets.

1.1 Decision under the *Environmental Effects Act 1978*

On the 14 April 2009, the Minister for Planning made a decision that an Environment Effects Statement (EES) is not required for the NVIRP project, although it is subject to several conditions (DPCD 2009). 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*

NVIRP have developed a Water Change Management Framework (WCMF, July 2009) in response to this condition. The framework outlines the processes and methodologies for preparing Environmental Watering Plans to mitigate potential impacts on wetlands and waterways at risk from the implementation of the NVIRP through adaptive water management (NVIRP 2009).

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

The NVIRP Environmental Referrals process prioritised ten wetlands and four rivers with significant environmental values that may be impacted by an 85% reduction in channel outfalls across the GMID. Waterways in the GMID currently recommended as requiring EWPs are (Feehan Consulting 2009):

1. Campaspe River (downstream of Campaspe Weir to Murray River)
2. Loddon River (downstream of Loddon Weir to Murray River)
3. Twelve Mile Creek (anabranh of the Loddon River)
4. Broken Creek (Goulburn Broken CMA).

The Campaspe and Loddon rivers will be influenced by the 2009 NVIRP winter works program while the Broken and Twelve Mile creeks will be influenced by the 2010 winter works program.

1.2 Environmental Water Change Management Framework

The Water Change Management Framework (NVIRP 2009) sets out the overarching principles with respect to environmental management for the operation of the modified GMID. These principles include:

- NVIRP will strive for efficiency in both water supply and farm watering systems
- NVIRP will design and construct the modernised GMID system to comply with environmental requirements as specified in the no-EES conditions
- NVIRP will develop management and mitigation measures consistent with established environmental policies and programs in place in the GMID

- renewal or refurbishment of water infrastructure will be undertaken to the current best environmental practice, including any requirements to better provide environmental water. Best environmental practice will require irrigation infrastructure required to deliver environmental water to be retained (no rationalisation at these sites) or upgraded to allow for future use or alternative means of delivery.
- management and mitigation measures will be maintained into the future through establishment of or modification to operating protocols and operational arrangements.

As part of this, the NVIRP Environmental Referrals process aims to ensure mitigation of the potential impacts of irrigation modernisation on high environmental value assets. The process assesses Stage 1 (upgrade of the backbone and connections) of the NVIRP and is concerned with operational impacts on waterways, wetlands and regional groundwater via increased system efficiencies such as changes in channel outfalls, delivery patterns and reductions in leakage and seepage.

1.3 Environmental Watering Plans (EWPs)

EWPs provide the water supply protocol to protect the high environmental values which may be impacted upon by the NVIRP. The Water Management Environmental Management Framework outlines two types of EWP that will be developed for the NVIRP:

- 'Long-term' EWP, where management and mitigation measures are appropriate for long-term implementation
- 'Interim' EWP, where management and mitigation measures are appropriate for Interim implementation, pending development of a 'long-term' EWP.

Interim EWPs are being developed for both the Loddon and Campaspe rivers due to insufficient understanding of the materiality of the interactions between environmental values and the altered hydrology as a result of the implementation of NVIRP (NVIRP 2009). Long-term EWPs for these systems will be developed and signed off prior to the completion of the 2010 winter works program.

1.3.1 Purpose and scope of the Interim EWPs

The purpose of the Loddon River Interim EWP is to assess the short-term (2009-10) risk from outfall reductions on the waterway. The EWP will:

- adopt a precautionary approach and present no greater risk of harm to the wetland or waterway, than it is currently subjected to
- retain all current options to provide environmental water to the wetland or waterway, including through the irrigation infrastructure
- incorporate management and mitigation measures which are reversible, should the subsequent EWP recommend different measures (NVIRP 2009).

1.3.2 Development process

The Loddon River Interim EWP was developed in collaboration with key stakeholders including North Central CMA (NCCMA), Goulburn-Murray Water (G-MW), NVIRP, Department of Sustainability and Environment (DSE), Parks Victoria and the Department of Primary Industries (DPI) according to the process outlined in Figure 1. A number of tasks were undertaken to develop the EWP, as follows:

- collation of information (defining waterway values, hydrology and outfall sites impacted by 2009 NVIRP works program)
- outfall site assessments to determine current condition of the waterway and outfall proximity to waterway
- short-term risk assessment: identification of short-term (next 12 months) risks to significant environmental values and drought refuge from the reduction in channel outfall

- recommend short-term mitigation measures and adaptive management (e.g. monitoring) for the 2009-10 irrigation season
- next steps and knowledge gaps – to inform the Long-term EWP requirements.

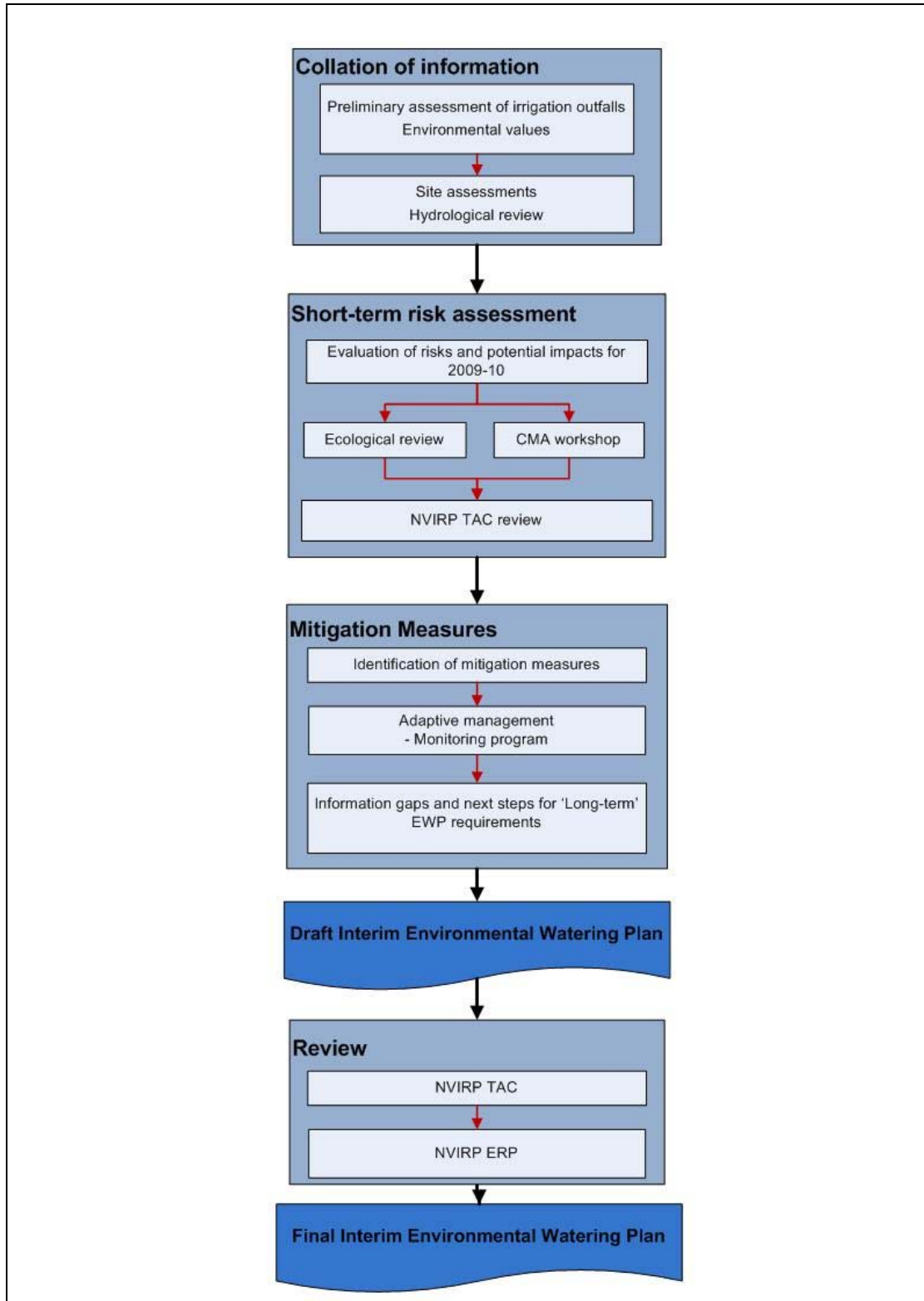


Figure 1: Interim EWP development process

1.3.3 Consultation

Key groups consulted during the development of the Loddon River Interim EWP were the NVIRP Technical Advisory Committee (TAC), agency stakeholders and adjoining landholders. An outline of the various groups' involvement is provided below.

The TAC was convened by the NVIRP to oversee the development of the EWPs to ensure quality, completeness and practicality. The TAC was consulted at various stages in the development of the Interim EWP with particular emphasis on the risk management framework and assessment. The committee includes representation from catchment management authorities, G-MW, DPI, NVIRP and DSE (Appendix A).

To assist in collating information for the Loddon River Interim EWP an internal North Central CMA working group was also convened (Appendix A). A workshop was held with this group on 1 July 2009 to review the proposed short-term risk assessment for the Loddon River.

Other community and agency people were directly engaged to provide technical and historical information (e.g. G-MW operations staff).

2. Loddon River

The lower Loddon catchment is a complex system with numerous tributaries, effluent streams and storages. Superimposed on this is the Torrumbarry Irrigation System (TIS) providing water for irrigated agricultural practices, town and stock and domestic consumption (SKM 2006). The irrigation season is from mid-August to mid-May (approximately 270 days) which corresponds with the occurrence of outfalls into the river.

The environmental flow determination report for the Loddon River (LREFSP, 2002) separated the river into six river reaches in order to develop the environmental flow recommendations (Refer to Section 3.1.3). The lower Loddon River has been separated into:

- Reach 4: Loddon Weir to Kerang Weir
- Reach 5 Kerang Weir to Murray River (refer to Figure 2).

2.1 Loddon River channel outfalls

An important characteristic of the Loddon River catchment is that it is influenced by water imported from the Goulburn and Murray rivers. Water is diverted into the Loddon River catchment from the Campaspe, Goulburn Broken and Murray River systems for use as potable and irrigation water. Two main supply routes exist, the Waranga Western Channel (WWC) and the TIS. In some lower catchment water bodies (especially in the Torrumbarry system) inflows from the Loddon River catchment only enter in times of flood (SKM 2006).

Several irrigation diverters pump directly from the lower Loddon River and are supplied by G-MW by passing flows over the Kerang Weir.

