Bottle Bend Environmental Water Management Plan

mallee catchment management authority

Department of Environment, Land, Water & Planning

State Government Victoria

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Contents

Executive Summary

Environmental Water Management Plans (EWMPs) have been developed for key sites in the Mallee region. The Mallee Waterway Strategy 2014-22 (Mallee CMA, 2014) identified 23 Waterway Management Units (WMU) from 216 targeted waterways in the Mallee. The interconnectedness and commonality of threats impacting on the waterway values were used to group the WMUs into planning units. This EWMP has been developed for the Bottle Bend a sub-unit of the Karadoc WMU, hereafter referred to as Bottle Bend. The EWMP will help to guide future environmental watering activities for this area.

Bottle Bend is located in the Robinvale Plains bioregion within the Mallee CMA region 15 km south-east of Mildura and covers 1487.23 ha.

Environmental values for Bottle Bend include a diverse range of water dependant flora and fauna species including some listed under state, national and international treaties, conventions, Acts and initiatives including the Regent Parrot and Eastern Great Egret. Bottle Bend has significant social values for the local community and the local indigenous community has strong connections to the area.

Some wetlands within Bottle Bend are used as irrigation drainage disposal basins, which has led to extensive reed growth at Bottle Bend. The Mallee CMA recognises irrigation drainage will be one of the uses for the site going forward and understands that any ecological and hydrological objectives recommended herein should acknowledge this use. Wetland areas that are either an irrigation drainage basin or are on private land are excluded from the target area for this EWMP.

Bottle Bend covers a series of 10 wetlands, however only two of these wetlands, #7329143026 and #7329152029 are included in the target area for this EWMP. Wetlands have been excluded for a range of reasons including:

- they are higher on the floodplain and watering them would inundate lower lying non-target areas on private land;
- they are not able to be watered with the current or proposed infrastructure; or
- watering them would result in unacceptable salinity impacts to the Murray River.

The long term management goal of Bottle Bend EWMP is:

The target area of Bottle Bend will be managed to maintain the condition of fringing Riverine Chenopod Woodland and provide seasonal habitat for waterfowl, wading birds and frogs.

To achieve this, ecological and hydrological objectives have been developed to sustain the ecological components of the target area. The ecological objectives for Bottle Bend target area are to:

- Provide shallow water habitat that supports waterfowl and waders through improved conditions for foraging, nesting and recruitment.
- Promote a diverse aquatic macrophyte zone.
- Provide seasonal aquatic habitat that supports a diverse frog population.
- Support the health of the fringing Riverine Chenopod Woodland.

Optimal watering regime

Fill wetland #7329143026 to 35.9m AHD every year in late spring to inundate littoral zone, allow water to recede naturally, gradually exposing the littoral zone and mudflats.

In every third year, fill wetlands #7329143026 and #7329152029 to 36.3m AHD late winter/spring to inundate surrounding Riverine Chenopod Woodland vegetation, allow water to recede naturally, gradually exposing the littoral zone and mudflats. Ensure that flooding to wetland #7329164034 is excluded.

Minor infrastructure requirements are required at Bottle Bend to allow inundation of the target area.

Acknowledgements

The EWMP was produced by the Mallee Catchment Management Authority, with funding from the Victorian Government. The valuable contributions of Parks Victoria, Jane Roberts, Terry Hillman, other agencies and community members are also acknowledged.

1 Introduction

This Environmental Water Management Plan (EWMP) has been prepared to establish the long-term management goals of Bottle Bend.

The key purposes of the EWMP are to:

- identify the long-term objectives and water requirements for the wetlands, identified as a high priority by the Mallee CMA;
- provide a vehicle for community consultation, including for the long-term objectives and water requirements of the wetlands;
- inform the development of seasonal watering proposals and seasonal watering plans; and
- inform long-term watering plans that will be developed under Murray-Darling Basin Plan requirements.

2 Site Overview

2.1 Site Location

The Mallee CMA region is situated in the north-west of Victoria. The area of responsibility is close to 39,000 km^2 (3.9 million ha), with a regional population estimated to be 65,000. Population centres include Mildura, Birchip, Sea Lake, Ouyen, Robinvale, Red Cliffs and Merbein.

The boundaries of the Mallee CMA region cover almost one fifth of Victoria, making it the largest area managed by a CMA in the state.

Approximately 40% of the land area within the Mallee CMA boundary is public land, consisting mainly of national parks, reserves, wilderness, and large areas of riverine and dryland forests. The other 60% is predominantly dryland crops, but there is also a significant investment in irrigation of grapes, citrus, almonds, olives and vegetables along the Murray River corridor which contributes over 40% of the value of agricultural production for the region.

In 2006, the Mallee CMA engaged consultants (Ecological Associates) to investigate water management options for the Murray River floodplain from Robinvale to Wallpolla Island. One of the major outcomes of these investigations was the development of a system of Floodplain Management Units (FMUs). These divide the floodplain into management units where water regimes can be managed independently of another FMU, but which are relatively consistent in their ecological values and land uses. The Mallee CMA has based its EWMPs on these FMUs to achieve more effective management of hydrologically connected systems. In addition to this, the Mallee CMA has also used individual FMUs or groupings of FMUs to form Waterway Management Units (WMUs) for planning within its Mallee Waterway Strategy.

The site for this plan is Bottle Bend, a sub-unit of the Karadoc FMU, hereafter referred to as Bottle Bend. Bottle Bend falls within the Karadoc Waterway Management unit in the Mallee Waterway Strategy 2014 – 2022. Karadoc FMU covers a series of physically disconnected Floodplain management sub-units from Nangiloc to Kings Billabong. It is located between 912 and 923 river km, 15 km south-east of Mildura on the Murray River Floodplain (Figure 1).

A regional context document has been prepared to compliment the Mallee CMA EWMPs and should be read in conjunction with this document (Sunraysia Environmental, 2014).

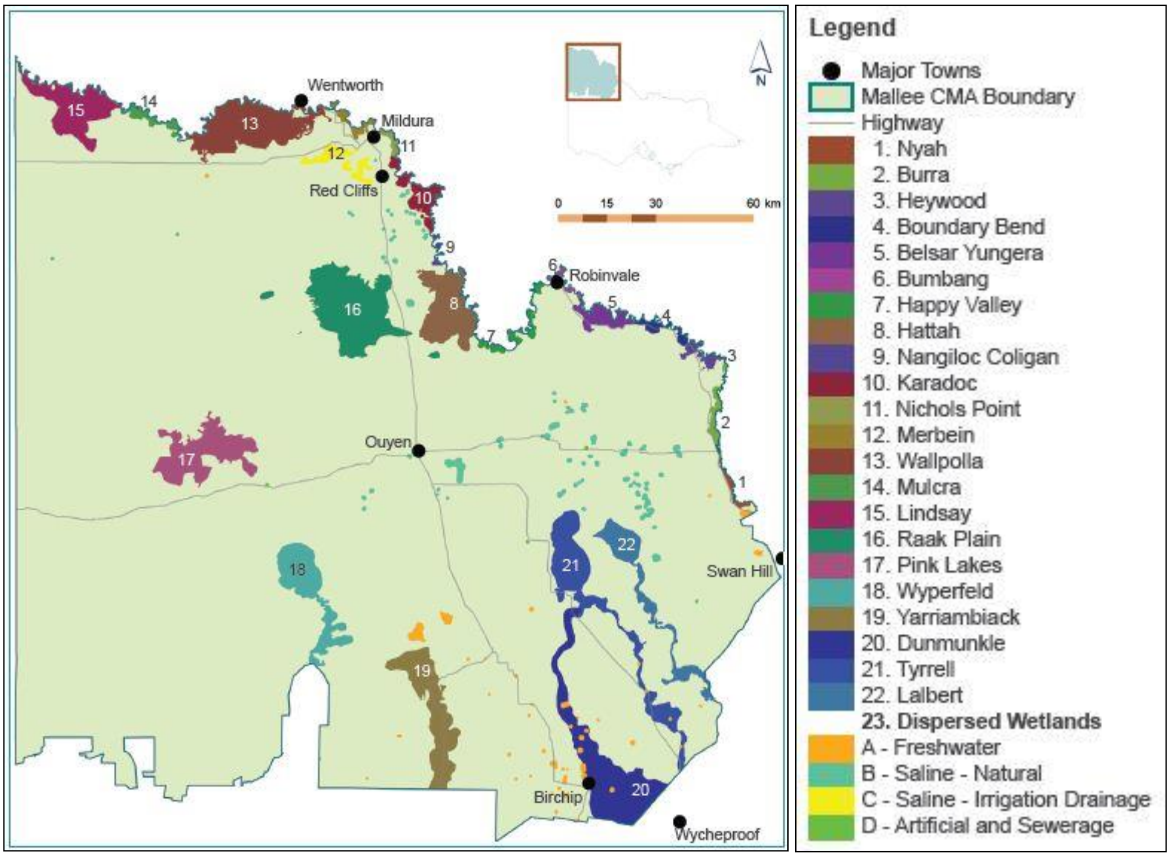


Figure 1. Mallee Water Management Units (Mallee CMA, 2014)

2.2 Catchment setting

Bottle Bend is located in the Robinvale Plains Bioregion within the Mallee CMA region. The Robinvale Plains Bioregion is characterised by a narrow gorge confined by the cliffs along the Murray River, which is entrenched within older up-faulted Cainozoic sedimentary rocks. Alluvial deposits from the Cainozoic period gave rise to the red brown earths, cracking clays and texture contrast soils (Dermosols, Vertosols, Chromosols and Sodosols) this supports Riverine Grassy Forest and Riverine Grassy Chenopod Woodland ecosystems (DEPI 2011).

Land systems

The major stratigraphic units encountered on the floodplain within the study area, in order of increasing depth, include the Coonambidgal Clay (aquitard), Monoman Formation (floodplain aquifer), Parilla Sands (regional aquifer) and Lower Parilla Clay (aquitard).

The Coonambidgal Clay acts as an aquitard for the floodplain aquifer. The extent and thickness of the Coonambidgal Clay is likely to be a key factor on the interaction between the Bottle Bend wetlands and the underlying groundwater system and therefore the magnitude of potential salinity impacts from floodplain watering. Significant volumes of groundwater will be removed from this layer as a result of the shallow groundwater levels (<5m from surface) and higher capillary rise potential than the underlying aquifer.

The Monoman Formation is semi-confined by the Coonambidgal Clay and forms the floodplain aquifer. There is some evidence of connectivity between the Murray River floodplain and regional aquifer. The floodplain aquifer has been observed to correspond to high river flows and is variably connected to the regional aquifer, with a potential for downward flux.

The Parilla Sands form the regional aquifer occurring across both the highland and floodplain. They can be divided into upper and lower units. The regional aquifer is recharged by irrigation drainage water. Elevated groundwater levels have created a radial flow pattern away from the irrigation area, with groundwater contours suggesting a flow towards the Bottle Bend floodplain.

2.3 Bottle Bend

Bottle Bend covers 1487 hectares. The floodplain height is between 35 – 39m AHD, and is bordered by the Murray River to the North and by higher land (roughly 50m AHD) to the south (Figure 2). The floodplain is located 34 km upstream of the Mildura Weir (Lock 11) which maintains a normal upstream water level of 34.4 m AHD (Ecological Associates and Tonkin Consulting, 2016).

The floodplain contains two low-lying meander scroll systems, however, most of the floodplain is a rarely-flooded dune of Woorinen Sand (approximately 42m AHD), only inundated at high river flows (Ecological Associates 2007b, Ecological Associates and Tonkin Consulting, 2016).

Low floodplain terraces support River Red Gum communities in poor health (Bluml 1992). The higher central floodplain is mainly vegetated with Lignum, along with areas of Black Box woodland considered significant vegetation due to the "extensive stands of Black Box present with prolific regeneration" (Land Conservation Council 1989). The easternmost portion of wetland #7329155000 features an extensive lignum wetland (Ecological Associates, 2007b).

Several wetland areas receive irrigation drainage water within Bottle Bend, these are known (by the Lower Murray Water Authority) as the South-east Drainage Basins. Saline drainage water is disposed of into the Southeast Drainage Basins from the Red Cliffs irrigation district.

The southern wetlands, #7329155000 and #7329138008, are broad and shallow, with an approximate bed height of 38m AHD. Two irrigation drainage outfalls discharge into these wetlands, drains 9 and 10, see figure 3. The northern wetlands,#7329143026, #7329140026, 7329152029 and #7329146026 are a series of shallow, elongated wetlands, approximately 100m wide and up to 2m deep, with a bed height of approximately 34.5m AHD, similar to the pool level of the River Murray. Between the southern wetland sand the northern wetlands, along the western boundary of Bottle Bend lies a broad, shallow wetland with a general bed height of 37m AHD called wetland #7329143017. This wetland receives drainage water from drains 8 and 7 (Ecological Associates and Tonkin Consulting, 2016).

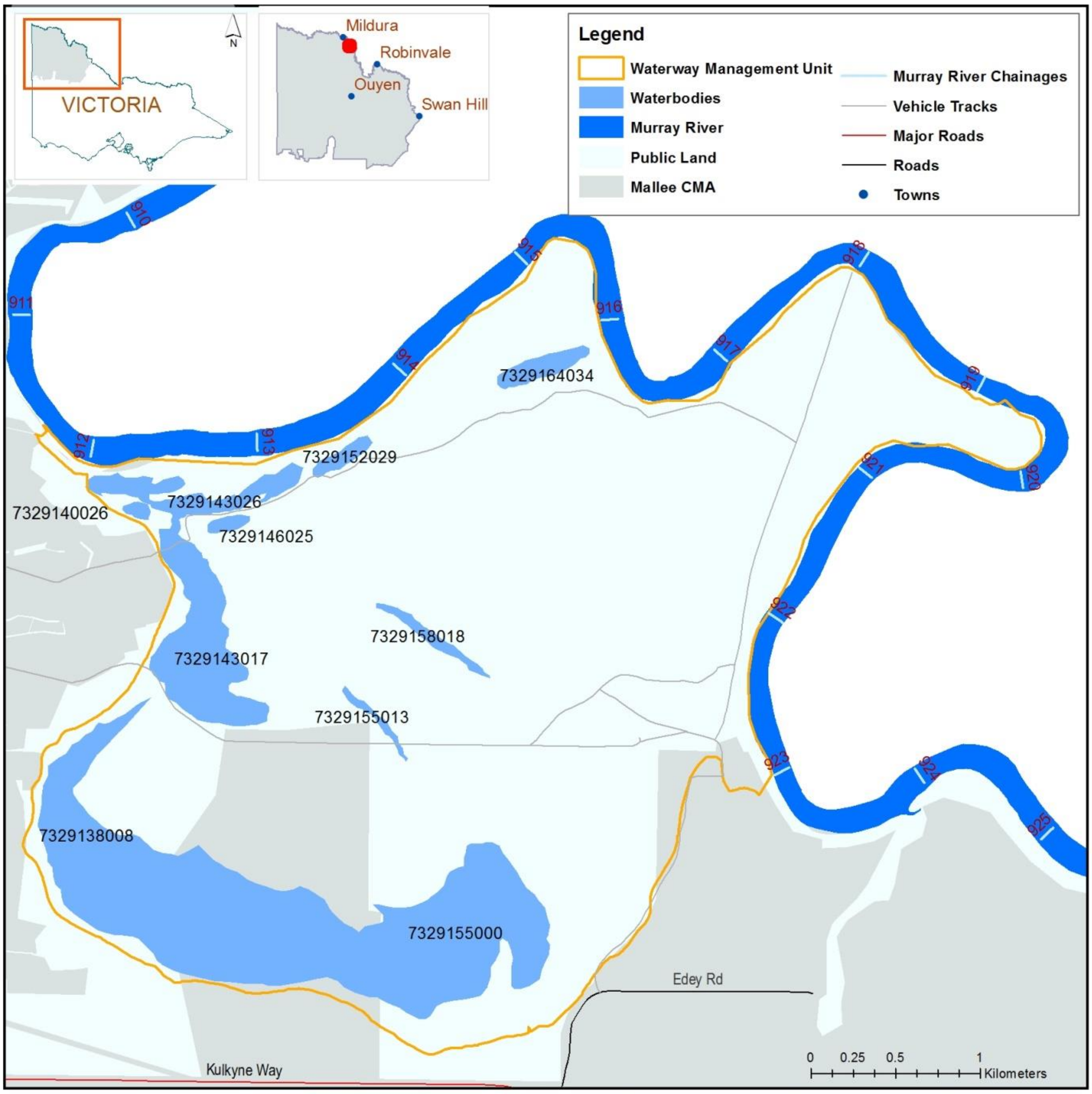


Figure 2. Bottle Bend

Permanent inundation as a result of irrigation drainage to the southern wetlands has created ideal conditions for flora such as Cumbungi (Typha spp.) and has led to large scale invasion of the wetlands by reed-bed vegetation, with approximately 37 ha of wetlands colonised in 2015 (Ecological Associates and Tonkin Consulting, 2016). The area colonised has shrunk from approximately 184 ha in 1992 (Bluml 1992), and 120 ha in 1997. This is likely to be due to reduced inflows from rainfall, groundwater and irrigation drainage and increased salinity (Ecological Associates and Tonkin Consulting, 2016). The irrigation drainage water from drains 10 8 have an average conductivity of 1,700 EC and 1,800 EC respectively (Ecological Associates and Tonkin Consulting, 2016). A combination of irrigation drainage and groundwater intrusion has led to an increase in salinity levels and degradation of local vegetation.

