Connecting Rivers, Landscapes, People

Wimmera Mallee Pipeline Wetlands Environmental Water Management Plan

North Central Catchment Management Authority

Department of Environment, Land, Water & Planning

VICTORIAN ENVIRONMENTAL WATER HOLDER

NORTH CENTRAL
Catchment Management Authority
Connecting Rivers, Landscapes, People

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Executive Summary

The Wimmera Mallee Pipeline (WMP) Wetlands Environmental Water Management Plan (EWMP) sets out the long-term objectives for the priority environmental values of the WMP Wetlands and its individual sites. The EWMP is an important part of the Victorian Environmental Water Planning Framework. It provides the five to ten year management intentions, based on scientific information and stakeholder consultation, which can be used by the respective agencies; North Central Catchment Management Authority (CMA), Department of Environment, Land, Water and Planning (DELWP) and the Victorian Environmental Water Holder (VEWH); for both short and longer-term environmental water planning.

This EWMP is not a holistic management plan for the complex, but focuses on environmental water management so that the WMP Wetlands and its sites can continue to provide environmental, social, cultural and economic values for all users. Actions such as pest plant and animal works are documented as complementary to environmental water management in this EWMP.

The following components are the main sections featured in the WMP Wetlands EWMP. A summary of the main conclusions to facilitate appropriate environmental water management into the future are summarised below.

Hydrology and system operations

The Avon-Richardson Catchment has a long history of land-use change that has affected the hydrology, catchment, biota, soils and physical form of its wetlands and waterways. The recent construction of the WMP as a mean of improving water use efficiency for town and agriculture has resulted in the widespread removal of the open water supply channel and dam network. Seven sites in the North Central region are now connected to the WMP and able to receive environmental water. However, the area that environmental water can influence is limited to either a dam or the dam and a small area of the surrounding wetland, due to pipeline capacity restrictions. All though small, these sites represent some of the only reliable water sources available in the Avon-Richardson catchment.

Water dependent values

The sites of the WMP are an important component of the Avon-Richardson Catchment, supporting a diversity of vegetation types that vary greatly across the landscape. At each site, the unique vegetation assemblage supports a range of water dependent and terrestrial fauna that utilise the site for shelter, water and food. Many of the vegetation communities, flora and fauna species within the WMP Wetlands are considered endangered or vulnerable.

Ecological condition and threats

The condition of the sites in the WMP Wetlands ranges from poor to good based primarily on their physical form, surrounding land use and flora and fauna diversity. The catchment supports very little remanent vegetation, and as a result, the sites of the WMP provide some of the only habitat patches in the region. Complex and site management therefore focuses on encouraging a diversity of aquatic and fringing vegetation (within dams) to support water dependent species as well as the provision of water in the landscape for terrestrial species.

Management objectives

A long-term management goal has been defined for the WMP Wetlands:

Wimmera Mallee Pipeline Wetlands

Maintain aquatic habitat and refugia through the landscape to provide refuge, shelter, watering points and feeding opportunities for waterbird, turtles, frogs and terrestrial fauna species in the region.

A management goal for each individual site has also been defined with the overall objective of aligning with the complex goal outlined above:

Chirrup Dam

To maintain Chirrup Dam as a refuge for water dependent fauna (particularly frogs and turtles) and to provide a point source for recolonisation of Chirrup Swamp when it is naturally inundated.

Corack Dam

Provide conditions that support an abundance of aquatic plants that promote refuge and nursery habitat for turtles and frogs and a variety of feeding conditions for waterbirds (i.e. drawdown zones, shallows).

Creswick Dam

Support a diversity of aquatic plants, including re-establishment of Marbled Marshwort, which will provide refuge, feeding and breeding opportunities for frog and turtles at Creswick Dam.

Davis Dam

Support the fauna (particularly that of the surrounding Black Box vegetation) of Davis Dam by providing drought refuge and a watering point for fauna (including mammals, reptiles and waterbirds).

Falla Dam

Provide a water regime that maintains Falla Dam as a watering point for terrestrial species and drought refuge for turtles and frogs during dry conditions.

Jeffcott Dam

Maintain the diversity of aquatic plants and provides refuge and breeding conditions for water dependent species such as frogs, macroinverbrates, turtles and waterbirds at Jeffcott Dam.

Jesse Dam

Promote native aquatic plant growth including re-establishment of Marbled Marshwort at Jesse Swamp dam and provides shallow foraging habitat for waterbirds (including Brolga) and feeding opportunities for frogs.

The ecological objectives and hydrological objectives that sit under the long-term management goal for the sites of the WMP Wetlands were informed by Howard *et al.*, (2014) and Rakali (2014) and reviewed and refined during the development of this EWMP. These objectives prescribe the environmental watering regime for each site in the WMP Wetlands.

Managing risks to achieving objectives

The threats to achieving the ecological objectives that are external to environmental water are identified. These include introduced species and morphological constraints (i.e. dam bank slope).

Environmental water delivery infrastructure

The constraints to the delivery of environmental water (such as the ability to water the wetland area) have been identified. Infrastructure recommendations have been made include increasing the capacity of the pipeline to allow great delivery rates and increased watering extent.

Demonstrating outcomes

Monitoring is required to allow adaptive management of annual environmental watering (intervention monitoring). It is also required to enable the CMA and VEWH to demonstrate the long term outcomes of the implementation of the WMP Wetlands EWMP. As the State is currently developing the Wetlands Monitoring Assessment Program (WetMAP), the WMP Wetlands EWMP recommends a suite of intervention and long-term monitoring activities that will meet the monitoring requirements.

Consultation

Key stakeholders, including DELWP, VEWH and Grampians Wimmera Mallee Water (GWMWater) have been engaged during the development of this EWMP. The community involved in the consultation phase of the WMP Wetlands EWMP also played a crucial role in advising the North Central CMA on its management of environmental water in the complex. This group was comprised of local community, private landholders, recreational and environmental interest groups. Barengi Gadjin Land Council was engaged through a field visit undertaken in May 2015.

Knowledge gaps and recommendations

The management actions in the WMP Wetlands EWMP are based on the best available information however; there are a number of knowledge gaps and associated recommendations identified for future funding. In particularly the need to develop a long term understanding of the flora and fauna values present as well as the need to address a number of constraints (i.e. steep dam banks) that prevent or reduce the achievement of key ecological objectives (i.e. aquatic vegetation diversity).

Acknowledgements

Acknowledgement of Country

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

Contributors to the Wimmera Mallee Pipeline Wetlands EWMP

The information contained in the Wimmera Mallee Pipeline Wetlands EWMP has been sourced from a variety of reports and field inspections and from individual knowledge and expertise. The North Central CMA acknowledges the assistance of the following people in preparing this EWMP:

- Suzanne Witteveen, Susan Watson, Jamie Bell and Andrea Keleher, Department of Environment, Land, Water and Planning (DELWP)
- Kym Wilson, Grampians Wimmera Mallee Water (GWMWater)
- Darren Griffin, Barenji Gadjin Land Council
- Julie Slater, Rob Loats, Greg Nunn, Liz Russell, Ann Dunstan, Trevor Campbell, Leo Tellefson, Adam Campbell, Lindsay Ezard, Neil and Sue Davis, Keith and Helen Barber and David Falla (Community Reference Group)
- Damien Cook (Rakali Ecological Consulting), Katie Howard and Di Crowther (Arthur Rylah Institute for Environmental Research)
- Greg Fletcher (Wimmera CMA), Louise Searle and Jane White (Mallee CMA)
- Marcus Cooling (Expert Reviewer)
- Emer Campbell, Darren White, Amy Russell, Bree Bisset, Louissa Rogers, Camille White, Phil Dyson, Rebecca Horsburgh and Peter McRostie (North Central CMA).

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1 Introduction

Management of environmental water is planned and implemented through a framework of key documents. Figure 1 illustrates the strategies, scientific reports and operational documents required for environmental water management in Victoria.

The 2014-22 North Central Waterway Strategy (NCWS) is an integrated strategy aimed at managing and improving the North Central CMAs waterways (rivers, streams and wetlands). The NCWS is guided by the Victorian Waterway Management Strategy (VWMS) and the North Central Regional Catchment Strategy (RCS). For the North Central Wimmera Mallee Pipeline (WMP) Wetlands, the long-term resource condition target is to: *Improve the condition of the Wimmera Mallee Pipeline supplied wetlands by 2050 as measured by Index of Wetland Condition (IWC).*

The achievement of the NCWS resource condition target is reliant on a number of management activities including pest plant and animal control works and environmental water delivery. This Environmental Water Management Plan (EWMP) aims to establish the long-term environmental water management goals for North Central WMP Wetlands.

The North Central CMA prepares Seasonal Watering Proposals (SWPs) for the WMP Wetlands each year, which is informed by the NCWS and the North Central WMP Wetlands EWMP.

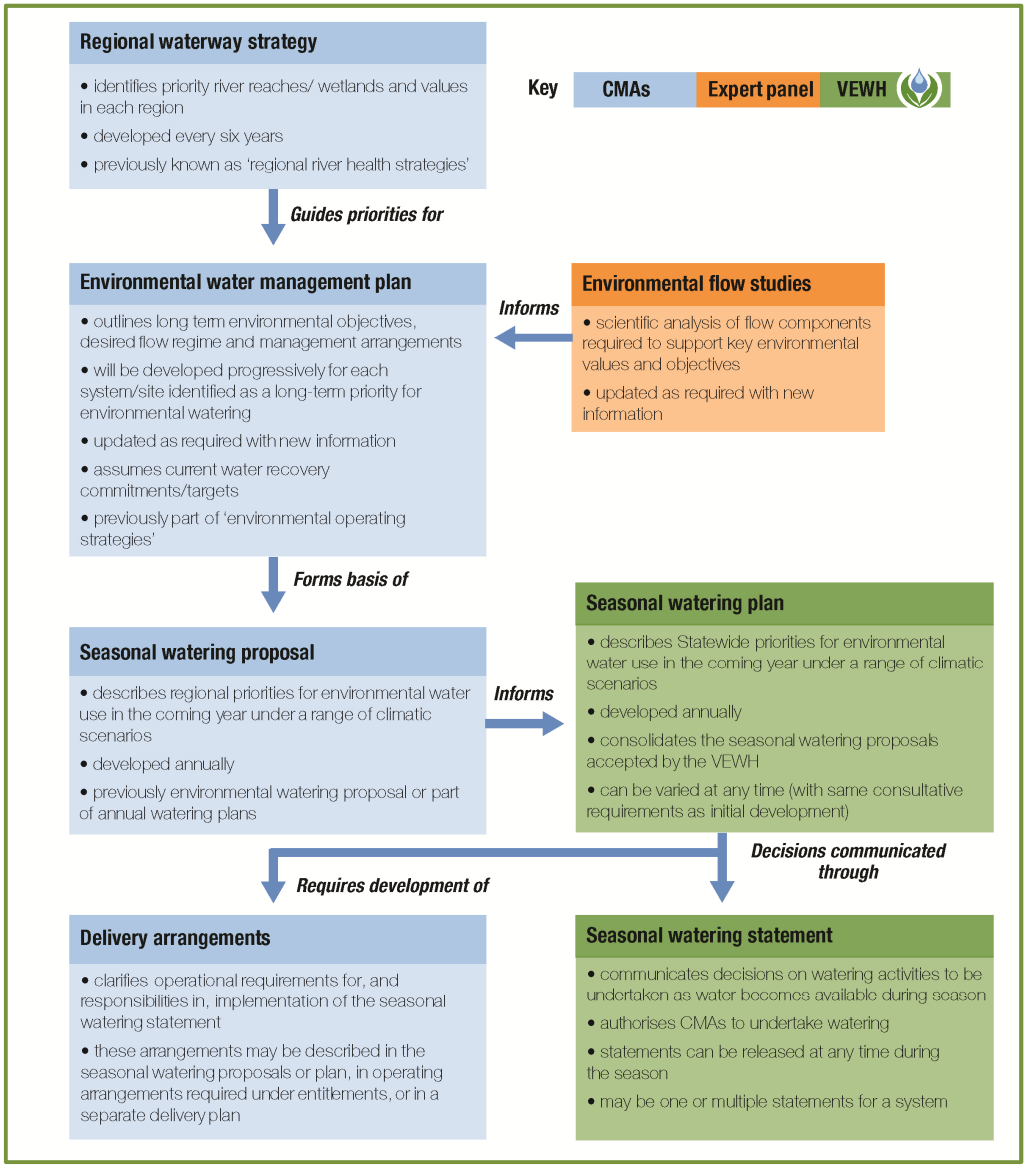

Figure 1. Planning framework for decisions about environmental water management in Victoria (VEWH, 2014)

1.1 Purpose and scope

The WMP Wetlands EWMP is a ten-year management plan that describes the ecological values of the sites, sets long-term goals, sets priority ecological objectives and determines the watering regime required to achieve these objectives. It is based on both scientific information and stakeholder consultation and will be used by the North Central CMA when developing watering proposals and implementing watering decisions. It will also help guide investments and decisions by Department of Environment, Land, Water and Planning (DELWP) and the Victorian Environmental Water Holder (VEWH) (DELWP, 2014).

The key purposes of this EWMP are to:

- identify the long-term objectives and water requirements for the sites;
- provide a vehicle for community consultation, including the long-term objectives and water requirements of each site in the complex;
- inform the development of SWPs and Statewide seasonal watering plans (developed by the VEWH); and
- inform Long-term Watering Plans that will be developed by the State under the Chapter 8 of the Basin Plan (DELWP 2014).

Unless otherwise stated, the scope of this EWMP refers collectively to the sites located in the North Central CMA region as the Wimmera Mallee Pipeline (WMP) Wetlands. When collectively referring to all 52 sites connected to the WMP in the North Central, Wimmera and Mallee CMA regions, the name Wimmera Mallee Wetland System is used (see Section 2.2). The Mallee and Wimmera CMAs have developed separate EWMPs for sites within their respective regions and integrated management across the entire landscape is documented in the *Wimmera Mallee Pipeline Wetlands Context Report* (Sunraysia Environmental, 2014).

1.2 Development process

The WMP Wetlands EWMP has been developed in collaboration with key stakeholders including DELWP, Parks Victoria, Mallee and Wimmera CMAs, VEWH, Grampians Wimmera Mallee Water (GWMWater) and landholders. A number of tasks were undertaken to develop the EWMP as detailed below:

- **Scoping and collating information:** Due to the lack of information available on the WMP Wetlands sites, baseline flora and fauna surveys were undertaken at the onset of the EWMP project. This included Ecological Vegetation Condition (EVC) mapping, IWC assessments and flora and fauna surveys (including targeted macroinvertebrate, turtle and frog surveys). The history of technical works undertaken is shown in Table 1.

Table 1. History of technical work undertaken in the WMP Wetlands

Name	Author	Date	Summary
Aquatic Biodiversity Surveys of Four Wimmera Mallee Pipeline Wetlands	Howard et al.	2014	Determined species composition, relative abundance and assemblage of frogs and turtles, document macroinvertebrate composition, richness and functional feeding groups and record incidental fauna.
Wetland Condition Benchmarking and Monitoring along the Wimmera-Mallee Pipeline	Rakali Ecological Consulting	2014	Identified, described and mapped EVC, vegetation communities, ecological condition (IWC), and flora and fauna species and provided advice on hydrological requirements and condition monitoring.

- **Community and stakeholder workshop No. 1:** key stakeholder and community members were engaged to assist with developing a picture of the history, values, threats, condition and management outcomes required at each site and the wider complex. The outcomes of this workshop are summarised in Appendix 6: Engagement Outcomes.

Information from the above tasks was analysed to provide justification and evidence for the following sections of the EWMP:

- **Water dependent values:** environmental values were derived from the baseline flora and fauna surveys, historical reports, DELWP databases and community and stakeholder accounts. General water dependent values (i.e. types of fauna and broad vegetation types) representing the complex as well as

site specific values (i.e. specific fauna and flora species and vegetation communities) are presented in this EWMP.

- **Terrestrial values:** Due to the ability for sites to support terrestrial fauna, terrestrial values are also considered for the complex and each individual site. The importance of the complex for terrestrial species was also considered in the original Wimmera Mallee Pipeline prioritisation process (see Sunraysia Environmental, 2014). Social values including cultural heritage, recreation and economic are further described for the complex.
- **Ecological condition, condition trajectory and threats:** Available information, including IWC assessments, were used to describe the current condition and water-related threats of the sites in the WMP Wetlands. A "do-nothing" scenario is further considered to understand the condition trajectory if no action is undertaken.
- **Management objectives:** The water management goal and the ecological objectives for the sites of the WMP Wetlands are based on the water dependent values recorded, the current condition and the condition trajectory. Individual site objectives are designed to align with the complex objectives as well as the broader environmental outcomes proposed in the Basin Plan draft Environmental Watering Strategy.
- **Managing risks:** the risks to achieving the ecological objectives for the WMP Wetlands have been assessed. Management actions to mitigate each risk have been recommended and residual risk (assuming full adoption of management action) identified.
- **Environmental water delivery infrastructure:** identification of current constraints in delivering environmental water is included in the EWMP as well as recommendations to achieve a greater ecological response.
- **Demonstrating outcomes:** monitoring methods to adaptively manage the delivery of environmental water and to demonstrate the outcomes against the ecological objectives and to manage risk are based on best available science. Justification for a suite of long term and intervention monitoring recommendations are given.
- **Knowledge gaps and recommendations:** a number of knowledge gaps were identified during the process of developing the ecological objectives, management actions and risk analysis sections. A series of recommended activities as well as a priority ranking is given for each knowledge gap.