Channel outfalls that result from operation of the system and that directly or indirectly outfall to the Loddon River have been identified and are presented in Table 1.

Table 1: Location of Loddon River outfalls that will be impacted by the NVIRP

Location	Irrigation area	Road Reference	Works Program
Loddon River Reach 4			
No. 2	Pyramid-Boort	Upstream Bennetts (off Loddon River Rd)	2010
No. 2	Pyramid-Boort	Caldwells Rd	2010
No. 1/9/2	Pyramid-Boort	Upstream of Macorna Main (downstream of Gilmour Lane)	2010
Twelve Mile Creek			
No. 1/1/12	Pyramid-Boort	Approx. halfway down the creek	2010
Loddon River Reach 5			
No. 1 McKnight ¹	Torrumbarry	Off Kerang-Murrabit Rd - McKnight	2009
No. 6 McKnight	Torrumbarry	Off Kerang-Murrabit Rd - McKnight	2010
No. 6 Heffer	Torrumbarry	Heffer Rd	2010
No. 7/1/7	Torrumbarry	McKerrow Rd	2010
No. 1/7	Torrumbarry	near Winlaton Rd	2010
No. 4	Torrumbarry	Benjaroop-Lake Charm Rd	2010

Note 1: The No. 1 McKnight outfall (highlighted in Table 1 above) is the only outfall impacted on by the 2009 NVIRP works program.

Note 2: All of the Barr Creek outfalls occur upstream of the Lake Tutchewop Salt Interception Scheme Pumping Station. Under current dry conditions all water from the Barr Creek has been pumped to Lake Tutchewop, therefore Barr Creek outfalls are assumed not to impact on the Loddon River streamflow in the short-term.

The construction works being undertaken during winter 2009 are focused on the major channels or backbone within the TIS (refer to Figure 2, page 9).

This Interim EWP for the Loddon River is focused on the channel outfalls that will be modernised by the NVIRP 2009 winter works. NVIRP have confirmed that only the No. 1 channel outfall located in Reach 5 of the Loddon River (Figure 2) will be modernised as part of the 2009 winter works.

As previously noted, the NVIRP will reduce outfall volumes to waterways by 85% due to increased efficiencies in the irrigation system. All channel outfalls listed in Table 1 will be assessed prior to the 2010 works as part of the Loddon River Long-term EWP. However, the current drought has already had significant impact on outfall volumes to waterways prior to NVIRP.

2.2 Assessment area for Interim EWP: Loddon River Reach 5

The No. 1 channel outfall is located approximately 12 km north of Kerang and outfalls to a short drain (0.5 km) before entering Reach 5 of the Loddon River. The Interim Loddon River EWP has focused on Reach 5 of the Loddon River (Kerang Weir to the Murray River).

Reach 5 of the Loddon River flows for 58 km from Kerang to the Murray River at Benjaroop and receives major tributary inputs from the Barr Creek (Figure 2). The Loddon River directly influences the health of the Murray River including salinity, flows, and the exchange of aquatic species.

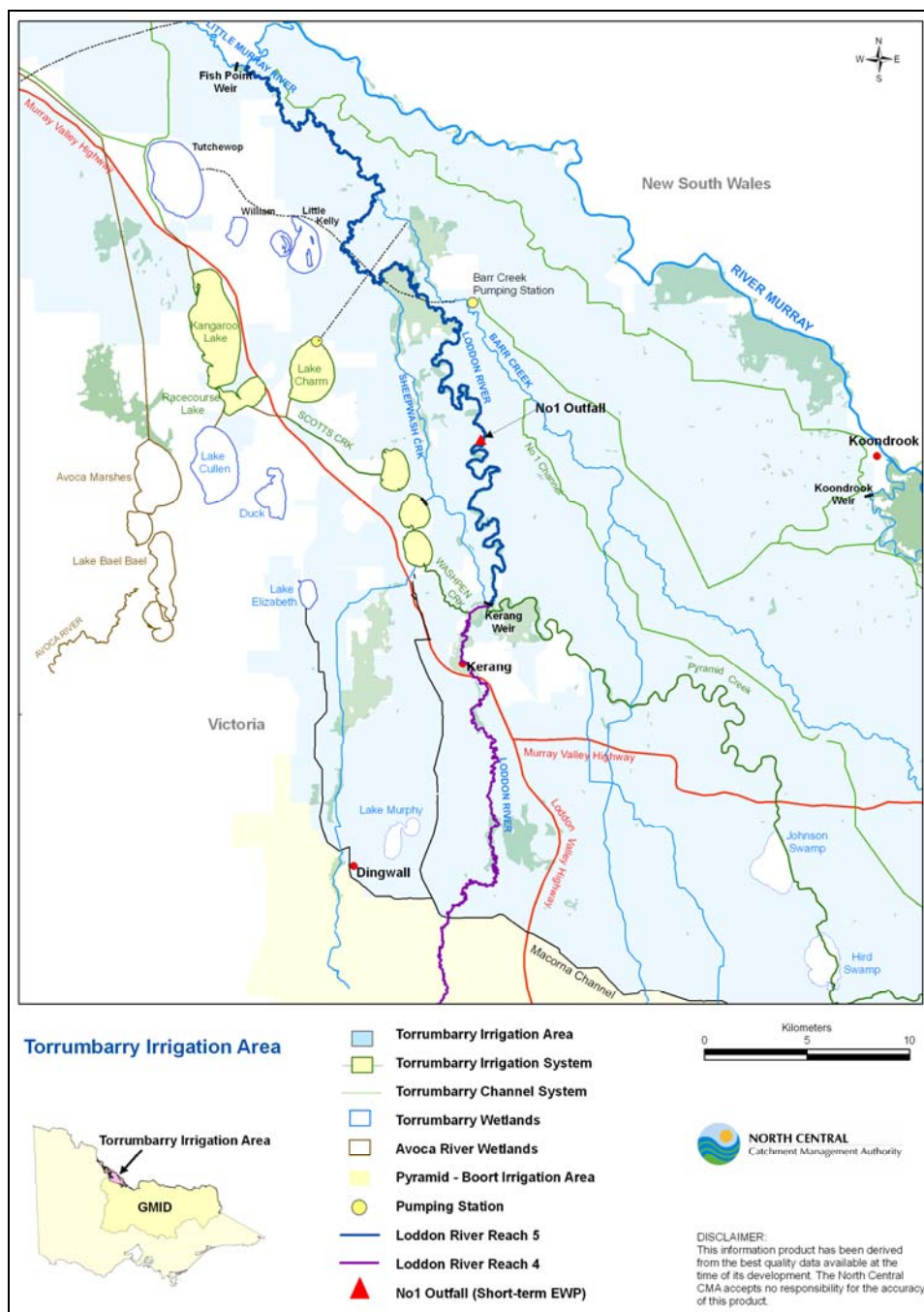


Figure 2: Location of Loddon River, Reach 5 – Torrumbarry Irrigation System

2.3 North Central River Health Strategy and River Health Program

The North Central River Health Strategy provides an integrated approach to river health management and sets a clear direction and priorities for taking action to meet the long-term vision of improving the health of rivers of the North Central region (NCCMA 2005).

The Loddon River is considered a high priority under the North Central River Health Strategy (RHS) 2005. The Loddon River below Kerang Weir has been identified as a priority due to the following key principles:

- minimise the risks to connected high value assets (Kerang Lakes and Murray River). Refer to Figure 2. The lower Loddon River can significantly influence the health of both the Kerang Lakes and the Murray River.
- protect and enhance reaches at high risk – ranked in top 20 high risk reaches. Objective is to focus on the high values within the reach at high risk and implement mitigation actions (i.e. values such as Murray Cod are important) (NCCMA 2005).

The values identified in the North Central RHS for the lower Loddon River are represented in two Index of Stream Condition (ISC) reaches:

- ISC Reach 1 – Dartagook Forest to Swan Hill
 - ISC Reach 2 – Tragowel to Dartagook Forest
- } *Environmental flows descriptor:
Loddon River Reach 5*

Please note: The ISC (Reach 1 & 2) and Environmental flows Reach 5 both cover the Loddon River from Kerang Weir to Murray River. The ISC reaches have been used to assess the condition of the Loddon River and the development of the River Health Strategy. Reach 5 has been used to develop environmental flow recommendations for the Loddon River. The Interim EWP has used the environmental flow reach 5.

Loddon Stressed River project

This large-scale project has aimed to complement the potential river health improvements to be gained through the delivery of environmental flows by implementing a range of integrated activities, including onground works in the riparian zone, investigations, capital works and community engagement.

Works that have been undertaken in Reach 5 include river frontage protected by fencing, off-stream watering, willow control works and revegetation.

Kerang Fishway

A fishway has recently been constructed at Kerang Weir to allow fish species including Murray Cod, Silver Perch and Golden Perch to move upstream of the Kerang Weir into middle reaches of the Loddon River and Pyramid Creek.

3. Loddon River values

The Loddon River supports a range of environmental, cultural heritage and recreational values. These are described specifically for Reach 5 (Figure 2) in the following sections.

3.1 Environmental values

The Loddon River Reach 5 follows a highly sinuous path from Kerang Weir to the Murray River across an expansive alluvial plain. An assessment of all environmental values associated with the lower Loddon River has been documented and recorded in this report. All listed values have been presented in this section with full species lists provided in Appendix B.

3.1.1 Fauna

Eight native fish species have been recorded in this section of the Loddon River (Table 2 and Appendix B). Of the native fish species, four are considered migratory, three are threatened in Victoria and four are listed for protection under the *Flora and Fauna Guarantee Act (FFG), 1988*. Golden Perch are stocked at Kerang Weir (DPI 2009). Although no longer present in the lower Loddon River natural populations of Macquarie Perch were recorded (pre-1970) (Cadwallader 1981).

Table 2: Significant fish species recorded in Reach 5 of the Loddon River

Common Name	Scientific Name	EPBC	FFG	VROTS
Golden Perch	<i>Macquaria ambigua</i>			VU
Murray Cod	<i>Maccullochella peelii peelii</i>	VU	L	EN
Silver Perch	<i>Bidyanus bidyanus</i>		L	CR
Murray-Darling Rainbowfish	<i>Melanotaenia fluviatilis</i>		L	DD
Unspecked Hardyhead	<i>Craterocephalus stermuscarum fulvus</i>		L	DD
Conservation Status:				
<i>Environment Protection and Biodiversity Conservation (EPBC) Act 1999</i> Listed: VU – Vulnerable				
FFG listing: L – listed as threatened				
Victorian Rare or threatened Species (VROTS): EN – Endangered, CR – Critical, VU – Vulnerable, DD – Data Deficient				

Source: (DSE 2009a)

As part of the Victorian Biological Assessment Program three sites in Reach 5 of the Loddon River are monitored for macroinvertebrates. Lowland communities have been recorded featuring a lower diversity of species than would naturally be expected (EPA, 2008).