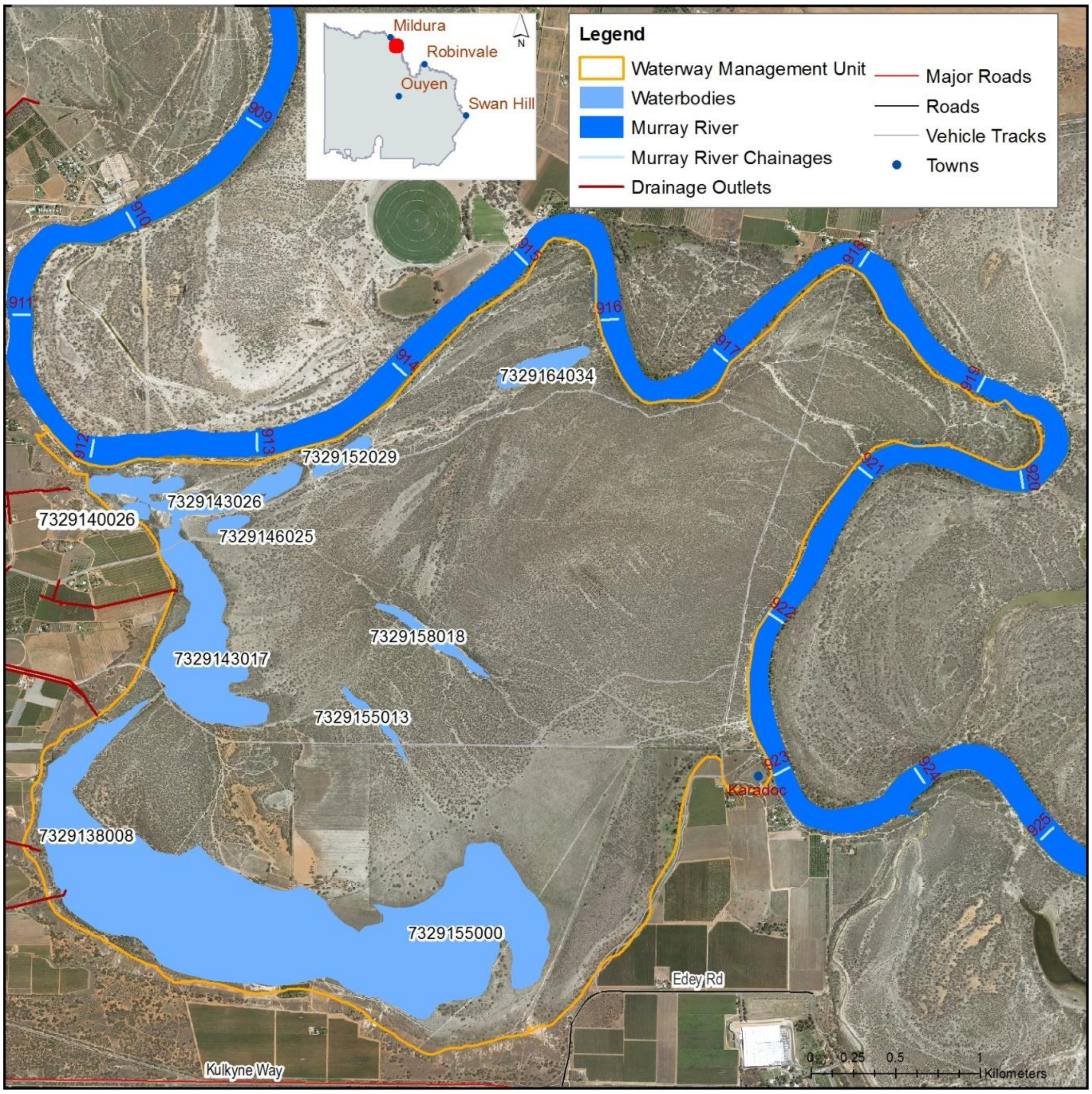
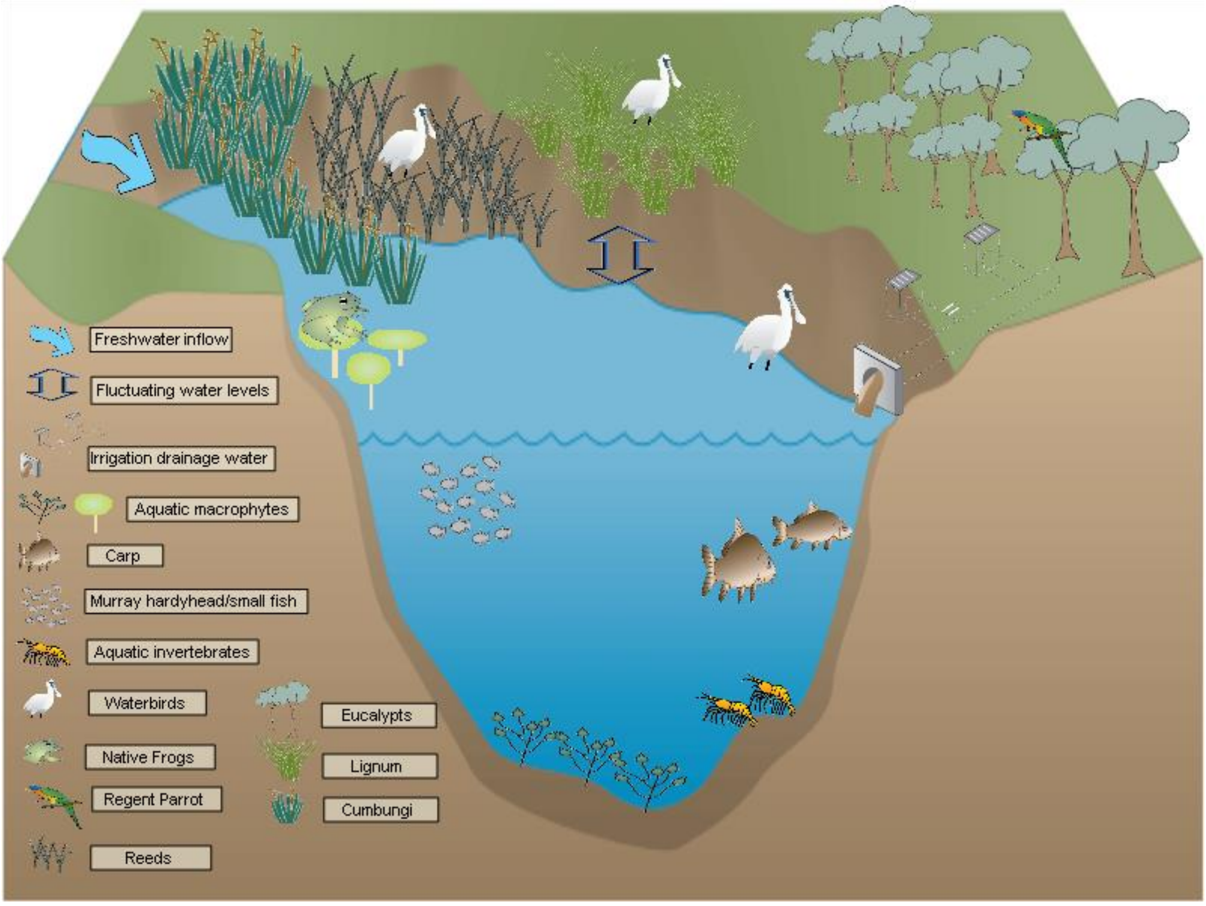


Figure 3. Bottle Bend irrigation drainage outlet points

2.4 Conceptualisation of the Site

A conceptual model of the site (Figure 4) has been developed which describes how the ecological processes and water dependent values interact. The model provides a visual representation of the site's processes and threats that are discussed throughout the document and represents the wetland system being targeted.



Saline irrigation drainage and groundwater discharge enter the wetland, increasing salinity levels. **Freshwater inflows** to the system will be delivered as environmental water to provide **fluctuating water levels** and reduce salinity. This flooding leads to the rapid release of nutrients from the soils, germination of aquatic plants from the seed banks, and emergence of invertebrates. This pulse in aquatic macrophytes and invertebrates provides food for waterbirds, frogs and turtles. The wetland becomes more productive as surrounding emergent vegetation benefits from periodic inundation and water recession.

Figure 4. Values, threats and processes associated with the Bottle Bend Wetlands

2.5 Land status and management

Bottle Bend largely consists of public land in the Murray River Park; a portion of the central floodplain and wetlands is privately owned and used for agriculture (Ecological Associates 2007b) (Figure 5).

The public land within Bottle Bend has historically been managed by the Department of Environment, Land, Water and Planning (DELWP) and its predecessors as State Forest under the Murray River Reserve (Parks Victoria 2012). The central floodplain is now incorporated into the Murray River Park as a result of the River Red Gum Forests Investigation (VEAC 2008) and is now managed by Parks Victoria. The target area lies within the Murray River Reserve.

Adjacent land to the west and south is managed for irrigated horticulture (Ecological Associates and Tonkin Consulting, 2016).

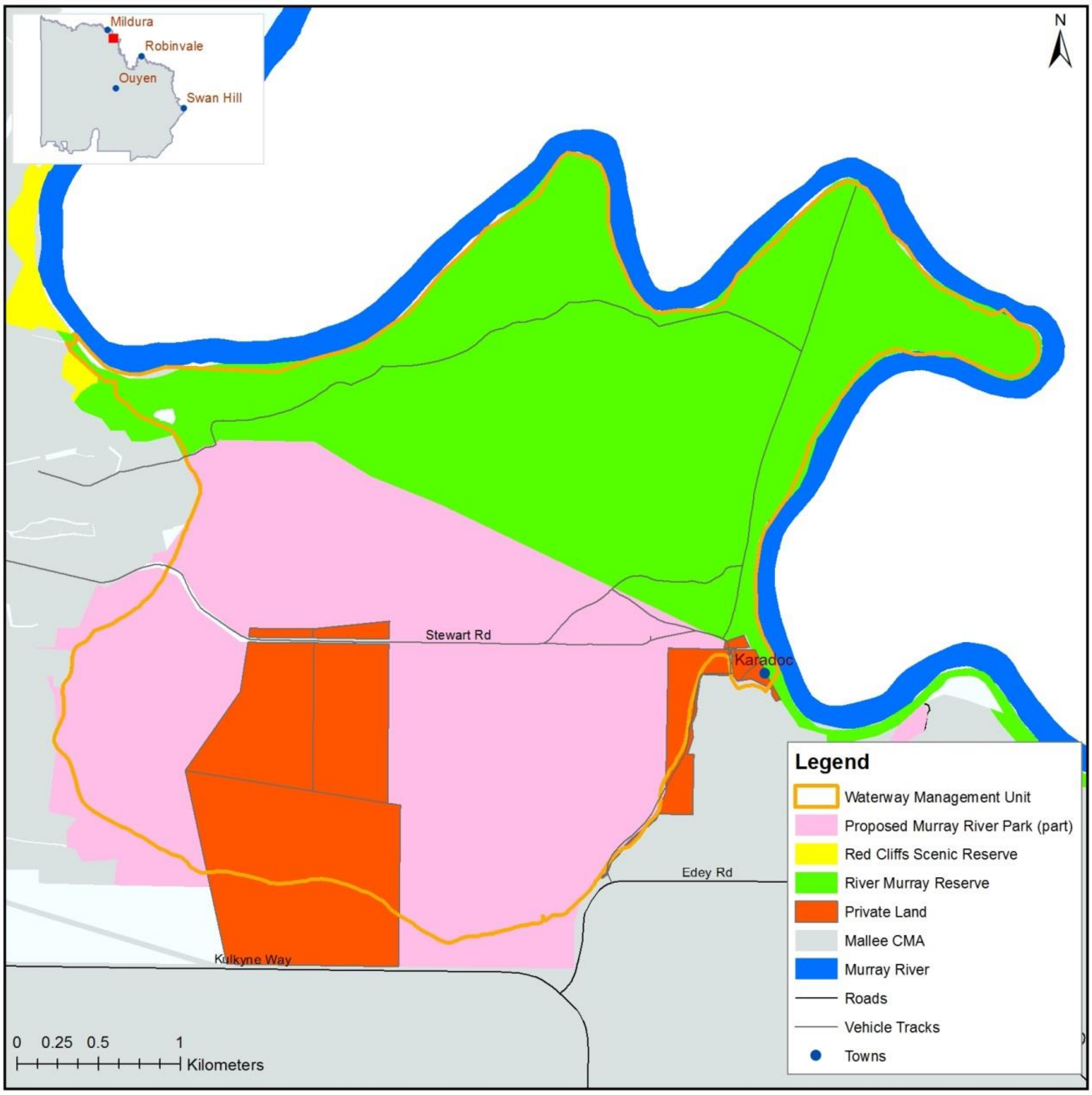


Figure 5. Land management boundaries at Bottle Bend

Stakeholders associated with or interested in environmental water management outcomes for Bottle Bend are listed in Table 1.

Table 1. Stakeholders for Bottle Bend

Group	Role
Parks Victoria	Land Manager. Parks Victoria are responsible for Conserving Victoria's Special Places with the aim to ensure that our valued parks, and the natural assets and cultural heritage they hold, can be enjoyed now and by future generations.
Mallee CMA	The Mallee CMA's responsibility is to ensure that natural resources in the region are managed in an integrated and ecologically sustainable way, including regional environmental water management.
Department of Environment, Land, Water and Planning	State level environmental water management planning, land manager, threatened species manager.
Victorian Environmental Water Holder	Management of Victorian environmental water holdings since July 1 2011.
Mildura Rural City Council	Local Government. Mildura Rural City Council has a number of Water Management Programs to save water resources and improve the health of waterways. They are responsible for disposing of storm water from Mildura into the Southeast Drainage Basins and for recreational planning.
Aboriginal Stakeholders	Provide assistance in planning and implementation of programs.
Lower Murray Water	Murray River operations and irrigation drainage.
Local Landholders	Land users, provide assistance in planning and implementation of programs.

2.6 Wetland characteristics

An overview of the main characteristics of wetlands at Bottle Bend is shown in Table 2 and wetland types are shown in Figure 6.

Table 2. Wetland characteristics of Bottle Bend

Characteristics	Description
Name	Bottle Bend
Individual wetlands (ID numbers follow Corrick numbering in Wetland 1994 layer)	**Bottle Bend Wetland Complex:** #7329143026, #7329140026, #7329164034 & #7329152029;#7329146025; #7329158018; #7329155013; #7329143017; #7329138008 & #7329155000
Area	Total area of WMU Sub-unit is 1487.23 ha Total area of wetlands at Bottle Bend is 246.96 ha
Bioregion	Robinvale Plains
Conservation status of Ecological Vegetation Classes	Vulnerable (Semi-arid Chenopod Woodland & Alluvial Plains Semi-arid Grassland); Depleted (Floodway Pond Herbland); Least Concern (Lignum Shrublands)
Land status	Murray River Park, Murray River Reserve, Scenic Reserve and private land
Land manager	Parks Victoria
Surrounding land use	Agriculture
Water supply	Controlled irrigation drainage water release, Murray River
Wetland area	#7329143026 (5.29 ha); #7329164034 (6.22 ha); #7329152029 (2.61 ha); #7329140026 (1.6 ha); #7329146025 (1.87 ha); #7329158018 (4.15 ha); #7329155013 (2.15 ha); #7329143017 (31.74 ha); #7329138008 (5.19 ha) & #7329155000 (186.14 ha).
Corrick wetland category	Permanent Open Freshwater (#7329413026, #7329152029, #7329158018, # 7329140026 & #7329143017) Freshwater Meadow (#7329164034, #7329146025 & #7329155013) Deep Freshwater Marsh (# 7329138008 & #7329155000)
Wetland depth at capacity	Unknown

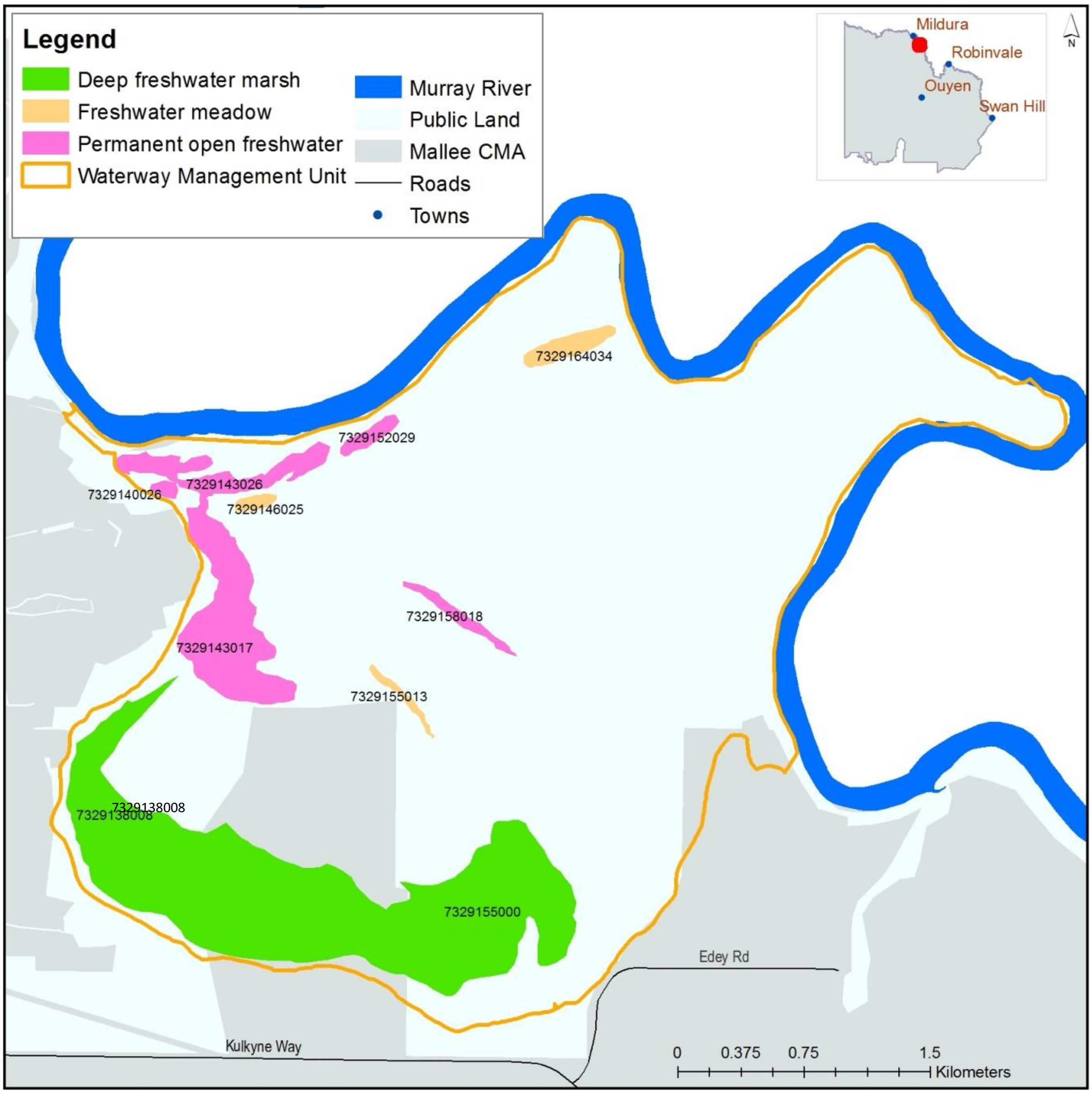


Figure 6. Bottle Bend Wetland Classification

2.7 Management Scale

The whole of Bottle Bend has a water requirement as a floodplain complex (Mallee CMA, 2014), however, this EWMP focuses on the area that can be inundated through environmental watering, referred to as the target area. The target area is the maximum extent to which environmental water is able to be managed with environmental water, following construction of infrastructure proposed in this EWMP.