- **Expert workshop**: a wetland ecologist was engaged to provide technical review on the draft ecological and hydrological objectives.
- **Community and stakeholder workshop No. 2**: The original community and stakeholder group was reconvened to provide input into the draft EWMP, particularly relating to the water management goals, ecological objectives and optimum watering regimes. See Appendix 6: Engagement Outcomes for further details.
- **Traditional Owner Group field visit**: A field trip was conducted with Barenji Gadjin Land Council to gather information on the cultural value of the area. Findings were incorporated into the relevant sections of this EWMP and documented in Appendix 6: Engagement Outcomes.
- **Collaboration with Mallee and Wimmera CMAs**: Draft EWMPs were reviewed by the respective CMAs to ensure consistency in the approach taken to develop each document. A workshop to review and provide comment on the *Wimmera Mallee Pipeline Wetlands Context Report* (Sunraysia Ecological, 2014) was also undertaken.

Following development, the EWMP was reviewed by Marcus Cooling (expert reviewer) prior to being incorporated into the one of the two Long-term Watering Plans that covers the North Central CMA region.

1.3 EWMP Structure

This document will assist the managers of the environmental water reserve to plan and implement the delivery of environmental water. The plan covers both the entire complex and its individual sites. Information that is applicable to all (or the majority of sites) is presented collectively for the complex. Site-specific information including hydrology,

ecological values, management goal, ecological and hydrological objectives and the recommended watering regime is presented separately for each site, representing a series of smaller EWMPs within the larger document.

To reduce duplication within the body of the EWMP, the structure and purpose of the following sections are summarised below.

Management goals: A long term management goal has been established for the entire WMP Wetlands as well as each individual site.

As delivery of environmental water is restricted by the capacity of the WMP, sites are broken down into wetland and dam management units, where applicable. Currently only the dam and in some cases a small area of surrounding wetland is able to be influenced by environmental water (see Section **Error! Reference source not found.** for further details). Where possible, dam management goals are aligned with wetland goals to enable environmental water management within the dam (and potential small area of wetland) to complement the larger site objectives.

To inform environmental water delivery in the event that constraints are alleviated in the future, wetland objectives and watering recommendations are documented in Appendix 10: Wetland Management Objectives.

Ecological objectives: For the purpose of this EWMP, ecological objectives have been developed to target the overarching values of the complex and the individual water dependent values of each site. Site-specific objectives are further broken down into wetland and dam objectives.

Ecological objectives can be described as the desired ecological outcomes for a site. Where appropriate, each key value detailed in this EWMP is expressed as a target condition or functionality, using one of following trajectories:

- Improve – improve the condition of the value by allowing natural processes of regeneration, disturbance and succession to occur.
- Maintain – maintain the current condition of the value while allowing natural processes of regeneration, disturbance and succession to occur.
- Re-establish – re-introduce values that can no longer be found in the area.
- Reduce – reduce threats to values.

Ecological objectives inform the associated hydrological objectives and watering regime recommended for each site.

The following descriptions apply only to the sections of this EWMP that describe individual site requirements.

Hydrological objectives: Hydrological objectives have been set to target the ecological objectives identified for each site in the Wimmera Mallee Wetlands.

Hydrological objectives are derived from the ecological objectives and the local hydrology of a site.

To meet the long-term requirements of the WMP Wetlands EWMP, hydrological objectives have been set considering the following factors (where applicable). The:

- recommended number of watering events over a ten year period
- preferred timing of watering events
- recommended duration for watering events
- tolerable intervals between events (condition tolerances)
- volume required to provide these events.

This information is presented in detail in Appendix 8: Water Requirements for Values and Appendix 9: Hydrological Objectives and is summarised for each site in the 'Hydrological Objectives' section.

Watering regimes: An optimum watering regime, based on the hydrological requirements of the key water dependent values, has been developed for each of the Wimmera Mallee Wetlands sites.

Optimum watering regimes have been derived from the ecological and hydrological objectives. The regime is intended to be managed to account for inter-annual variability (particularly climatic conditions). Therefore the volume of water required in any given year will be determined by the environmental water manager. The contribution of natural rainfall-runoff should be considered when planning watering events.

Management will be undertaken as per the seasonally adaptive approach outlined in the *Wimmera Mallee Wetland System Context Report* (Sunraysia Ecological, 2014). This requires collaborative management between the CMAs to ensure that recommendations put forward in each EWMP and SWP reflects the broader ecological objectives and priorities of the region. These recommendations are considered by the VEWH in line with the *Water Act 1989* and incorporated into the Statewide Seasonal Watering Plan.

2 Site Overview

2.1 Site Location

The WMP Wetlands consist of seven public and privately owned sites located within the Wimmera bioregion of the Avon-Richardson Catchment in the North Central CMA region:

Public land sites:

- Creswick Swamp
- Chirrup Swamp
- Corack Lake
- Jeffcott Wetland

Private land sites:

- Davis Wetland
- Falla Dam
- Jesse Swamp.

The WMP Wetlands are spread across an area of approximately 130,000 hectares, and are bordered by the townships of Marnoo, St Arnaud and Birchip. Historically these sites and many others in the region were part of an open channel supply system and were utilised for water storage (Butcher et al., 2007). However by 2010 all had been disconnected from their former water supply through the construction of the WMP, a large scale pipeline scheme aimed at improving the efficiency of water use across a large area of the Wimmera and Mallee regions. The WMP Wetlands as well as an additional 45 sites across the Mallee and Wimmera CMA regions (collectively referred to as Wimmera Mallee Wetland System- see Section 2.2) were prioritised for connection to the WMP through a selection procedure. A small section of each site (i.e. dam and in some cases a small section of surrounding wetland) is now able to receive environmental water through the WMP network. Figure 2 shows the location of the seven WMP Wetlands within the North Central CMA region.

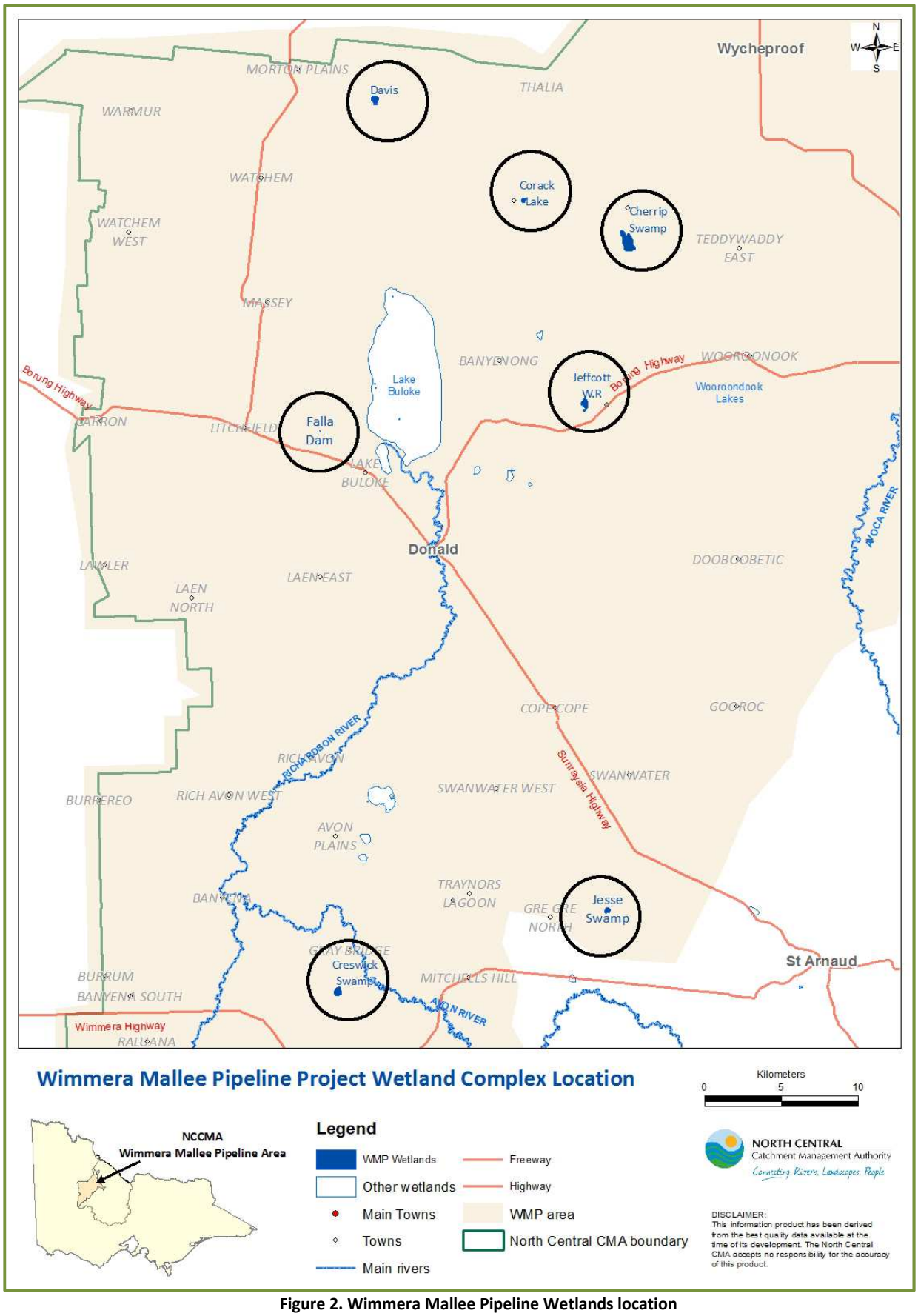

Figure 2. Wimmera Mallee Pipeline Wetlands location

2.2 Landscape context

The seven Wimmera Mallee Pipeline Wetlands sites comprise of the North Central CMA component of the Wimmera Mallee Pipeline System. An additional 45 sites, spread across the Mallee (32 sites) and Wimmera (13 sites) CMA regions are also connected to the WMP and able to receive environmental water through the pipeline. Figure 3 shows the location of all sites within the larger system.

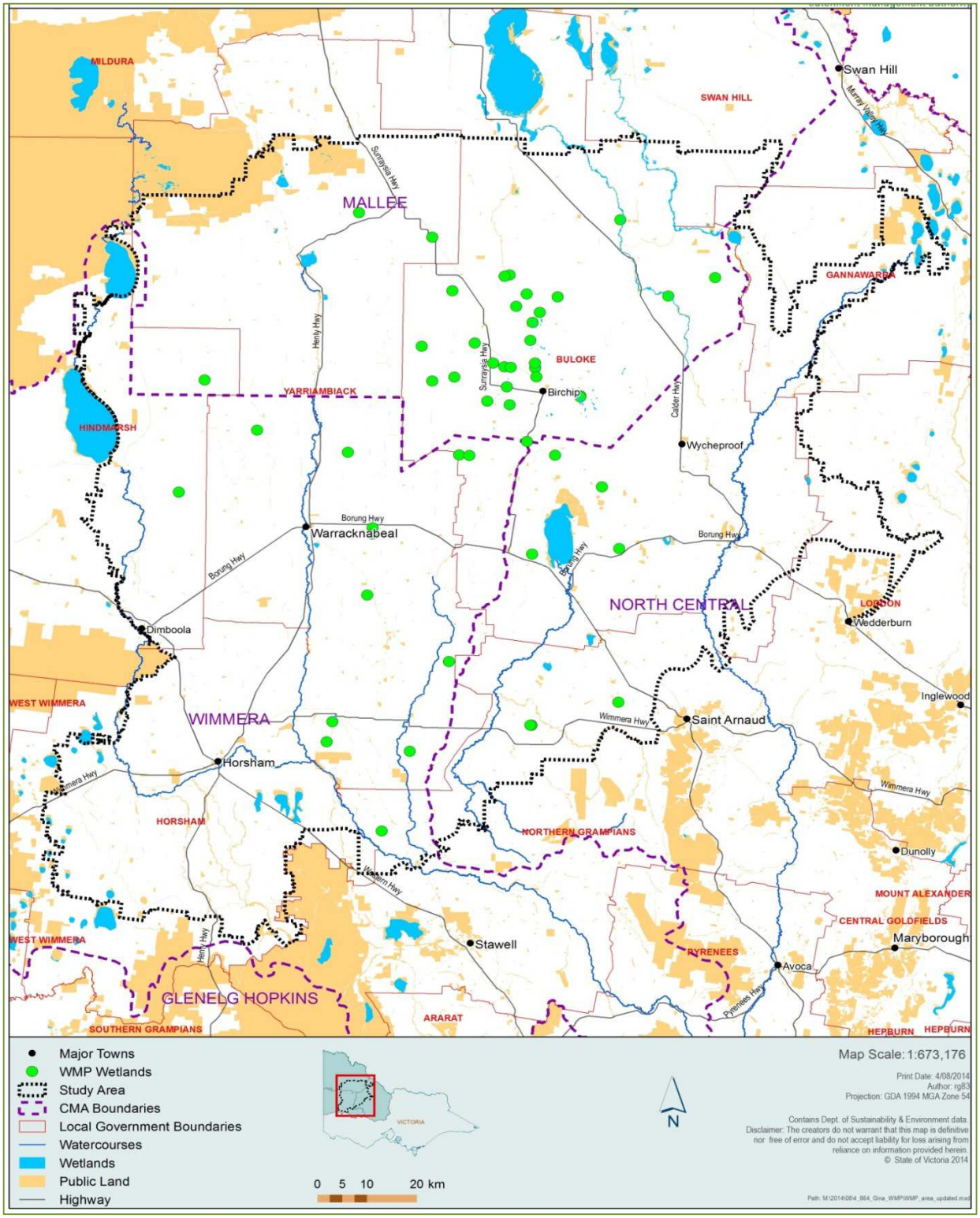

Figure 3. Location of sites in the Wimmera Mallee Wetland System

2.3 Catchment setting

Climate

Average annual rainfall in the Avon-Richardson Catchment varies from 499 mm in St Arnaud to 357 mm at Birchip. Rainfall is significantly higher between May to October (average range of 38-34 mm) than in November to April (average range of 26-22 mm). Average temperatures range from 29 °C in January to 12 °C in July, with the minimum temperature rarely dropping below zero degrees (BOM, 2014). Annual evaporation greatly exceeds rainfall across the whole region leading to a significant water deficit each year. Average evaporation rates are estimated to vary from 1,300 mm to 1,800 mm per annum (Oates et al., 2003 cited in Duncan et al., 2005).

Hydro-physical characteristics

The WMP Wetlands is part of the Murray-Darling depression within the Wimmera bioregion in the Avon-Richardson catchment (Halliwell, 1998). The upper catchment is characterised by steep hills, with hard setting sandy loam soils which lead to high runoff rates. The mid to lower catchment is characterised by poor soil drainage in low lying areas such as Marnoo, York Plains, Avon Plains, Lake Batyo Catyo and Lake Cope Cope (GHD, 2014). Historically the catchment was predominately open grasslands, grassy Black Box and Buloke Woodlands with scattered wetlands associated with the river systems and active floodplains (McMahon et al., 2003).

The two major river systems include the Avon River and Richardson River. The Avon River originates from the sedimentary rises, hills and alluvial plains to the south-east of the catchment. The Richardson River flows from the south of the catchment through predominately marine sediments and flat clay plains. Historically both rivers would have been intermittent, fed by catchment precipitation and over bank flooding from the Wimmera River to the south (SKM, 2006; Halliwell, 1998). The Avon River meets the Richardson River at the township of Banyena before flowing for approximately 30 kilometers northward to enter the terminal lake system of Lake Buloke.

The ancient Lake Buloke system would have historically covered an area of at least 30,000 hectares (six times the current size of Lake Buloke), extending as far eastward as the foot-slopes of Mt Jeffcott (White *et al*., 2003). This area is confined between two ridges of Parilla Sand which are strandlines from the retreat of the Plicoene sea some 5 to 1.8 million years ago (Department of Environment, 2010). The lake size reduced as the climate became drier and successive lunettes formed along the eastern margins in a step-wise regression. Through time, each regression became separated by an inter-dune corridor comprising heavy grey clays that were once the floor of the old lake bed. This repetitious lunette/ inter-dune corridor system began to trap water as a series of pools behind each dune disrupting the natural drainage network of the area. Through successive periods of extended wetting and drying and the process of deflation, a series of wetlands were formed (White et al., 2003). Lake Buloke and its associated wetlands are now recognised as a nationally significant complex in the Directory of Important Wetlands in Australia (DIWA) (Environment Australia, 2010). Figure 4 shows the natural topography and major wetlands and rivers of the Avon-Richardson Catchment.

The Avon-Richardson Catchment has changed dramatically since the advent of European agricultural practices in the region. Ninety five percent of the river basin is now cleared of native vegetation (GHD, 2014; Draper et al., 2006; SKM, 2005). The natural hydrology of catchment's wetlands, floodplains and rivers has also been altered through river regulation and the construction of a network of channels, levees and dams (Draper et al., 2006). In addition the conversion to the WMP has further altered the hydrology of the region (see Sunraysia Environmental, 2014 for information on the WMP Program).