Forty-nine bird species have been recorded in the lower Loddon River using a Geographical Information System (GIS) database (Table 3 and Appendix B). From this list, three species are listed for protection under the *FFG Act 1988* and one is protected by international migratory bird agreements with Japan and China.

Table 3: Significant bird species recorded in Reach 5 of the Loddon River

Common Name	Scientific Name	International Agreements	EPBC	FFG	VROTS
Bush Stone-curlew	<i>Burhinus grallarius</i>			L	EN
Great Egret	<i>Ardea alba</i>	J/C		L	VU
Grey-crowned Babbler	<i>Pomatostomus temporalis</i>			L	EN
Nankeen Night Heron	<i>Nycticorax caledonicus</i>				NT
Royal Spoonbill	<i>Platalea regia</i>				VU
Conservation Status:					
<ul style="list-style-type: none"> J/C/R/B: JAMBA/CAMBA/ROKAMBA/Bonn international agreements FFG listing: L – listed as threatened VROTS: EN – Endangered, VU – Vulnerable, NT – Near Threatened 					

Source: (DSE 2009b)

3.1.2 Vegetation

Prior to European settlement, according to pre-1750 Ecological Vegetation Class (EVC) mapping, vegetation communities in the northern floodplain area were characterised by River Red Gum and Black Box above a shrub layer of wattle, lignum and saltbush (NCCMA 2003).

Reach 5 of the Loddon River falls mainly within the Murray Fans Bioregion, with a small portion upstream within the Victorian Riverina Bioregion. The predominant EVCs such as Lignum Swampy Woodland and Grassy Riverine Forest/Riverine Swamp Forest Complex are characterised by open eucalypt forests of River Red Gum and Black Box with a lignum understorey with a ground-layer of obligate wetland flora, or a grassy-herbaceous understorey. These forests occur within flood-prone areas. The remainder of EVCs occur in slightly more elevated areas and are less prone to flooding. The understorey consists of grasses, herbs and small shrubs (DSE 2004).

Table 4: EVCs at Loddon River Reach 5

EVC No.	EVC Name	Bioregional Conservation Status		pre-1750 ¹ (ha)	2005 ¹ (ha)
		Victorian Riverina	Murray Fans		
829	Chenopod Grassland	-	Endangered	1	1
946	Grassy Riverine Forest/Riverine Swamp Forest Complex	-	Depleted	217	178
823	Lignum Swampy Woodland	Vulnerable	Vulnerable	434	236
103	Riverine Chenopod Woodland	-	Endangered	354	149
295	Riverine Grassy Woodland	-	Vulnerable	85	49
97	Semi-arid Woodland	-	Endangered	<1	<1

Note 1: Modelled EVC information pre 1750 and 2005 within Loddon River Reach 5.

Source: (DSE 2009c)

No flora species listed under the EPBC Act or the FFG Act have been recorded in Reach 5 of the Loddon River. However a number of species threatened within Victoria have been recorded (Table 5).

Table 5: Significant flora species at Loddon River Reach 5

Common Name	Scientific Name	EPBC	FFG	VROTS
Black Roly-poly	<i>Sclerolaena muricata</i> var. <i>muricata</i>			k
Bluish Raspwort	<i>Haloragis glauca</i> f. <i>glauca</i>			k
Cane Grass	<i>Eragrostis australasica</i>			v
Spreading Emu-bush	<i>Eremophila divaricata</i> subsp. <i>divaricata</i>			r
Twin-leaf Bedstraw	<i>Asperula gemella</i>			r
Wetland Blown-grass	<i>Lachnagrostis filiformis</i> var.2			k
Conservation Status:				
• VROTS: v- vulnerable in Victoria, r - rare in Victoria, k – poorly known in Victoria				

Source: (DSE 2009d)

3.1.3 Environmental flow recommendations

The environmental flow recommendations from the Loddon River Environmental Flows Scientific Panel (LREFSP 2002) have been developed for the Loddon River below Cairn Curran Reservoir. These environmental flow recommendations were used to develop the Loddon River (Environmental Reserve) Bulk Entitlement (BE) Order 2005. The Loddon BE clarifies rights to water for both water users and the environment.

Reach 5 is operationally managed through the Torrumbarry Irrigation System and forms part of the Victorian Murray BE and has not been specifically considered as part of the Loddon BE process.

The environmental flow recommendations for Reach 5 were developed based on preservation of flows from the upstream Reach 4 rather than based on natural flows or ecological thresholds (due to absence of natural flow data). Table 6 outlines the environmental flow recommendations and associated ecological objectives for Reach 5 of the Loddon River.

Table 6: Current environmental flow recommendations – Reach 5 (LREFSP 2002)

Season and component	Reach 5 Kerang Weir to the Murray River	Justification
Summer low flow	NOV-APR >7 to <12 ML/d (variable minimum)	Fish community: <ul style="list-style-type: none"> available habitat and movement Macroinvertebrate community: <ul style="list-style-type: none"> habitat availability Aquatic macrophytes: <ul style="list-style-type: none"> colonisation and disturbance
Summer freshes	JAN-FEB >50 ML/day (1 per year, 14 days duration)	Fish community: <ul style="list-style-type: none"> breeding cues for Golden Perch Macroinvertebrate community: <ul style="list-style-type: none"> habitat maintenance Aquatic macrophytes: <ul style="list-style-type: none"> habitat maintenance
Winter low flow	MAY-OCT 61 ML/d	Fish community: <ul style="list-style-type: none"> available habitat and movement
Winter high flow	JUL-OCT >400 ML/day (2 per year, 7 days duration)	Fish community: <ul style="list-style-type: none"> available habitat and movement breeding cues for Murray Cod Aquatic macrophytes: habitat maintenance
Overbank	JUL-OCT >1200 ML/d (2 per year, 7 days duration)	Floodplain: <ul style="list-style-type: none"> maintain riparian EVCs and flood dependent species restore/maintain floodplain/wetland processes entrain organic litter – carbon cycling
Rise and fall	No recommendation	Lack of natural flow data

Note: the environmental flow recommendations for both Reach 4 and 5 of the Loddon River will require review prior to the development of the Long-term EWP.

3.2 Cultural heritage

The lower Loddon catchment is recognised as an important cultural heritage and archaeological region in Victoria. The Loddon River downstream of Kerang is mapped as an area of cultural heritage sensitivity. The traditional owners include the Baraparapa people (Kerang to the Murray River) and Wamba Wamba (junction of the Loddon River and Little Murray River) (DPCD 2008).

A number of Aboriginal sites have been located at the junction of Barr Creek and the Loddon River and near the Little Murray River. Several sites (over 200) such as mounds or ovens, graves, scarred trees and surface scatters containing freshwater shells, stone artefacts and burnt clay are recorded (NCCMA 2006).

3.3 Recreation

The lower Loddon River provides opportunities for fishing, camping and swimming. Occasional boating activities have also been recorded in the lower Loddon River (NCCMA 2003). It has a high scenic value river landscape (LCC 1989) and is used informally by tourists.

4. Risk management framework

Only one outfall site on the Loddon River is impacted by the 2009 NVIRP works out of a total of ten outfall sites that will be assessed as part of the Long-term EWP. The Interim EWP and risk management framework presented here do not negate the need for a more detailed risk management approach in developing the Long-term EWPs. The risk management framework involves risk analysis, evaluation and management for the short-term risk from reduced outfalls on threatened species and drought refuges (Figure 3).

The precautionary principle is being applied in determining the short-term risks associated with the reduction in outfalls to the Loddon River. This principle allows for the lack of full scientific certainty in determining risks and impacts, and facilitates 'erring on the side of caution'. The risk management framework has been developed in accordance with AS/NZS 4360:2004 and is illustrated in Figure 3.