There are ten wetlands at Bottle Bend, only two of these wetlands, #7329143026 and #7329152029 are in the target area for this EWMP. Wetlands have been excluded from the target area because they are either:

- higher on the floodplain and watering them would inundate lower lying non-target areas on private land;
- not able to be watered with the current or proposed infrastructure; or
- watering them would result in unacceptable salinity impacts to the Murray River.

The reason why each wetland has been excluded from the target area is provided in Table 3.

Table 3 – Justification for exclusion of wetlands from the target area

Wetland	Justification for exclusion from the target area
#7329140026	Excluded due to risk of unacceptable salinity impact at Morgan (Richardson and Currie, 2015)
#7329164034	Excluded due to risk of unacceptable salinity impact at Morgan (Richardson and Currie, 2015)
#7329146025	Excluded due to risk of unacceptable salinity impact at Morgan (Richardson and Currie, 2015)
#7329158018	Inundation would flood non-target areas
#7329155013	Inundation would flood private land
#7329143017	Active irrigation drainage disposal
#7329138008	Inundation would flood private land
#7329155000	Inundation would flood private land

Wetlands not targeted in this EWMP may be considered in the future for environmental watering.

Figure 7 - Target inundation area for Bottle Bend

2.8 Assessment of Salinity Risk

The Murray-Darling Basin Ministerial Council released the *Basin Salinity Management 2030* (BSM 2030) in 2015. This document builds on the *Basin Salinity Management Strategy of 2001-2015* (BSMS) and provides a program of salinity management across governments to meet the Basin Salinity Target of maintaining the salinity at Morgan at less than 800 EC for 95 per cent of the time. An accountable action under this plan is one that is assessed as causing a change in average daily salinity at Morgan of 0.1 EC or more by 2100.

Schedule B of the *Water Act 2007* requires that, if an activity causes a significant salinity effect it be treated as an accountable action; triggering a detailed assessment and possible entry on either of the salinity Registers (A or B) (SKM, 2014). For example, if an event such as wetland flushing provides a reduction in salinity then the Commonwealth may allocate credits to the Commission A Register to offset actions to provide environmental and social benefits (MDBA, 2001).

An assessment of proposed watering regimes and target areas for Bottle Bend was undertaken at the draft EWMP stage. A watering regime proposed for wetlands #7329143026, #7329152029, #7329140026 and #7329164034 was assessed to determine their potential impacts on salinity in the Murray River (Richardson and Currie, 2015) via the mobilisation of salt. The modelling identified the salinity pathways for these wetlands during environmental watering are:

- enhanced recharge to groundwater;
- rise in groundwater levels and an altered hydraulic gradient across the floodplain; and
- a resultant increase in groundwater flux (and salt load) to the River.

Salinity assessments were undertaken to model the estimated potential EC impact at Morgan, for two watering options at Bottle Bend (see Table 4). The reportable impacts are highlighted in red. The recommended watering regime is option 2, which will have an impact of less than 0.1 EC at Morgan.

Table 4 - Estimated potential EC impact at Morgan for proposed Bottle Bend watering options (Richardson and Currie, 2015)

Option	Watering regime	Estimated EC impact at Morgan		
		Groundwater pathway	Surface water pathway	Total
Option 1 –7329164034, #7329152029, #7329143026, #7329140026)	Min	0.13	n.a	0.13
	Opt & Max	0.26	n.a	0.26
Option 2 - #7329143026, #7329143029	Min	0.10*	n.a	0.10*

* While the EC impact at Morgan is calculated to be equal to 0.1 EC for the Option 2 (alternate) watering regime, the conservative nature of the calculation method means it is reasonable to consider the impact to be less than 0.1 EC at Morgan.

2.9 Environmental Water Sources

The Environmental Water Reserve (EWR) is the legally recognised amount of water set aside to meet environmental needs. The Reserve can include minimum river flows, unregulated flows and specific environmental entitlements. Environmental entitlements can be called out of storage when needed and delivered to wetlands or streams to protect their environmental values and health.

Environmental Water for Bottle Bend may be sourced from the water entitlements and their agencies (Table 5) which are further explained in the Regional Context Document for Environmental Water Management Plans (Sunraysia Environmental 2014).

Table 5. Summary of environmental water sources available to Bottle Bend

Water Entitlement*	Responsible Agency
River Murray Unregulated Flows	Murray Darling Basin Authority
Murray River Surplus Flows	
Victorian River Murray Flora and Fauna Bulk Entitlement	Victorian Environmental Water Holder
Commonwealth water	Commonwealth Environmental Water Office
Donated Water	Victorian Environmental Water Holder

* Other sources of water may become available through water trading or changes in water entitlements.

2.11 Related Agreements, Policy, Plans and Activities

There are a range of international treaties, conventions and initiatives, as well as National and State Acts, policies and strategies that determine management of the target area. Those with particular relevance to the site and the management of its environmental values are listed in Table 6. For the functions and major elements of each refer to the Regional Context Document (Sunraysia Environmental 2014).

Table 6. Legislation, agreements, convention and listings relevant to the target area

Legislation, Agreement or Convention	Jurisdiction
China-Australia Migratory Bird Agreement (CAMBA) Japan-Australia Migratory Bird Agreement (JAMBA)	International agreements administered under the federal *Environment Protection and Biodiversity Conservation Act 1999*
Environment Protection and Biodiversity Conservation Act 1999 (EPBC)	National
Flora and Fauna Guarantee Act (FFG)	State
Department of Environment, Land, Water and Planning advisory lists	State

Bottle Bend is situated on the Victorian floodplain of the Murray River which is the subject of investigation in many guises. These include Salinity Management Plans, Flow studies and Land Conservation Council Reviews. An investigation into River Red Gum Health by the Victorian Environmental Assessment Council (VEAC) in 2008 resulted in changes in areas within Bottle Bend from State Park to Regional Park in 2010.

The following policies, plans and activities are directly relevant to the environmental management of Bottle Bend.

Investigation of Water Management Options for the River Murray – Robinvale to Wallpolla Island

In 2006, Mallee CMA engaged consultants Ecological Associates to investigate water management options for the floodplain of the Murray River from Robinvale to Wallpolla Island. This investigation proposed infrastructure to enable greater inundation of the target area in Bottle Bend which is outlined as part of this plan.

Water Management Options for the Murray River – Robinvale to Wallpolla, Stage II

In 2007, Ecological Associates developed the Water Management Options for the Murray River – Robinvale to Wallpolla, Stage II for the Mallee CMA. This report costs designs for environmental watering infrastructure, proposes alternative water management options, documents environmental impacts and documents Cultural heritage values.

Mallee Waterway Strategy 2014 - 2022

The Mallee Waterway Strategy (Mallee CMA, 2014) sets regional goals for waterway management that align with the Mallee Regional Catchment Strategy's broader objectives, identifies high value waterways, details strategic work programs for priority waterways, identifies the roles and responsibilities of regional stakeholders and establishes principles to guide the implementation. Under this strategy the Bottle Bend Wetland complex is listed as a high priority.

Regional Context Document for Environmental Water Management Plans

The Regional Context Document for Environmental Water Management Plans; Mallee CMA Region (Sunraysia Environmental, 2014) provides background context for the region, outlines significant wetlands and rivers, sources of environmental water and policy, legislative and planning frameworks.

Mallee Catchment Management Authority Frontage Action Plan

Bottle Bend wetlands are within the area covered by the Mallee CMA Frontage Action Plan Merbein to South Australian Border (Mallee, CMA 2003) and has the potential to attract future funding for works through that project. This action plan incorporates a range of actions to enhance riparian frontage of the Murray River (Mallee CMA, 2003).

Basin Salinity Management 2030

As mentioned previously, the Murray-Darling Basin Ministerial Council released the Basin Salinity Management 2030 (BSM 2030) in 2015.

Schedule B of the Water Act (2007) requires that, if an activity; causes a significant salinity effect it be treated as an accountable action. Accountable actions trigger a detailed assessment and possible entry on either of the salinity Registers (A or B).

Salinity Impact Assessment of Mallee CMA Environmental Watering Sites

A preliminary salinity impact assessment was undertaken on three proposed environmental watering regimes to identify if there were accountable salinity impacts under the BSMS (Australian Water Environments 2014). Australian Water Environments identified key salt mobilisation processes that could be triggered by the proposed watering activities and salinity impacts from the hydrogeological characteristics of the site.

Results confirmed that all three studied regimes would produce in-stream salinity impacts required to be accounted for under the BSMS registers; with recommendations to undertake groundwater and salinity level monitoring during watering events to assess vertical and horizontal leakage rates through the Coonambidgal clay.

Waterwatch

Initiated in 1993, Waterwatch Victoria monitors waterways to raise knowledge and awareness in the community about issues with water and encourage monitoring groups to undertake actions to protect waterways. There is currently one active (last monitored during December 2014) and one inactive (last monitored in October 2007) water quality monitoring site adjacent to or within the Bottle Bend area. Refer to Appendix 3 for monitoring results.

3 Hydrology and System Operations

Wetland hydrology is the most important determinant in the establishment and maintenance of wetland types and processes. It affects the chemical and physical aspects of the wetland which in turn affects the type of flora and fauna that the wetland supports (DEPI, 2005). A wetland's hydrology is determined by surface and groundwater inflows and outflows in addition to precipitation and evapotranspiration (Mitsch and Gosselink, 2000 in DEPI, 2005). Duration, frequency and seasonality (timing) are the main components of the hydrological regime for wetlands and rivers.

3.1 Hydrogeology

Hydrostratigraphy

The major stratigraphic units encountered on the floodplain at Bottle Bend, in order of increasing depth, include the Coonambidgal Formation, Channel Sands Formation, Parilla Sands and Lower Parilla Clay. The Coonambidgal Formation forms an aquitard at the top of the sedimentary sequence within the River Murray trench and semi-confines the underlying Channel Sands floodplain aquifer. The Channel Sands and underlying Parilla Sands form a single composite aquifer, the regional water table aquifer.

The extent and thickness of the Coonambidgal Formation is likely to be a key control on the interaction between the Bottle Bend wetlands and the underlying groundwater system and therefore the magnitude of potential salinity impacts from floodplain watering (Richardson and Currie, 2015).

Groundwater levels and flow

Groundwater level contours reflect groundwater flow to the floodplain from highland irrigation areas to the west and south. The data on the floodplain itself is sparse, but suggest a slight head gradient towards the River (34.4 mAHD). Hydrograph data for the Channel Sands indicate a general decline in groundwater levels on the floodplain since the early 2000s. This is likely to be due to lower than average rainfall and River flows, while groundwater elevations under some irrigated areas have remained relatively stable. Groundwater wells situated close to the Bottle Bend Wetland Complex show an increase in groundwater levels around 2010-2012, in response to receiving recharge from high River flows entering the floodplain, while wells situated further away do not display the same response (Richardson and Currie, 2015).

Groundwater salinity

Groundwater salinity data, while sparse, shows salinity in the Channel Sands aquifer ranges from <10,000 to 50,000 EC across the floodplain, with salinity generally increasing with distance from the irrigation area towards the River. Available data shows a rise in salinity that coincides with declining groundwater levels since the early 2000s (Richardson and Currie, 2015). An Airborne Electro-Magnetic survey undertaken during low flows in 2007 suggests the presence of high salinity groundwater beneath the majority of the Bottle Bend floodplain. Patches of low salinity water have been identified under sections of wetland which may reflect the Woorinen Sand and or an influence of lower salinity drainage water recharging the water table. Near River groundwater salinity is high and may have significant instream impacts if mobilised by floodplain inundation (Australian Water Environments, 2014).

A rise in groundwater levels has been recorded within a bore monitoring the Monoman Formation in the north of the site. Salinity levels monitored in the Monoman Formation aquifer ranged between 6,680 and 44,200 EC, whilst the Parilla Sands aquifer ranged between 6,700 and 58,700 EC. This data suggest that near river groundwater salinity is high and may have a significant instream impact if mobilised by floodplain inundation (Telfer, 2014).

Surface water-groundwater interactions

Groundwater levels have declined in the region since the mid-1990s. This may be due to improved irrigation practices, low rainfall and/or river flow conditions. This has resulted in a reduction in the amount of recharge to the water table and reduced volumes of drainage water being disposed of on the Bottle Bend floodplain.

The water table below Bottle Bend is contained within the Coonambidgal Clay formation and lies between 0-10 m below the surface. Morphological studies suggest that Bottle Bend is a high terrace floodplain represented by the oldest and thickest clay sequences with a low vertical hydraulic conductivity of less than 10^{-3} m/d.

The measured groundwater elevation on the western side of wetlands #7329138008 and #7329143017 is approximately 2 m below the wetland bed elevation, indicating that the wetlands are disconnected from the groundwater system and are likely to experience losing conditions when filled. Closer to the River and in the centre of the floodplain (wetlands #7329140026, #7329143026, #7329152029 and #7329158018) the groundwater elevation is approximately 35 mAHD indicating gaining conditions to the River are probable (Richardson and Currie, 2015). Groundwater level data suggest that there is some hydraulic separation between the Channel Sands and Parilla Sands aquifers and indicates a potential for downward fluxes (Australian Water Environments, 2014). Hydrographs show a rise in ground levels following the high River flows in 2010, indicating some connection between the floodplain aquifer and River Murray.

Overall, it is likely that the proposed height of ponded water from the inundation options will be higher than groundwater heads in the adjacent floodplain aquifer suggesting the potential for the discharge of environmental water to groundwater (Richardson and Currie, 2015).

3.2 Water management and delivery

Pre-regulation

Under natural conditions, flow is understood to have been strongly seasonal, with median daily discharge highest in late winter to spring and lowest in autumn (SKM, 2002). Prior to river regulation, floodplain inundation would have occurred more frequently than under current regulated conditions. In order to inundate low areas of floodplain and many wetlands, the flows would need to be 20,000 to 60,000 ML/d. These flow conditions would have occurred for longer duration than under the current base line conditions (Ecological Associates, 2007b) (Figure 8).

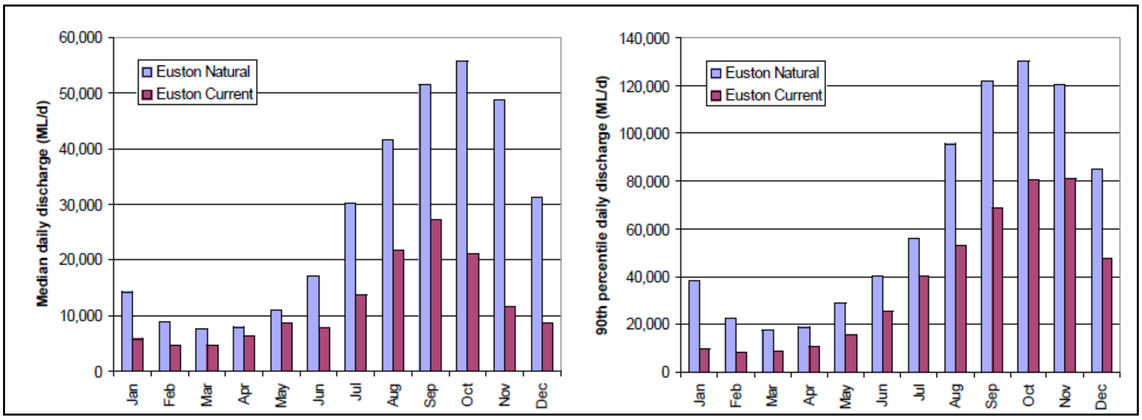


Figure 8. Distribution of median flows and 90th percentile flows for each month in the River Murray through Euston Weir for natural and current (benchmark) conditions. Data derived from MDBC MSM-Bigmod 109-year-data (Ecological Associates, 2007b)

Post-regulation

In this section of the Murray River, the frequency, duration and magnitude of all but the largest floods have been reduced due to effects of major storages in the Murray and its tributaries (Thoms et al, 2000). The seasonal distribution of flows in this section of the Murray River shows that despite a reduction in discharge, the river retains the same annual pattern of higher flows in winter and spring with lower flows in summer and autumn (Figure 8).