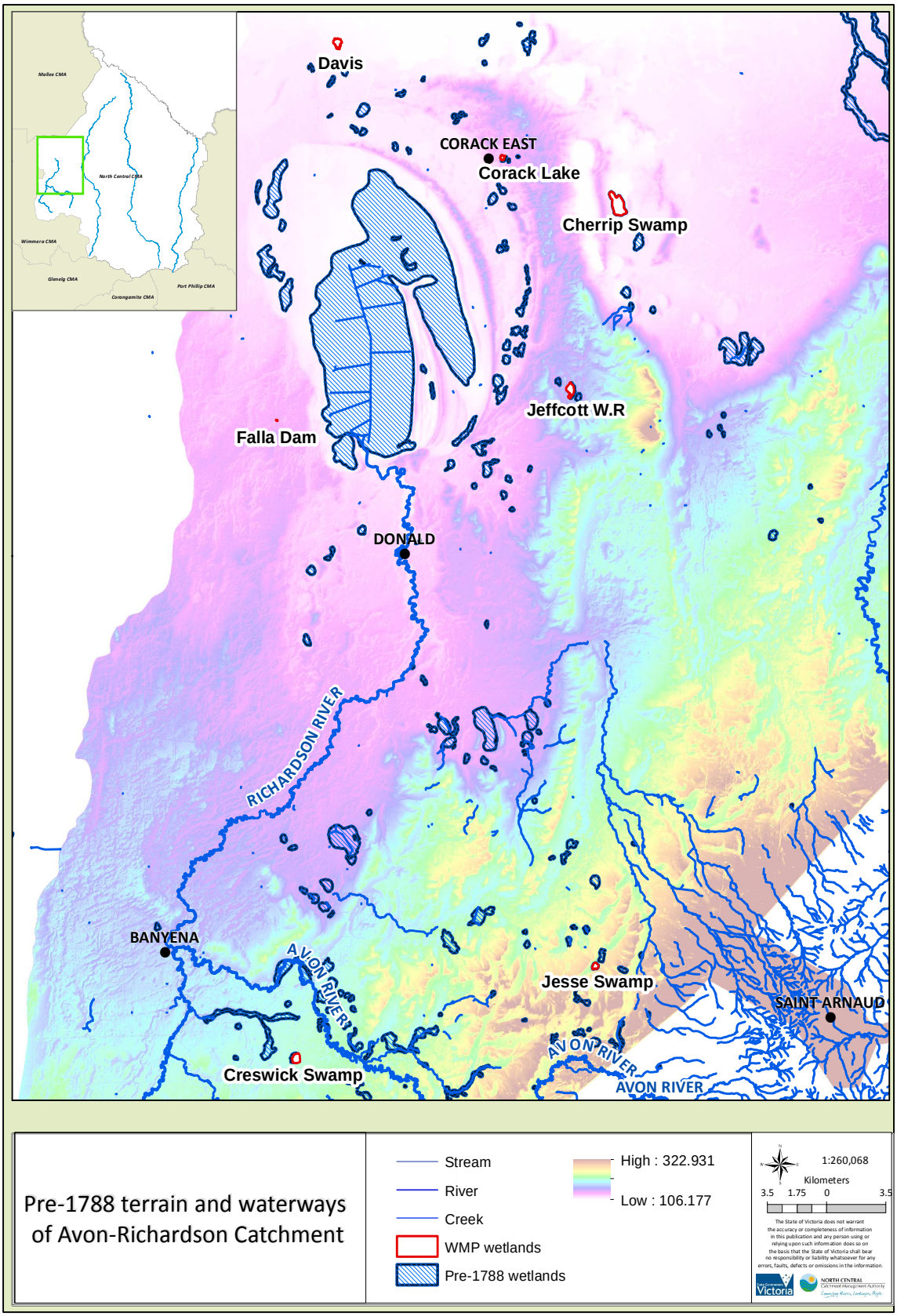

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Figure 4. Terrain of the Avon-Richardson Catchment

2.4 Land Status and management

Public land sites

Creswick Swamp, Jeffcott Wildlife Reserve (containing Jeffcott Wetland) and Chirrup Swamp are listed as Wildlife Reserves under the *Crown Land (Reserves) Act 1978* and are managed by Parks Victoria under the *Wildlife Act 1975* (LCC, 1986 & LCC, 1981). As per the Land Conservation Council (LCC) recommendations, management of these sites focuses on conservation of native flora and fauna, recreation (including hunting) and education.

Corack Lake is listed as a Recreational Reserve under the *Crown Land (Reserves) Act 1978* and is managed by DELWP for informal recreation such as camping, swimming and picnicking (LCC, 1986).

Private land sites

Falla Dam, Jesse Swamp and Davis Wetland are located on private land and are managed for environmental water delivery under the agreements shown in Table 2.

Table 2. Private land management agreements

Agreement type	Purpose	Contractual parties
Deed of Agreement	Outlines the requirements for supply and use of water, land access, warranty, release and indemnity	Private landholder, North Central CMA, VEWH and GWMWater
Management Agreement	Defines the landholder obligations and commitments (including monitoring) regarding delivery of environmental water to their private dam	Private landholder and North Central CMA

The land parcel that includes Davis Wetland is protected by a Trust for Nature Conservation Covenant under the *Victorian Conservation Trust Act 1972* (Hutchinson, 2010).

Environmental water management

There are several agencies directly involved in environmental water management in Victoria. Other agencies, such as public land managers, play an important indirect role in facilitating the delivery of environmental watering outcomes. Table 3 describes the key stakeholders that are involved in the management of WMP Wetlands.

Table 3. Roles, responsibilities and interest in the management of the WMP Wetlands

Group	Responsibility / Interest
Responsible for environmental water management	
Commonwealth Environmental Water Holder (CEWH)	- Make decisions about the use of Commonwealth water holdings, including providing water to the VEWH for use in Victoria - Liaise with the VEWH to ensure coordinated use of environmental water in Victoria - Report on management of Commonwealth water holdings.
Department of Environment, Land, Water and Planning (DELWP)	- Manage the water allocation and entitlements framework - Develop state policy on water resource management and waterway management for approval by the Minister for Water and Minister for Environment and Climate Change - Develop state policy for the management of environmental water in regulated and unregulated systems - Act on behalf of the Minister for Environment and Climate Change to provide oversight of the VEWH and waterway managers (in their role as environmental water managers) - Legislative responsibilities for the management of flora and fauna - Provides approval of EWMPs and endorsement of SWP.
Grampians Wimmera Mallee Water (GWMWater)	- Water Corporation – Storage Manager and Resource Manager - Work with the VEWH and waterway managers in planning the delivery of environmental water to maximise environmental outcomes - Operate water supply infrastructure such as dams and irrigation distribution systems to deliver environmental water - Ensure the provision of passing flows and compliance with management of diversion limits in unregulated and groundwater systems - Provide endorsement of SWP and facilitate on-ground delivery.

Group	Responsibility / Interest
Murray-Darling Basin Authority (MDBA)	- Enforcement of the Murray-Darling Basin Plan - the Basin Plan sets legal limits on the amount of surface water and groundwater that can be taken from the Basin from 1 July 2019 onward - Integration of Basin wide water resource management.
North Central CMA	- Waterway Manager - Identify regional priorities for environmental water management in regional Waterway Strategies - In consultation with the community assess water regime requirements of priority rivers and wetlands to identify environmental watering needs to meet agreed objectives identify opportunities for, and implement, environmental works to use environmental water more efficiently - Propose annual environmental watering actions to the VEWH and implement the VEWH environmental watering decisions - Provide critical input to management of other types of environmental water (passing flows management, above cap water) report on environmental water management activities undertaken.
Parks Victoria	- Land Manager of Chirrup Swamp, Creswick Swamp and Jeffcott Wetland - Implement the relevant components of EWMPs - Operate, maintain and replace, as agreed, the infrastructure required for delivery of environmental water, where the infrastructure is not part of the GMW irrigation delivery system - Where agreed, participate in the periodic review of relevant EWMPs and provide endorsement of SWP.
Private landholders	- Land managers of privately owned sites - Responsible for adhering to the conditions detailed in the Deed of Agreement and Management Agreement for delivery of water to private land - Participated in the development of this EWMP and the SWP.
Victorian Environmental Water Holder (VEWH)	- Make decisions about the most effective use of the Water Holdings, including use, trade and carryover - Authorise waterway managers to implement watering decisions - Liaise with other water holders to ensure coordinated use of all sources of environmental water - Publicly communicate environmental watering decisions and outcomes. - Author of the statewide Seasonal Watering Plan - Provides final endorsement of SWP - Approve delivery of environmental water (Seasonal Watering Statement) - Fund environmental water related monitoring.
Input, advice and interest in environmental water management	
Barengi Gadjin Land Council	- Represents the Wergaia and Jardwadjali family groups which are the traditional owner groups for the area that includes Corack Lake, Chirrup Swamp, Davis Wetland, Falla Dam and Jeffcott Wetland - Participated in the development of this EWMP.
Dja Dja Wurrung traditional owners	- Traditional owners of the area encompassing Creswick Swamp and Jesse Swamp
Field and Game Australia	- A voluntary organisation formed by hunters to promote responsible firearm ownership and ethic hunting - Participated in the development of this EWMP.
Local community	- Recreational users of the Wimmera Mallee Pipeline wetlands, including passive recreational pursuits such as walking, bird watching, camping and yabbying - Participated in the development of this EWMP.
Northern Grampians Shire Council	- Local council for area that includes Creswick Swamp and Jesse Swamp - Responsible for regulation of local development through planning schemes and on-ground works.
Shire of Buloke	- Local council for area that includes Jeffcott Wetland, Corack Lake, Chirrup Swamp, Davis Wetland and Falla Dam - Responsible for regulation of local development through planning schemes and on-ground works.

2.5 Wetland Characteristics

The WMP Wetlands sites range in size from less than 1 hectare to 70 hectares and are connected to the WMP via a farm dam. Each site can be broadly grouped into one of two categories (natural or artificial) and three sub-categories based on its historical water supply:

Natural wetland sites:

- Floodplain wetlands: Creswick Swamp is located on the floodplain of the Avon and Richardson Rivers;
- Lake Buloke wetlands: Corack Lake, Jeffcott Wetland and Cherrip Swamp are located within the ancient lunette/ inter-dune system of Lake Buloke;
- Catchment wetlands: Jesse Swamp and Davis Wetland historically received runoff from their local catchments.

Artificial wetland sites:

- Artificial dams: Falla Dam is a constructed water-storage in a terrestrial landscape.

The sites that are considered natural wetlands are currently classified in Victoria using a system developed by Corrick and Norman (1980) that reflects water depth, permanency and salinity (Corrick & Norman, 1980 in DSE, 2007). These wetlands and others in Victoria were mapped and classified between 1975 and 1994 and developed into spatial geographic information system (GIS) layers. These layers aim to represent the wetland characteristics at the time of mapping (referred to as Wetlands 1994 layer), as well as a categorisation of the wetland characteristics prior to European settlement (referred to as Wetlands 1788 layer) (DSE, 2007).

The Wetlands 1975 and 1994 layers are currently the best available datasets for wetland classification within the North Central CMA region. There are however, some issues with the mapping, including the location of some wetlands, their size and their classification. With the exception of Creswick Swamp, on-ground assessment undertaken as part of this EWMP identified that not all 1994 wetland classifications were representative of the true vegetation composition, water holding capacity and depth of the sites (D. Cook [Rakali Ecological Consulting] pers. comm., 25 July 2014). This EWMP therefore refers to the current wetland classification when discussing sites characteristics. The characteristics of each site, including wetland classification, land status, management and water supply as well as wetland and dam volume and capacity are presented in Table 4.

Table 4. Summary of the characteristics of the sites in the WMP Wetlands

Characteristics		Site description						
Name		Chirrup Swamp	Corack Lake	Creswick Swamp	Davis Wetland	Falla Dam	Jeffcott Wetland	Jesse Swamp
Mapping ID		7525 911925	7525 843956	7525 700445	7425 750027	7425 705812	7525 879821	7524 879489
Wetland area		69 hectares	8 hectares	21 hectares	20 hectares	N/A	25 hectares	10 hectares
Dam area		1,070 m^2	1,500 m^2	830 m^2	740 m^2	3,950 m^2	1,700 m^2	450 m^2
Bioregion		Wimmera	Wimmera	Wimmera	Wimmera	Wimmera	Wimmera	Wimmera
Conservation Status		N/A	N/A	DIWA listed	N/A	N/A	N/A	N/A
Land Status		Wildlife Reserve	Recreation Reserve	Wildlife Reserve	Private land	Private land	Wildlife Reserve	Private land
Land Manager		Parks Victoria	DELWP	Parks Victoria	Private	Private	Parks Victoria	Private
Surrounding land use		Dryland cropping and grazing	Dryland cropping	Dryland cropping and grazing	Dryland cropping	Dryland cropping	Dryland cropping and grazing	Dryland cropping
Natural water supply		Catchment runoff from lunettes	Catchment runoff from lunettes	Flooding from Avon/Richardson Rivers	Artificial dam	Artificial dam	Catchment runoff from lunettes	Catchment runoff from the south
Current water supply		Piped via supply system 4/ 12E002758	Piped via supply system 4/ 13D000007	Piped via supply system 4/ 13D000005	Piped via supply system 3/ 08C007462	Piped via supply system 3/ 12B195908	Piped via supply system 4/ 12E002758	Piped via supply system 4/ 13C003269
Wetland category	1788	Shallow freshwater marsh	Shallow freshwater marsh	Shallow freshwater marsh	Not mapped	N/A	Freshwater meadow	Shallow freshwater marsh
	1994	Deep freshwater marsh	Shallow freshwater marsh	Freshwater meadow	Not mapped	N/A	Freshwater meadow	Permanent open freshwater
	Current[1]	Shallow freshwater marsh	Deep freshwater marsh	Freshwater meadow	Shallow freshwater marsh	N/A	Deep freshwater marsh	Shallow freshwater marsh
Volume	Historic wetland[2]	unknown	80 ML	30 ML	21 ML	N/A	250 ML	59 ML
	Current wetland[3]	5.7 ML	88 ML	37 ML	21 ML	N/A	259 ML	60 ML
	Dam[4]	1.2 ML	0.3 ML	2 ML	0.2 ML	5 ML	6 ML	0.4 ML
Mean depth at Capacity	Historic wetland[2]	0.6 metres	2.6 metres	0.6 metres	0.6 metres	N/A	1.4 metres	1.2 metres
	Current wetland[3]	3 metres	4.4 metres	4.2 metres	0.6 metres	N/A	4.8 metres	1.6 metres
	Dam[4]	2.6 metres	0.6 metres	1.8 metres	1 metre	<4 metres	3 metres	0.4 metres

[1]Likely wetland category based on wetland characteristics (i.e. depth, water holding capacity etc.) and expert advice from Rakali Ecological Consulting (2014)
[2]Likely volume prior to construction of dam
[3]Wetland depth and volumes are based on the maximum depth/volume required to inundate both the wetland area and any dams located within the wetland
[4]Figures are based on a combination of LiDAR analysis, previous volumes delivered and estimates from Howard et al., (2014), Rakali Ecological Consulting (2014) and local landholders. LiDAR volumes and depths may be inaccurate due to the presence of water within the wetland/dam at time of survey. Information is presented as an estimate only.

2.6 Environmental Water Sources

The primary source of environmental water for use in the WMP Wetlands is the *Wimmera and Glenelg Rivers Environmental Entitlement 2010* for wetlands. This entitlement was set up specifically to support priority sites disconnected from the water supply through the construction of the WMP. The entitlement, which is held by the VEWH, is shared across priority sites in the Wimmera, Mallee and North Central CMA regions. Management is fully flexible although delivery is significantly constrained by the capacity of the pipeline and the demand of other users (see Section **Error! Reference source not found.** for more information). The water is stored in the WMP headwork system (predominately Lake Bellfield) and allocations are subject to water storage levels and spillable water rules.

There is also the potential to use water from the *Bulk Entitlement (Wimmera and Glenelg Rivers- GWMWater) Order 2010*, which is held by the CEWH. However, use of this water is not clearly defined in the Bulk Entitlement and as a result, year-to-year supply is not guaranteed. There are also opportunities for private donations to assist with purchasing temporary water allocations for use in the system. Table 5 details the water entitlements and their responsible agencies. It is important to note that water availability varies from season to season, according to climatic conditions, volumes held in storage and carryover entitlements.

Table 5. Environmental water that may be available for use for the WMP Wetlands

Water Entitlement	Volume (ML)	Responsible Agency
Wimmera and Glenelg Rivers Environmental Entitlement 2010 for wetlands	1,000 ML	VEWH
Bulk Entitlement (Wimmera and Glenelg Rivers- GWMWater) Order 2010[1]	28,000 ML	CEWH
Temporary water allocation donations	N/A	VEWH
[1]The CEWH holds a volume of 28,000 ML as part of the Bulk Entitlement (Wimmera and Glenelg Rivers- GWMWater) Order 2010, however the use of this water is not clearly defined.		

2.7 Related Arrangements, Policy, Plans and Activities

There are a number of policies, strategies, plans and activities that direct management of wetlands within Victoria. Those that may have particular relevance to the WMP Wetlands and the management of the environmental and cultural values of the sites are listed below. The function and major elements of each is presented in Appendix 1: Legislative Framework.

- State legislation (such as the *Water Act 1989, Catchment and Land Protection (CaLP) Act 1994, Flora and Fauna Guarantee (FFG) Act 1988, Aboriginal Heritage Act 2006, Traditional Owner Settlement Act 2010, Conservation, Forests and Lands Act 1987* and *Crown Land (Reserves) Act 1978*
- National legislation (such as *the Water Act 2007 and Water Amendment Act 2008 (Cth), the Environment Protection and Biodiversity Conservation (EPBC) Act 1999* and the *Native Title Act 1993 and Murray-Darling Basin Plan*)

Strategies, programs and projects relevant to the WMP Wetlands EWMP include:

- Victorian Waterway Management Strategy 2013 (VWMS) – this strategy outlines the direction for the Victorian Government's investment over an eight year period (beginning in 2012-13). The overarching management objective is to maintain or improve the environmental condition of waterways to support environmental, social, cultural and economic values (DELWP, 2013a).
- 2014-2022 NCWS – this regional strategy is an action out of the VWMS and provides the framework for managing rivers and wetlands with the community over the next eight years. It delivers key elements of the VWMS including developing work programs to maintain or improve the environmental condition of waterways in the North Central region.

3 WMP Wetlands

3.1 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 affect the type of flora and fauna that the wetland supports (DSE, 2007). A wetland's hydrology is determined by surface and groundwater inflows and outflows in addition to precipitation and evapotranspiration (Mitsch and Gosselink, 1993). Duration, frequency and seasonality (timing) are the main components of the hydrological regime for wetlands and rivers.

3.1.1 Natural hydrology

The Avon and Richardson rivers are ephemeral rivers originating in the uplands and flowing north towards Lake Buloke (McGuckin et al., 1991 in SKM, 2005). Historically both rivers would have experienced prolonged periods of low or no flow, most commonly during the months of December to May. During autumn and spring, catchment precipitation and the occasional over bank flooding event in the Wimmera River to the south would have provided sporadic inflows, most commonly in early spring (SKM, 2006).