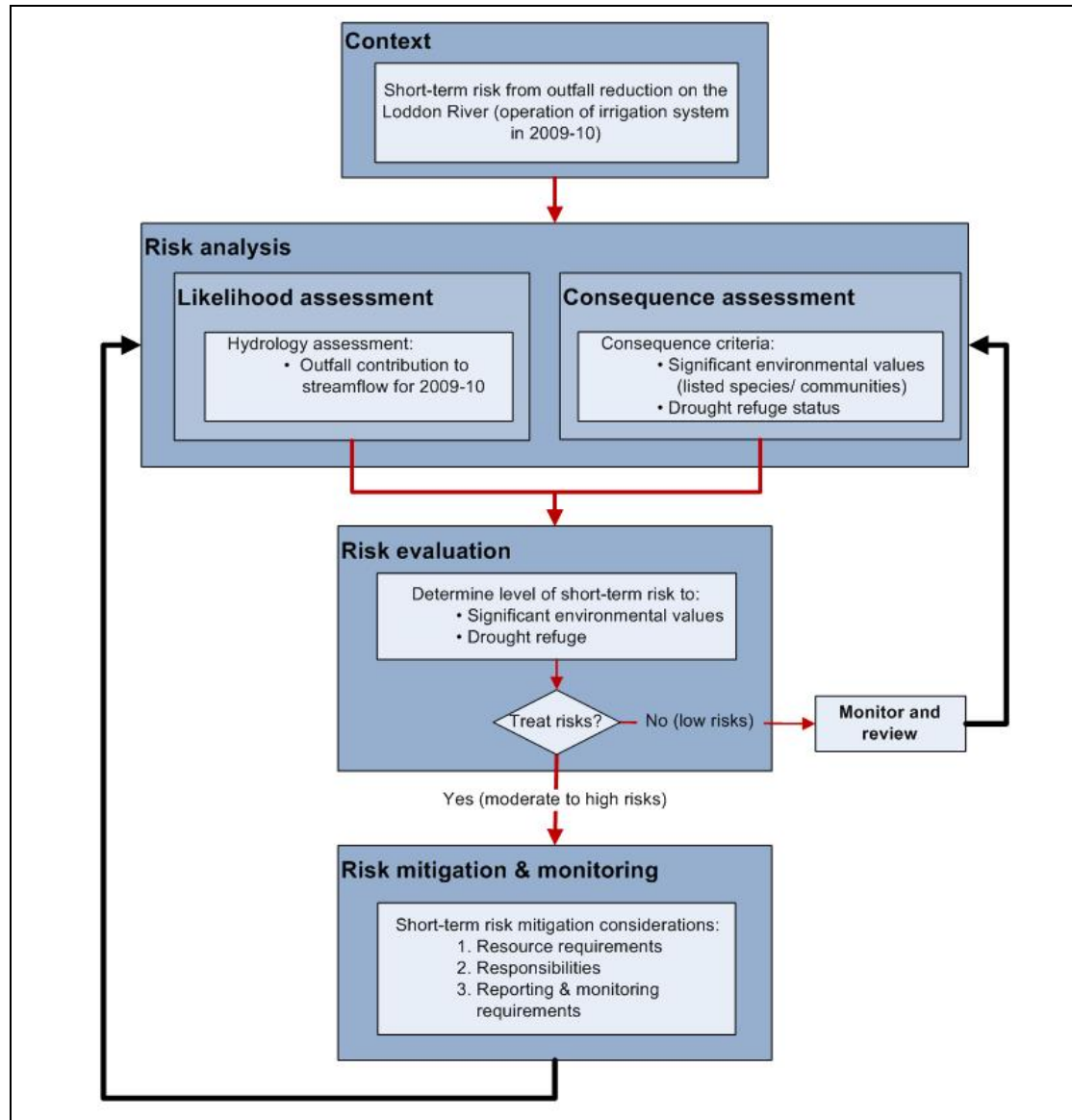


Figure 3: Risk management framework

4.1 Risk analysis and evaluation

A qualitative risk assessment has been undertaken to assign the level of short-term risk to the Loddon River No. 1 outfall site. The relationship between likelihood (probability of occurrence) and the consequence (severity of the impact) provide the basis for evaluating the level of risk. The results for the Loddon River are presented in Section 5. An outline of the components of the risk assessment is provided below.

4.1.1 Likelihood assessment

A hydrology assessment was undertaken to assess the magnitude and timing of outfalls compared to the current operation of the system (likely operation in 2009-10 irrigation season). Table 7 outlines the descriptors used for assessing the likelihood of the outfall reduction impacting on streamflow.

Table 7: Qualitative measures for likelihood assessment

Descriptor	Description
Probable	In the 2009-10 irrigation season, the reduction in outfall as a direct result of modernisation will significantly change streamflow (outfall provided significant contribution to streamflow)
Possible	In the 2009-10 irrigation season, the reduction in outfall as a direct result of modernisation will moderately change streamflow (outfall provides moderate contribution to streamflow)
Improbable	In the 2009-10 irrigation season, the reduction in outfall as a direct result of modernisation will not change streamflow (low outfall contribution to streamflow)

4.1.2 Consequence assessment

The first two principles from the DSE environmental water allocation process¹ have been selected as the criteria to inform the consequence assessment and are described below.

1. Avoid loss of threatened species/communities

Significant environmental values include listed flora and fauna species that have been recorded or are considered likely to occur in the waterway:

- a. *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*
- b. *Flora and Fauna Guarantee (FFG) Act 1988*
- c. Species listed as critically endangered, endangered or vulnerable by DSE
- d. Species considered regionally significant and/or iconic species or communities

A summary of significant environmental values in the Loddon River is provided in Sections 3.1.1 and 3.1.2. Section 5 outlines the risk assessment on identified specific species that are likely to be impacted by reduced outfalls.

2. Maintain key refuges

A drought refuge is an area within the waterway that sustains populations of water-dependent flora and fauna. The following features are considered important characteristics for drought refuge status and will be used for determining presence/absence of a drought refuge at the outfall site:

- a. Depth of pool
- b. Woody debris presence
- c. Diversity of instream and riparian vegetation/habitat
- d. Water Quality (salinity, temperature, dissolved oxygen and turbidity)

¹ DSE environmental water principles were developed to prioritise the use of the Murray Flora and Fauna Environmental Water Entitlement during the prolonged dry periods (DSE, 2007).

A qualitative rating system was used to assess the quality of drought refuge habitat at the outfall site (refer to Appendix C).

The third principle “Avoid catastrophic events” (e.g. fish kills and algal blooms) was not used to inform the short-term risk assessment as it is closely linked with the previous two criteria (e.g. the impact of a catastrophic event will cause the loss of threatened species or drought refuge status).

Please Note: Catastrophic events such as the occurrence of acid sulphate soils in Reach 5 of the Loddon River was considered unlikely (cease to flow event unlikely to occur in the river due to the presence of licensed diverters downstream).

Table 8 below provides the descriptors for assessing the consequence to significant environmental values and drought refuge at the outfall site.

Table 8: Qualitative measures for consequence assessment

Descriptor	Description
Major	Significant environmental values: irreversible damage to listed species/communities Drought refuge: irreversible loss of drought refuge characteristics (e.g. loss of adequate depth for Murray Cod/Golden Perch habitat)
Moderate	Significant environmental values: short-term damage to listed species/communities Drought refuge: some impacts to drought refuge characteristics (e.g. water quality decline)
Minor	Significant environmental values: minor damage to listed species/communities. Drought refuge: minor impact to drought refuge characteristics

Note: Listed species/communities refers to species listed under the EPBC Act, FFG Act, DSE listing and regionally significant communities

4.1.3 Risk assessment matrix and descriptors

A significant risk requiring short-term mitigation measures is defined as a score of moderate or high risk (Likelihood x Consequence rating system). Table 9 below presents how the level of short-term risk was determined.

Table 9: Risk Matrix

		Consequence (C)		
		Major	Moderate	Minor
Likelihood (L)	Probable	High	High	Moderate
	Possible	High	Moderate	Low
	Improbable	Moderate	Low	Low

4.2 Risk management (mitigation and monitoring)

The Risk Management Framework (Figure 3) outlines the process used to evaluate, mitigate and review risk. The mitigation actions and monitoring requirements are determined based on the level of risk.

Low risk actions will only require appropriate monitoring and review. Moderate or high risks will require short term actions to mitigate the 2009-10 risk to the waterway. Mitigation actions will clearly outline resourcing requirements, responsibilities and a robust monitoring and reporting process.

An adaptive management process will also be applied to ensure adaptive decision making. If monitoring indicates either mitigation actions are not working, or the conditions on which the risk assessment is based on have changed, a review will be undertaken.

5. Risk assessment – No. 1 channel outfall

The No. 1 channel outfall (only site in the Loddon River impacted by the 2009 NVIRP works program) is located approximately 12 km north of Kerang and outfalls to a short drain (0.5 km) before entering the Loddon River (refer to Figure 4 and Plates 1 to 6).

The site inspection of the No. 1 channel outfall occurred on 22 June 2009 by North Central CMA and DPI personnel and ecologists from SKM. The site was assessed for its ability to support significant environmental values and drought refuge characteristics. Figure 4 represents the aerial imagery of the site and the location of the No. 1 channel on the Loddon River.

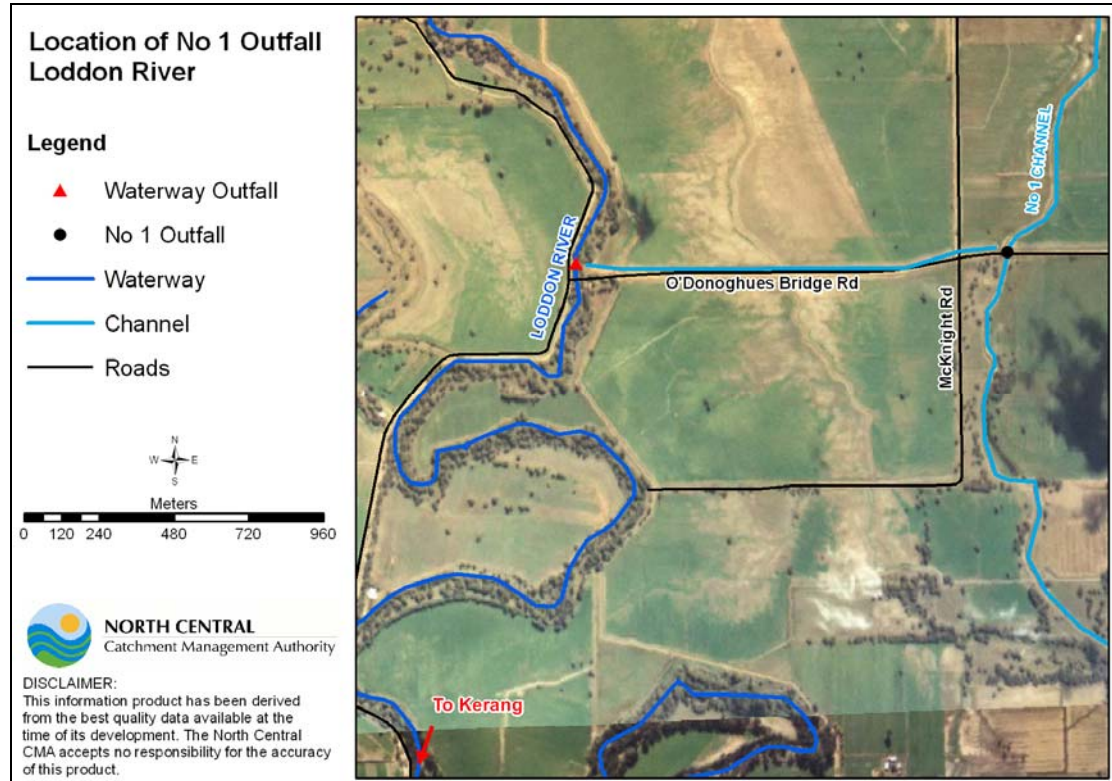


Figure 4: Aerial map of No. 1 channel outfall site

Plates 1 to 6 below illustrate the No. 1 outfall, corresponding waterway outfall and the Loddon River upstream and downstream of the outfall.



Plate 1: No. 1 outfall (June 2009)



Plate 2: No. 1 outfall (June 2009)



Plate 3: Outfall to the Loddon River
(June 2009)



Plate 4: Outfall to the Loddon River
(June 2009)



Plate 5: Loddon River downstream of outfall
(June 2009)



Plate 6: Loddon River upstream of outfall
(June 2009)

5.1 Likelihood assessment - hydrology

5.1.1 Torrumbarry operations – Loddon River downstream of Kerang Weir

Historically (past 20 years) approximately 100ML/day has been passed over the Kerang Weir into the lower Loddon River (Reach 5) regardless of irrigation demands downstream. Since 2007 extreme drought and the need to save water has meant that flows over the Kerang Weir have largely been reduced to zero unless an irrigation order was received. The graph (Figure 5) represents the change in operation of the lower Loddon River in the past two to three years due to drought and low water allocations.