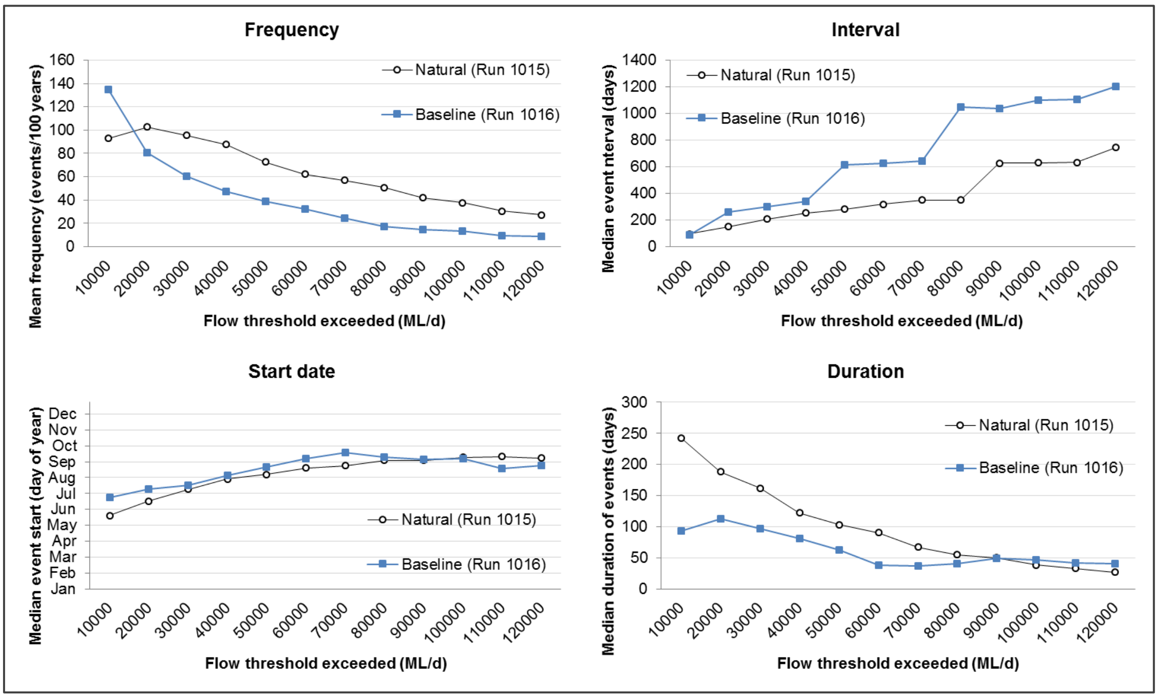


Figure 9. Comparison of Natural (pre-regulation) and Baseline Modelled Flow (post-regulation) scenarios for Euston Downstream (Gippel, 2014)

Spells analysis shows that the events most affected are those generated by flows above approximately 15,000 ML/d, which now occur less frequently. Floods generated by flows greater than 90,000 ML/d now occur for a shorter duration (Figure 9) (Gippel 2014). Commence to flow data suggests that the River Wetlands/the Fish Ponds are inundated when river flows exceed 37,900 ML/d. The frequency of these events has reduced by almost 50 per cent since regulation Figure 9.

Under current conditions water enters the wetland system from the Murray River at wetland #7329143026 and continues on to #7329152029 & #7329164034 (River Wetlands/the Fish Ponds) (Figure 10). Water then backs up into wetland #7329 143017 and on to the southern-most wetlands #7329138008 &#7929155000. The Southeast Drainage Basins are connected by an excavated channel. The inflow of drainage water to these wetlands has caused dense reed growth which impedes flows (Ecological Associates, 2007b) (Figure 11).

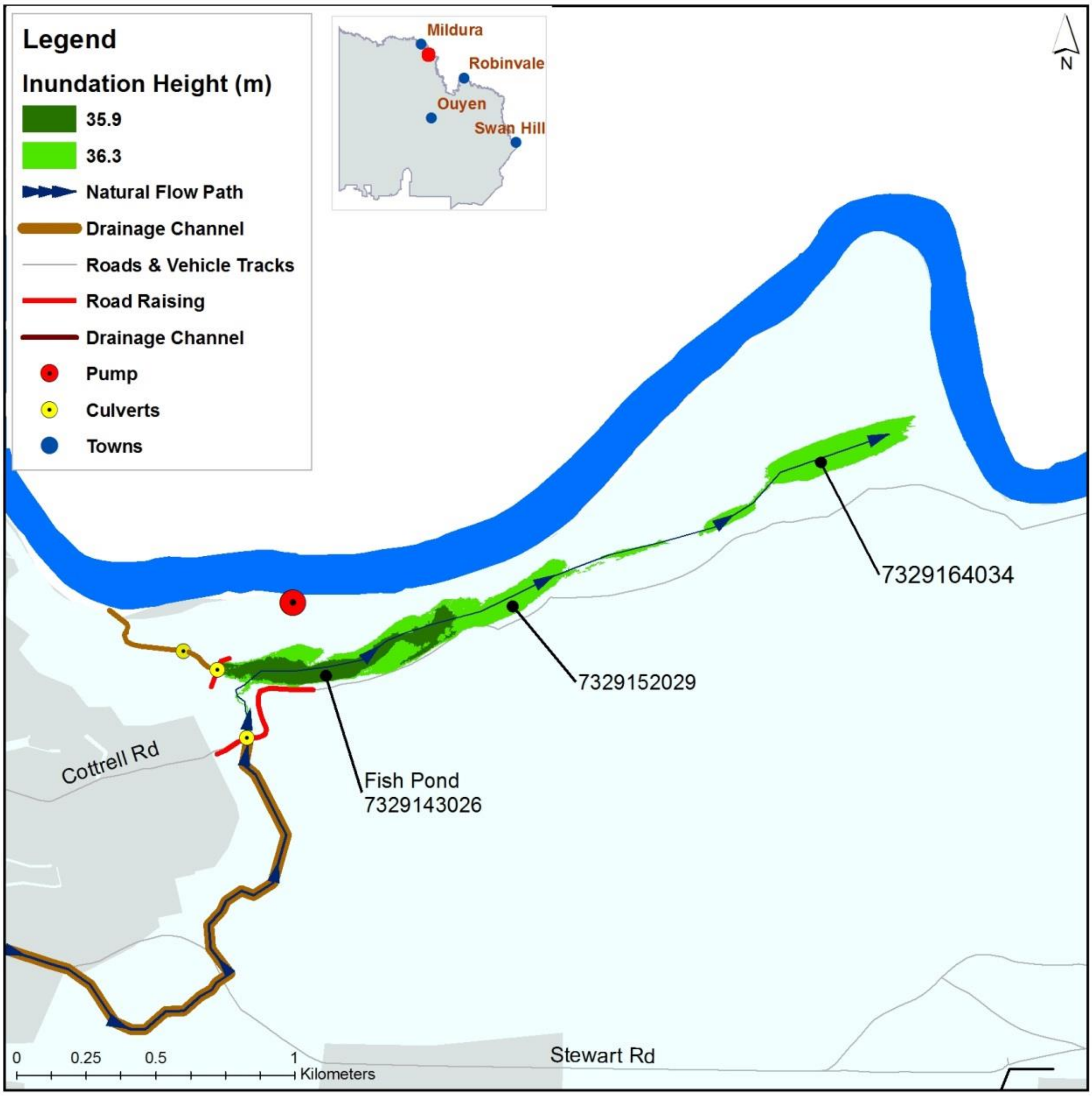


Figure 10. Targeted wetlands showing irrigation drainage and natural flow path

Figure 11. Common Reed growing in the southern-most wetland (Ecological Associates and Tonkin Consulting, 2016)

3.3 Previous Environmental Watering

There has been no environmental water delivery to Bottle Bend to date.

4 Water Dependent Values

4.1 Environmental Values

Wetlands and waterways on the floodplain are a vital component of the landscape supporting a vast array of flora and fauna which may vary greatly with the type of wetland/waterway system. The habitat provided by vegetation communities around wetlands is essential for maintaining populations of water dependent fauna species.

Listings and significance

Fauna

Bottle Bend consists of a series of wetlands and creeks that provide habitat for a large range of fauna. Native species recorded in the area are listed in Appendix 1. This list includes a range of water dependent species which will benefit from the wetland in the target area receiving water on a more regular basis. Of special interest and responsibility are the water dependent species listed in legislation, agreements or conventions summarised in Table 7.

Table 7. Listed fauna recorded at the site

Common name	Scientific name	Type	International agreements	EPBC status	FFG status	DELWP status
Eastern Great Egret	*Ardea modesta*	B	CAMBA, JAMBA		L	V
Nankeen Night Heron	*Nycticorax caledonicus hillii*	B				NT
Hardhead	*Aythya australis*	B				V
Blue-billed Duck	*Oxyura australis*	B			L	EN
Regent Parrot*	*Polytelis anthopeplus monarchoides*	B		VU	L	V
Broad Shelled Turtle	*Chelodina expansa*	R			L	EN
Growling Grass Frog	*Litoria raniformis*	A		VU	L	EN

Legend
Type: Invertebrate, Fish, Amphibian, Reptile, Bird, Mammal
EPBC status: EXtinct, CRitically endangered, ENdangered, VUlnerable, Conservation Dependent, Not Listed
FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing
DELWP status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known, Not Listed

*Species are included as water dependent due to habitat requirements

Table 7 includes water-dependent species that forage or nest in or on water or require flooding to trigger breeding and fledging. In order to provide breeding opportunities, habitat elements such as temporary wetlands and Lignum communities must be maintained in good condition. The list also includes the Regent Parrot (*Polytelis anthopeplus monarchoides*) which is indirectly dependent on water, i.e. they require riparian trees for breeding and feeding habitat.

Birds

The Regent Parrot is listed as nationally vulnerable under the EPBC Act, with estimates of only 2,900 birds left in the wild. This species has quite specific habitat requirements. It breeds almost exclusively in River Red Gum (*Eucalyptus camaldulensis*) forest and woodland, typically in large, old and healthy hollow-bearing trees close to water. They require trees that are a minimum of 160 years old (Baker-Gabb and Hurley, 2011). However, Regent Parrots have also been known to breed in Black Box (*Eucalyptus largiflorens*). They mostly feed in large blocks of intact Mallee woodlands usually within 5-10km (maximum 20km) of nest sites, but also consume flower buds of River Red Gum, Black Box and Buloke (*Allocasuarina leuhmanii*) (Baker-Gabb and Hurley, 2011). Regent Parrots are reluctant to fly through open areas and require corridors of vegetation between nesting and foraging sites.

Nankeen Night Herons utilise shallow water for foraging and breed in colonies building stick nests over water (Pizzey and Knight, 2007). They are nomadic in response to rainfall and flooding of suitable habitat. Breeding usually occurs from September to February. Nankeen Night Herons have a minimum lag time to breeding of three months from flood, and breeding success is significantly enhanced by longer durations of inundation, up to 12 months (Rogers & Ralph, 2011).

Great Egrets breed on a stick platforms built over water, usually between November and February (Pizzey & Knight, 2007). They have a preference for permanent water sites, and forage in water up to 30 cm deep (Rogers & Ralph, 2011). Fish are a significant part of the diet (Rogers & Ralph, 2011). Nests are built in the forks of trees over water, in colonies (which can be of mixed species). Long lag times for breeding have been recorded, though this may be variable depending on whether flooding occurs during the optimal breeding season of November to May or whether it occurs outside of the main breeding season (in which case the lag period is longer) (Rogers & Ralph, 2011). Minimum flood duration needs to be six to seven months to support breeding (Rogers & Ralph, 2011).

The Hardhead (*Aythya australis*) favours inland wetlands, preferring deep waters, but also frequents shallow and ephemeral wetlands and inundated floodplains (Rogers and Ralph, 2011; Marchant and Higgins, 1990). The Hardhead dives deep to forage and nests in dense vegetation above the water level, whether permanent water or ephemeral deep water (Rogers and Ralph, 2011; Marchant and Higgins, 1990). The Hardhead lives for approximately three to four years in the wild, therefore conditions suitable for breeding should occur every second year to maintain numbers of breeding adults. Breeding is stimulated by flooding and season (Briggs, 1990). Although information on breeding is limited, it is estimated that fledging occurs at two to three months suggesting flooding should last for four to six months. Food resources are more abundant for Hardhead when a flood follows a period of wetland drying, suggesting that inter-flood drying for a few months may increase breeding success of the Hardhead (Rogers and Ralph, 2011).

The Blue-billed Duck (*Oxyura australis*) is secretive and prefers stable or permanent deep wetlands with dense and abundant vegetation such as rushes, sedges or lignum. The species is herbivorous (leaves and seeds) (Marchant and Higgins, 1990) but opportunistically consumes crustaceans and insects. Feeding occurs in open water adjacent to vegetation and the species can dive to three metres depth (Rogers and Ralph, 2011). The breeding season is mostly between September and February, though this varies with hydrological conditions and food availability. Breeding occurs in temporary or permanent waterbodies. For breeding to occur in temporary wetlands, an (estimated) minimum of five to six months flooding is required (Rogers and Ralph, 2011). The Blue-billed Duck nests in vegetation over water, preferring vegetation within one metre of the edge of vegetation in deep water (Marchant and Higgins, 1990). The main threats to the species are the loss of suitable wetlands and hunting (DSE, 2003a).

As well as the listed species recorded in Table 7, Bottle Bend has historically supported a diverse range of waterbirds with 24 species recorded in the species list for this site (Appendix 1). Australia's waterbirds are often nomadic and take advantage of highly variable and often temporary aquatic resources. The distribution of temporary habitat patches throughout the landscape may facilitate movement and exploitation of available resources for waterbirds (Roshier et al., 2001). The provision of environmental water to wetlands is one method of creating such habitat patches for waterbirds, allowing them to move between suitable habitat to survive and reproduce (MDBA, 2009). Taft et al. (2002, cited in MDBA, 2009) states that wetland management which increases the diversity of available habitat types such as variable water depths, mud flats, inundated vegetation and deep water areas have the greatest abundance and diversity of waterbirds. For this reason, drawdown patterns are important as they change habitat types and influence waterbird presence (MDBA, 2009). Exposed mud flats and fringing vegetation provide ideal feeding grounds for wading birds upon drawdown (DEWNR, 2012).

<u>Frogs</u>

The *EPBC Act* listed Growling Grass Frog (*Litoria raniformis*), is usually found in seasonally flooded wetlands with complex aquatic vegetation communities and relies on drought refuges to survive dry periods. The Growling Grass Frog is particularly sensitive to changes in wetland hydrology and prefers annual flooding and long periods of inundation (five to seven months) due to a long larval phase. This frog requires flooding in spring/summer for successful recruitment as this is when it is active and breeding takes place. It can be excluded from wetlands under reduced flood frequency (Rogers & Ralph 2011).

Five additional species of native frog have been recorded at Bottle Bend (Table 8). The diversity of frog species and the presence of the Growling Grass Frog, which has suffered major declines throughout the Murray-Darling Basin (Rogers & Ralph 2011), is of significant ecological value. Like most flood dependent species frogs respond to the timing, duration and frequency of flooding, with the timing of inundation being the most significant factor. Close proximity to permanent waterbodies and drought refuges is also important for frogs. Aquatic vegetation complexity is important for many species, particularly at tadpole stage, and can drive occupancy patterns and recruitment success (Tarr & Babbitt, 2002, cited in Rogers & Ralph, 2011).

Frogs are considered to be good indicators of environmental health and may act as 'sentinel' species for secondary salinisation (DSE, 2006). A study by the Arthur Rylah Institute (2006) found that salinity levels up to 3000 EC did not limit amphibian occupancy but amphibian diversity declined significantly between 3000 and 6000 EC.

Table 8. Breeding habitat requirements of frogs at Bottle Bend

Common Name	Preferred length of inundation			Timing of Breeding				Tadpole life-span (months)
	<3 months	3-6 months	Permanent	Spring	Summer	Autumn	Winter	
Growling Grass Frog		*	*	C	CM	M		3-5
Barking Marsh Frog		*	*	C	CM	M		3-4
Spotted Marsh Frog	*	*	*	C	CM	M		3-4
Plains Froglet	*	*	*	C	CM	CM	M	2-4
Peron's Tree Frog	*	*	*	C	CM	M		3-4
Eastern Banjo Frog		*	*	CT	CM	CM	T	5-6

C = Calling **M** = Mating **T** – Tadpoles

Vegetation communities

Ecological Vegetation Classes (EVCs) were developed by the state of Victoria in 1994 and have been utilised since for mapping floristic biodiversity. Vegetation communities are grouped based on structural, floristic and ecological features. DELWP has defined all of the EVCs within Victoria.

The EVCs are modelled as present within the Bottle Bend target area are Floodway Pond Herbland and Alluvial Plains Semi-arid Grassland along the floor of the channel, surrounded by Lignum Shrubland and Riverine Chenopod Woodland along the less frequently inundated edges.

Floodway Pond Herbland and Alluvial Plains Semi-arid Grassland are comprised of low vegetation of up to 0.3 m tall with occasional emergent plants, dominated by herbs and herbs or grasses respectively. Alluvial Plains Semi-arid grassland also has a variety of shrub species including Tangled Lignum (*Muehlenbeckia florulenta*). Both EVCs are present in areas that experience episodic floods and consequently have a high proportion of ephemeral plants that germinate and grow in response to inundation.

Riverine Chenopod Woodland is a Eucalypt Woodland to 15 m tall, with an overstorey of Black Box with an understorey of River Coobah (*Acacia stenophylla*), and chenopods.

Black Box provides essential habitat and foraging opportunities for a range of species including mammals and reptiles and supports a high proportion of ground foraging and hollow-nesting birds, Black Box can tolerate a range of conditions from wet to dry and saline to fresh (Roberts & Marston, 2011). However, under extended periods of dry conditions trees will suffer a decline in health and eventually death (Ecological Associates, 2007a). Black Box woodlands provide strong habitat links to the surrounding Mallee landscape in this region. They can support rich bird diversity, with both riverine and woodland species utilising these EVCs (Ecological Associates, 2007a).

For a full list of EVCs within Bottle Bend and details on each see Appendix 2. The EVCs within the target area and their conservation status can be seen in Figure 12 and Table 9.