At the downstream end of the Avon and Richardson rivers, flood flows and catchment runoff would enter the ancient Lake Buloke and its associated wetlands. These wetlands (which include Corack Lake, Chirrup Swamp and Jeffcott Wetland) formed through the contraction and expansion of the larger lake system, eventually becoming isolated from the larger lake when its extent retreated (SKM, 2006). The high variability in rainfall across the entire catchment meant that many of the wetlands filled sporadically in winter and spring but also occasionally following large summer storms (Rakali Ecological Consulting, 2014). Table 4 details the pre-regulation water supply and pre-European wetland categories of the sites within the WMP Wetlands.

3.1.2 Historic hydrology- channel system

Since earlier settler times, the farmers of the Avon-Richardson catchment have relied heavily on the semi-permanent and permanent water supply of the catchments rivers, wetlands and lakes. After devastating drought between 1877 and 1882, a government enquiry was held into water supply regulation in north-west Victoria. The enquiry resulted in the establishment of a series of waterworks trusts to develop schemes for domestic, town and stock water supplies. From 1880s onwards river regulation, water channels, bores and dams were established. This coincided with the construction of a network of roads, railways, levees and banks which contributed not only to the substantially growth of the agricultural industry but also to a dramatic change in the natural hydrology of rivers and wetlands in the region. Supplies, water, materials and people were able to be moved with greater efficiency and speed and areas formerly considered too remote for development were quickly cleared (White et al., 2003).

During this time many wetlands in the region, including a number of the WMP Wetlands, were utilised as water storages for stock and domestic supply. Catchment dams and drainage lines were excavated in and around wetlands in an effort to capture natural runoff and improve storage efficiency. In time many dams and wetlands were connected to the irrigation channel network which continued to expand across the region thus improving the efficiency and reliability of water in the region.

However periods of prolonged drought as well as erosion, rising groundwater, pests and poor soil fertility saw a decline in agricultural activity such as wool production, with many farmers forced to leave their land. Through time the dominant farming enterprise shifted to cropping (i.e. wheat, oats, legumes and barley). More recently farm productivity has improved through practices such as laser grading, gypsum and chemical application. Now the region's remnant vegetation is represented on roadsides, a handful of reserves and the occasional paddock (White et al., 2003).

3.1.3 Current hydrology- Pipeline system

The water supply network in the Wimmera and Mallee regions was upgraded to be more efficient due to drought conditions between 1997 and 2009 (McMahon et al., 2003). The WMP, which was constructed over a four year period and finalised in April 2010, saw the almost total decommissioning of the former open supply channel. This disconnected approximately 22,000 dams and wetlands across 2.4 million hectares. An investigation commissioned by the Birchip Landcare Group and funded through the Australian Government Envirofund grant, found that there was

the potential for significant environmental impacts from the reduction of open water in the landscape. This study supported the development of the 1,000 *ML Wimmera and Glenelg Rivers Entitlement 2010* for wetlands, which was aimed at supporting the region's water dependent (i.e. waterbirds, turtles and frogs) and terrestrial (i.e. mammals and reptiles) biodiversity (Butcher et al., 2007; Draper et al., 2006).

In 2010-11, widespread flooding through the region resulted in the inundation of much of the catchment and its wetlands (North Central CMA, 2012). Many of the WMP sites remained inundated through 2011-12 and into 2012-13, with some dams still retaining water at the time of writing this EWMP.

After the initial construction phase a nomination process was undertaken across Wimmera, Mallee and North Central regions to determine priority sites for connection to the WMP. This process, which occurred between 2011 and 2013, resulted in a total of fifty-two sites being connected to the WMP and able to share in the environmental entitlement. Seven of these sites were located within the North Central CMA region. The prioritisation process undertaken is detailed in *Wimmera Mallee Wetland System Context Report* (Sunraysia Ecological, 2014).

Serving over 36 towns, 2,500 rural and 35,000 urban customers, the WMP is extensive (Rigby, 2009). However its capacity is variable with factors such as proximity to the headworks system, distance to towns and customer demand impacting significantly on the delivery rate. For this reason, watering is limited to either a dam or a small wetland area, with total wetland filling unachievable (see Section 12.1.1 for more detail).

3.2 Complex Environmental Values

3.2.1 Listings

The sites of the WMP are an important component of the Avon-Richardson Catchment, supporting a diversity of vegetation types that vary greatly across the landscape. Each site and its unique vegetation assemblage supports a range of water dependent fauna species including frogs, turtles and waterbirds. Due to the limited habitat and availability of open water in the landscape, the sites are also particularly important for providing shelter, water and food for terrestrial fauna species. For this reason, the following sections collectively refer to both the water dependent and terrestrial fauna and flora values of the entire WMP Wetlands.

Legislation relevant to the management of these species within the WMP Wetlands falls within one national listing (EPBC Act 1999) and two state listings (FFG Act 1988 and Victorian Advisory List) as shown in Table 6. A full species list is presented in Appendix 3: Fauna Species List and Appendix 5: Flora Species List.

Table 6. Legislation, agreements, convention and listings relevant to the sites or species recorded in WMP Wetlands

Legislation, Agreement or Convention	Jurisdiction	Listed
Ramsar Convention on Wetlands	International	×
Japan Australia Migratory Birds Agreement (JAMBA)	International	×
China Australia Migratory Birds Agreement (CAMBA)	International	×
Korea Australia Migratory Birds Agreement (ROKAMBA)	International	×
Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)	International	×
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	National	✓[1]
Flora and Fauna Guarantee Act 1988 (FFG Act)	State	✓
Department of Environment, Land, Water and Planning (DELWP) advisory lists	State	✓
[1]EPBC listing is for a terrestrial species		

3.2.2 Fauna

The individual sites of the WMP Wetlands are known to support a range of waterbirds, frogs, turtles, macroinvertebrates, mammals, reptiles and woodland/ grassland birds, some of which are listed as significant under regional, state and/or federal legislation (see Sections 4 to 10 for detail). However in general, these sites are relatively small in size and as a result have limited habitat diversity and extent. In recognition of the highly modified nature of the landscape and lack of open water and remnant vegetation, the significance of each site is amplified when they are considered collectively. The sites provide vital aquatic and fringing terrestrial habitat for the region's biodiversity (i.e. waterbirds, terrestrial birds, mammals, reptiles, frogs and turtles) and offer refuge, feeding grounds as well as

watering points. They also serve as stepping stones for migration between the Wimmera, Avon, Richardson, Avoca and Murray Rivers. The significance of the complex from an ecological perspective is explored in Section 3.4.3.

3.2.3 Flora and Vegetation Communities

The WMP Wetlands is located in the Wimmera bioregion which is characterised by flat to gently undulating plains in the east and ancient stranded beach ridges interspersed with clay plains to the west. Water dependent vegetation is typified by Black Box Wetland (EVC 369), Red Gum Wetland (EVC 292), Lignum Swampy Woodland (EVC 823), Lignum Shrubland (EVC 808) and Lake Bed Herbland (EVC 107). These areas are surrounded by Plains Woodland (EVC 803) Plains Grassy Woodland (EVC 125), Plains Grassland (EVC 132) and Grassy Woodland (EVC 175) with the less fertile plains to the west dominated by Heathy Woodland (EVC 048) and Shallow Sands Woodland (EVC 882) (DELWP, 2014g; Rakali Ecological Consulting, 2014). These vegetation communities provide important resources for a suite of terrestrial and water dependent fauna, which rely on the habitat for shelter, feeding, breeding, nesting and resting.

Large proportions of the Avon-Richardson Catchment have been cleared for agricultural development and as a result the extent of remaining habitat is limited (see Section 3.1). Desktop analysis shows that the WMP Wetlands represents some of the only reliable remaining aquatic habitat, and in itself, supports at least eight water dependent and two terrestrial EVCs. These EVCs support at least 251 native flora species, with approximately thirty percent of these being water dependent. Twelve of the recorded water dependent species are listed as significant on the DELWP Advisory List, with one Marbled Marshwort (*Nymphoides spinulosperma*) also FFG listed.

3.2.4 Wetland Depletion and Rarity

Five of the seven sites are currently[1] classified as deep freshwater marsh or shallow freshwater marsh. Both these wetland classification are considered to be some of the most depleted wetland types in Victoria with approximately 70 and 57 percent loss respectively, since European settlement (DNRE, 1997b).

In the Wimmera bioregion shallow freshwater marsh has decreased by 46 percent, however deep freshwater marsh has increased by 66 percent (DELWP 2014a; DELWP, 2014b). It is likely that this wetland classification is over-represented in the DELWP-1994 mapping due to the large number of constructed farm-dams in the catchment.

Creswick Swamp is classified as freshwater meadow, which is considered a depleted wetland type in the North Central region with a loss of 48 percent since European settlement. In the Wimmera bioregion this wetland classification has decreased by four percent (DELWP 2014a; DELWP, 2014b).

Falla Dam, which is a constructed feature, does not have a wetland classification.

Table 7 shows the current distribution of shallow freshwater marsh, deep freshwater marsh and freshwater meadow in proportion to the regional total that the WMP Wetlands contributes to across the landscape.

Table 7. Current area by Corrick classification

Classification	WMP Wetlands		Representativeness in Avon Richardson Catchment			Decrease in wetland area from 1788 to 1994		
	No. of sites	Total area (ha)	No. of sites	Total area (ha)	% represented by WMP	% in Victoria	% in North Central	% in Wimmera Bioregion
Shallow Freshwater Marsh	2	79	59	709	11	57	60	46
Freshwater Meadow	1	25	126	1,405	1.8	34	48	4
Deep Freshwater Marsh	2	29	10	117	24.8	70	54	-66

The importance of the complex from a regional perspective is further emphasised when the number of potential alternative aquatic habitats (i.e. wetlands, rivers, dams etc. that are visible from a scale 1:10,000) within five kilometers[2] of each of the WMP Wetlands sites are analysed. A desktop assessment of aerial photos found that

[1] Current classification refers to classification determined by D. Cook (Rakali Ecological Consulting) pers comm., 25 July 2014.

[2] Five kilometres was identified as the maximum distance turtles will undertake when preforming overland migration. (Howard et al., 2014). Actual distance moved will however be dependent on sufficient terrestrial habitat cooridorrs and presence/ absence of water in the landscape.

between 27 and 72 waterbodies exist within five kilometers of each target site, with the average nearest waterbody being 320 metres away. The number of potential alternative waterbodies is greatest in the south and south-east of the catchment (i.e. Jesse and Creswick Swamp), decreasing with distance towards the township of Birchip in the east (i.e. Davis Wetland). Although this provides some perspective on the importance of particular sites in different areas of the landscape (i.e. Davis Wetland located in the driest area of the catchment), it is unclear as to how many of these alternative sites have been decommissioned through the WMP Project. The frequency and duration of inflows to those that still exist is also unknown. However it is probable that in very wet years a range of waterbodies may be presence in the landscape, however in dry years the sites of the WMP Wetlands are likely to represent the only open water available. Table 8 summarises the findings of the desktop assessment and ranks each site from 1 to 7 based on the proximity and number of surrounding waterbodies in the landscape. These categories are further collated to create a combined ranking score, with the aim of identifying the likelihood of close alternative sites in the landscape (i.e. 1= potentially a high number of surrounding sites within close proximity vs. 5= isolated with a lack of surrounding or nearby sites).

Table 8. Potential aquatic habitats within five kilometres of each WMP Wetlands site

Dam location	Sites within 5 kilometers		Nearest site		Combined ranking
	Number of sites	Rank (largest to smallest)	Distance (metres)	Rank (closest to further)	
Chirrup Swamp	54	3	<60	2	1
Corack Lake	42	5	<50	1	2
Creswick Swamp	72	1	170	4	1
Davis Wetland	27	7	865	7	5
Falla Dam	32	6	510	5	4
Jeffcott Wetland	50	4	515	6	3
Jesse Swamp	56	2	75	3	1
Average	**48**	-	**320**	-	-

3.2.5 Ecosystem Functions

Ecosystem functions are activities or actions that occur naturally in wetlands as a product of the interactions between the ecosystem structure and processes. This include flood water control, nutrient, sediment and contaminant retention, food web support, shoreline stabilisation and erosion controls, storm protection and stabilisation of local climatic conditions, particularly rainfall and temperature. Functions also relate to the structural components of an ecosystem (i.e. vegetation, water, soil, atmosphere and biota) and how they interact with each other, within ecosystems (i.e. site specific) and across ecosystems (i.e. landscape). This includes processes that are essential for maintaining life such as storage, transport and nutrient cycling as well as the provision of resources that support biodiversity such as habitat, food and shelter. The individual sites of the WMP Wetlands support a range of species including threatened flora, fauna and vegetation communities, however the sites are generally small in size and in most cases, highly modified. However, in light of the low availability of water and habitat in the landscape particularly during dry years, the sites collectively provide important ecosystem functions for the Avon-Richardson Catchment. Table 9 broadly shows the ecosystem functions provided by the individual sites and the collective WMP Wetlands.

Table 9. Ecosystem processes, functions and services of WMP Wetlands from a local and regional scale

Local (site specific)
• **Convert matter to energy for uptake by biota (i.e. feeding habitat)**- this includes substrate surfaces (i.e. rocks, woody debris, gravel) for biofilms and plant matter and interactions between primary producers and consumers such as the breakdown of carbon and nutrients by zooplankton and macroinvertebrates for higher order consumers. In addition aquatic habitats host a range of invertebrates including adult flying insects that provide prey for aquatic and terrestrial vertebrates such as waterbirds, bats, reptiles and terrestrial birds. • **Provide shelter for biota**- this includes amelioration of extremes in temperature, sunlight exposure and wind as well as protection from predators. The interrelationship of tree, shrub, forb and grass species with compatible geology, soil type, slope aspect, elevation, moisture availability and temperature range characteristics are the main ecosystem components supporting this function. • **Provision of water for consumption**- retention and storage of water for use by biota to enhance growth and development and

to ensure survival and reproduction. The provision of watering points in a dry landscape is a key value of the system.

- **Reproduction**- recruitment of new individuals requires sufficient shelter from predators, food for growth, resources for nest building and cues for breeding (i.e. water level changes, temperature, rainfall etc.). Adequate resources to support newly fledged individuals are also required, including shelter, food and provision of water for consumption. Plants also require specific germination and growth conditions (including flood cues, follow up flooding, drying etc.) to ensure successful recruitment.

Note: The above ecosystem services are particularly important for species with low mobility (i.e. frogs and turtles).

Regional (complex)

- **Movement/ dispersal**- movement of individuals is linked to food web functions (detailed above) and is a requirement for the life cycle of some species (i.e. migration). It is also assists with maintaining genetic diversity within the landscape and reduces the risk of local species extinction. The movement of mobile species through the landscape further supports the dispersal of seeds/progapules in the landscape providing a source for colonisation.
- **Biological diversity**- the provision of a sufficient number and range of habitat types in the landscape supports a diversity of native species. This in turn assists to safe guard the region from the impacts of local catastrophic events (i.e. loss of habitat through fire and clearing) due to there being sufficient alternative habitats available. This supports the maintenance of genetic and species diversity in the region.

3.3 Social and Economic Values

3.3.1 Cultural Heritage

The traditional owner groups of the area encompassing the WMP Wetlands includes Barenji Gadjin, which represents traditional owners from the Jardwadjali (Richardson River basin) and Wergaia (North of Lake Buloke) family groups, and the Dja Dja Wurrung (Avon River Basin) Language Groups (VACL, 2014; White et al., 2003) (see Appendix 7: Distribution of Traditional Owner Groups). These groups were historically made up of separate, but linguistically, socially and culturally related clans including the Larninjundidj clan which occupied land on the Richardson River between Donald and Marnoo (Clarke, 1990 cited in GWMWater, 2010). Wetlands and rivers in the Avon Richardson Catchment would have provided an array of food sources such as fish, birds, mammals, reptiles and plants (Taylor, 1996 cited in White et al., 2003).

In the WMP Wetlands all of the natural wetland sites are registered with Aboriginal Affairs Victoria (AAV) as sites of cultural sensitivity. Records of cultural heritage include but are not limited to artefacts (i.e. quartz fragments at a number of sites) and scar trees (see Plate 1). During the Barenji Gadjin Land Council site visit in May 2015, canoe and shelter slab scars were most commonly observed with evidence of both steel (likely to be traded into the area around the 1830s) and stone axe use (likely prior to the 1830s) (see Appendix 6: Engagement Outcomes).

Plate 1. Scar trees in the WMP Wetlands

3.3.2 Recreation

The sites of the WMP Wetlands are used broadly for passive recreational pursuits such as wildlife observation (i.e. bird watching) camping and yabbying. Hunting (primarily duck and quail) is also permitted at Creswick Swamp, Jeffcott Wetland and Chirrup Swamp which are designated as Wildlife Reserves (in season as specified by the land managers) under the *Crown Land (Reserves) Act 1978* (LCC, 1986). Hunting is further undertaken for control of pest animals (i.e. fox, rabbit and hare) on private property within the WMP Wetlands area (see Appendix 6: Engagement Outcomes for detail).

As per its status as a Recreational Reserve under the *Crown Land (Reserves) Act 1978,* Corack Lake is managed for informal recreation such as swimming, camping and picnicking (LCC, 1986). The local community also noted that some of the sites have been historically used for water-skiing and fishing, particularly during very wet years. Chirrup Swamp has also been noted by the community as a popular summer camping spot whilst Creswick Swamp is considered important for tourism due to its association with the first settlers of the region including its close proximity to the Creswick cemetery and the presence of the Creswick Well historical marker (see Plate 2) (see Appendix 6: Engagement Outcomes for detail).

Plate 2. Creswick cemetery and Creswick Well historical marker

3.3.3 Economic Values

The economic value of a particular site or complex to the regional economy can be quite difficult to measure. For the purpose of this EWMP, a general discussion of the economic benefit of wetlands is provided, based on ACF (2010).