It is expected that dry conditions will prevail for season 2009-10 (G-MW 2009). Under this scenario G-MW will continue to operate the lower Loddon River to minimise water losses. Therefore it is expected that the low flow conditions observed in the lower Loddon post-2007 will continue for the 2009-10 irrigation season.

The Draft Northern Sustainable Water Strategy (draft NSWS, 2008) has proposed a set of categories that broadly link environmental outcomes to required environmental flow components. These categories range from protection of drought refuge with baseflows (category 1) to meeting all environmental flow recommendations (Category 6). Currently Reach 5 of the Loddon River is flow stressed and is likely to be within category 1 and 2.

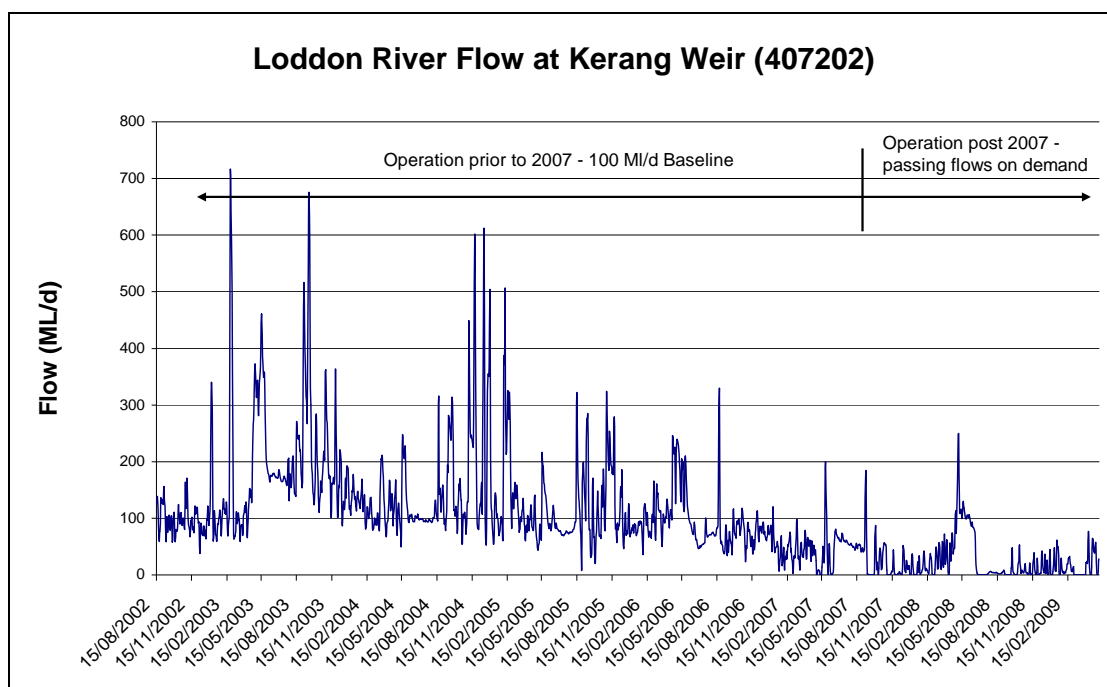


Figure 5: Loddon River flow at Kerang Weir (2002 onwards)

5.1.2 Compliance with environmental flow recommendations

Environmental flow recommendations have been made for the Loddon River Reach 5 (refer to section 3.1.3 and Table 6). Presented in Table 10 is an assessment of the compliance with the environmental flow recommendations.

Table 10: Loddon River Reach 5 environmental flow compliance

Season and component	Reach 5 Environmental flow recommendation	Achieved (Pre-2007) (LREFSP 2002)	Achieved (Post-2007)
Summer low flow	NOV-APR >7 to <12 ML/d (variable minimum)	Achieved <ul style="list-style-type: none"> Flow historically always higher than 12ML/day due to historic operation (i.e. 100ML/day release d/s Kerang Weir) 	Not achieved <ul style="list-style-type: none"> In 2007/08 & 2008/09 seasons (cease to flow events occurred) Achieved in 2006/07
Summer freshes	JAN-FEB >50 ML/day (1 per year, 14 days duration)	Achieved <ul style="list-style-type: none"> Flow historically always higher than 50ML/day due to historic operation (i.e. 100ML/d passing d/s Kerang Weir) 	Not achieved <ul style="list-style-type: none"> In 2006/07, 2007/08 & 2008/09 seasons Although greater 50ML/d was passed over the weir during this period it was not sustained for 14 days on any occasion.

Extremely low flows have been observed in the Loddon River downstream of Kerang Weir post-2007 (refer to Figure 5).

5.1.3 Number 1 channel outfall

Annual volumes for the No. 1 channel outfall have been provided by G-MW and are presented in Figure 6 below. Analysis of the recorded outfall data is outlined in Table 11.

Table 11: Analysis of recorded outfall data

No. 1 Outfall	Annual Volume (ML)	Year
Maximum record	1289	1999-00
Minimum record	25	2007-08
Long-term average	689	1998-99 to 2008-09
Short-term average	49	2007-08 & 2008-09
Baseline year	931	2004-05

The No. 1 channel outfall has had a 93% reduction in average outfalls (2007-08 & 2008-09) compared to long-term average.

G-MW operations staff have indicated that 21 irrigators pump water directly from the lower Loddon River. In the 2008/09 irrigation season a total of 306ML was pumped directly from the lower Loddon River. The volume of water delivered down the Loddon River via Kerang Weir to supply these irrigators has been reduced in recent years due to low water allocations. It is expected that similar demands and flow patterns as seen in 2007-08 and 2008-09 irrigation seasons will occur in the lower Loddon River in the 2009-10 irrigation season.

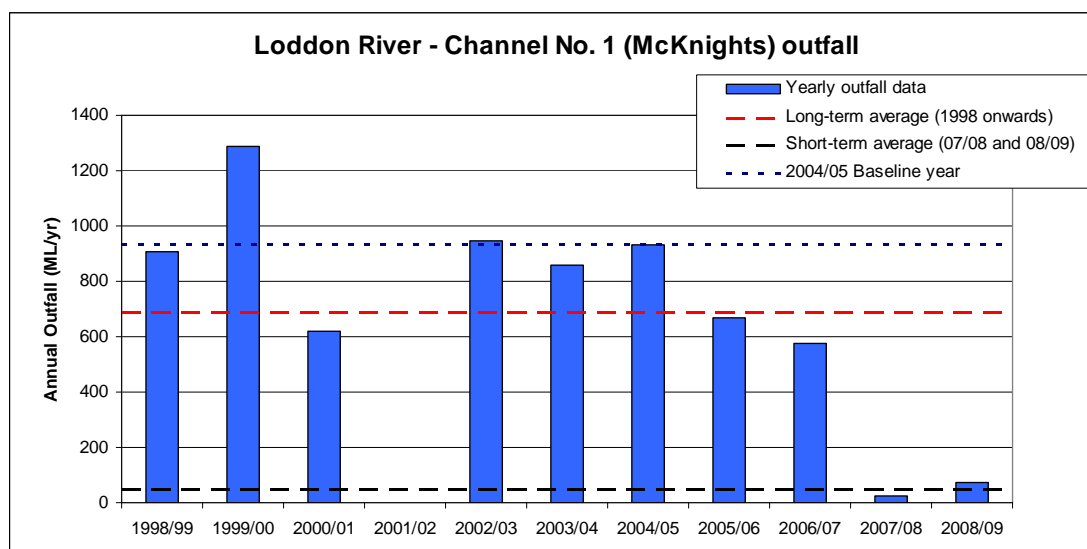


Figure 6: Annual outfall data – No. 1 channel outfall

Note: No channel outfall data was available for 2001/02

5.1.4 Outfall contribution to streamflow

Analysis of the contribution of the No. 1 channel outfall to Loddon River streamflow highlights the variation over the past four irrigation seasons (refer to Figure 7). The analysis has concluded that the outfall contribution over the past four irrigation seasons is not likely to be significant due to:

- the contribution of outfall is below 5% of weekly streamflow (on average)
- the 2008-09 irrigation season outfall contributed to 100% of flows for the Loddon River on five occasions, although these outfall volumes are relatively small ranging from 1 to 10 ML/week.
 - These outfall volumes are not considered significant due to the short outfall period and relatively small contribution to meeting the environmental base flow recommendations (refer to Table 10).

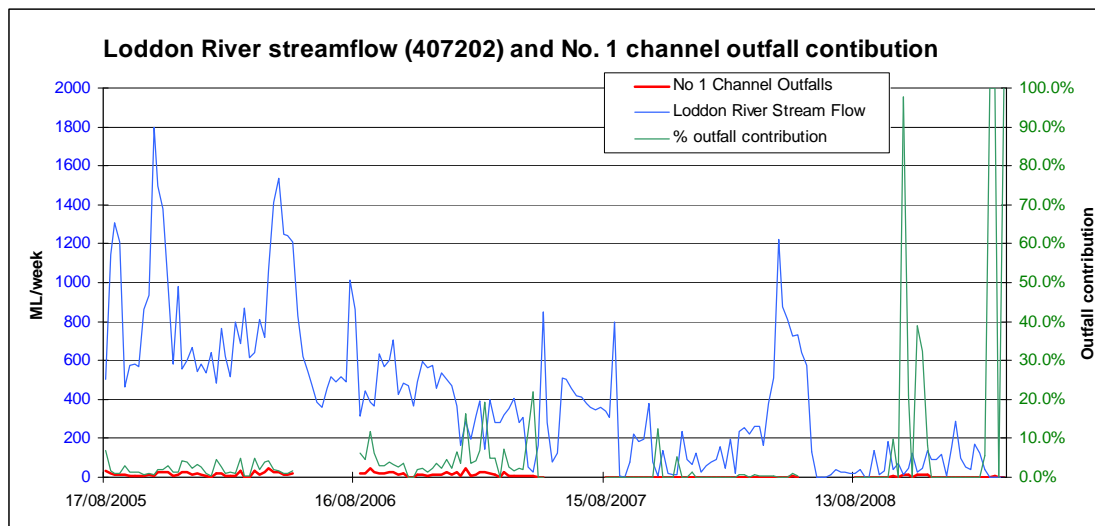


Figure 7: Loddon River streamflows (d/s of Kerang Weir) and No. 1 channel outfalls

Overall likelihood rating = Possible

The above assessment is based on assessing the No. 1 outfall in isolation; cumulative impacts of all of the outfalls (listed in Table 1) will be considered as part of the Long-term EWP.