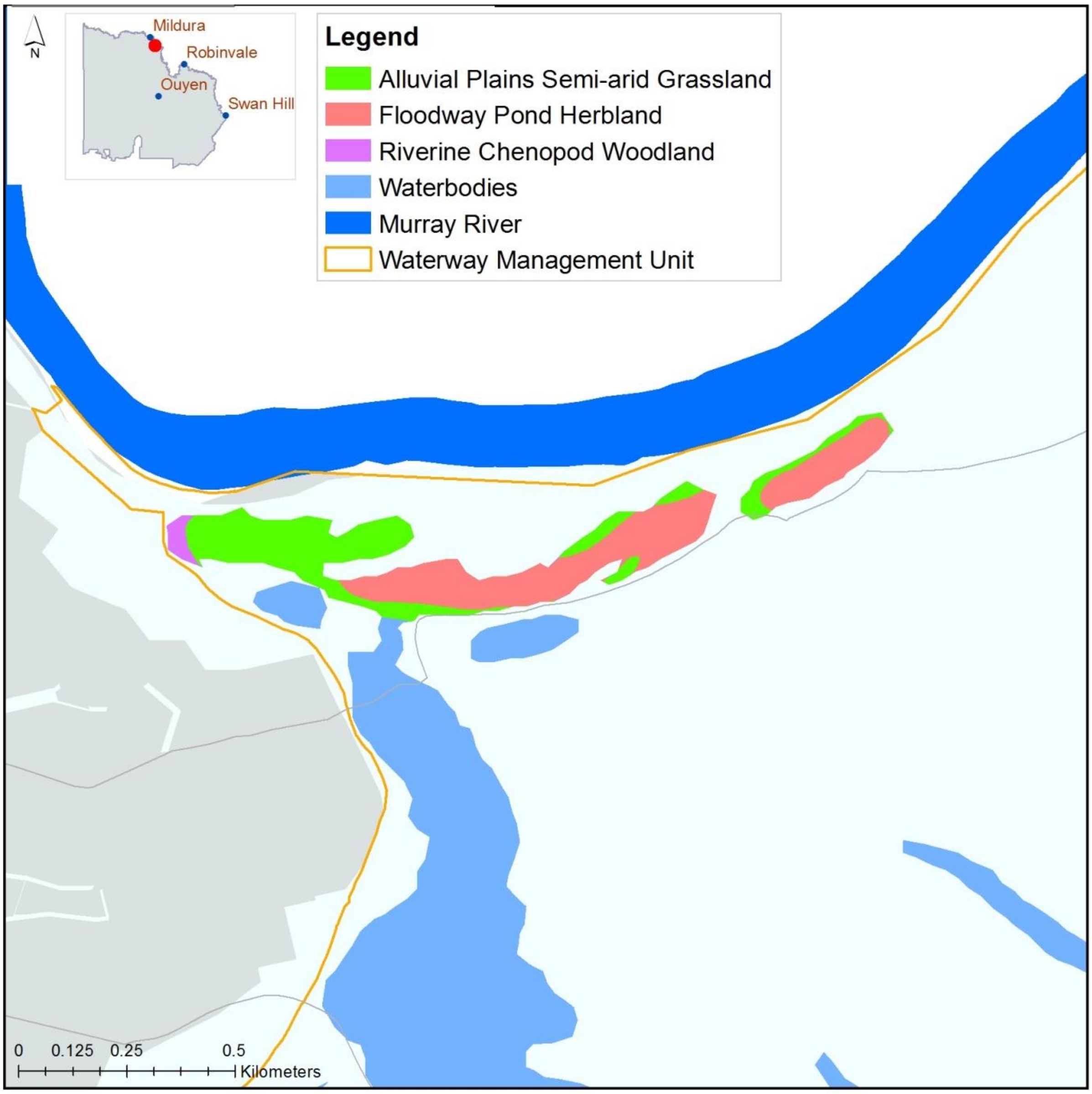


Figure 12. Ecological Vegetation Classes (EVCs) present within the Bottle Bend target area

Table 9. Conservation status of water dependent EVCs at Bottle Bend

EVC no.	EVC name	Bioregional Conservation Status - Robinvale Plains	EVC Area (ha)
810	Floodway Pond Herbland	Depleted	9.81
103	Riverine Chenopod Woodland	Depleted	0.45
806	Alluvial Plains Semi-arid Grassland	Vulnerable	8.12

Flora

A full list of flora recorded at Bottle Bend can be found in Appendix 1. Water dependent flora species listed in the various legislation and agreements which have been recorded at Bottle Bend are shown in Table 10.

Table 10. Listed water dependent flora species recorded at Bottle Bend

Common name	Scientific name	EPBC status	FFG status	DELWP status
Spiny-fruit Saltbush	*Atriplex spinibractea*			EN
Goat Head	*Malacocera tricornis*			R
Waterbush	*Myoporum montanum*			R
Lagoon Spurge	*Phyllanthus lacunarius*			V
Hoary Scurf-pea	*Cullen cinereum*		L	EN
Warty Peppercress	*Lepidium papillosum*			PK
Cane Grass	*Eragrostis australasica*			V
Spotted Emu-bush	*Eremophila maculata* subsp. *maculata*			R
Dwarf Flat-sedge	*Cyperus pygmaeus*			V
Jerry-jerry	*Ammannia multiflora*			V
Twin-leaf Bedstraw	*Asperula gemella*			R
Mealy Saltbush	*Atriplex pseudocampanulata*			R
Small Water-fire	*Bergia trimera*			V
Spreading Emu-bush	*Eremophila divaricata* subsp. *divaricata*			R

EPBC status: EXtinct, CRitically endangered, ENdangered, VUlnerable, Conservation Dependent, Not Listed
FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing
DELWP status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known, Not Listed

The Land Conservation Council survey (1989) stated that the understorey at Bottle Bend included the only known Victorian populations of *Hibiscus brachysiphonius* and *Abutilon oxycarpum* at that time. *Abutilon oxycarpum* is an annual herb that can grow to 8 cm, while *Hibiscus brachysiphonius* is a perennial subshrub to 15 cm high. The Victorian populations of these species are widely separated from other populations and represent their southern limit. Their Victorian range is an area less than 3 km of Murray River floodplain within 0.6 km of the River at Bottle Bend. Browne & Parsons (2000) suggest that the determinants of *Abutilon oxycarpum* occurrence are warm-season rainfall, which is required for recruitment, and flooding, which temporarily excludes Abutilon by increasing competitive species. While many transient species such as this regenerate profusely once favourable conditions return, if habitat is continuously unfit for occupation then these species may be lost entirely (Browne & Parsons, 2000). Both of these species are found within Bottle Bend but outside the target area and will not be subject to inundation.

Wetland depletion and rarity

Victoria's wetlands are mapped and are contained within a state wetland database, using an accepted statewide wetland classification system developed by Corrick and Norman. Mapping was undertaken from 1981 using 1:25,000 colour aerial photographs, along with field checking and developed into spatial geographic information system (GIS) spatial layers. This database is commonly known as the 1994 wetland layer and contains the following information:

- categories (primary) based on water regime; and
- subcategories based on dominant vegetation.

At the same time, an attempt was made to categorise and map wetland areas occupied prior to European settlement. This was largely interpretive work and uses only the primary category, based on water regime. This is known as the 1788 layer (DSE, 2007).

Victoria's wetland classification and inventory was updated in 2013 and replaces the system developed by Corrick and Norman. The updated classification is based on the Australian National Aquatic Ecosystem (ANAE) Classification Framework with data on wetlands and their classification attributes converted into GIS spatial layers.

Utilising the 1994 inventory, the Bottle Bend wetlands within the target area (#7329143026 and #7329152029) have been classified as Permanent Open Freshwater within the Corrick-Norman wetland classification system.

It has been possible to determine the depletion of wetland types across the state using the primary category only, based on a comparison of wetland extent between the 1788 and 1994 wetland layers (Table 11). Comparison between the wetland layers has demonstrated the impact of European settlement and development on Victorian wetlands. This has been severe, with approximately one-third of the state's wetlands being lost since European settlement; many of those remaining are threatened by continuing degradation from salinity, drainage and agricultural practices (ANCA, 1996).

Across the state, the greatest decreases in original wetland area have been in the Freshwater Meadow (43 per cent decrease), Shallow Freshwater Marsh (60 per cent decrease) and Deep Freshwater Marsh (70 per cent decrease) categories (DNRE 1997).

Table 11. Changes in area of wetland types by Corrick classification (Mallee CMA, 2006)

Category*	Total area (ha)	Decrease in wetland area from 1788 to 1994		
		% Change in area in Victoria	% Change in area in Mallee CMA	% Change in area in Robinvale Plains
Permanent Open Freshwater	7.9	-6	+5	-1

*Source: DELWP Biodiversity interactive maps: http://www.depi.vic.gov.au/environment-and-wildlife/biodiversity/biodiversity-interactive-map

4.3 Ecosystem functions

Wetland ecosystems support distinctive communities of plants and animals and provide numerous ecosystem services to the community (DSE 2005). Floodplain wetlands perform important functions necessary to maintain the hydrological, physical and ecological health of river systems. These ecosystem functions may include:

- enhancing water quality through filtering sediments and re-using nutrients
- providing organic material to rivers to maintain riverine food chains and
- absorbing and releasing floodwaters
- providing feeding, breeding and drought refuge sites for an array of flora and fauna, especially waterbirds and fish.

Wetland inundation transports nutrients and carbon into the water column, which then becomes available for consumption by bacteria, algae and macroinvertebrates. On re-wetting, decomposition accelerates and becomes more efficient. Carbon and nutrients are released from the soil and enter the water and are available for aquatic plants and animals. The release of energy and nutrients results in increased productivity, with an increase in bacteria and invertebrates (Ecological Associates, 2013). This results in abundant food for fish, birds and other animals.

Drying of wetlands, particularly during summer and autumn, exposes sediments and facilitates decomposition and processing of organic matter. The microbial decay of plant material is an important route for energy and nutrients to enter the riverine food chain (Young, 2001).

Fluctuations in water levels allows exposure of substrates such as large wood and plant stems through a drying cycle, which increases the diversity of the biofilms grazed by macroinvertebrates and fish.

Seasonal fluctuations in water levels in the wetlands increase the availability of specific habitat niches for feeding, breeding and nursery areas. Permanent and semi-permanent water bodies provide a source of food, refuge from predators and nesting sites and materials (Kingsford and Norman, 2002). Receding water levels expose mudflats required by small waders (Roshier, Robertston and Kingsford, 2002).

Wetland filling and water recession increases the extent of the band of sedges, rushes and semi-aquatic forbs surrounding wetlands. Areas of deeper water support submerged aquatic macrophytes, and promote high levels of aquatic productivity and high habitat value for frogs, fish, and waterbirds.

Altered water regimes in the target area due to river regulation and dry conditions have seen a decrease in the frequency of inundation in the floodplain wetlands including the River Wetlands/the Fish Ponds and therefore a subsequent decrease in the ability for these wetlands to perform these valuable ecosystem functions.

4.5 Social

Cultural Value

The Mallee has been occupied for thousands of generations by Indigenous people with human activity dated as far back as 23,400 years ago. The region's rich and diverse Indigenous heritage has been formed through the historical and spiritual significance of sites associated with this habitation; together with the strong connection traditional owners continue to have with the Mallee's natural landscapes.

Given the semi-arid climate of the region, ready access to more permanent water has been a major determinant of human habitation, and as such the highest density of identified Indigenous cultural heritage site are located around or close to areas of freshwater sources.

The Murray River and its associated waterways were important habitation areas for multiple Indigenous groups, containing many places of spiritual significance. The high number of Indigenous cultural heritage sites throughout the Murray floodplain is unique in Victoria, for both concentration and diversity. They include large numbers of burial, midden and hunting sites.

Waterways also play a large role in the region's more recent non-Indigenous heritage due to the historical infrastructure (e.g. buildings, irrigation and river navigation structures) they often contain. These places provide links to early industries and settlements and play a key part in the region's identity.

Cultural Heritage

The Bottle Bend area is of significant cultural value to Indigenous and non-Indigenous people, with the area popular for walking, bird-watching, fishing, boating and camping.

In regard to Indigenous cultural values, some cultural sites have been documented through various archaeological investigations, but the true extent of the number and types of sites present is still unknown.

Surveyed sites within the Mallee region include middens, earth features, scarred trees, oven mounds, surface scatters, stone quarries and places of burial. The recorded cultural heritage sites show the area was an important meeting place for Aboriginal people, with water and food sources making it possible to survive in this landscape.

Aboriginal people continue to have a connection to this country. Latji Latji and Tati Tati are Indigenous groups that have a vested interest in this area; however, other groups/community members may also have an interest in this area. The Aboriginal community continues to value this country through traditional laws and customs.

European heritage reflects the pioneering history of the area. Significant European development is evident today including Canadians George and William Chaffey, who came to develop irrigation infrastructure on an old sheep station arising to the settlement of Mildura in 1887.

Recreation

The region is popular for walking, bird-watching, fishing, boating and camping along the river (Parks Vic 2002). The ability to provide many of these recreational values is highly dependent on the delivery of environmental water.

4.6 Economic

The Bottle Bend site has been used for grazing, irrigation, stock and domestic water in the past. The Southeast Drainage Basins actively provide the function of drainage water disposal for the adjacent Red Cliffs irrigation district.

4.7 Significance

The environmental, social and economic values outlined contribute to the significance of this site. While these values do not constitute Bottle Bend being a unique or pristine site, the riparian and floodplain communities of the Murray River are important to the functioning of the river system and its sustainability. The area is rich in biodiversity, essential as habitat to native species and a refuge for listed flora and fauna species.

The site already supports many listed species, including the EBPC listed Growling Grass Frog and Regent Parrot. Regular inundation and drawdown of the wetland in the target area would provide shallow and mudflat habitat for wader birds that frequent the site.

The cultural importance of this site is significant as wetlands and floodplains of the Murray River are highly valued by Indigenous communities. There are also significant recreational values associated with Bottle Bend. These social and cultural values are important to local communities of the area. The values contained within Bottle Bend and specifically the target area for this plan makes this area a priority for protection and enhancement through environmental water management.

5 Ecological Condition and Threats

5.1 Current condition

The use of wetlands within Bottle Bend as irrigation drainage basins has led to issues with salinity and resulted in degradation of the floodplain and its vegetation. Tree health has diminished and colonisation by reed bed vegetation such as Cumbungi and Spiny Rush (*Juncus acutus*) has occurred in wetlands that are permanently inundated by drainage water (Bluml 1992).

River Red Gum stands that line the Murray River and wetlands are in poor condition and many mature trees have died or are dying. A stand of Slender Cypress-pine (*Callitris* preisii) on the northern side of the Southeast Drainage Basins is in a state of decline due to grazing, rubbish dumping and vehicle access. Figure 13 and Figure 14 illustrate the current condition within the target area, including a decline in Black Box health between the Murray River and the wetland with a carpet of saltbush. Salt tolerant species such as Glasswort, Seablite and Rounded Noon-flower have succeeded where overstorey species have died out (Figure 15).

Figure 13. Wetland #7329143026 looking northeast (Mallee CMA March 2015)

Figure 14. Wetland #7329143026 looking southwest (Mallee CMA March 2015)

Figure 15. Samphire, Lignum and sparse Black Box growing at the River Wetlands/the Fish Ponds (Ecological Associates and Tonkin Consulting, 2016)

5.2 Condition trajectory

Without management intervention in the form of environmental watering, water dependent condition within the target area is expected to worsen. Dry conditions and salinity will continue to impact already severely stressed vegetation, including key species like River Red Gum and Black Box. This will result in loss of valuable habitat for listed fauna within the target area and these species may be lost from the area. Wetland productivity and biodiversity, which is directly dependent on water, will continue to decline.

5.3 Water related threats

Threats to the water dependent ecological values of the site include:

- changed water regime;
- loss or reduction of wetland connectivity;
- poor water quality; and
- introduction/increase of exotic flora and fauna.

Changed Water Regime

The regulation of the Murray River has seen the water regime through the Bottle Bend floodplain altered. Flow events of the magnitude required to commence flows into the creeks and wetlands of the floodplain are less frequent and of shorter duration. This combined with dry conditions over the last decade affects the vigour of the vegetation and places trees under stress, affecting the productivity and functioning of the floodplain ecosystem.

Additionally, constant inputs of irrigation drainage water has led to an increase in the area of reed growth, which limits flora diversity, impacts on habitat availability for fauna and inhibits flow through the wetlands.

Loss or reduction of wetland connectivity

Loss of connectivity between wetlands and the Murray River disable the biotic and abiotic connections between complex habitats. Water depth, flow and intensity define the characteristic flora and fauna, including aquatic species such as fish, shrimp, and some insects.

Water Quality

The use of Bottle Bend for irrigation drainage has led to an increase in salinity levels, leading to degradation of the surrounding land and its vegetation. Salt tolerant species such as salt bush are thriving at Bottle Bend, reducing habitat for native species.

Permanent inundation of wetlands can alter natural hydrological regimes and reduce water circulation. This can lead to changes in water temperatures, dissolved oxygen levels, salinity and pH which, in turn, can lead to acid sulphate soils over time. Nutrient outflow can be reduced resulting in a build-up of salt and/or agricultural chemicals. Sedimentation within the wetland can increase as soils are no longer exposed to periods of drying (Mitsch & Gosselink 1993).

Introduction/increase of exotic flora and fauna

Introduced fish species Common Carp (*Cyprinus carpio*), and Mosquito fish (*Gambusia holbrooki*) pose a serious threat the ecology of the Bottle Bend wetlands. Ho et al (2004) found both these species to be present during aquatic vertebrate surveys at one of the Bottle Bend wetlands. Carp have been found to contribute to the loss of aquatic vegetation and increased turbidity, resulting in loss of habitat for waterfowl (Purdey & Loyn 2008). This species also competes with the native fish for habitat and food as well as having a detrimental effect on water quality (Mallee CMA, 2003. Spencer and Wassen (2009, cited in Rogers & Ralph 2011) suggest that Common Carp also significantly reduce recruitment success of the Growling Grass Frog.