There are direct and indirect uses of wetlands which generate economic benefit on a local, regional and wider scale. Direct uses of the WMP Wetlands include the income generated from recreational pursuits and tourism, while indirect 'uses' include ecosystem services such as groundwater recharge and flood mitigation (ACF, 2010).

The economic benefit to the region from the WMP Project should also be recognised, increasing water supply security from 78 to 96 percent, improving water quality, generating jobs, increasing farm efficiency, improving water supply to recreational lakes and attracting new agribusiness to the region (including diversification of agriculture through grain, oilseed processing and new primary production) (Rigby, 2009).

3.4 Ecological Condition

3.4.1 Current Condition

Rakali Ecological Consulting undertook IWC assessments of the natural wetland sites in the WMP Wetlands in 2014. The IWC defines condition as a state of the biological, physical and chemical component of the wetland ecosystem and their interactions. The method undertaken involves measuring five sub-indices based on the catchment of the site and its fundamental characteristics of physical form, hydrology, water properties, soil and biota (DSE, 2009a; DSE, 2007). Falla Dam and Davis Wetland were not assessed as both were originally determined to be terrestrial sites. Davis Wetland was later confirmed to contain a small wetland area (see Section 1 for more information) however, reassessment was not undertaken.

The condition of the dams within the WMP Wetlands was also assessed based on the presence of aquatic vegetation, fringing vegetation cover, morphology (i.e. steepness of banks), and fauna diversity (i.e. frogs, turtles, macroinvertebrate etc.). Information used to inform each rating was based on Howard *et al.*, (2014), Rakali Ecological Consulting (2014) and through D. Cook (Rakali Ecological Consulting pers. comm., 21 August 2014). The IWC and dam condition assessments results are presented in characterisation of the individual sites in Sections 4 to 10.

3.4.2 Condition Trajectory

The Avon-Richardson Catchment has a long history of land-use change that has affected the hydrology, catchment, biota, soils and physical form of the wetlands and waterways in the catchment. The recent construction of the WMP as a mean of improving water use efficiency for town and agriculture resulted in the widespread removal of the open water supply channel and dam network. The decommissioning of open channels and dams caused a dramatic hydrological change to the region over a relatively short timeframe and saw many of the regions wetlands disconnected from their former water supply. This resulted in a reduction in the total volume of water and the diversity of aquatic habitat types available to biota in the landscape, with WMP Wetlands now effectively representing some of the only remaining reliable water in the region. Flooding in 2010-11 masked many of the immediate effects of the construction of the pipeline, however without intervention (i.e. provision of environmental water), there is potential for future localised biodiversity loss and population crashes. These impacts are likely to be exacerbated by climate change, with the southern end of the Murray Darling Basin projected to experience up to a 40 percent reduction in rainfall by the year 2070 (Whetton et al., 2002 in Duncan et al., 2005).

3.4.2.1 Do Nothing

There are a number of localised and landscape scale changes that could occur or be exacerbated by not delivering environmental water to WMP Wetlands in the future. These include:

- species mortality and local extinctions
- terrestrialisation of sites formerly supporting aquatic vegetation
- Weed and exotic fauna invasion
- Increased pressure on permanent storage systems (i.e. recreational lakes, farm dams etc.) by terrestrial fauna (i.e. kangaroos) causing a decline in vegetation health, erosion and water quality.

At a landscape scale, this may result in:

- the range of some species retracting and others being lost permanently from the region
- Loss of aquatic refuge and watering points in the landscape
- Loss of habitat diversity and wetland types from the landscape
- Loss of recreational and aesthetic values in the region.

The severity and time lag of these impacts will be dependent on climatic conditions, with drought years accelerating change.

3.4.3 Significance

The WMP Wetlands provides a range of ecosystem services including feeding and breeding habitat for waterbirds, frogs and turtles, watering points for terrestrial fauna (including mammals, reptiles and woodland/ grassland birds), drought refuge and areas of remnant vegetation supporting nationally listed flora species (North Central CMA, 2014a). Due to the currently scarcity of water in the landscape and the likely impacts of future climate change, the delivery of environmental water to these sites is considered important for maintain a range of native flora and fauna values in the region. Table 10 summarises the importance of the complex based on whether it meets the criteria for the assessment indicators identified in schedule 8 of the Basin Plan.

Table 10. Wimmera Mallee Pipeline Wetlands assessed against the Murray Darling Basin Plan criteria for identifying an environmental asset

Item	Criteria	Meets criteria	Justification
Criterion 1: The water dependent ecosystem is formally recognised in international agreements or, with environmental watering, is capable of supporting species listed in those agreements			
1	Assessment indicator: A water dependent ecosystem is an environmental asset that requires environmental watering if it is:		
	(a) a declared Ramsar wetland; or		
	(b) with environmental watering, capable of supporting a species listed in or under the JAMBA, CAMBA, ROKAMBA or the Bonn Convention.		
Criterion 2: The water dependent ecosystem is natural or near-natural, rare or unique			
2	Assessment indicator: A water dependent ecosystem is an environmental asset that requires environmental watering if it:		
	(a) represents a natural or near-natural example of a particular type of water dependent ecosystem as evidenced by a relative lack of post-1788 human induced hydrologic disturbance or adverse impacts on ecological character; or		
	(b) represents the only example of a particular type of water dependent ecosystem in the Murray-Darling Basin; or		
	(c) represents a rare example of a particular type of water dependent ecosystem in the Murray-Darling Basin.	✓	A number of rare water dependent ecosystems are present in the WMP Wetlands including the rare Cane Grass field at Cherrip Swamp (see Section 6) and FFG listed Marbled Marshwort at Jesse and Creswick swamps (see 4 and 10, respectively).
Criterion 3: The water dependent ecosystem provides vital habitat			
3	Assessment indicator: A water dependent ecosystem is an environmental asset that requires environmental watering if it:		
	(a) provides vital habitat, including: (i) a refuge for native water dependent biota during dry spells and drought; or	✓	With over 22,000 dams and 17,500 kilometers of open channel being decommissioned in the region through the Wimmera Mallee Pipeline Project (Draper et al., 2006), the WMP Wetlands provides some of the only remaining refuges for water dependent fauna. The impacts of the dramatic loss of open water are not yet quantified however the provision of environmental water to connected sites will ensures that reliable open water remains in the landscape to support some of the regions environmental values.
	(ii) pathways for the dispersal, migration and movements of native water dependent biota; or		
	(iii) important feeding, breeding and nursery sites for native water dependent biota; or	✓	The lack of open water in the landscape limits the opportunity for feeding and breeding in the region. The WMP Wetlands will therefore provide some opportunities for breeding (primarily opportunistic generalist species) and feeding (i.e. dabbling duck, grazing water-fowl).

Item	Criteria	Meets criteria	Justification
	(b) is essential for maintaining, and preventing declines of, native water dependent biota.	✓	The WMP Wetlands will ensure that pockets of aquatic habitat remains in the landscape for the benefit of biodiversity.
Criterion 4: Water dependent ecosystems that support Commonwealth, State or Territory listed threatened species or communities			
4	Assessment indicator: A water dependent ecosystem is an environmental asset that requires environmental watering if it:		
	(a) supports a listed threatened ecological community or listed threatened species; or Note: See the definitions of ***listed threatened ecological community*** and ***listed threatened species*** in section 1.07. (Listed under the EPBC Act 1999)	o	The WMP Wetlands does not support any water dependent EPBC listed species however there are three terrestrial EPBC listed species have been recorded and require watering points in the landscape (refer to Section 3.2).
	(b) supports water dependent ecosystems treated as threatened or endangered (however described) under State or Territory law; or	✓	The WMP Wetlands supports seven water dependent EVCs two of which are considered endangered and three vulnerable in the Wimmera Bioregion. A further two EVCs are not listed for the Wimmera bioregion but are considered endangered/ vulnerable in neighboring bioregions (refer to Section 3.2.3).
	(c) supports one or more native water dependent species treated as threatened or endangered (however described) under State or Territory law.	✓	The WMP Wetland supports two water dependent (as well as three terrestrial) FFG listed species and 16 water dependent DELWP Advisory listed species (as well as 15 terrestrial) (not including those non-indigenous to the area or planted).
Criterion 5: The water dependent ecosystem supports, or with environmental watering is capable of supporting, significant biodiversity			
5	Assessment indicator: A water dependent ecosystem is an environmental asset that requires environmental watering if it supports, or with environmental watering is capable of supporting, significant biological diversity. This includes a water dependent ecosystem that:		
	(a) supports, or with environmental watering is capable of supporting, significant numbers of individuals of native water dependent species; or		
	(b) supports, or with environmental watering is capable of supporting, significant levels of native biodiversity at the genus or family taxonomic level, or at the ecological community level.		

3.5 Management Objectives

3.5.1 Management Goal

The long-term management goal for the entire WMP Wetlands has been developed based on information derived from Rakali Ecological Consulting (2014), Howard *et al.*, (2014) and Sunraysia Environmental (2014). It considers the value of the complex within the Avon-Richardson Catchment, in light of the hydrological changes recently experienced in the region.

Wimmera Mallee Pipeline Wetlands environmental water management goal

Maintain aquatic habitat and refugia through the landscape to provide refuge, shelter, watering points and feeding opportunities for waterbird, turtles, frogs and terrestrial fauna species in the region.

3.5.2 Ecological Objectives

Table 11 describes the ecological objectives and justification for the management goal presented in Section 3.5.1.

Table 11. Ecological objectives for the WMP Wetlands

Ecological objective	Justification
Re-establish **aquatic habitat and refugia through the landscape**	- Provide refuge and shelter for water dependent fauna (i.e. frogs, turtles and waterbirds)
2. Provide **watering points** for terrestrial species	- Provide fresh drinking water for water dependent and terrestrial fauna to ensure persistence of a range of species in the dry landscape.

3.5.3 Hydrological Objectives

As the management goal considers the complex as a whole, hydrological objectives are set at the site specific scale as detailed in Sections 4 to 8 These objectives are based on information provided in Appendix 8: Water Requirements for Values and Appendix 9: Hydrological Objectives.

3.5.4 Watering Regime

Water regimes are set at the site-specific scale with the overarching objective of supporting the complex management goal detailed in Section 3.5.1. Individual site watering regimes are presented in Sections 4 to 8. A summary of all optimum watering regimes over the next ten years are shown in Appendix 12: Long term recommended watering regime.

Although there is not a specific watering regime for the entire WMP Wetlands, strategic management of the individual sites is required, particularly during dry years. Under such a scenario, sites would be prioritised based on the following components:

1. Proximity to other waterbodies: Low priority would be given to sites close to inundated dams or recreational waterbodies. Depending on the volume of water available, environmental water management would aim to ensure a distribution of water throughout the landscape
2. Presence of significant water dependent species reliant on the dam: Priority would be given to a site that directly supported a federally or state listed species
3. Presence of significant population reliant on the dam: Priority would be given to sites that support an abundance of a particular species and may provide a point source for recolonisation of nearby waterbodies
4. Water holding potential: Although habitat diversity is important, sites likely to hold water for extended periods of time would be prioritised above those that would dry quickly.

Prioritisation would be undertaken at the Wimmera Mallee Wetland System scale and would require collaboration between the respective CMAs. As management under this scenario would change depending on catchment conditions, it would be explored as part of the SWP development process.

The following sections detail the site specific hydrology, values, management goals ecological and hydrological objectives and the recommended watering regime for each of the WMP Wetlands sites, as discussed in Section 1.2.

4 Chirrup Swamp

4.1 Catchment Setting

Chirrup Swamp is a 69 hectare natural wetland located on public land between the oldest lunette formations of the ancient Lake Buloke Complex at the north-east boundary of the Avon-Richardson catchment (DNRE, 1997a). The wetland has a maximum depth of approximately 0.6 metres (FSL of 105.4 m AHD) and is characterised as a shallow freshwater marsh (D. Cook pers. comm., [Rakali Ecological Consulting], 21 August 2014).

There is no long term data regarding the frequency, duration and timing of fill events at the site, however based on its wetland classification, it likely that it received runoff from the west and east lunettes on an intermittent to seasonal basis during winter and spring. The topography and associated vegetation in the bed of the wetland further suggests that the bed often remained moist beyond this period (Rakali Ecological Consulting, 2014).

Three dams have been constructed around Chirrup Swamp with one situated at the north-east (Dam No. 2) and two at the south-east boundary (Chirrup Dam and Dam No. 1). Chirrup Dam is connected to the WMP and is the focus for environmental water delivery (Figure 5).

4.2 Land Use

There is no information describing the history of Chirrup Swamp prior to it being leased for grazing purposes under the *Land Act of 1958*. The reserve was fully fenced and used primarily during August and September as shelter for freshly shorn sheep (DNRE, 1997a). It is likely that the three dams constructed around the boundary of the wetland were used primarily as watering points for stock but may have also served domestic purposes for nearby landholders. The majority of the surrounding area is now cleared and is used predominately for broadacre grazing and cropping.

4.3 Hydrology

Chirrup Swamp has gentle slopping banks and a relatively flat bed at 104.8 m AHD. The surrounding dams have steep banks and are deeper than the wetland. Chirrup Dam, which was connected to the WMP in 2012, has a bank gradient rise of 22 cm/metre and is at least two metres deep (bed level of ~102.4 m AHD). The dam is also bordered by two spoil heaps at its north and western boundaries which are approximately 1.5 metres (106.5 m AHD) above the FSL level of the dam (105 m AHD). This changes the hydrology of the wetland fringe, with catchment runoff from the south caught by the dam before it can enter Chirrup Swamp.

When filled above 105.2 m AHD, Chirrup Dam can be overtopped at its north-west edge so that water enters Chirrup Swamp. However due to the small capacity of the dam (approximately 1.2 ML) in comparison to that of the wetland (approximately 662 ML), overflow water is quickly absorbed into the bed with little effect on wetland vegetation. Environmental water management therefore targets the dam only. The bathymetry of Chirrup Swamp and surrounding dams is shown in Appendix 2: Bathymetry and Capacity Tables.

Chirrup Dam was connected to the WMP in 2012 and received its first delivery of environmental water in spring and summer 2013 (see Table 12). At the time the dam was at approximately 50 percent capacity from flood waters received during 2010-11 (North Central CMA, 2014a). The history of the site prior to 2010-11 is unknown.

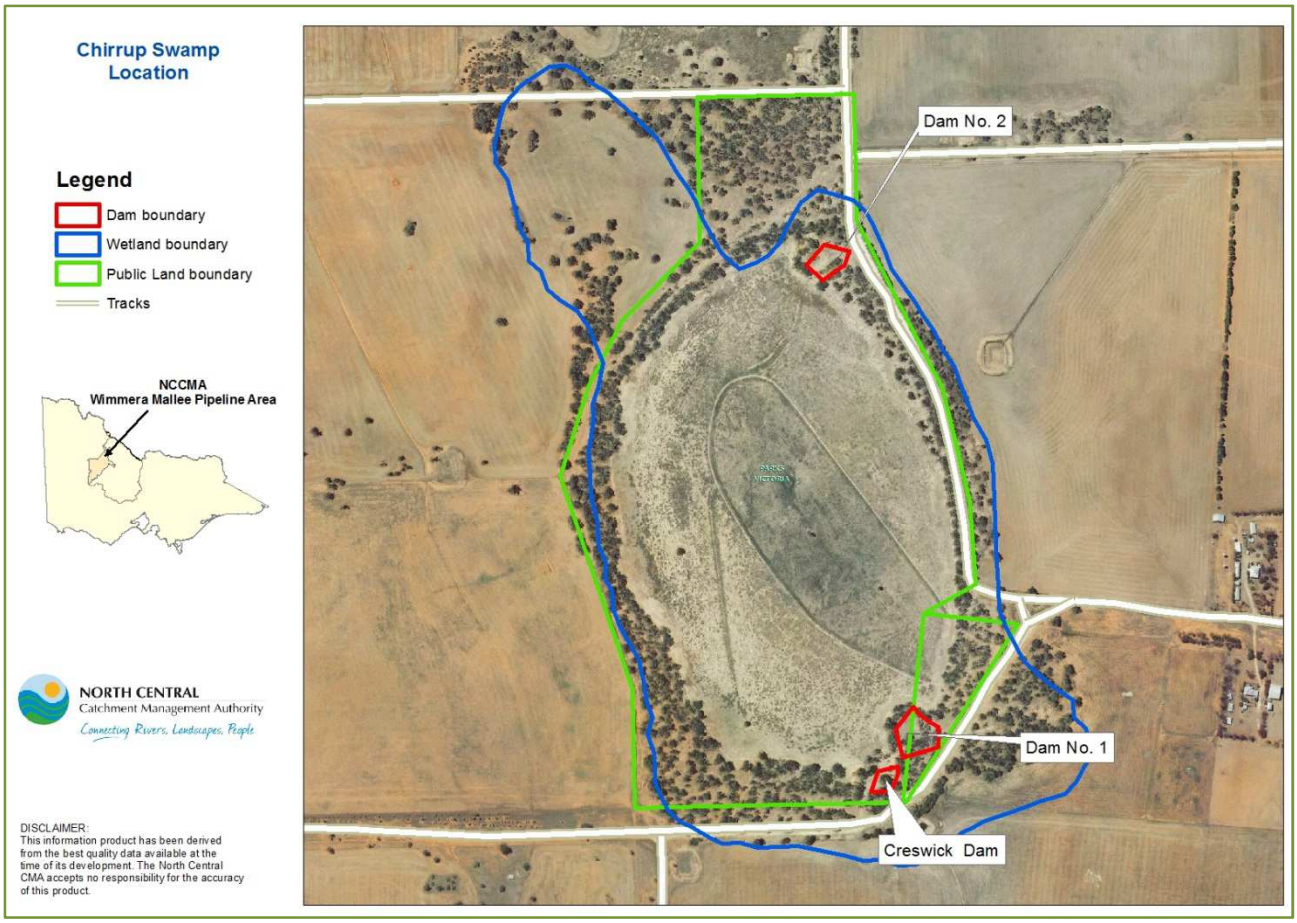


Figure 5. Chirrup Swamp location map

Table 12. Watering history of Chirrup Swamp

Watering History	Season							
	2010-2011[1]		2011-2012[1]		2012 -2013		2013-14	
	Wetland	Dam	Wetland	Dam	Wetland	Dam	Wetland	Dam
Status *	W	W	D	W	D	W	D	W
Water source #	F	F	-	-	-	-	-	E
Volume (ML)	U	U	0	0	0	0	0	2.617
Notes	Flooding in summer 2010-11		Water receded to dam		Dry		Spring fill and summer top-up to dam	

KEY:

Unknown/ Environmental water allocation / Flood inundation

W Water for entire year
D Dry for entire year
D-W Dry at start of year, filled later
W-D Wet at started of year, dried later

[1]Likely status as advised by Parks Victoria, landholders and general topographical understanding of the landscape

4.4 Water Dependent Values

4.4.1 Fauna

In total 20 macroinvertebrates, 17 waterbirds, four frogs and one turtle species has been recorded at Chirrup Swamp and Chirrup Dam (DELWP, 2014e; Rakali Ecological Consulting, 2014; Howard *et al.*, 2014). The majority of waterbird species recorded in the wetland belong to either dabbling duck, fish-eating, grazing water-fowl, shoreline foraging or small wader waterbird feeding guilds (approximately 18 percent each). One of these species, the Australasian Shoveler (*Anas rhynchotis*), is considered significant with a vulnerable status on the DELWP Advisory List. Black Swan (*Cygnus atratus),* which is reported to have nested in the soft cane grass in the bed of the wetland, is the only deep-water foraging waterbird recorded at the site (see in Appendix 6: Engagement Outcomes for detail).