5.2 Consequence assessment - environmental

The objective of the site assessments undertaken on the 22 June 2009 was to assess the short-term risk to significant environmental values and drought refuge from the reduction in outfalls. The potential consequence to significant environmental values and drought refuge are presented below. Refer to Appendix D for the site assessment results (SKM 2009).

Specifically the Interim Loddon River EWP has focused on the section of river directly influenced by the No 1 channel outfall due to the localised effect of the outfall on the Loddon River under dry flow conditions. Therefore the focus of the Interim EWP has been to assess the risk to specific species that are likely to be influenced by reduced outfalls and any drought refuge immediately downstream of the outfall site.

The Long-term EWP will focus more broadly on the cumulative impacts of reduced outfall across both Reach 4 and 5 of the Loddon River and will consider the long term objectives for the Loddon River as outlined in North Central River Health Strategies.

5.2.1 Significant environmental values

The lower Loddon River supports significant flora and fauna species as listed in Sections 3.1.1 and 3.1.2.

This Interim EWP is focusing on the impact of reduced outfalls and therefore only the listed species that are likely to be impacted on by reduced outfall will be considered as part of the risk assessment (i.e. Murray Cod, Silver Perch, Golden Perch, Bluish Raspwort and Cane Grass²).

The environmental assessment concluded that the Loddon River site at the outfall is not currently supporting any significant environmental values due to:

- currently, the shallow river channel depths being unsuitable to support large-bodied native fish
- the absence of aquatic vegetation, high turbidity and excessive sedimentation being unsuitable for small fish or macroinvertebrates
- no Cane Grass or Bluish Raspwort present at the outfall site during field assessments

² Note: According to the Victorian FLOWS method (DNRE, 2002), only two of the threatened plant species listed in Table 5 (Bluish Raspwort and Cane Grass) are considered to be found within wetland habitat or on the margins of wetland habitat. The remainder are considered to be associated with riparian habitat and are not considered to be at risk from short-term outfall reductions.

- recommended environmental summer base flows for Reach 5 not being achieved in the past two years due to drought (low water allocation) conditions (refer to Table 10)
- local catchment erosion delivering a substantial amount of sediment to the Loddon River and the lack of high flows in recent years meaning that this material has accumulated in the bottom of the channel and smothered important habitat features.

Note: recolonisation of fish species is possible from Little Murray and Murray River if high flows are reinstated.

Overall consequence rating = Minor

5.2.2 Drought refuge

Poor drought refuge habitat was found on the Loddon River downstream of the No.1 Outfall. Silt has smothered important habitat features and infilled pools in this reach. There were no observable deep, shaded pools with good water quality, aquatic vegetation and in-channel diversity, which are required to support aquatic life during drought conditions.

Further assessment of the instream condition downstream of the outfall site and discussion with local landholders has confirmed that the lower Loddon River is currently not providing any deep refuge pools and is therefore unlikely to be supporting large-bodied fish species (Rob O'Brien, DPI, pers comm. 2009).

Overall consequence rating = Minor

5.3 Risk evaluation

The short-term risk evaluation from the information gathered is presented in Table 12.

Table 12: Short-term risk assessment – No. 1 channel outfall

	Likelihood	Consequence	Level of risk
Significant environmental values	Possible <ul style="list-style-type: none"> • <i>generally outfall contributes to less than 5% of flow</i> 	Minor <ul style="list-style-type: none"> • <i>The site is not currently supporting any listed environmental values</i> 	Low
Drought refuge	Possible <ul style="list-style-type: none"> • <i>generally outfall contributes to less than 5% of flow</i> 	Minor <ul style="list-style-type: none"> • <i>Drought refuge rating of poor</i> 	Low

Overall the short-term risk of reducing No. 1 channel outfalls to the Loddon River is considered to be **low** for both significant species and drought refuge. The Loddon River site at the No. 1 outfall channel is not currently supporting significant values previously recorded in the reach or providing important drought refuge. The site has been impacted by drought, low natural flows and changed river operations from Kerang Weir (reduced from 100ML/d to only meeting irrigation demands).

It should be noted that if increased flows can be reinstated into the lower Loddon River then the river is likely to support a greater diversity of species.

5.4 Monitor and review

The short-term risk assessment from the reduction in the No. 1 channel outfalls to the Loddon River is considered to be **low** for both significant species and drought refuge.

According to the Risk Management Framework outlined in Section 4 and results summarised in Section 5.3, no mitigation actions are required for the 2009-10 irrigation season. A monitoring and review process is recommended to ensure the risk does not change over the 2009-10 irrigation season due to changes in conditions or the presence of species not found during ecological assessments undertaken in June 2009.

The ecological site assessment completed as part of the Interim EWP was undertaken in winter when many ecological processes are dormant. Therefore it is recommended that a late spring site assessment be undertaken to monitor spring ecological processes and/or values more likely to be present during this period.

Table 13 summarises the monitoring and review requirements recommended for the Loddon Interim EWP.

Table 13: Monitoring requirements for 2009-10

Component	Method	Timing	Responsibility
Environmental response	Undertake site assessment (significant environmental values and drought refuge status) to ensure risk to the Loddon River remains low	One site assessment during the irrigation season (late Spring)	NVIRP
Operational management	Provide recorded actual outfall into the Loddon River (No. 1 channel outfall) and flows provided downstream of Kerang Weir (for development of the Long-term EWP).	Provide the NVIRP with outfall data on a monthly basis	G-MW

6. Summary

A Interim Environmental Watering Plan for the Loddon River has considered the risk to the Loddon River from the NVIRP 2009 winter works program. Conclusions from the Interim EWP for the Loddon River are summarised below:

- the short-term risk assessment from the reduction in the No. 1 channel outfall to the Loddon River is considered to be **low** for both significant species and drought refuge.
- it is recommended that a monitoring program is implemented during the 2009/10 irrigation season to monitor any changes in risk during this period
- no mitigation actions are required for the 2009-10 irrigation season.

A Long-term EWP for the Loddon River is still required to clarify the long-term risk of NVIRP works on the Loddon River.

7. Next steps and knowledge gaps

The Loddon River Interim EWP has been developed using the best available information. However a number of information and knowledge gaps exist which may impact on the development of the Long-term EWP. These are summarised below:

- environmental flow recommendations for Reach 4 and 5 of Loddon River require review
- a better understanding of the hydrology including natural, historic, existing and proposed flow regimes
- the impacts of climate change will also need to be considered
- a detailed assessment of cumulative impacts of all outfalls on Loddon River streamflow
- The Water Change Management Framework will be used to guide the Long-term Loddon River EWP.

The Loddon River Interim EWP has only considered the short-term risks of the NVIRP works occurring during the 2009 winter works program.

A Long-term EWP is required to clarify the long-term risk of NVIRP works on the Loddon River. The following steps are required to develop the Loddon River Long-term EWP:

1. review of the Environmental Flow recommendations for the lower Loddon River (Reach 4 and 5)
2. undertake a detailed hydrology assessment taking into account the long-term changes from NVIRP works. This will include:
 - cumulative impact of outfalls, considering outfall patterns across the irrigation seasons
 - quantifying the magnitude and pattern of change on streamflow from reduced outfalls within the Loddon River over the long-term
3. undertake a more detailed assessment of the impacts of NVIRP works on the Loddon River
4. determine the volume of water required to mitigate the risk of NVIRP works (determine volume of Mitigation Water).

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Appendix A: NVIRP TAC and risk workshop participants

Table A1: NVIRP TAC members

Name	Organisation and Job title
Anne Graesser	Manager – Water Systems Health Goulburn-Murray Water
Emer Campbell	Manager – NRM Strategy North Central CMA
Jen Pagon	Environmental Program Leader Department of Primary Industries
John Cooke	Manager Sunraysia Department of Sustainability and Environment
Ken Sampson	Shepparton Irrigation Region Executive Officer Goulburn Broken CMA
Ross Plunkett	Executive Manager Planning NVIRP
Tamara Boyd	State Parks and Environmental Water Coordinator Parks Victoria

Table A2: North Central CMA risk workshop participants

Name	Organisation and Job title
Angela Gladman	Project Manager – Upper Loddon Campaspe Project North Central CMA
Bridie Velik-Lord	Loddon River Environmental Flows Officer North Central CMA
Darren White	Campaspe River Environmental Flows Officer North Central CMA
Emer Campbell	Manager – NRM Strategy North Central CMA
Jon Leever	Project Manager - Loddon Stressed River Restoration Project North Central CMA
Michelle Bills	Strategic Environmental (Modernisation) Coordinator North Central CMA
Rob O'Brien	Senior Environmental Officer Department of Primary Industries
Rohan Hogan	Science & Strategy Leader North Central CMA
Tim Shanahan	Team Leader – Irrigation and Water Resources North Central CMA

Appendix B: Loddon River Reach 5 Flora and fauna species

Flora Key

- Conservation status: v = vulnerable in Victoria; r = rare in Victoria; k = poorly known in Victoria; inadequate distribution information.
- * = introduced; # = native but now extends beyond natural distribution