Agricultural and other weeds are an ongoing threat and management issue along the Murray River floodplain. Cumbungi and Spiny Rush in particular have become problematic at Bottle Bend as they have formed dense stands in areas inundated by irrigation drainage (Bluml 1992). These plants use large amounts of water and can alter wetland character, reduce plant diversity and obstruct water flow (Roberts & Marston 2011). The dense Cumbungi stands which have established in the wetlands also provide cover for feral pigs which, in turn, cause major damage to the ecosystem. Pigs can destroy native vegetation through wallowing and rooting out underground plants leading to erosion and reduced water quality. Pigs may also spread invasive plants and disease and are known to prey on native wildlife such as frogs, turtles, ground-nesting birds and freshwater crayfish (DEPI 2014).

Biodiversity can decline as breeding cues and recruitment of flora and fauna are lost. Invasive species which favour permanent inundation, such as Carp and Cumbungi, may thrive contributing further to the decline of native biodiversity (Mallee CMA, 2012). In summary, the overall productivity and ability of the wetland to perform essential ecosystem functions is reduced.

6 Management Objective

6.1 Management goal

The management goal for Bottle Bend is:

The target area of Bottle Bend will be managed to maintain the condition of fringing Riverine Chenopod Woodland and provide seasonal habitat for waterfowl, wading birds and frogs.

6.2 Ecological objectives

Ecological objectives represent the desired ecological outcomes of the site based on the key values outlined in the water dependent values section. In line with the Victorian Waterway Management Strategy the ecological objectives are expressed as the target condition or functionality for each key value.

The ecological objectives for target area of Bottle Bend are:

- Provide shallow water habitat that supports waterfowl and waders through improved conditions for foraging, nesting and recruitment.
- Promote a diverse aquatic macrophyte zone.
- Provide seasonal aquatic habitat that supports a diverse frog population.
- Support the health of the fringing Riverine Chenopod Woodland.

Table 12. Ecological objectives for the site

Ecological Objectives	Justification (value based)
Provide shallow water habitat that supports waterfowl and waders through improved conditions for foraging, nesting and recruitment.	Australia's waterbirds are often nomadic, requiring habitat patches throughout the landscape to facilitate movement. Shallow waters and reeds at the wetland edge will provide ideal feeding grounds for wading birds, particularly as water levels fluctuate increasing productivity along the wetland margin. Twenty-four species of waterbirds have been found at Bottle Bend.
Promote a diverse aquatic macrophyte zone	Semi-emergent macrophytes provide highly productive wetland habitats. The soft-leaved plants and their biofilms provide shelter and flood for macroinvertebrates, tadpoles and small fish. Waterfowl and dabbling ducks, will graze on the vegetation and prey on macro-invertebrates (Ecological Associates, 2006). Species likely to be supported include Australian Shoveler, Pink-eared Duck, Black Swan and Wood Duck (Ecological Associates, 2006).
Provide seasonal aquatic habitat that supports a diverse frog population	There are six species of frog found at Bottle Bend including the listed Growling Grass Frog. Growling Grass Frog prefer sites that have a large proportion of vegetation that is emergent, submerged and floating (Clemann and Gillespie, 2012).
Support the health of the fringing Riverine Chenopod Woodland	Black Box communities have suffered from lack of water within Bottle Bend. In a healthy state these flora species provide important habitat and feeding opportunities for listed species found in the target area, particularly hollow-dependent species such as Regent Parrot.

As more is learnt about the area and the response to the watering events are monitored the principles of adaptive management along with availability of environmental water sources will guide future requirements and management actions at this and other environmental watering sites.

6.3 Hydrological Objectives

Hydrological objectives describe the components of the water regime required to achieve the ecological objectives at this site. The hydrological requirements to achieve each of these objectives are presented in Table 13.

Black Box woodlands require flooding to occur every three to seven years with durations of two to six months. This species can tolerate shorter flood durations but plant vigour will suffer. Although timing of flood events is not crucial for Black Box it will affect understorey and other woodland biota. Black Box trees may survive prolonged periods of 12 to 16 years with no flooding but tree health will suffer and woodland will become dysfunctional (Roberts and Marston, 2000).

A flooding regime dominated by spring, rather than summer, flooding promotes higher macrophyte diversity and abundance (Robertston, Bacon and Heagney, 2001). Semi-emergent macrophytes occupy shallower water that is generally flooded from one to two metres (Ecological Associates, 2006).

Flooding of wetland and floodplain vegetation in spring and summer provides a source of food, refuge and nesting sites and materials for waterbirds (Kingsford and Norman, 2002). Food availability is enhanced in wetlands that have been subjected to dry periods of one or more years prior to filling (Briggs, Lawler and Thornton, 1997). Receding waters levels over summer provide shallow open water and mudflats which are important foraging habitat for wading birds (Ecological Associates, 2013).

Growling Grass Frogs prefer large continuous areas containing a range of regularly flooded permanent and ephemeral waterbodies with nearby refugia (Clemann and Gillespie, 2012). During the winter months individuals may shelter under cover close to the water such as rocks, logs and vegetation (Pyke, 2002). Breeding is triggered by flooding of wetlands and floodplains during spring and summer (Clemann and Gillespie, 2012).

Table 13. Hydrological objectives for the target area

Ecological Objectives	Hydrological Objectives: Mean frequency of events (No. per 10 years) Min.	Opt.	Max.	Tolerable interval between events Min.	Max.	Duration of ponding (months) Min.	Opt.	Max	Preferred timing of inflows	Inundation height mAHD		
Promote a diverse aquatic macrophyte zone	2	5	10	0	1	1	6	12	Spring/Summer	35.9		
Provide shallow water habitat that supports waterfowl and waders through improved conditions for foraging, nesting and recruitment.*										35.9		
Provide seasonal aquatic habitat that supports a diverse frog population*							3		Spring/ Summer	35.9		
Support the health of the fringing Riverine Chenopod Woodland.	1	2	3	3	10	2	4	6	Winter/Spring	36.3		

*Provided by other objectives

6.4 Watering regime

The wetland watering regime has been derived from the ecological and hydrological objectives. To allow for adaptive and integrated management, the watering regime is framed using the seasonally adaptive approach. This means that a watering regime is identified for optimal conditions, as well as the maximum and minimum tolerable watering scenarios. The minimum watering regime is likely to be provided in drought or dry years, the optimum watering regime in average conditions and the maximum watering regime in wet or flood years.

The optimal and minimum watering regimes are described below. Due to the inter-annual variability of these estimates (particularly the climatic conditions), determination of the predicted volume requirements in any given year will need to be undertaken by the environmental water manager when watering is planned.

As discussed earlier, the salinity risk assessment identified that flooding of the river wetlands every year would provide an accountable salinity risk (Richardson and Currie, 2015). The assessment identified an alternate watering option (referred to as option 2 in this EWMP) which has been used in the development of the watering regime for this site. This watering regime is the optimal regime. A maximum watering regime is not provided for this site due to the salinity risk.

Minimum watering regime

Fill wetlands #7329143026 and #7329152029 to 36.3 mAHD every three years in late spring to inundate surrounding Riverine Chenopod Woodland vegetation, allow water to recede naturally, gradually exposing the littoral zone and mudflats. Ensure that flooding to wetland #7329164034 is excluded.

Optimum watering regime

Fill wetlands #7329143026 to 35.9 mAHD every year in late spring to inundate littoral zone, allow water to recede naturally, gradually exposing the littoral zone and mudflats.

In every third year, fill wetlands #7329143026 and #7329152029 to 36.3 mAHD late winter/spring to inundate surrounding Riverine Chenopod Woodland vegetation, allow water to recede naturally, gradually exposing the littoral zone and mudflats. Ensure that flooding to wetland #7329164034 is excluded.

7 Managing Risks to Achieve Objectives

Table 14 below identifies the risks associated with the proposed environmental watering plan. Risks are classified as high, medium, or low depending on the likelihood of occurrence as well as the consequences if they were to occur.

Prior to delivering environmental water in any given season, these risks will be further refined as part of the Seasonal Watering Proposal and Environmental Water Delivery Plan process. These documents will provide a greater level of risk analysis and mitigation measures according to conditions observed closer to the proposed delivery (i.e. operational risks). The documents will also include detailed consideration of the impact of proposed mitigation measures on the likelihood and consequence of the risk occurring (residual risk) as this may change according to catchment conditions and operations closer to the proposed delivery. They will clearly outline roles and responsibilities regarding risk management.

Table 14. Risks associated with proposed environmental watering

Threat	Likelihood	Consequence	Risk – H, M, L (likelihood x consequence)	Management Measure	Residual Risk
Flood duration too long or too short	Possible	Moderate - Water regime does not support breeding and feeding requirements of fauna or vegetation establishment and growth	Medium	Determine water requirements to support potential breeding events Monitor flood duration to inform water delivery Monitor the ecological response of the wetlands to flooding Add or drawdown water where appropriate or practical	Low
Unable to provide optimal water regime to the target area	Possible	Moderate - Failure to achieve hydrological and ecological objectives for the site	Medium	Monitor the ecological response of the wetlands to the water regime and add top-ups where appropriate or practical	Low
Reduced water quality in the wetlands	Possible	Major - Reduced habitat for aquatic vegetation and native fish	High	Monitor water quality before, during and after watering events Monitor the response of the wetlands and fauna populations to watering events Top-up water to freshen	Medium

Threat	Likelihood	Consequence	Risk – H, M, L (likelihood x consequence)	Management Measure	Residual Risk
Flooding of surrounding private land	Likely	Moderate - Mallee CMA liable for damage	High	Monitor water delivery rate and level to ensure inundation does not extend beyond the target area Landholder agreements will be undertaken for water delivery involving private land	Medium
Growth and establishment of aquatic pest plants – particularly Cumbungi	Possible	Moderate - Reduced habitat quality and increased competition for native fish	Medium	Watering regime incorporates a drying phase following natural recession of environmental water. Monitor the abundance of native and invasive aquatic plants. Control invasive plants in connected waterways. Spray or mechanically remove invasive plants (if appropriate and practical).	Low
Increased habitat and recruitment of feral pigs	Likely	Moderate - Predation on native fauna reducing recruitment	High	Monitor the response of pigs to environmental water delivery Establish a feral pig trapping/removal program	Medium

8 Environmental Water Delivery Infrastructure

8.1 Constraints

Salinity impacts and inflows of drainage water are the main constraints limiting the extent of environmental water delivery at Bottle Bend. The watering regime has been developed to mitigate any risks associated with these threats.

8.2 Infrastructure recommendations

The watering regime will involve controlling the discharge of irrigation water into wetland #7329143026. Regulators will be used to intermittently hold or release water to and from the Murray River, to freshen the wetlands (Figure 16). Existing infrastructure will allow the target area to be watered. An additional earthen bank will be required to exclude environmental water from #7329164034 during environmental watering.

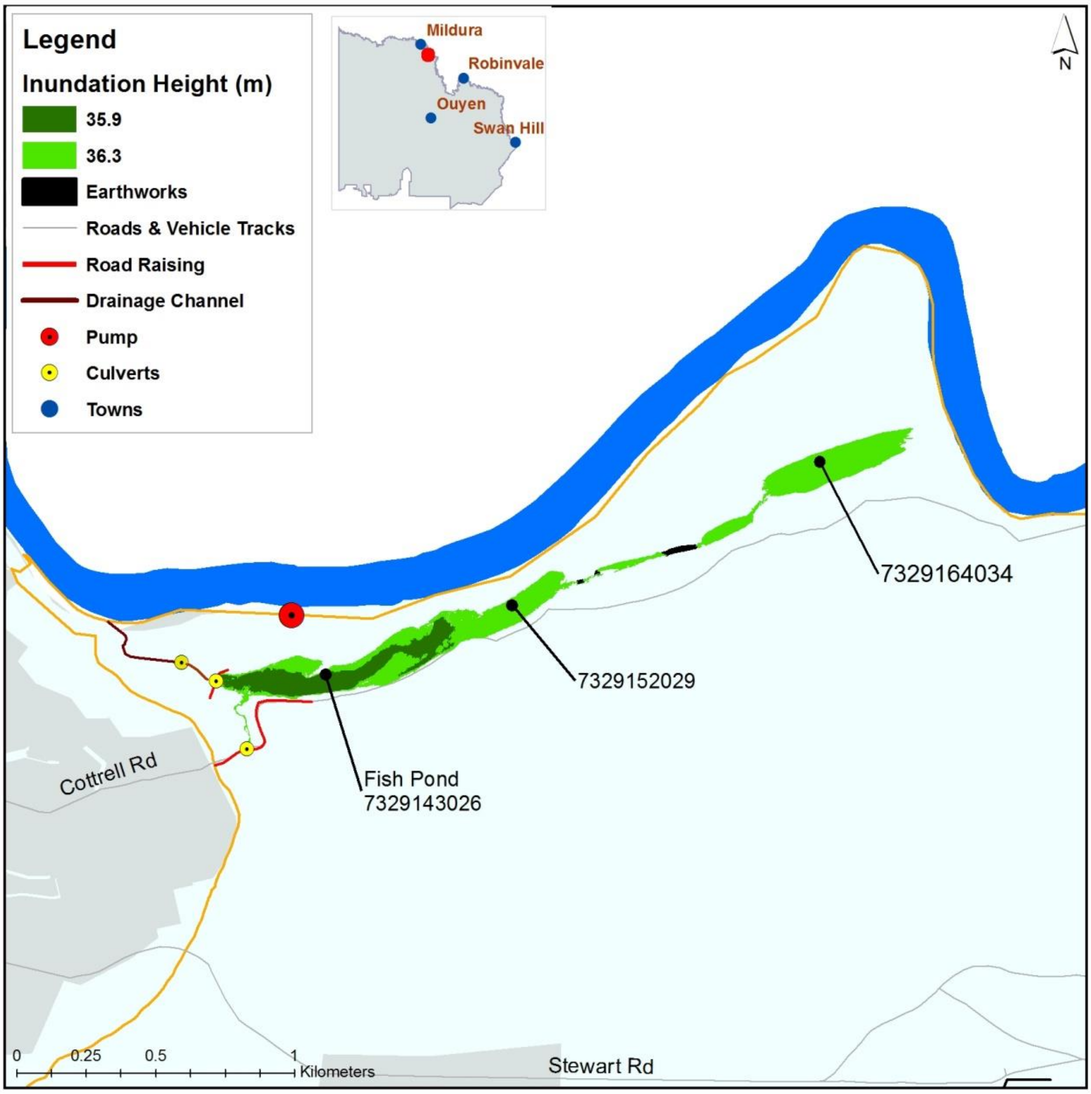


Figure 16. Proposed infrastructure within the target area

9 Demonstrating Outcomes

9.1 Monitoring priorities at the site

Table 15. Monitoring priorities for Bottle Bend

Objective	Method	Priority
Measure the success of environmental water in improving wetland and riparian vegetation communities	Photo point monitoring	Medium
Ensure the water regime supports breeding and feeding requirements of fauna or vegetation establishment and growth	Flood duration to inform water delivery Monitor the ecological response of the wetlands to flooding	High
Ensure inundation does not extend beyond the target area, In particular onto private land	Monitor water delivery rate and levels	High
Manage the growth and establishment of aquatic pest plants – particularly Cumbungi	Monitor the abundance of native and invasive aquatic plants	Medium
Manage pig populations	Monitor the response of pigs to environmental water delivery	Medium

10 Consultation

This Plan was developed in collaboration with key stakeholders namely Parks Victoria, the Department of Environment, Land, Water and Planning, Lower Murray Water and local interest groups. A summary of the consultation process is shown in Table 16. Part of Bottle Bend is private land and consultation with local landholders was required regarding the management of all wetlands and associated waterways.

Table 16. Consultation Process for development of Bottle Bend Environmental Water Management Plan

Meeting date	Stakeholders	Details
27th May 2014	Parks Victoria	Initial discussion to introduce concept of plan and discuss the issue of feral pigs in the area.
TBA	Department of Environment, Land, Water and Planning	Consultation on environmental and threatened species management and project development
27th May 2014	Lower Murray Water	Discussion on drainage disposal to the wetlands creating habitat for feral pigs and management actions going forward.
TBA	Local residents and landholders	Informal gathering to discuss possibilities for environmental watering plan and signing of deeds
TBA	Indigenous Groups	Face-to-face discussions/on-country visits
February 2015	Mallee CMA – Land and Water Advisory Group (Waterway health specialists)	Discuss ecological objectives and proposed environmental watering actions
02 March 2015	Aboriginal Reference Group	Discuss proposed environmental watering actions and direct engagement strategies with Traditional Owners

11 Knowledge Gaps and Recommendations

This plan is based on the best information at the time of writing. In some cases, this information is scarce or outdated. Further investigation and information collection will continue and the results of this further work will continue to build a better picture of the site and add rigor to future planning. Some areas where further knowledge would be beneficial are outlined in Table 17. A cultural heritage management plan and salinity impact assessment are essential before any on ground works can be undertaken.