Chirrup Dam supports a number of other waterbirds species including the grazing Australian Wood Duck (*Chenonetta jubata*) and shoreline foraging Black-tailed Native-hen (*Tribonyx ventralis*) as well as fish-eating White-faced Heron (*Egretta novaehollandiae*) and breeding Australasian Grebe (*Tachybaptus novaehollandiae*) (Rakali Ecological Consulting, 2014; Howard et al., 2014) (shown in Plate 3). These omnivorous species, which are often observed feeding from a barbwire fence transecting the dam, are likely attracted to the presence of adult and juvenile Eastern Sign-bearing Froglet (*Crinia parinsignifera*), Spotted Marsh Frog (*Limnodynastes tasmaniensis*) ((shown in Plate 3) and Plains Froglet (*Crinia parinsigniferia*) (shown in Plate 3) in the dam (Rakali Ecological Consulting, 2014; Howard *et al.*. 2014). In comparison to the other WMP Wetlands sites, the dam also supports the highest density of Eastern Long-necked Turtles (*Chelodina longicollis)* (eight recorded in total), which is listed as data deficient on the DELWP Advisory List (Howard et al., 2014).

The depth and subsequent high water holding capacity of Chirrup Dam allows the site to act as a refuge for at least eight water dependent species during times when Chirrup Swamp is dry. However the quality of this habitat is limited, due to the lack of aquatic vegetation within the dam. This is reflected by the low abundance of macroinvertebrates in comparison to other WMP sites, and the absence of scraper/ grazer (i.e. snails) and shredders (i.e. aquatic caterpillars) feeding guilds (Howard et al., 2014). Table 13 shows the significant water dependent fauna recorded at Chirrup Swamp with a full species listed provided in Appendix 3: Fauna Species List.

Australasian Grebe on Chirrup Dam, October 2014

Spotted Marsh Frog (K. Howard [ARI] 2014)

Plate 3. Fauna of Chirrup Swamp

Table 13. Significant water dependent fauna recorded at Chirrup Swamp

Common name	Scientific name	Type	Last record	Inter-national agreement	EPBC status	FFG status	DELWP status
Australasian Shoveler	*Anas rhynchotis*	WB	1995				VU
Eastern Long-necked Turtle	*Chelodina longicollis*	RW	2014	N/A			DD

Legend
Type: Reptile Water dependent, Waterbird
DELWP status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), DELWP (2014e), DSE (2013) and landholder records.

4.4.2 Flora and Vegetation Communities

The majority of the bed of Chirrup Swamp is classified as Lignum Shrubland (EVC 808) and is dominated by a thick bed of Cane Grass (*Eragrostis australasica)* which is listed as vulnerable on the DELWP Advisory List (see Plate 4). In Victoria, this Cane Grass is particularly important as it is confined to a small number of clay plans and shallow wetlands in north-west Victoria. At Chirrup Swamp, this community has previously been mistaken for a relatively common form of Cane Grass (*Eragrostis infecunda*) found in the Avon-Richardson catchment (DNRE, 1997a). The habitat provided by this species is important for waterbird species such as stilts and Black Swans, which utilise the soft Cane Grass vegetation for nesting and foraging (Roberts & Marston, 2011). The Lignum Shrubland EVC is also made up of a mix of exotic (52 percent of species recorded) and native grasses and herbs species including water dependent Common Swamp Wallaby-Grass (*Amphibromus nervosus*), Common Blown-grass (*Lachnagrosits filiformis*), Mousetail

(*Mysosurus australis*), Ferny Small-flower Buttercup (*Ranunculus pumilio*), Starry Goosefoot (*Scleroblitum atriplicinum*) and the DELWP Advisory Listed Early Nancy (*Wurmbea dioica subsp. lacunaria*) (Rakali Ecological Consulting, 2014; DELWP, 2014b).

Plate 4. Cane Grass part of Lignum Shrubland (EVC 808) at Chirrup Swamp in June 2012

As elevation increases to approximately 105.2 m AHD the Lignum Shrubland vegetation transitions into a narrow band (approximately 30 to 60 metres wide) of Lignum Swampy Woodland (EVC 823) (Plate 5). This EVC is dominated by Tangled Lignum (*Duma florulenta*), a low, open canopy of Black Box (*Eucalyptus largiflorens*) and a groundlayer consisting of woody debris and flora species tolerant to intermittent flooding (Rakali Ecological Consulting, 2014). Table 14 summarises the conservation significance of the water dependent flora species at Chirrup Swamp.

Chirrup Dam and neighboring Dam No. 2, are located in the south-eastern corner of the Lignum Swampy Woodland zone of the site (Plate 5). Both dams are surrounded by scattered Black Box but contain poor structural diversity at the mid to groundlayer (Rakali Ecological Consulting, 2014). Chirrup Dam supports a low diversity and cover of aquatic vegetation with only Water milfoil (*Myriophyllum L.*) recorded when inundated (Howard et al., 2014). It is likely that aquatic vegetation growth and establishment is limited by the steep banks and the depth of the dam (Lindenmayer et al., 2003). Table 15 summarises the conservation significance of the water dependent EVCs in the Wimmera Bioregion, Appendix 4: Ecological Vegetation Classes shows the extent of each EVC and Appendix 5: Flora Species List shows the full species list at Chirrup Swamp.

Table 14. Significant water dependent flora species recorded at Chirrup Swamp

Common name	Scientific name	Type	Last record	EPBC status	FFG status	DELWP status	EVC found within
Cane Grass	*Eragrostis australasica*	W	2013			v	808
Spiny Lignum	*Duma horrida subsp. horrida*	W	2013			r	803, 808, 823
Swamp Early Nancy	*Wurmbea dioica subsp. lacunaria*	W	2013			k	808

Legend
Type: Wetland dependent
DELWP status: presumed eXtinct, endangered, vulnerable, rare, near threatened, data deficient, poorly known
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), North Central CMA (2014b), DELWP (2014f), DSE (2005) and landholder records.

Lignum Swampy Woodland (EVC 823), June 2012	Cherrip Swamp dam, November 2014

Plate 5. Vegetation communities and habitats of Chirrup Swamp

Table 15. Conservation status of water dependent EVCs in Chirrup Swamp

EVC no.	EVC name	Source	Wimmera Bioregional Conservation Status
808	Lignum Shrubland	Rakali Ecological Consulting (2014)	Not listed in Wimmera Bioregion (Vulnerable in Murray Mallee bioregion)
823	Lignum Swampy Woodland	Rakali Ecological Consulting (2014)	Vulnerable
Source: Rakali Ecological Consulting (2014), Howard *et al.*, (2014), DELWP (2014d), DSE (2012)			

4.5 Terrestrial Species

4.5.1 Fauna

Chirrup Swamp supports at least 25 terrestrial native birds, one lizard and two mammal species (DELWP, 2014e; Rakali Ecological Consulting, 2014; Howard et al., 2014). Three of these species are listed as significant including the FFG listed Hooded Robin (*Melanodryas cucullata cucullata*), the near threatened Brown Treecreeper (*Climacteris picummnus*) and the endangered Lace Monitor (*Varanus varius).* These species rely predominately on the habitat of the Lignum Swampy Woodland and Plains Woodland EVC zones and likely utilise the surrounding dams as watering points during dry conditions (see
Plate **6**).
Table **16** shows the significant terrestrial fauna species recorded and their conservation listing. Appendix 3: Fauna Species List shows the full species list for Chirrup Swamp.

Plate 6. Red-rumped Parrots drinking from Chirrup Dam (D. Cook [Rakali Ecological Consulting] 2014)

Table 16. Significant terrestrial fauna species recorded at Chirrup Swamp

Common name	Scientific name	Type	Last record	Inter-national agreement	EPBC status	FFG status	DELWP status
Brown Treecreeper	*Climacteris picumnus*	TB*	2014				NT
Hooded Robin	*Melanodryas cucullata cucullata*	TB	2000			L	NT
Lace Monitor	*Varanus varius*	R	A[1]				EN

Legend
Type: Reptile, Terrestrial Bird
DELWP status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known
*Species is dependent on water dependent vegetation/ [1]Ancedotal record from community (Appendix 6: Engagement Outcomes)
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), DELWP (2014e), DSE (2013) and landholder records

4.5.2 Flora and Vegetation Communities

Bordering the wetland area of Chirrup Swamp (at elevation above 105.4 m AHD) is Plains Woodland (EVC 803) and EVC which is of high conservation significance being listed as endangered in the Wimmera bioregion as shown in Table

18 (see Plate 7) (Rakali Ecological Consulting, 2014; DELWP, 2013d). This EVC is predominately Black Box with annual herbs adapted to low summer rainfall. The quality of the EVC range from poor at the southern end to intact and highly significant at the northern end of the wetland (Rakali Ecological Consulting, 2014). Three species- Scrufy Germander (*Teucrium albicaule*) (as shown in Plate 7), Black Roly-poly (*Sclerolaena muricata*) and the EPBC listed Chariot Wheels (*Maireana cheelii*) (as shown in Plate 7) are also located in this zone and are listed as significant on the DELWP Advisory List (Rakali Ecological Consulting, 2014). Table 17 summarises the significant flora species recorded at Chirrup Swamp, with a full species list in Appendix 5: Flora Species List.

Table 17. Significant terrestrial flora species recorded at Chirrup Swamp

Common name	Scientific name	Type	Last record	EPBC status	FFG status	DELWP status	EVC found within
Black Roly-Poly	*Sclerolaena muricata*	T	1991			k	-
Chariot Wheels	*Maireana cheelii*	T	2013	v		v	803
Scurfy Germander	*Teucrium albicaule*	T	2013			k	803

Legend
Type: Terrestrial
EPBC status: EXtinct, CRitically endangered, ENdangered, VUlnerable, Conservation Dependent, Not Listed
DELWP status: presumed eXtinct, endangered, vulnerable, rare, near threatened, data deficient, poorly known
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), North Central CMA (2014b), DELWP (2014f), DSE (2005) and landholder records.

Plains Woodland (EVC 803), December 2013 (D. Cook [Rakali Ecological Consulting] 2014)

Scrufy Germander (D. Cook [Rakali Ecological Consulting] 2014)

Chariot Wheels in flower (D. Cook [Rakali Ecological Consulting] 2014)

Plate 7. Significant terrestrial flora at Chirrup Swamp

Table 18. Conservation status of terrestrial EVCs in Chirrup Swamp

EVC no.	EVC name	Source	Wimmera Bioregional Conservation Status
803	Plains Woodland	Rakali Ecological Consulting (2014)	Endangered
Source: Rakali Ecological Consulting (2014), Howard *et al.*, (2014), DELWP (2014d), DSE (2012)			

4.6 Current Condition and Threats

4.6.1 Current Condition

According to IWC assessment, Chirrup Swamp is in good condition with an overall score of 98.7/100 (Table 19). The site is considered to have excellent soil structure and physical form, with no major disruptions or modifications to the bed of the wetland. It is however probable that the surrounding dams have reduced the volume of catchment runoff able to reach the wetland, due to the volume of water required to fill the dam airspace before water can overtop and enter the wetland. The biota component reveals that both water dependent EVCs (Lignum Shrubland and Lignum Swampy Woodland) are in good condition (overall score if 17.3/20) with only 35 percent of species exotic in in these zones (Rakali Ecological Consulting, 2014). Chirrup Swamp is rated the highest for overall condition when compared to all of the North Central CMA WMP sites assessed.

Table 19. IWC Assessment for Chirrup Swamp

IWC sub-index	Wetland catchment	Physical form	Hydrology	Water properties	Soils	Biota	Overall IWC score
Score/ 20	12	19.9	15	15	19.5	17.3	**98.7**
Category	Moderate	Excellent	Good	Good	Excellent	Good	**Good**
Source: Rakali Ecological Consulting (2014)							

Chirrup Dam, which was assessed using the method detailed in Section 3.4.1, was however rated as moderate in condition based on its habitat values (Table 20). The main areas that scored poorly were aquatic and fringing vegetation due to the relatively steep banks and depth. The impact of this is reflected in the macroinvertebrate assemblage which is dominated up of predatory feeding guilds with low overall abundance. However, when assessed for other water dependent fauna values (i.e. diversity and abundance of water dependent species), the dam received a high score. It is therefore probable that the dam is able to provide refuge for water dependent species (in particular turtles and frogs) that have retreated when Chirrup Swamp has dried. Although not assessed as part of the Howard *et al.,* (2014) survey, it is likely that the aquatic conditions in the dam are sufficient to support survival, however may not promote breeding and replacement of individuals due to lack of resources (including food and shelter).

Table 20. Condition of key attributes of Chirrup Dam

Indicator	Aquatic vegetation	Fringing vegetation	Morphology	Water dependent fauna	Overall rating
Score/ 3	2	2	1	3	**8**
Category	Moderate	Moderate	Poor	Excellent	**Moderate**
Key					
Score	**Rating**	**Aquatic vegetation (no. of species)**	**Fringing vegetation (cover)**	**Morphology (bank steepness)**	**Water dependent fauna (no. of species)**
1	Poor	< 4 species	Sparse or no cover	>20 cm/ metre	<10 species
2	Moderate	4-10 species	Sparse to good cover	10-20 cm/ metre	10-20 species
3	Excellent	>10 species	high cover	<10 cm/ metre	>20 species

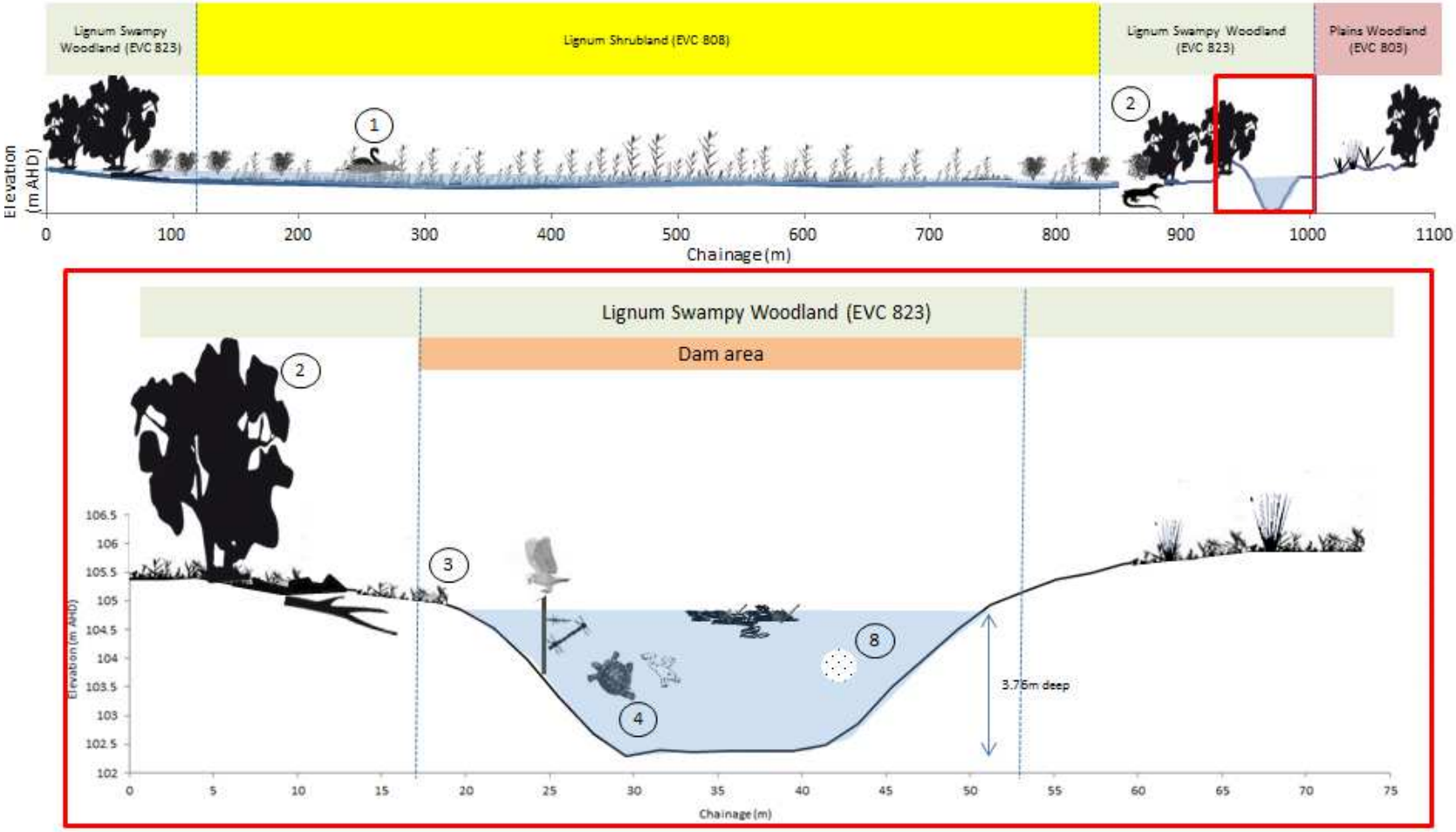
4.6.2 Condition Trajectory

Although widespread landing clearing has occurred in the area immediately surrounding Chirrup Swamp, the site is in good condition supporting relatively intact vegetation and maintaining good natural hydrology (Rakali Ecological Consulting, 2014). However Chirrup Dam, which provides refuge for water dependent species during dry phases at Chirrup Swamp, is in moderate condition, and may not provide sufficient resources for breeding. This is supported by the low abundance of juvenile turtles and frogs recorded in the dam. It is therefore likely that the diversity and abundance of water dependent species will decrease with time, as individual's age and are not replaced. This will negatively impact on the abundance and diversity of water dependent species that are able to immediately recolonise the wetland when it is naturally inundated.