Common Name	Scientific Name	Origin	EPBC	FFG	VR0TS
African Box-thorn	<i>Lycium ferocissimum</i>	*			
Annual Beard-grass	<i>Polygomon speliensis</i>	*			
Argentine Cress	<i>Lepidium bonariense</i>	*			
Aster-weed	<i>Aster subulatus</i>	*			
Austral Mudwort	<i>Limosella australis</i>				
Barley Grass	<i>Hordeum spp.</i>	*			
Berry Saltbush	<i>Atriplex semibaccata</i>				
Billabong Rush	<i>Juncus usitatus</i>				
Black Box	<i>Eucalyptus largiflorens</i>				
Black Roly-poly	<i>Sclerolaena muricata var. muricata</i>				k
Blue Sow-thistle	<i>Sonchus asper subsp. glaucescens</i>	*			
Bluish Raspwort	<i>Haloragis glauca f. glauca</i>				k
Bristly Wallaby-grass	<i>Austrodanthonia setacea</i>				
Buttercup	<i>Ranunculus spp.</i>				
Cane Grass	<i>Eragrostis australasica</i>				v
Cat's Ear	<i>Hypochoeris radicata</i>	*			
Caustic Weed	<i>Chamaesyce spp.</i>	*			
Clove-strip	<i>Ludwigia peploides subsp. montevidensis</i>				
Coast Barb-grass	<i>Parapholis incurva</i>	*			
Common Blown-grass	<i>Lachnagrostis filiformis var. 1</i>				
Common Boobiolla	<i>Myoporum insulare</i>	#			
Common Peppergrass	<i>Lepidium africanum</i>	*			
Common Reed	<i>Phragmites australis</i>				
Common Spike-sedge	<i>Eleocharis acuta</i>				
Cotton Fireweed	<i>Senecio quadridentatus</i>				
Couch	<i>Cynodon dactylon var. dactylon</i>	*			
Curled Dock	<i>Rumex crispus</i>	*			
Delicate Hair-grass	<i>Aira elegantissima</i>	*			
Desmazeria	<i>Tribolium acutiflorum s.l.</i>	*			
Dock	<i>Rumex spp.</i>				
Drain Flat-sedge	<i>Cyperus eragrostis</i>	*			
Fat Hen	<i>Chenopodium album</i>	*			
Ferny Cotula	<i>Cotula bipinnata</i>	*			
Fog-fruit	<i>Phyla spp</i>	*			
Forde Poa	<i>Poa fordeana</i>				
Grass	<i>Poaceae spp.</i>				
Grey Roly-poly	<i>Sclerolaena muricata var. villosa</i>				
Hedge Saltbush	<i>Rhagodia spinescens</i>				
Hollow Rush	<i>Juncus amabilis</i>				
Inland Pigface	<i>Carpobrotus modestus</i>				
Jagged Bitter-cress	<i>Rorippa laciniata</i>				
Kidney-weed	<i>Dichondra repens</i>				
Knob Sedge	<i>Carex inversa</i>				
Knotted Barley-grass	<i>Hordeum secalinum</i>	*			

Common Name	Scientific Name	Origin	EPBC	FFG	VROTS
Lesser Canary-grass	<i>Phalaris minor</i>	*			
Lesser Joyweed	<i>Alternanthera denticulata s.l.</i>				
Mallow	<i>Malva spp.</i>	*			
Mousetail	<i>Myosurus minimus var. australis</i>				
Nitre Goosefoot	<i>Chenopodium nitrariaceum</i>				
Nodding Saltbush	<i>Einadia nutans subsp. nutans</i>				
Paspalum	<i>Paspalum dilatatum</i>	*			
Perennial Rye-grass	<i>Lolium perenne var. perenne</i>	*			
Plains Sedge	<i>Carex bichenoviana</i>				
Poong'ort	<i>Carex tereticaulis</i>				
Prickly Saltwort	<i>Salsola tragus subsp. tragus</i>				
Prostrate Knotweed	<i>Polygonum aviculare s.l.</i>	*			
Rat-tail Couch	<i>Sporobolus mitchellii</i>				
Red Brome	<i>Bromus rubens</i>	*			
River Club-sedge	<i>Schoenoplectus tabernaemontani</i>				
River Red-gum	<i>Eucalyptus camaldulensis</i>				
Ruby Saltbush	<i>Enchylaena tomentosa var. tomentosa</i>				
Rush	<i>Juncus spp</i>				
Sagittaria	<i>Sagittaria platyphylla</i>	*			
Sea Barley-grass	<i>Hordeum marinum</i>	*			
Small Spike-sedge	<i>Eleocharis pusilla</i>				
Soft Brome	<i>Bromus hordeaceus</i>	*			
Southern Cane-grass	<i>Eragrostis infecunda</i>				
Spear Thistle	<i>Cirsium vulgare</i>	*			
Spiked Centaury	<i>Centaureum spicatum</i>				
Sprawling Saltbush	<i>Atriplex suberecta</i>				
Spreading Emu-bush	<i>Eremophila divaricata subsp. divaricata</i>				r
Squirrel-tail Fescue	<i>Vulpia bromoides</i>	*			
Stinkwort	<i>Dittrichia graveolens</i>	*			
Swamp Crassula	<i>Crassula helmsii</i>				
Tall Fireweed	<i>Senecio runcinifolius</i>				
Tall Flat-sedge	<i>Cyperus exaltatus</i>				
Tangled Lignum	<i>Muehlenbeckia florulenta</i>				
Tufted Burr-daisy	<i>Calotis scapigera</i>				
Twinleaf Bedstraw	<i>Asperula gemella</i>				r
Varied Raspwort	<i>Haloragis heterophylla</i>				
Warrego Summer-grass	<i>Paspalidium jubiflorum</i>	#			
Water Starwort	<i>Callitriche spp.</i>				
Wetland Blown-grass	<i>Lachnagrostis filiformis var.2</i>				k
Willow Wattle	<i>Acacia salicina</i>				
Wingless Bluebush	<i>Maireana enchylaenoides</i>				
Woodland Swamp-daisy	<i>Brachyscome basaltica var. gracilis</i>				

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 = listed under the Japan–Australia Migratory Bird Agreement (JAMBA) or China–Australia Migratory Bird Agreement (CAMBA).
- = introduced

Common Name	Scientific Name	Origin	EPBC	VROTS	FFG
Fish					
Australian Smelt	<i>Retropinna semoni</i>				
Carp Gudgeon	<i>Hypseleotris spp.</i>				
Common Carp	<i>Cyprinus carpio</i>	*			
Flat-headed Gudgeon	<i>Philypnodon grandiceps</i>				
Gambusia	<i>Gambusia holbrooki</i>	*			
Golden Perch	<i>Macquaria ambigua</i>			VU	I
Goldfish	<i>Carassius auratus</i>	*			
Murray Cod	<i>Maccullochella peelii peelii</i>		VU	EN	L
Murray-Darling Rainbowfish	<i>Melanotaenia fluviatilis</i>			DD	L
Redfin	<i>Perca fluviatilis</i>	*			
Silver Perch	<i>Bidyanus bidyanus</i>			CR	L
Unspecked Hardyhead	<i>Craterocephalus stermuscarum fulvus</i>			DD	L
Mammals					
Common Brushtail Possum	<i>Trichosurus vulpecula</i>				
House Mouse	<i>Mus musculus</i>	*			
Water Rat	<i>Hydromys chrysogaster</i>				
Reptiles					
Turtle	<i>Chelodina sp.</i>				

Common Name	Scientific Name	Origin	International Agreements	EPBC	FFG	VROTS
Birds						
Australasian Grebe	<i>Tachybaptus novaehollandiae</i>					
Australian Magpie	<i>Gymnorhina tibicen</i>					
Australian Pelican	<i>Pelecanus conspicillatus</i>					
Australian Shelduck	<i>Tadorna tadornoides</i>					
Australian Wood Duck	<i>Chenonetta jubata</i>					
Black Kite	<i>Milvus migrans</i>					
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>					
Black-shouldered Kite	<i>Elanus axillaris</i>					
Black-tailed Native-hen	<i>Gallinula ventralis</i>					
Brown Falcon	<i>Falco berigora</i>					
Bush Stone-curlew	<i>Burhinus grallarius</i>				L	EN
Common Bronzewing	<i>Phaps chalcoptera</i>					
Common Starling	<i>Sturnus vulgaris</i>	*				
Crested Pigeon	<i>Ocyphaps lophotes</i>					
Dusky Moorhen	<i>Gallinula tenebrosa</i>					
Dusky Woodswallow	<i>Artamus cyanopterus</i>					
Eastern Rosella	<i>Platycercus eximius</i>					
Flame Robin	<i>Petroica phoenicea</i>					
Galah	<i>Cacatua roseicapilla</i>					



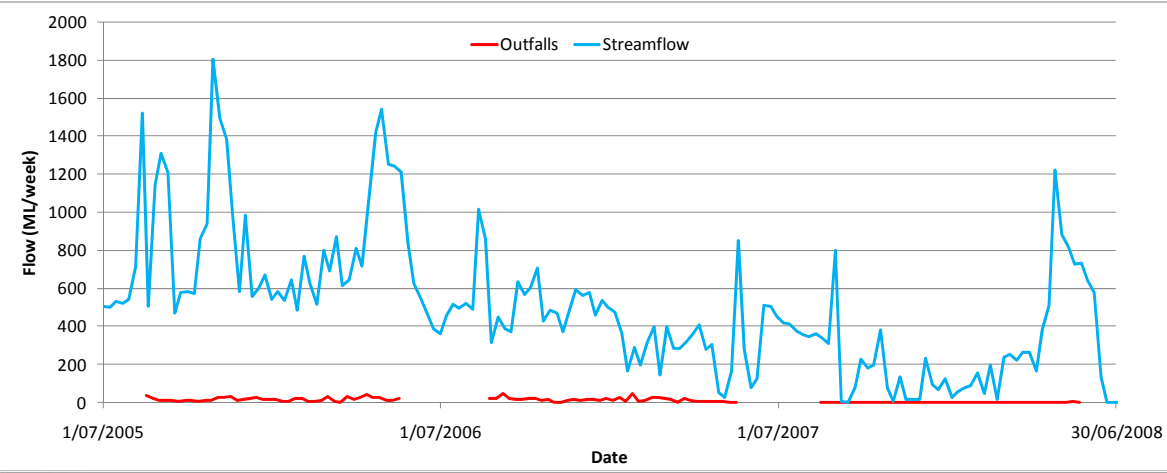
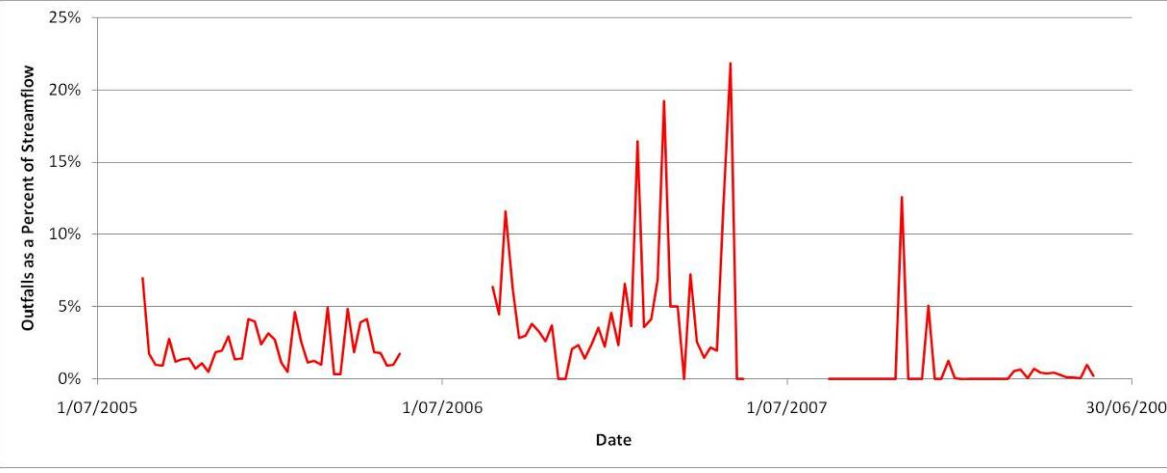
Gilbert's Whistler	<i>Pachycephala inornata</i>					
Great Egret	<i>Ardea alba</i>		J/C		L	VU
Grey Shrike-thrush	<i>Colluricincla harmonica</i>					
Grey-crowned Babbler	<i>Pomatostomus temporalis</i>				L	EN
House Sparrow	<i>Passer domesticus</i>	*				
Laughing Kookaburra	<i>Dacelo novaeguineae</i>					
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>					
Little Pied Cormorant	<i>Phalacrocorax melanoleucos</i>					
Little Raven	<i>Corvus mellori</i>					
Magpie-lark	<i>Grallina cyanoleuca</i>					
Nankeen Kestrel	<i>Falco cenchroides</i>					
Nankeen Night Heron	<i>Nycticorax caledonicus</i>					NT
Noisy Miner	<i>Manorina melanocephala</i>					
Pacific Black Duck	<i>Anas superciliosa</i>					
Pied Butcherbird	<i>Cracticus nigrogularis</i>					
Red-capped Robin	<i>Petroica goodenovii</i>					
Red-rumped Parrot	<i>Psephotus haematonotus</i>					
Royal Spoonbill	<i>Platalea regia</i>					VU
Sacred Kingfisher	<i>Todiramphus sanctus</i>					
Southern Boobook	<i>Ninox novaeseelandiae</i>					
Straw-necked Ibis	<i>Threskiornis spinicollis</i>					
Striated Pardalote	<i>Pardalotus striatus</i>					
Superb Fairy-wren	<i>Malurus cyaneus</i>					
Variegated Fairy-wren	<i>Malurus lamberti</i>					
White-faced Heron	<i>Egretta novaehollandiae</i>					
White-fronted Chat	<i>Epthianura albifrons</i>					
White-plumed Honeyeater	<i>Lichenostomus penicillatus</i>					
White-winged Fairy-wren	<i>Malurus leucopterus</i>					
Willie Wagtail	<i>Rhipidura leucophrys</i>					
Zebra Finch	<i>Taeniopygia guttata</i>					