Table 17. Knowledge gaps and recommendations for the target area

Knowledge and data gaps	Action recommended*	Responsibility
Impacts of nearby irrigation on wetland health	Investigation of surface water, groundwater and irrigation water interaction	MCMA
Wetland condition	Index of Wetland Condition assessments	MCMA
Salt loads within the wetlands	Data collection and monitoring	MCMA
Role of wetland on waterbird breeding and populations	Data collection and monitoring	MCMA
Accurate depth and volumes for the wetland	Install depth gauges and undertake a bathymetric survey	MCMA
Extent of Cumbungi infestation within the wetlands	Data collection and monitoring	MCMA
Current fauna and flora populations using the site	Surveys, data collection and monitoring	MCMA

* Implementation of any of these recommendations would be dependent on investment from Victorian and Australian Government funding sources as projects managed through the Mallee CMA

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Department of Planning and Community Development: http://www.dpcd.vic.gov.au/indigenous/heritage-tools/areas-of-cultural-sensitivity/ rostr-mallee-region-maps

Parks Victoria, Mildura's Murray River Parklands:

http://parkweb.vic.gov.au/explore/parks/river-murray-reserve

13 Abbreviations and Acronyms

CAMBA	China-Australia Migratory Bird Agreement
CMAs	Catchment Management Authorities
DELWP	Department of Environment, Land, Water and Planning
EVC	Ecological Vegetation Class
EPBC Act	Environment Protection and Biodiversity Conservation Act
EWMP	Environmental Water Management Plan
EWH	Environmental Water Holder
FSL	Full Supply Level
JAMBA	Japan-Australia Migratory Bird Agreement
MDBA	Murray-Darling Basin Authority (formally Murray-Darling Basin Commission, MDBC)
TSL	Targeted Supply Level
VEWH	Victorian Environmental Water Holder

14 Appendix 1. Flora and Fauna Species List

Flora – Native

Common Name	Scientific Name	Records
Spreading Emu-bush	*Eremophila divaricata* subsp. *divaricata*	2
Black Cotton-bush	*Maireana decalvans* s.l.	4
Dwarf Lantern-flower	*Abutilon fraseri*	1
Small Cooba	*Acacia ligulata*	1
Wait-a-while	*Acacia colletioides*	1
Willow Wattle	*Acacia salicina*	1
Eumong	*Acacia stenophylla*	7
Dwarf Nealie	*Acacia wilhelmiana*	1
Common Blown-grass	*Lachnagrostis filiformis* s.l.	25
Jerry-jerry	*Ammannia multiflora*	1
Long Grey-beard Grass	*Amphipogon caricinus* var. *caricinus*	2
Shrubby Cress	*Arabidella trisecta*	1
Twin-leaf Bedstraw	*Asperula gemella*	5
Small Saltbush	*Atriplex eardleyae*	9
Corky Saltbush	*Atriplex lindleyi* subsp. *inflata*	11
Slender-fruit Saltbush	*Atriplex leptocarpa*	9
Flat-top Saltbush	*Atriplex lindleyi*	9
Mealy Saltbush	*Atriplex pseudocampanulata*	1
Berry Saltbush	*Atriplex semibaccata*	12
Sprawling Saltbush	*Atriplex suberecta*	1
Babbagia	*Osteocarpum acropterum* var. *deminutum*	1
Small Water-fire	*Bergia trimera*	2
Salt Club-sedge	*Bolboschoenus caldwellii*	1
Woodland Swamp-daisy	*Brachyscome basaltica* var. *gracilis*	1
Variable Daisy	*Brachyscome ciliaris*	6
Hard-head Daisy	*Brachyscome lineariloba*	1
Leek Lily	*Bulbine semibarbata*	5
Slender Cypress-pine	*Callitris gracilis*	1
Lemon Beauty-heads	*Calocephalus citreus*	1
Pale Beauty-heads	*Calocephalus sonderi*	17
Garland Lily	*Calostemma purpureum* s.l.	1
Blue Burr-daisy	*Calotis cuneifolia*	1
Tangled Burr-daisy	*Calotis erinacea*	1
Hairy Burr-daisy	*Calotis hispidula*	4
Desert Cassia	*Senna artemisioides* spp. agg.	1
Belah	*Casuarina pauper*	1

Spiked Centaury	*Schenkia australis*	1
Common Sneezeweed	*Centipeda cunninghamii*	1
Flat Spurge	*Euphorbia drummondii*	4
Crested Goosefoot	*Dysphania cristata*	1
Windmill Grass	*Chloris truncata*	1
Bell-fruit Tree	*Codonocarpus cotinifolius*	1
Dense Crassula	*Crassula colorata*	4
Sieber Crassula	*Crassula sieberiana* s.l.	3
Couch	*Cynodon dactylon*	7
Tall Flat-sedge	*Cyperus exaltatus*	1
Flecked Flat-sedge	*Cyperus gunnii* subsp. *gunnii*	1
Spiny Flat-sedge	*Cyperus gymnocaulos*	3
Dwarf Flat-sedge	*Cyperus pygmaeus*	2
Common Wallaby-grass	*Rytidosperma caespitosum*	1
Australian Carrot	*Daucus glochidiatus*	1
Silky Umbrella-grass	*Digitaria ammophila*	1
Rounded Noon-flower	*Disphyma crassifolium* subsp. *clavellatum*	4
Hard-head Saltbush	*Dissocarpus paradoxus*	1
Yellow Twin-heads	*Eclipta platyglossa* subsp. *platyglossa*	1
Nodding Saltbush	*Einadia nutans*	12
Common Spike-sedge	*Eleocharis acuta*	1
Ruby Saltbush	*Enchylaena tomentosa* var. *tomentosa*	8
Common Bottle-washers	*Enneapogon avenaceus*	1
Cane Grass	*Eragrostis australasica*	4
Mallee Love-grass	*Eragrostis dielsii*	1
Weeping Love-grass	*Eragrostis parviflora*	1
Berrigan	*Eremophila longifolia*	2
Spotted Emu-bush	*Eremophila maculata* subsp. *maculata*	1
River Red-gum	*Eucalyptus camaldulensis*	1
Black Box	*Eucalyptus largiflorens*	5
Broom Ballart	*Exocarpos sparteus*	1
Annual Cudweed	*Euchiton sphaericus*	6
Pale Goodenia	*Goodenia glauca*	2
Spreading Goodenia	*Goodenia heteromera*	3
Cut-leaf Goodenia	*Goodenia pinnatifida*	1
Silky Goodenia	*Goodenia fascicularis*	3
Comb Grevillea	*Grevillea huegelii*	1
Silver Needlewood	*Hakea leucoptera* subsp. *leucoptera*	1
Hooked Needlewood	*Hakea tephrosperma*	1
Rough Raspwort	*Haloragis aspera*	1

Blackseed Glasswort	*Tecticornia pergranulata*	6
Low Hibiscus	*Hibiscus brachysiphonius*	9
Stalked Plover-daisy	*Leiocarpa websteri*	2
Warty Peppercress	*Lepidium papillosum*	2
Australian Box-thorn	*Lycium australe*	1
Leafless Bluebush	*Maireana aphylla*	1
Short-leaf Bluebush	*Maireana brevifolia*	5
Hairy Bluebush	*Maireana pentagona*	6
Erect Bluebush	*Maireana pentatropis*	1
Sago Bush	*Maireana pyramidata*	1
Goat Head	*Malacocera tricornis*	1
Narrow-leaf Nardoo	*Marsilea costulifera*	1
Common Nardoo	*Marsilea drummondii*	6
Minnie Daisy	*Minuria leptophylla*	1
Tangled Lignum	*Duma florulenta*	35
Turkey Bush	*Eremophila deserti*	1
Waterbush	*Myoporum montanum*	2
Sugarwood	*Myoporum platycarpum*	1
Poached-eggs Daisy	*Polycalymma stuartii*	1
Club-moss Daisy-bush	*Olearia lepidophylla*	1
Pimelea Daisy-bush	*Olearia pimeleoides*	3
Knottybutt Grass	*Paspalidium constrictum*	1
Warrego Summer-grass	*Paspalidium jubiflorum*	39
Common Reed	*Phragmites australis*	2
Lagoon Spurge	*Phyllanthus lacunarius*	2
Native Picris	*Picris angustifolia*	1
Weeping Pittosporum	*Pittosporum angustifolium*	1
Dark Plantain	*Plantago drummondii*	1
Creeping Knotweed	*Persicaria prostrata*	1
Small-leaf Mint-bush	*Prostanthera serpyllifolia* subsp. *microphylla*	1
Jersey Cudweed	*Helichrysum luteoalbum*	2
Hoary Scurf-pea	*Cullen cinereum*	1
Tough Scurf-pea	*Cullen tenax*	2
Crimson Tails	*Ptilotus sessilifolius*	1
Mulla Mulla	*Ptilotus nobilis*	1
Yellow Tails	*Ptilotus nobilis* var. *nobilis*	4
Hedge Saltbush	*Rhagodia spinescens*	2
Prickly Fan-flower	*Scaevola spinescens*	1
Desert Bog-sedge	*Schoenus subaphyllus*	1
Short-wing Saltbush	*Sclerochlamys brachyptera*	16

Grey Copperburr	*Sclerolaena diacantha*	4
Black Roly-poly	*Sclerolaena muricata*	1
Limestone Copperburr	*Sclerolaena obliquicuspis*	2
Streaked Copperburr	*Sclerolaena tricuspis*	16
Slender Groundsel	*Senecio glossanthus* s.l.	29
Tall Fireweed	*Senecio runcinifolius*	2
Sand Sida	*Sida ammophila*	1
Narrow-leaf Sida	*Sida trichopoda*	4
Coast Sand-spurrey	*Spergularia media* s.l.	1
Rat-tail Couch	*Sporobolus mitchellii*	83
Star Bluebush	*Stelligera endecaspinis*	5
Graceful Spear-grass	*Austrostipa acrociliata*	1
Feather Spear-grass	*Austrostipa elegantissima*	2
Rough Spear-grass	*Austrostipa scabra* subsp. *falcata*	2
Mallee Fringe-lily	*Thysanotus baueri*	1
Annual New Holland Daisy	*Vittadinia cervicularis*	3
Woolly New Holland Daisy	*Vittadinia gracilis*	1
River Bluebell	*Wahlenbergia fluminalis*	4
Pointed Twin-leaf	*Zygophyllum apiculatum*	1
Notched Twin-leaf	*Zygophyllum crenatum*	1
Mat Saltbush	*Atriplex pumilio*	4
Smooth Elachanth	*Elachanthus glaber*	2
Southern Cane-grass	*Eragrostis infecunda*	10
Pale Mat-rush	*Lomandra collina*	2
Desert Spinach	*Tetragonia eremaea* s.l.	1
Climbing Twin-leaf	*Zygophyllum eremaeum*	2
Mallow-leaf Lantern-flower	*Abutilon malvifolium*	8
Flat-top Saltbush	*Atriplex lindleyi* subsp. *lindleyi*	2
Broad-leaf Desert Cassia	*Senna* form taxon *'coriacea'*	1
Slender Hop-bush	*Dodonaea viscosa* subsp. *angustissima*	1
Spiny-fruit Saltbush	*Atriplex spinibractea*	2
Plains Billy-buttons	*Craspedia haplorrhiza*	2
Native Sow-thistle	*Sonchus hydrophilus*	1
Squat Picris	*Picris squarrosa*	1
Pink Mulla-mulla	*Ptilotus nobilis* subsp. *nobilis*	1
Ferny Small-flower Buttercup	*Ranunculus pumilio* var. *politus*	1
Ferny Small-flower Buttercup	*Ranunculus pumilio* var. *pumilio*	1
Grey Roly-poly	*Sclerolaena muricata* var. *villosa*	1
Annual Spinach	*Tetragonia moorei*	1
Annual New Holland Daisy	*Vittadinia cervicularis* var. *subcervicularis*	1

Dissected New Holland Daisy	*Vittadinia dissecta* var. *hirta*	1
Lesser Joyweed	*Alternanthera denticulata* s.s.	1
Slender Love-grass	*Eragrostis exigua*	1
Prickly Saltwort	*Salsola tragus* subsp. *tragus*	1
Salt Sea-spurrey	*Spergularia brevifolia*	1
Yellow Pea-bush	*Sesbania cannabina* var. *cannabina*	1
Wimmera Woodruff	*Asperula wimmerana*	2
Saltbush	*Atriplex* spp.	8
Goosefoot	*Chenopodium* spp.	3
Buttercup	*Ranunculus* spp.	2
Bitter Cress	*Rorippa* spp.	1
Spear Grass	*Austrostipa* spp.	3
Seablite	*Suaeda* spp.	5

Flora – Exotic

Common Name	Scientific Name	Records
Great Brome	*Bromus diandrus*	1
Cape weed	*Arctotheca calendula*	1
Onion Weed	*Asphodelus fistulosus*	1
Aster-weed	*Aster subulatus*	21
Hastate Orache	*Atriplex prostrata*	8
Wild Oat	*Avena fatua*	1
Red Brome	*Bromus rubens*	2
Malta Thistle	*Centaurea melitensis*	1
Spear Thistle	*Cirsium vulgare*	4
Ferny Cotula	*Cotula bipinnata*	9
Paddy Melon	*Cucumis myriocarpus* subsp. *leptodermis*	1
Curry Flat-sedge	*Cyperus hamulosus*	1
Stinkwort	*Dittrichia graveolens*	2
Spiny Emex	*Emex australis*	1
Terracina Spurge	*Euphorbia terracina*	1
Barley-grass	*Hordeum leporinum*	1
Smooth Cat's-ear	*Hypochaeris glabra*	21
Flatweed	*Hypochaeris radicata*	1
Spiny Rush	*Juncus acutus* subsp. *acutus*	1
Willow-leaf Lettuce	*Lactuca saligna*	1
Prickly Lettuce	*Lactuca serriola*	8
Common Peppercress	*Lepidium africanum*	2
African Box-thorn	*Lycium ferocissimum*	4
Little Medic	*Medicago minima*	5
Lucerne	*Medicago sativa* subsp. *sativa*	1

Sweet Melilot	*Melilotus indicus*	3
Common Ice-plant	*Mesembryanthemum crystallinum*	1
Small Ice-plant	*Mesembryanthemum nodiflorum*	3
Tripteris	*Monoculus monstrosus*	1
Coast Barb-grass	*Parapholis incurva*	1
Paspalum	*Paspalum dilatatum*	1
Water Couch	*Paspalum distichum*	1
False Hair-grass	*Pentameris airoides* subsp. *airoides*	2
Fog-fruit	*Phyla canescens*	19
Ribwort	*Plantago lanceolata*	1
Prostrate Knotweed	*Polygonum aviculare* s.l.	1
Wiry Noon-flower	*Psilocaulon granulicaule*	2
False Sow-thistle	*Reichardia tingitana*	1
Wild Sage	*Salvia verbenaca*	1
Arabian Grass	*Schismus barbatus*	2
Smooth Mustard	*Sisymbrium erysimoides*	4
London Rocket	*Sisymbrium irio*	1
Indian Hedge-mustard	*Sisymbrium orientale*	1
Rough Sow-thistle	*Sonchus asper* s.l.	1
Common Sow-thistle	*Sonchus oleraceus*	12
Lesser Sand-spurrey	*Spergularia diandra*	2
Red Sand-spurrey	*Spergularia rubra* s.l.	5
Rat's-tail Fescue	*Vulpia myuros*	7
Noogoora Burr spp. agg.	*Xanthium strumarium* spp. agg.	1
Bathurst Burr	*Xanthium spinosum*	1
Field Dodder	*Cuscuta campestris*	3
Barley-grass	*Hordeum murinum* s.l.	4
Red Sand-spurrey	*Spergularia rubra* s.s.	2

Fauna – Native

Common Name	Scientific Name	Type	Records
Little Pied Cormorant	*Microcarbo melanoleucos*	B	2
Pied Butcherbird	*Cracticus nigrogularis*	B	1
Peaceful Dove	*Geopelia striata*	B	2
Common Bronzewing	*Phaps chalcoptera*	B	1
Crested Pigeon	*Ocyphaps lophotes*	B	3
Australian Spotted Crake	*Porzana fluminea*	B	1
Spotless Crake	*Porzana tabuensis*	B	1
Dusky Moorhen	*Gallinula tenebrosa*	B	1
Purple Swamphen	*Porphyrio porphyrio*	B	1
Hoary-headed Grebe	*Poliocephalus poliocephalus*	B	2
Little Black Cormorant	*Phalacrocorax sulcirostris*	B	1
Darter	*Anhinga novaehollandiae*	B	1
Australian Pelican	*Pelecanus conspicillatus*	B	2
Red-kneed Dotterel	*Erythrogonys cinctus*	B	1
Masked Lapwing	*Vanellus miles*	B	1
Black-fronted Dotterel	*Elseyornis melanops*	B	3
Yellow-billed Spoonbill	*Platalea flavipes*	B	1
Eastern Great Egret	*Ardea modesta*	B	2
White-faced Heron	*Egretta novaehollandiae*	B	1
White-necked Heron	*Ardea pacifica*	B	2
Nankeen Night Heron	*Nycticorax caledonicus hillii*	B	2
Australian Wood Duck	*Chenonetta jubata*	B	3
Black Swan	*Cygnus atratus*	B	2
Australian Shelduck	*Tadorna tadornoides*	B	2
Pacific Black Duck	*Anas superciliosa*	B	2
Grey Teal	*Anas gracilis*	B	2
Hardhead	*Aythya australis*	B	2
Blue-billed Duck	*Oxyura australis*	B	1
Swamp Harrier	*Circus approximans*	B	3
Brown Goshawk	*Accipiter fasciatus*	B	2
Little Eagle	*Hieraaetus morphnoides*	B	1
Whistling Kite	*Haliastur sphenurus*	B	1
Black Kite	*Milvus migrans*	B	2
Sulphur-crested Cockatoo	*Cacatua galerita*	B	1
Little Corella	*Cacatua sanguinea*	B	1
Galah	*Eolophus roseicapilla*	B	3
Cockatiel	*Nymphicus hollandicus*	B	2
Regent Parrot	*Polytelis anthopeplus monarchoides*	B	1