4.6.2.1 Do Nothing

If environmental water is not provided to Chirrup Dam, the dam will no longer provide vital refuge for water dependent fauna species which have retreated to it when the wetland has dried. This has implications for the recolonisation of the wetland area when naturally inundated, particularly for turtles and frogs which have low mobility. This is particularly important due to the isolated nature of the wetland in terms of nearby surrounding waterbodies (see Section 3.4.3).

4.7 Conceptualisation of the Site



N.B. cross section not to scale

Key descriptions:

1. The Cane Grass bed of Chirrup Swamp provides an important feeding and breeding ground for waterbirds, turtles and frogs. Periodic wetting and drying will cue waterbird, turtle and frog breeding and promote the growth and establishment of new recruits. This zone is considered to be in good condition.
2. The fringing Lignum Swampy Woodland Zone provides important food and shelter for a range of fauna including waterbirds, woodland birds, reptiles and mammals (some of which are listed). The condition of this zone varies from intact at the northern end to degraded at the south. This vegetation is the interface between the wetland and dam environments.
3. The steep banks of Chirrup Dam limits vegetation establishment with only a small area of scattered water milfoil. Surrounding vegetation is also sparse (often completely bare) with little structure and diversity.
4. Chirrup Dam provides refuge for species (i.e. turtles and frogs) with low mobility during dry phases in the wetland. The dam supports a relatively high density of adults however little evidence of breeding or juveniles present.
5. A diversity of macroinvertebrates requires a range of habitat types (i.e. open water column, littoral vegetation, wood debris, gravel and sand substrate etc.). The lifecycle of many species is therefore supported by wetting and drying.

4.8 Management Objectives

4.8.1 Management Goal

The long-term management goals for Chirrup Swamp and Chirrup Dam are based on the information derived from Rakali Ecological Consulting (2014) and Howard et al., (2014) and presented in Section 4. However, due to the size of Chirrup Swamp and the current capacity restrictions of the WMP, this section will only consider management of Chirrup Dam. Management objectives, ecological and hydrological objectives and a recommended watering regime for the swamp are presented in Appendix 10: Wetland Management Objectives.

Chirrup Dam environmental water management goal

To maintain Chirrup Dam as a refuge for water dependent fauna (particularly frogs and turtles) and to provide a point source for recolonisation of Chirrup Swamp when it is naturally inundated.

4.8.2 Ecological Objectives

The ecological objectives and justification for the management goal presented in Section 4.7 are presented below. Please note that consideration has been given to wetland ecological objectives that may benefit (either fully or in part) from environmental water delivery to the dam. This includes opportunities to overtop dam banks and provide low-level inundation.

Table 21. Ecological objectives of Chirrup Dam

Ecological objective	Justification
1 Improve **aquatic and littoral vegetation** cover and diversity	- Provide not only refuge but resources (i.e. high quality shelter, feeding habitat) to promote breeding and ensure long term survival of frogs, turtles and macroinvertebrates - Assists with nutrient cycling (i.e. biofilms/bacteria on surface of plants) *Objective may require active intervention i.e. revegetation, bank modification work to allow achievement (see Section 13).*
2. Increase **turtle and frog breeding and feeding** opportunities	- Safeguard populations from decline if Chirrup Swamp experienced prolonged dry periods - Provide food source for omnivorous and carnivorous waterbirds - Objective based on achievement of ecological objective 1
3. Increase diversity of **macroinvertebrate** functional group assemblage	- A diversity of macroinvertebrates will provide feeding opportunities for turtles, frogs and waterbirds and assist with cycling nutrients in the dam - Objective based on achievement of ecological objective 1

Ecological objective	Justification
4. Maintain as a point source for **recolonisation** of nearby waterbodies	- Maintain a viable frog and turtle population for recolonisation of Chirrup Swamp during natural inundation events
5. Maintain as a **watering point** for terrestrial species	- Continue to support surrounding terrestrial fauna including FFG listed Hooded Robin, near threatened Brown Treecreeper and endangered Lace Monitor.

4.8.3 Hydrological Objectives

Hydrological objectives are based on the hydrological requirements of the ecological objectives detailed in Section 4.8.2. The information provided below is a summary of this information with specific detail and justification given in Appendix 8: Water Requirements for Values and Appendix 9: Hydrological Objectives.

Table 22. Hydrological objectives of Chirrup Dam

		Description
Timing		Provide fresh inflows to Chirrup Dam most often between August and October (with variability in some years).
Watering frequency	Minimum	Annual/ as required to maintain permanency (10 in 10 years).
	Optimum	
	Maximum	
Ponding duration	Minimum	Permanent ponding[2].
	Optimum	
	Maximum	
Duration of dry between events	Minimum	No drying at Chirrup Dam to occur unless there is significant natural flooding at Chirrup Swamp- duration would depend on long flood water is retained in Chirrup Swamp (aim is to not have them dry at same time).
	Optimum	
	Maximum	
Extent		CHIRRUP DAM: 1-2.6 metres (103.4-105 m AHD)
Variability		High- mimic natural variability by providing occasional watering events outside of the optimum timing (i.e. summer fill to mimic summer thunder storm event)
Estimated volume per event		At least 1.2 ML

[1] Under extremely dry catchment conditions and low to no allocations the application of prioritisation criteria in Section 3.5.4 will apply. This may result in a low priority ranking for the site, and as such insufficient water resources to maintain the minimum regime (i.e. thus the need to dry the site).
[2] Maintaining depth during wet years may increase the chance of natural flooding at Chirrup Swamp by removing the need to initial fill the dam airspace.

4.8.4 Watering Regime

The optimum watering regime for Chirrup Dam is derived from the ecological and hydrological objectives presented in Sections 4.8.2 and 4.8.3. The regime should be managed adaptively to account for climatic variation and water availability.

Chirrup Dam optimum watering regime

Maintain permanent inundation with variability

Provide fresh inflows annually between August and October to a level of up to 105 m AHD (2.6 metres) in Chirrup Dam to promote aquatic plant growth and provide breeding cues for frogs and turtles. Allow natural drawdown during autumn and winter; however maintain depth above 103.4 m AHD (>1 metre) to maintain refuge conditions for turtles and frogs. If Chirrup Swamp naturally floods, only provide environmental water when the wetland begins to drawdown.

5 Corack Lake

5.1 Catchment Setting

Corack Lake is an eight hectare natural wetland located on public land at the western edge of the third lunette formation of the ancient Lake Buloke system. The wetland would have formed through the process of deflation during the contraction and expansion of the larger lake system (White et al., 2003). The wetland has a maximum depth of 2.6 metres (115.2 m AHD) and is characterised as a deep freshwater marsh (D. Cook [Rakali Ecological Consulting Ecological Consulting] pers. comm., 21 August 2014). There is no long term data regarding the frequency, duration and timing of fill events at the wetland, however it is likely to have received runoff predominately from the north-east during periods of extended rainfall in winter and spring (Rakali Ecological Consulting, 2014).

Two constructed dams are present in the bed of Corack Lake, namely Corack Dam and Dam No. 2. Corack Dam is connected to the WMP and is shallower and smaller then neighboring Dam No. 2.

5.2 Land Use

Historically Corack Lake was used primarily for recreational activities such as swimming, picnicking and hunting due to its close proximity to the township of Corack East. Although little information is available on its history, *The Argus* (Melbourne, Vic: 1848-1957, 11 February 1941, pp. 2) reports that the wetland flooded during unprecedented rains in February 1941 causing it to flood some areas of the township of Corack East as well as nearby properties, causing damage to agricultural land and stock death. Dam No. 2 supported stock and domestic pumping until the construction of the pipeline (see Appendix 6: Engagement Outcomes).

5.3 Hydrology

With the exception of the township, Corack Lake is surrounded by cleared land used for grazing and cropping. The site is bordered by a relatively intact Black Box (*Eucalyptus largiflorens*) and River Red Gum (*Eucalyptus camaldulensis*) fringe with moderately sloping banks that flatten out to a deeper, central area. The bed typically has an elevation of 112.6 m AHD.

Corack Dam is approximately 0.4 metres deep (FSL of 112.8 m AHD) with a bed level of 112.2 m AHD which is approximately 0.4 m below that of the wetland lake bed level. The dam is 1,500 m^2 in size and has relatively flat banks (average rise of 8 cm/ metre). A 0.6 metres high spoil heap exists between it and Dam No. 2 however water can move between the sites either through overtopping of the banks or via lateral seepage through the spoil head. When overtopped, a small pool forms (approximately 0.2 metres deep) in the deeper sections of the wetland. Dam No. 2 is bordered at its north, east and south boundaries by a spoil heap that ranges from 0.8 to 2 metres above the FSL of the Corack Dam. The size, depth (approximately 1.8 metres deep with a bed level of 110.8 m AHD) and position of Dam No. 2 has impact the natural hydrology of the wetland. The dam now captures the majority of catchment runoff, which historically would have pooled in the wetland bed (Rakali Ecological Consulting, 2014a). Appendix 2: Bathymetry and Capacity Tables, shows the bathymetry of Corack Lake with Figure 6 detailing the location and key features described above.

Corack Dam, which was connected to the WMP in early 2013, received its first delivery of environmental water in spring and summer 2013 (see Table 23). At the time, Corack Dam was dry and Dam No. 2 was at approximately 60 percent capacity (North Central CMA, 2014a). There is no information on the history of inundation prior to 2010-11.

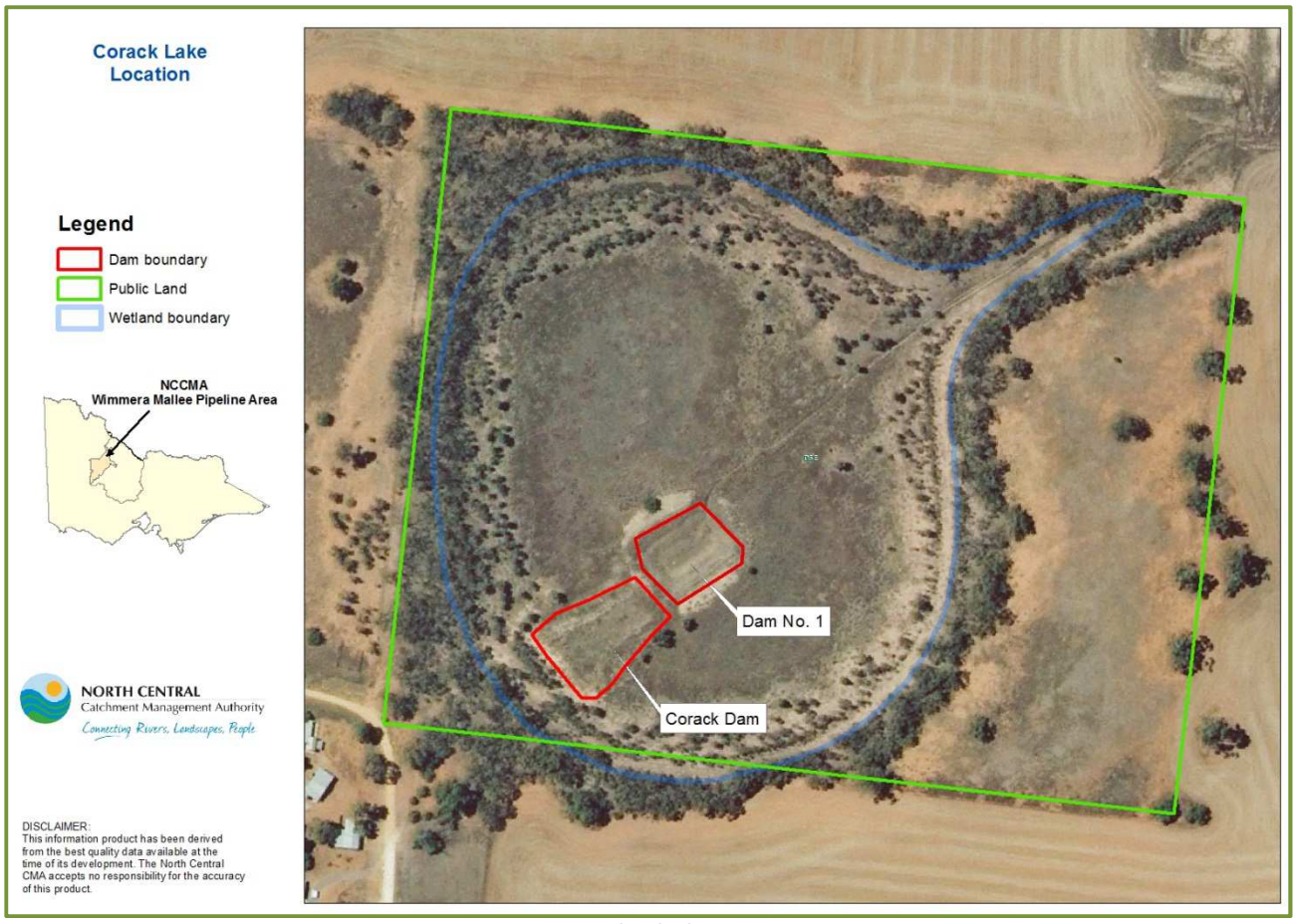


Figure 6. Corack Lake location map

Table 23. Watering history of Corack Lake

Watering History	Season							
	2010-2011[1]		2011-2012[1]		2012 -2013		2013-14	
	Wetland	Dam	Wetland	Dam	Wetland	Dam	Wetland	Dam
Status *	W	W	W	W-D	D	W	D	D-W
Water source #	F	F	-	-	-	-	-	E
Volume (ML)	U	U	0	0	0	0	0	1.961
Notes	Flooding in summer 2010-11		Water was visible in patches within wetland		Dry wetland/ dam still inundated		Spring and summer top-ups to dam	

KEY:

Unknown/ Environmental water allocation / Flood inundation

W	Water for entire year	D-W	Dry at start of year, filled later
W-D	Wet at started of year, dried later	D	Dry for entire year

[1]Likely status as advised by Parks Victoria, landholders and general topographical understanding of the landscape

5.4 Water Dependent Values

5.4.1 Fauna

A total of 35 macroinvertebrates, seven waterbirds, four frog and one turtle species have been recorded at Corack Lake (DELWP, 2014e; Rakali Ecological Consulting, 2014; Howard *et al.*, 2014). Of the water dependent species present, only one- the Eastern Long-necked Turtle (*Chelodina longicollis*) (shown in Plate 8) is listed as significant, as shown in Table 24.

All seven waterbird species recorded have been sighted utilising the dam environments. Four of these species- Sacred Kingfisher (*Todiramphus sanctus*), White-faced Heron (*Egretta novaehollandiae*), Egrets (*Ardea* spp.) and Australasian Grebes (*Tachybaptus novaehollandiae*) (as shown in Plate 8 during breeding event) are fish eating and likely attracted to the more permanent habitat of Dam No. 2 (Howard *et al.*. 2014; Rakali Ecological Consulting, 2014). This site has remained inundated since Corack Lake flooded in 2010-11 (B. Bisset pers obs., [North Central CMA], 11 June 2014). Over half of the macroinvertebrates recorded in Dam No. 2 are represented by scrapers and grazers (i.e. snails and baetid mayflies) reflecting the presence of good aquatic vegetation structural diversity and cover (Howard *et al.*, 2014). However in contrast, less than a quarter of macroinvertebrates at Corack Dam are scrapers/ grazers, with predators representing over 65 percent of the taxa (Howard et al., 2014).

In both dams, Spotted Marsh Frog (*Limnodynastes tasmaniensis*), Eastern Sign-bearing Froglet (*Crinia parinsignifera*) and Eastern Banjo Frog (*Limnodynastes dumerilli*) have been recorded, however in low numbers when compared to the other WMP Wetlands sites. During the recent summer fauna surveys it was noted that Corack Dam supported a relatively high abundance of tadpoles and only juvenile turtles were caught. In comparison Dam No. 2 supported only adult turtles. It is thought that the shallow depth and intermittent nature of Corack Dam provides highly productive conditions and plays an important role as a nursery for turtles and frogs (Howard et al., 2014). Appendix 3: Fauna Species List shows the full species list for Corack Lake.

Eastern Long-necked Turtles at dam 2 (K. Howard [ARI], 2014)

Australasian Grebe nestling (D. Cook [Rakali Ecological Consulting], 2014)

Plate 8. Fauna of Corack Lake

Table 24. Significant water dependent fauna recorded at Corack Lake

Common name	Scientific name	Type	Last record	Inter-national agreement	EPBC status	FFG status	DELWP status
Eastern Long-necked Turtle	*Chelodina longicollis*	RW	2014	N/A			DD

Legend
Type: Reptile Water dependent,
DELWP status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), DELWP (2014e), DSE (2013) and landholder records.