Appendix C: Drought refuge rating system

Rating	Drought refuge characteristics
Excellent	Diverse habitat types in excellent condition <ul style="list-style-type: none"> - Large, deep pool and/or riffle habitat of varying depths - Presence of submerged (10-30% of substrate covered) and emergent aquatic vegetation (15-30% of channel margins) - Large woody debris, undercut banks, heterogeneous substrate - Excellent water quality (compliance with SEPP (WoV)) - Good connection (i.e. no barriers) with other habitat close-by - Established riparian zone that provides shading (>20% of channel) - No stock access
Good	Diverse habitat types in good condition <ul style="list-style-type: none"> - Deep pool and/or riffle habitat of varying depths - Presence of submerged (5-10% of substrate covered) and emergent aquatic vegetation (5-15% of channel margins) - Large woody debris, undercut banks, heterogeneous substrate - Good water quality (rare exceedance of SEPP (WoV)) - Good connection (i.e. no barriers) with other habitat close-by - Established riparian zone that provides shading (5-20% of channel) - No stock access
Moderate	Suitable habitat in moderate condition <ul style="list-style-type: none"> - Deep pool or riffle habitat - Limited submerged (<5% of substrate covered) and emergent aquatic vegetation (<5% of channel margins) - Large woody debris or undercut banks - Moderate water quality (occasionally exceeds SEPP (WoV)) - Limited connection (i.e. only during high flows) with other habitat nearby - Sparse riparian zone with limited shading (0-5% of channel) - Limited stock access
Poor	Limited habitat diversity in poor condition <ul style="list-style-type: none"> - Shallow, homogenous channel - Minimal aquatic vegetation, large woody debris and/or undercut banks - Poor water quality (frequently exceeds SEPP (WoV)) - Unconnected to other habitats nearby - Sparse riparian zone - Stock access
Very Poor	No habitat diversity and in poor condition <ul style="list-style-type: none"> - Shallow, homogenous channel (e.g. heavily silted) - No habitat features, e.g. aquatic vegetation, large woody debris - Very poor water quality (i.e. high turbidity, high EC, low DO) - Isolated from other potential habitats - No riparian zone - Stock access

(Source: SKM 2009)

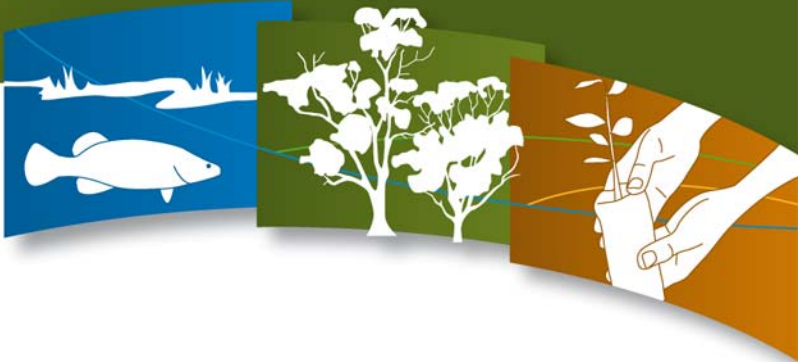
Appendix D: Short-term Ecological Risk Assessment

Receiving waterway : Loddon River		Irrigation outfall : No. 1	
Easting	55 H 0313471	Northing	5808816
			
Description	<p>The Loddon River receives water from the No. 1 irrigation outfall via a direct connection about 10 km downstream of Kerang. This outfall site is located on the lower Loddon floodplain immediately downstream of McKnight Road bridge near the intersection of Roney and Robertson Roads. The site has turbid, slow-flowing water, an abundance of large woody debris (LWD) and a native, mature and continuous 20 m riparian buffer zone that provides good shading of the river channel.</p>		
Operation/ hydrology	<p>This assessment is to assist in determining the risk of reduced outfalls for the 2009/10 irrigation season. The following analysis has been based on the last 3 years of operation:</p> <ul style="list-style-type: none"> ■ The No. 1 irrigation outfall supplements the flow in this reach during the irrigation season (Aug-May). ■ Prior to 2007, 100 ML/day was consistently passed downstream of the Kerang Weir during the irrigation season. Since 2007/08, outfalls have been significantly reduced due to low water allocations. ■ On average, the No.1 outfall contributes less than 5% of the weekly river flows, however, there have been a few occasions during very low river flows that the contribution of the drain has been higher (e.g. >20%). ■ The outfall contributions to river flows are highly variable and are not consistent between months of the year or between years. ■ The water quality of the outfall is expected to be no worse than current water quality conditions in the river. <div style="display: flex; flex-direction: column; align-items: center;">   </div>		

Receiving waterway : Loddon River		Irrigation outfall : No. 1	
Ecological values/ threats	<u>Expected Values</u> <ul style="list-style-type: none"> Native fish (Murray Cod, Golden Perch, Flat-headed Gudgeon, Murray-Darling Rainbowfish, Australian Smelt) 	<u>Current threats</u> <ul style="list-style-type: none"> Very low flows Low dissolved oxygen Siltation of the river bed, including infilling pools Stock access Terrestrial encroachment of weeds and River Red Gums 	
Current condition	<ul style="list-style-type: none"> Currently, the shallow channel depths are unsuitable to support large-bodied native fish. The absence of aquatic vegetation, high turbidity and excessive sedimentation are unsuitable for small fish or macroinvertebrates. The bottom of the channel would have naturally been quite heterogeneous with deep pools, shallow runs and scour holes around the LWD. However, local catchment erosion has delivered a substantial amount of sediment to the Loddon River and the lack of high flows in recent years has meant that this material has accumulated in the bottom of the channel and smothered important habitat features. The lack of aquatic vegetation, and an expected low macroinvertebrates and fish community abundance, also means that this reach is unlikely to support many birds, turtles or frogs. 		
Drought refuge habitat characteristics		Drought refuge rating: Poor	
Depth	<1m, very shallow in areas	Undercut banks	None
Width	<3m	Large woody debris	Present, native, but heavily silted
Velocity	<0.05 m/s	Substrate	90+% silt, 10+% leaf packs
Riparian zone	Good cover (50-70%)	Aquatic vegetation	Absent
Land-use	Grazing	Water quality (taken at 11am)	Overall: Poor pH 7.08 EC 128 µS/cm DO 6.60 mg/L (57%sat) Temp 9.5 °C Turb 128 NTU
Stock access	No restrictions, frequent		
Channel	Meander bends d/s with pools		
In-stream barriers	Natural barriers – LWD dams & shallow sections		
Field assessment summary	<p>Based on the field assessment undertaken on 22 June 2009:</p> <ul style="list-style-type: none"> There are currently no significant critical water dependant environmental values that are likely to be impacted by reduced outfalls for season 2009/10 in this reach of the Loddon River. This is because the current channel depths would not support large-bodied fish and the absence of aquatic vegetation, high turbidity and excessive sedimentation would make it unsuitable for small fish or macroinvertebrates. Poor drought refuge habitat was found downstream of the No.1 Outfall. Silt has smothered important habitat features and infilled pools in this reach. There were no observable deep, shaded pools with good water quality, aquatic vegetation and in-channel diversity, which are required to support aquatic life during drought conditions. 		
Short-term risks	<ul style="list-style-type: none"> Reducing outfalls from the No.1 Outfall Channel is unlikely to have any short-term impact on the environmental values of the Loddon River. This is because outfalls from the No.1 Outfall Channel have already been reduced significantly (see Operation/ Hydrology). The main risk of further flow reductions in this reach is that River Red Gums and terrestrial weeds will colonise the bottom of the river channel. This has happened upstream and downstream of the No.1 Outfall and so changes to the operation of this outfall are not likely to have a significant effect. It is expected that if higher flows return to this reach in the future then fish will re-colonise the reach from the Murray River or Little Murray River. 		
Disclaimer	This preliminary assessment is to assist in determining the risk of reduced outfalls for the 2009/10 irrigation season. The risks of long-term operational plans for the system and any associated long-term ecological impacts of reduced outfalls will be considered further in a more detailed assessment.		

(Source: SKM 2009)

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