Red-rumped Parrot	*Psephotus haematonotus*	B	4
Budgerigar	*Melopsittacus undulatus*	B	1
Tawny Frogmouth	*Podargus strigoides*	B	1
Laughing Kookaburra	*Dacelo novaeguineae*	B	2
Sacred Kingfisher	*Todiramphus sanctus*	B	2
Rainbow Bee-eater	*Merops ornatus*	B	2
Pallid Cuckoo	*Cuculus pallidus*	B	1
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	B	1
Black-eared Cuckoo	*Chrysococcyx osculans*	B	1
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*	B	1
Welcome Swallow	*Petrochelidon neoxena*	B	1
Tree Martin	*Petrochelidon nigricans*	B	3
Grey Fantail	*Rhipidura albiscarpa*	B	1
Willie Wagtail	*Rhipidura leucophrys*	B	2
Restless Flycatcher	*Myiagra inquieta*	B	1
Jacky Winter	*Microeca fascinans*	B	1
Red-capped Robin	*Petroica goodenovii*	B	2
Golden Whistler	*Pachycephala pectoralis*	B	1
Rufous Whistler	*Pachycephala rufiventris*	B	1
Grey Shrike-thrush	*Colluricincla harmonica*	B	3
Magpie-lark	*Grallina cyanoleuca*	B	2
Crested Shrike-tit	*Falcunculus frontatus*	B	1
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	B	2
White-browed Babbler	*Pomatostomus superciliosus*	B	1
Chestnut-crowned Babbler	*Pomatostomus ruficeps*	B	1
White-fronted Chat	*Epthianura albifrons*	B	1
Western Gerygone	*Gerygone fusca*	B	3
Weebill	*Smicrornis brevirostris*	B	4
Yellow Thornbill	*Acanthiza nana*	B	1
Chestnut-rumped Thornbill	*Acanthiza uropygialis*	B	2
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	B	2
Little Grassbird	*Megalurus gramineus*	B	1
Variegated Fairy-wren	*Malurus lamberti*	B	1
White-breasted Woodswallow	*Artamus leucorynchus*	B	2
Varied Sittella	*Daphoenositta chrysoptera*	B	1
Mistletoebird	*Dicaeum hirundinaceum*	B	1
Brown-headed Honeyeater	*Melithreptus brevirostris*	B	1
Striped Honeyeater	*Plectorhyncha lanceolata*	B	1
Black Honeyeater	*Sugamel niger*	B	2
Eastern Spinebill	*Acanthorhynchus tenuirostris*	B	1

White-fronted Honeyeater	*Phylidonyris albifrons*	B	1
Pied Honeyeater	*Certhionyx variegatus*	B	1
White-plumed Honeyeater	*Lichenostomus penicillatus*	B	2
New Holland Honeyeater	*Phylidonyris novaehollandiae*	B	1
Noisy Miner	*Manorina melanocephala*	B	2
Red Wattlebird	*Anthochaera carunculata*	B	1
Blue-faced Honeyeater	*Entomyzon cyanotis*	B	1
Little Friarbird	*Philemon citreogularis*	B	2
White-winged Chough	*Corcorax melanorhamphos*	B	1
Grey Currawong	*Strepera versicolor*	B	1
Grey Butcherbird	*Cracticus torquatus*	B	1
Australian Magpie	*Gymnorhina tibicen*	B	3
Australian Raven	*Corvus coronoides*	B	2
Striated Pardalote	*Pardalotus striatus*	B	2
Common Brushtail Possum	*Trichosurus vulpecula*	M	2
Western Grey Kangaroo	*Macropus fuliginosus*	M	1
Water Rat	*Hydromys chrysogaster*	M	2
Southern Spiny-tailed Gecko	*Strophurus intermedius*	R	2
Tree Dtella	*Gehyra variegata*	R	1
Bynoe's Gecko	*Heteronotia binoei*	R	3
Beaded Gecko	*Diplodactylus damaeus*	R	2
Beaked Gecko	*Rhynchoedura ornata*	R	1
Burton's Snake-Lizard	*Lialis burtonis*	R	1
Painted Dragon	*Ctenophorus pictus*	R	1
Carnaby's Wall Skink	*Cryptoblepharus pannosus*	R	2
Regal Striped Skink	*Ctenotus regius*	R	3
Tree Skink	*Egernia striolata*	R	4
Dwarf Burrowing Skink	*Lerista timida*	R	15
Spotted Burrowing Skink	*Lerista punctatovittata*	R	5
Grey's Skink	*Menetia greyii*	R	3
Western Blue-tongued Lizard	*Tiliqua occipitalis*	R	1
Peters's Blind Snake	*Ramphotyphlops bituberculatus*	R	2
Eastern Brown Snake	*Pseudonaja textilis*	R	3
Bandy Bandy	*Vermicella annulata*	R	1
Eastern Striped Skink	*Ctenotus orientalis*	R	2
Broad Shelled Turtle	*Chelodina expansa*	R	2
Eastern Long-necked Turtle	*Chelodina longicollis*	R	12
Southern Bullfrog (ssp. unknown)	*Limnodynastes dumerilii*	A	2
Barking Marsh Frog	*Limnodynastes fletcheri*	A	5
Spotted Marsh Frog (race unknown)	*Limnodynastes tasmaniensis*	A	9

Plains Froglet	*Crinia parinsignifera*	A	7
Peron's Tree Frog	*Litoria peronii*	A	2
Growling Grass Frog	*Litoria raniformis*	A	1
Yellow Rosella	*Platycercus elegans flaveolus*	B	2
Mallee Ringneck	*Barnardius zonarius barnardi*	B	1
Brown Treecreeper (south-eastern ssp.)	*Climacteris picumnus victoriae*	B	2
Pobblebonk Frog	*Limnodynastes dumerilii dumerilii*	A	2
Black-winged Stilt	*Himantopus himantopus*	B	1
Carp Gudgeon spp	*Hypseleotris spp*	F	1239
Fly-specked Hardyhead	*Craterocephalus stercusmuscarum*	F	8
Flathead Gudgeon	*Philypnodon grandiceps*	F	3

Legend
Type: Invertebrate, Fish, Amphibian, Reptile, Bird, Mammal

Fauna – Exotic

Common Name	Scientific Name	Type	Records
Common Blackbird	*Turdus merula*	B	1
Common Starling	*Sturnus vulgaris*	B	2
Red Fox	*Vulpes vulpes*	M	1
Gambusia	*Gambusia holbrooki*	F	325
Common Carp	*Cyprinus carpio*	F	80
Goldfish	*Carassisus auratus*	F	9

Legend
Type: Invertebrate, Fish, Amphibian, Reptile, Bird, Mammal

15 Appendix 2. Ecological Vegetation Classes

Appendix 2 provides a description of each EVC within Bottle Bend

EVC no.	EVC name	Bioregional Conservation Status Murray Fans	Description
810	Floodway Pond Herbland	Depleted	Low herbland to < 0.3 m tall with occasional emergent life forms, usually with a high content of ephemeral species. Floors of ponds associated with floodway systems. Typically, heavy deeply cracking clay soils. Characteristically smaller wetlands with a more regular flooding and drying cycle in comparison to sites supporting Lake Bed Herbland.
103	Riverine Chenopod Woodland	Endangered	Eucalypt woodland to 15 m tall with a diverse shrubby and grassy understorey occurring on most elevated riverine terraces. Confined to heavy clay soils on higher level terraces within or on the margins of riverine floodplains (or former floodplains), naturally subject to only extremely infrequent incidental shallow flooding from major events if at all flooded.
806	Alluvial Plains Semi-arid Grassland	Vulnerable	Grassland (turf) to herbland to <0.2 m tall with only incidental shrubs. Flood-promoted flora, potentially including a wide range of opportunistic ephemeral / annual species occupying low-lying areas within at least previously flood-prove (mostly) higher-level terraces, which may be effectively shallow lakes when flooded. Also sometimes on flats along creeks of the further north-west, in habitat akin to that of Floodway Pond Herbland.

16 Appendix 3. Waterwatch Monitoring

Bottle Bend – Active Site (located approximately 800m north west of Bottle Bend)

Site Name	Visit Date	Visit Time	Electrical Conductivity (µS/cm)	pH (pH Units)	Reactive Phosphate (mg/L) (mg/L P)	Soluble phosphate (mg/L P)	Temperature - WATER (° C)	Turbidity - NTU (NTU)	Phy/Chem Tests Comments	Weather Condition	Last Rainfall	Estimate of Flow	Water Appearance	Water Flowing From Drain	Water Type	Region	Basin	Zone	Northing	Easting	Electrical Conductivity (µS/cm) QA/QC	pH (pH Units) QA/QC	Reactive Phosphate (mg/L) (mg/L P) QA/QC	Soluble phosphate (mg/L P) QA/QC	Temperature - WATER (° C) QA/QC	Turbidity - NTU (NTU) QA/QC
Red Gum Gully Boardwalk	09/03/2014	02:30 PM	155	7.3		0	32	31						No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	04/02/2014	07:30 PM	156	6.7		0.1	25	30						No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	04/01/2014	10:30 AM	92	6.7		0	18	29						No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	07/09/2013	04:00 PM	98	7.5		0.1	14	70		overcast		MEDIUM: flow is normal/typical average flow	Milky	No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	01/07/2013	02:45 PM	274	6.9		0	8.4	40		overcast		LOW: Minimum flow in channel/continuous flow in some part of channel (in-stream habitats connected)		No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	06/06/2013	10:35 AM	305	6.7		0	10	36	The river has dropped 3-5m because the weir has been taken out. I assume that accounts for the salinity. Birds: Pelicans; swamp harrier; lots of smaller birds; 2 terns; and loads of mussels exposed.					No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	06/05/2013	12:30 PM	177	7.4		0	11	20	Birds: Snake neck darter; kookaburras; heron. Some carp activity.					No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	03/04/2013	05:00 PM	160	6.8		0	17	30						No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2

Red Gum Gully Boardwalk	02/02/2013	04:50 PM	187	7.1		0	20	31						No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	02/01/2013	08:30 PM	158	6.9		0	23	30						No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	14/11/2012	01:30 PM	126	7		0	18	20						No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	02/09/2012	04:15 PM	115	7.2		0.1	9.6	80	River risen since last time. During week workers been felling trees. Magpie larks, blue wrens, ring necks.					No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	02/08/2012	05:00 PM	135	8		0.1	8.4	33						No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	02/04/2012	12:00 PM	150	7.1		0.1	19	50	Weir downstream may have been taken out, level falling. Plenty of houseboat activity but think too far out to affect turbidity		During the last week			No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	02/01/2012	05:54 PM	151	7.2		0	25	21			More than a week ago			No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	05/12/2011	06:30 PM	158	7		0	20	25	white necked heron with grey wings		During the last week			No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	07/11/2011	05:00 PM	149	6.6		0	20	32	birds present Lots of thick grey mud about. No one around but some may have been stirred up.		More than a week ago			No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	06/09/2011	10:00 AM	125	7		0	10	40	wood ducks, white heron, black wing heron		More than a week ago			No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	03/08/2011	04:45 PM	130	7.1		0.1	16	70	cormorant, kookaburra		More than a week ago			No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	27/07/2011	10:45 AM	140	7		0	12	40	heard kookaburras		More than a week ago			No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	06/06/2011	10:25 AM	310	7.4		0.1	13	50	water noticably clearer than on 3rd March 2011		During the last 24 hours			No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	03/06/2011	01:15 PM	150	6.9		0.3	14	150	The overcast conditions perhaps made the phosphate test harder to do - evidence of dead carp i.e. scales, gutted carp hanging in bushes.	overcast	During the last week		Stained brown	No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	01/05/2011	04:00 PM	210	7.3		0.1	18	50	kookaburras, magpies; lots of big fish breaching		More than a week ago			No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	03/04/2011	03:55 PM	190	7.1		0.1	20	28						No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	05/03/2011	04:52 PM	280	7		0.2	24	26	River has dropped over a metre. 2 ravens, and pobblebonk frogs present. House boat and jet ski across river may influence turbidity.		More than a week ago			No	Other	Mallee	Mallee	54	6203250	613500	2	2		2	2	2
Red Gum Gully Boardwalk	03/01/2011	06:00 PM	230	7	0.2		26	19	rain within one week, frog calls heard, river very high					No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3

Red Gum Gully Boardwalk	01/11/2010	02:00 PM	150	7.6	0.1		20	30	pair black swans with 1 cygnet, cormorant					No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardwalk	27/09/2010	03:20 PM	180	7.3	0		18	45	rain within one week, water up at least 50cm					No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardwalk	06/09/2010	02:18 PM	110	7.3	0		13	40	pied butcher bird, white heron, heard lots of others as well poured with rain last few days, flotsam in river included dead fish about 20 cm long					No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardwalk	05/08/2010	02:30 PM	90	7.3	0		12	20	ducks, whistling kite, no frog calls water volume low due to weir removal in Mildura					No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardwalk	01/07/2010	02:00 PM	150	7.1	0		11	15	last rainfall within week birds: wagtail, whistling kite, ravens					No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardwalk	08/06/2010	04:50 PM	110	7.7	0		12	15	last rainfall: within week kookabura, corella, crows					No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardwalk	03/05/2010	03:30 PM	150	7.2	0		20	20						No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardwalk	03/03/2010	06:30 PM	120	7.4	0		25	20						No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardwalk	02/02/2010	03:00 PM	100	7.3	0		29	21						No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardwalk	02/01/2010	03:15 PM	170	7.5	0		28	20	some motor boat activity in area probably contributed to turbidity reading					No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardwalk	04/12/2009	12:33 PM	80	6.9	0		24	20	wagtail chasing grey butcher bird, wren and magpie lark.					No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardwalk	04/11/2009	05:25 PM	90	7	0		24	15	Saw yellow parrot - nest in tree hollow - can hear babies; ibis; heard crows					No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardwalk	06/10/2009	02:25 PM	110	7	0		18	15	Renewal for standard solutions needed; last rainfall within week; heard what could have been a 'clamorous reed-warbler' but didn't see it; ducks, cockatoo,ravens and fairy wrens sighted.					No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardwalk	02/09/2009	02:24 PM	170	7.1	0		17	18	Last rainfall witin week					No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardwalk	30/07/2009	03:10 PM	140	7.2	0		12	10	Last rainfall one week; magpies sighted; water clear.					No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3

Red Gum Gully Boardw alk	02/07/2009	01:30 PM	170	6.9	0		13	10	Last rainfall w itin w eek; sheep on opposite bank; saw ducks, heard w histling kite, magpie, galahs; turbidity - even filled to brim could easily see gap betw een lines					No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardw alk	03/05/2009	02:30 PM	110	6.7	0		17	15	Last rainfall w ithin w eek; ducks, magpie, sw allow s, corellas, female fairy w ren sighted.					No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardw alk	04/03/2009	02:45 PM	120	7	0.1		22	24						No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardw alk	03/02/2009	08:25 AM	130	7.3	0		31	16						No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardw alk	03/01/2009	02:00 PM	160	7	0		25	22						No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardw alk	27/11/2008	11:45 AM	110	6.8	0		26	19						No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardw alk	06/11/2008	02:30 PM	160	7.1	0		25	12	There w as a house boat nearby					No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardw alk	03/10/2008	11:00 AM	140	7.2	0		21	17						No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardw alk	02/09/2008	03:50 PM	140	7.6	0		18							No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	
Red Gum Gully Boardw alk	05/08/2008	11:35 AM	150	7.4	0		13	12						No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardw alk	06/07/2008	03:12 PM	140	7.2	0		13	17						No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardw alk	04/06/2008	01:30 PM		7.5	0		16	13						No	Other	Mallee	Mallee	54	6203250	613500		3	3		3	3
Red Gum Gully Boardw alk	05/05/2008	11:30 AM	220	7.6	0		17	11						No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardw alk	05/04/2008	05:45 PM	250	7.4	0		20	19	On Wednesday the second there w as a massive dust/w ind storm. EC result w as checked tw ice. Huge rain event 24/03/08					No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3
Red Gum Gully Boardw alk	07/03/2008	02:05 PM	150	7.6	0		30	22						No	Other	Mallee	Mallee	54	6203250	613500	3	3	3		3	3

Bottle Bend – Inactive Site (located on a drainage outfall adjacent to wetland #7329138008)

Waterwatch - Bottle Bend - Inactive Sites

Site Name	Visit Date	Visit Time	<>	Electrical Conductivity (µS/cm)	<>	pH (pH Units)	<>	Reactive Phosphate (mg/L) (mg/L P)	<>	Temperature - WATER (° C)	<>	Turbidity - NTU (NTU)	Phy/Chem Tests Comments	Water Flowing From Drain	Water Type	Region	Basin	Longitude	Latitude	Zone	Northing	Easting	Electrical Conductivity (µS/cm) QA/QC	pH (pH Units) QA/QC	Reactive Phosphate (mg/L) (mg/L P) QA/QC	Temperature - WATER (° C) QA/QC	Turbidity - NTU (NTU) QA/QC	Creature Comments	Diary Photos
Catchment 8 Drainage outfall - Stewart Rd	13/06/2007	09:00 AM		1840						15				No	Other	Mallee	Mallee	142.238035847 N	-34.3212466088 E	54	6201530	613901	3			3			None
Catchment 8 Drainage outfall - Stewart Rd	18/05/2007	10:40 AM		1850		8.5				21		10		No	Other	Mallee	Mallee	142.238035847 N	-34.3212466088 E	54	6201530	613901	3	3		3	3		None
Catchment 8 Drainage outfall - Stewart Rd	03/04/2007	11:45 AM		1960		8.5		0.01		23		10		No	Other	Mallee	Mallee	142.238035847 N	-34.3212466088 E	54	6201530	613901	3	3	3	3	3		None
Catchment 8 Drainage outfall - Stewart Rd	13/03/2007	09:00 AM		2200						20				No	Other	Mallee	Mallee	142.238035847 N	-34.3212466088 E	54	6201530	613901	3			3			None
Catchment 8 Drainage outfall - Stewart Rd	12/02/2007	09:30 AM		1930		8.2		0.02		22	<	10	very clear	No	Other	Mallee	Mallee	142.238035847 N	-34.3212466088 E	54	6201530	613901	3	3	3	3	3	very clear	None
Catchment 8 Drainage outfall - Stewart Rd	24/01/2007	02:30 PM		2200		8.4				26	<	10		No	Other	Mallee	Mallee	142.238035847 N	-34.3212466088 E	54	6201530	613901	3	3		3	3		None