5.4.2 Flora and Vegetation Communities

There are no significant water dependent flora species recorded at Corack Lake. The bed of Corack Lake is classified as Lake Bed Herbland (EVC 107) (or Aquatic Herbland (EVC 653) when inundated) which is predominately made up of amphibious species such as Common Blown-grass (*Lachnagrostis filiformis*), Clammy Goosefoot (*Chenopodium pumilio*), Common Spike-sedge (*Eleocharis acuta*) and Common Sneezeweed (*Centipedia cunninghamii*). Of the 25 species recorded by Rakali Ecological Consulting (2014) 64 percent are native and of these 87 percent is water dependent. The EVC contains a number of Red Gum saplings at the fringe and elevated margins of the dams, the likely result of the 2010-11 floods (Rakali Ecological Consulting, 2014).

Corack Dam contains a high cover but low structural diversity of submerged and emergent vegetation with the dominant species being Red Water-milfoil (*Myriophyllum verrucosum*), Creeping Knotweed (*Periscaria prostrata*) and Small Knotweed (*Polygonum plebeium*) (Rakali Ecological Consulting, 2014, Howard et al., 2014). Dam No. 2 contains a moderate cover and structural diversity of aquatic plants with the dominant species being Water-milfoil (*Myriophyllum* spp.) and Water Ribbons (*Triglochin* spp.) (Howard et al., 2014).

Bordering the Lake Bed Herbland EVC at elevations above 113.2 m AHD is a fringe of Intermittent Swampy Woodland (EVC 813). At Corack Lake this zone transitions from a Red Gum to a Black Box overstorey with a shrubby and rhizomatous sedgy understorey. This zone features both flood-stimulated species such as Common Nardoo (*Marsilea drummondii*) and species tolerant to inundation such as Jersey Cudweed (*Pseudognaphalium luteoalbum*) (Rakali Ecological Consulting, 2014). Plate 9 shows the water dependent EVC communities of Corack Lake, Table 25 summarises the conservation significance of these EVCs in the Wimmera Bioregion, Appendix 4: Ecological Vegetation Classes, shows the extent of each EVCs present and Appendix 5: Flora Species List shows the full species list for Corack Lake.

Lake Bed Herbland (EVC 107), October 2013

Corack Dam, January 2014

Dam No. 2 with Australasian Grebe nest, December 2013

Intermittent Swampy Woodland (EVC 813)

Plate 9. Water dependent vegetation communities of Corack Lake

Table 25. Conservation status of water dependent EVCs in Corack Lake

EVC no.	EVC name	Source	Wimmera Bioregional Conservation Status
107	Lake Bed Herbland	Rakali Ecological Consulting (2014)	Not listed in Wimmera Bioregion (Endangered in Victorian Volcanic Plain bioregion)
813	Intermittent Swampy Woodland	Rakali Ecological Consulting (2014)	Vulnerable
Source: Rakali Ecological Consulting (2014), Howard *et al.*., (2014), DELWP (2014d), DSE (2012)			

5.5 Terrestrial Species

5.5.1 Fauna

The surrounding Black Box and River Red Gum fringe of Corack Lake supports 15 terrestrial birds, two mammals and one reptile species (DELWP, 2014e; Rakali Ecological Consulting, 2014; Howard *et al.*, 2014). Of these the near threatened Spotted Harrier (*Circus assimilis*) and the FFG listed Square-tailed Kite (*Lophoictinia isura*) are listed as significant, as shown in Table 26. A full species list for Corack Lake can be found in Appendix 3: Fauna Species List.

Table 26. Significant terrestrial fauna species recorded at Corack Lake

Common name	Scientific name	Type	Last record	International agreement	EPBC status	FFG status	DELWP status
Spotted Harrier	*Circus assimilis*	TB	2013				NT
Square-tailed Kite	*Lophoictinia isura*	TB	2013			L	VU

Legend
Type: Terrestrial Bird
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
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), DELWP (2014e), DSE (2013) and landholder records.

5.5.2 Flora and Vegetation Communities

The wetland area of Corack Lake is immediately surrounded by Plains Woodland (EVC 803) at its north and south-western boundaries, which is made up of sedgy/ grassy woodland dominated by Black Box. A sandy ridge to the east of the wetland further supports a degraded patch of Lunette Woodland (EVC 652) which has a sparse Eucalyptus overstorey and shrubby and grassy understorey (Rakali Ecological Consulting, 2014). There are not significant species listed for these EVCs. The conservation significance of these EVCs is shown in Table 27 with a full species list in Appendix 5: Flora Species List.

Table 27. Conservation status of terrestrial EVCs in Corack Lake

EVC no.	EVC name	Source	Wimmera Bioregional Conservation Status
652	Lunette Woodland	Rakali Ecological Consulting (2014)	Endangered
803	Plains Woodland	Rakali Ecological Consulting (2014)	Endangered
Source: Rakali Ecological Consulting (2014), Howard *et al.*, (2014), DELWP (2014d), DSE (2012)			

5.6 Current Condition and Threats

5.6.1 Current Condition

According to the IWC assessment, Corack Lake is in good condition with an overall score of 94.2/100 (Table 28). The site has excellent physical form and soils structure and scores well for natural hydrology, water properties and biota (i.e. vegetation composition and species diversity). In particular the presence of River Red Gum saplings at the fringe and elevated margins of the dams suggests that the recent hydrology has been conclusive to regeneration. However the site is considered poor for wetland catchment with widespread clearing of native vegetation in the area and the excavation of dams in the bed of the wetland changing the hydrology. The presence of the two dams, in particular Dam No. 2, would also have a significant impact on the natural spread of water through the wetland (Rakali Ecological Consulting, 2014). Future changes the physical form of the wetland is unlikely to occur due to the site's protected status as a Recreational Reserve.

Table 28. IWC Assessment for Corack Lake

IWC sub-index	Wetland catchment	Physical form	Hydrology	Water properties	Soils	Biota	Overall IWC score
Score/ 20	9	18.5	15	15	20	16.7	**94.2**
Category	Poor	Excellent	Good	Good	Excellent	Good	**Good**
Source: Rakali Ecological Consulting (2014)							

Corack Dam, which is assessed using the method detailed in Section 3.4.1, is rated as high for its habitat values (Table 29). This is based on a high abundance and diversity of aquatic vegetation and water dependent fauna and a more natural morphology (i.e. gentle slopes as opposed to the typical dam bank steepness). Although this is the case, macroinvertebrate surveys of Corack Dam show that the majority of individuals belong to predatory feeding guilds.

This is contrasting to the more permanent Dam No. 2, where over half are represented by scrapers and grazers (i.e. snails and baetid mayflies) (Howard et al., 2014). This may be the result of the intermittent nature of the dam and the timing of the survey (survey undertake soon after the dam was filled from empty), resulting in an insufficient lag time for macroinvertebrate establishment. However from a turtle and frog perspective, the dam is highly productive providing opportunistic nursery conditions for juveniles (Howard et al., 2014). This provides a complementary habitat to Dam No. 2 by reducing initial competition between adults and juveniles for resources.

Table 29. Condition of key attributes of Corack Dam

Indicator	Aquatic vegetation	Fringing vegetation	Morphology	Water dependent fauna	Overall rating
Score/ 3	3	2	3	3	**11**
Category	Excellent	Moderate	Excellent	Excellent	**Excellent**
Key					
Score	**Rating**	**Aquatic vegetation (no. of species)**	**Fringing vegetation (cover)**	**Morphology (bank steepness)**	**Water dependent fauna (no. of species)**
1	Poor	< 4 species	Sparse or no cover	>20 cm/ metre	<10 species
2	Moderate	4-10 species	Sparse to good cover	10-20 cm/ metre	10-20 species
3	Excellent	>10 species	high cover	<10 cm/ metre	>20 species

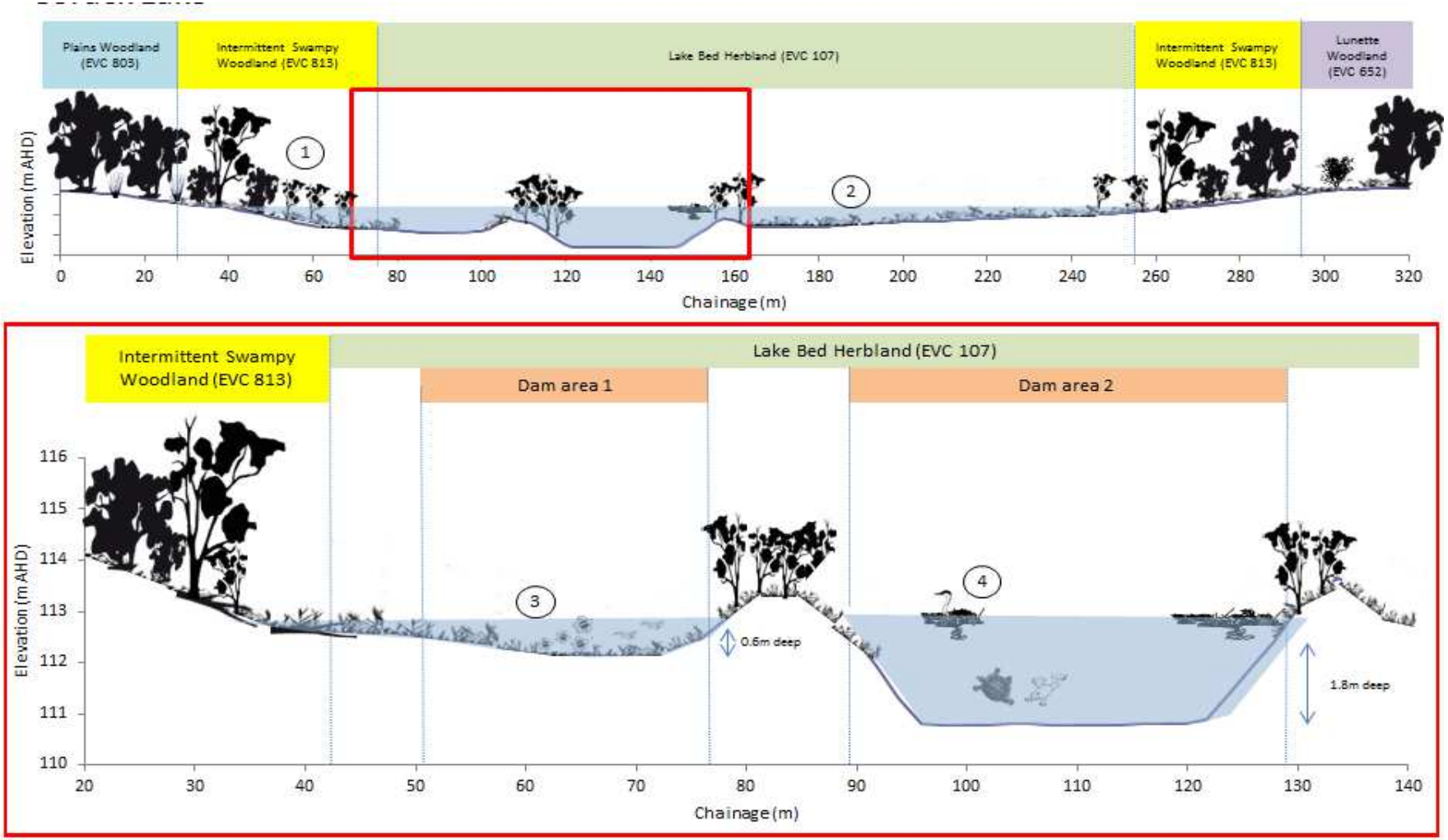
5.6.2 Condition Trajectory

With the exception of the wetland catchment area, Corack Lake is in good condition supporting relatively intact vegetation and hosting a variety of water dependent species when inundated (Rakali Ecological Consulting, 2014). Corack Dam is also considered to be in excellent condition due to its intermittent nature which supports a diversity of aquatic vegetation and providing high quality opportunistic conditions for juvenile turtles and frogs. These conditions support the permanent refuge of Dam No. 2 by reducing competition for resources. Prolonged dry periods in Corack Dam would therefore impact on the number of juveniles that survive to adulthood and join the larger population. The loss of permanent refuge in Dam No. 2 is however a larger risk, with the current population unlikely to find refuge elsewhere in the immediate area (see Section 3.4.3). Complete drying of both sites would reduce the water dependent biodiversity available for recolonisation of Corack Lake during natural inundation events.

5.6.2.1 Do Nothing

If environmental water is not provided to Corack Dam, nursery conditions will be reduced for frogs and turtles. This may not result in an immediate impact to the current population, as it is likely that some breeding would still occur in Dam No. 2. However should the permanent refuge of Dam No. 2 be lost, there is a risk local extinction due to the lack of available surrounding waterbodies. Environmental water is therefore required to ensure both dams can continue to support the different life histories of turtles and frogs.

5.7 Conceptualisation of Site



N.B. cross section not to scale

Key descriptions:

1. River Red Gum and Black Box recruitment exists from the 2010-11 floods, particularly on the fringe and spoil heaps of the dam. This provides habitat structure and encourages a variety of waterbirds to utilise the site. This zone is considered to be in good condition.
2. The amphibious and aquatic zones of the wetland provide shelter and feeding opportunities for fauna. Weeds however impact on diversity.
3. Corack Dam (referred to as Dam area 1 in diagram) is shallow with gentle sloping edges, supporting a diversity of aquatic and littoral plants. Wetting and drying promotes highly productive but intermittent conditions for water dependent fauna. This includes a relatively high abundance of juvenile turtles and tadpoles. Due to topography, Corack Dam could be overtopped to provide benefit to aquatic vegetation in the bed of the wetland.
4. Dam No. 2 has steep sides and is deeper then Corack Dam allowing it to hold water for extended periods of time. Although it has less aquatic vegetation diversity it provides refuge conditions that support adult turtles and frogs. Australasian Grebe has also bred at the site.

5.8 Management Objectives

5.8.1 Management Goal

A long-term management goal (i.e. ten years) for Corack Lake and Corack Dam (including Dam No. 2) has been developed based on the information derived from Rakali Ecological Consulting (2014) and Howard et al., (2014) and presented in Section 5. Due to the size of Corack Lake and the current capacity restrictions of the WMP, this section will only focus on management of Corack Dam, a small area of the wetland bed and adjoining Dam No. 1. Management objectives, ecological and hydrological objectives and a recommended watering regime for Corack Lake are presented in Appendix 10: Wetland Management Objectives. Please note that consideration has been given for wetland ecological objectives that may benefit (either fully or in part) from environmental water delivery to the dam. This includes opportunities to overtop dam banks to provide low-level inundation.

Corack Dam environmental water management goal

Provide conditions that support an abundance of aquatic plants that promote refuge and nursery habitat for turtles and frogs and a variety of feeding conditions for waterbirds (i.e. drawdown zones, shallows).

5.8.2 Ecological Objectives

The ecological objectives and justification for the management goal presented in Section 5.8.1 are presented below in Table 30.

Table 30. Ecological objectives of Corack Dam

Ecological objectives	Justification
1. Maintain/ increase cover and structural diversity of **aquatic vegetation in dam and in area** immediately surrounding the dam (i.e. via overtop)	- Provide important feeding habitat for turtles, frogs, waterbirds and macroinvertebrates - Create habitat diversity to increase diversity of fauna species utilising dam - Support wetland ecological objectives relating to aquatic plants and waterbirds (see Appendix 10: Wetland Management Objectives)
2. Maintain nursery habitat for juvenile **turtles and frogs** in Corack Lake Dam	- Reduce competition with adult frogs and turtles in Dam No. 2 by providing nursery conditions - Tadpoles/frogs provide food source to support turtles and waterbirds
3. Maintain **permanent refuge** conditions for turtles and frogs in Dam No. 2	- Reduce competition between adult and juvenile frogs and turtles - Maintaining breeding individuals to ensure long term survival of population at wetland

	- Provide food source for waterbirds and turtles
4. Increase **waterbird feeding** opportunities (particularly shoreline foragers)	- Promote a diversity of habitat types through wetting and drying of the area immediately surrounding the dam - Support wetland ecological objectives relating to waterbirds - Support wetland ecological objectives relating to aquatic plants and waterbirds (see Appendix 10: Wetland Management Objectives)
5. Providing watering point for **terrestrial fauna**	- Support terrestrial fauna including FFG listed Square-tailed Kite and near threatened Spotted Harrier known to frequent the area.

5.8.3 Hydrological Objectives

Hydrological objectives are based on the hydrological requirements of the ecological objectives detailed in 5.8.2. The information provided below in Table 31 is a summary of this information with specific detail and justification given in Appendix 8: Water Requirements for Values and Appendix 9: Hydrological Objectives.

Table 31. Hydrological objectives of Corack Dam

		Description
Timing		Provide fresh inflows to Corack Dam most often in winter to ensure overtopping to inundate a small area of the wetland bed and fill Dam No. 1 can occur in spring. In following year, fill Corack Dam (only) most often between August and October and top-up as required to maintain depth target.
Watering frequency	Minimum[1]	Water Corack Dam (no overtopping to occur) 5 in every 10 years.
	Optimum	Water Corack Dam (only) annually to maintain seasonal regime (10 in 10 years). Allow overtop to inundate small area of wetland and Dam No. 1 5 in every 10 years.
	Maximum	Water Corack Dam (only) annually to maintain seasonal regime (10 in 10 years). Allow overtop to inundate small area of wetland and Dam No. 1 7 in every 10 years.
Ponding duration	Minimum[1]	3 months in Corack Dam (only).
	Optimum	6 months in Corack Dam and small area of wetland and Dam No. 1
	Maximum	9 months in Corack Dam and small area of wetland and Dam No. 1[2]
Duration of dry between events	Minimum[1]	3 months in Corack Dam (only)
	Optimum	6 months in Corack Dam (only)
	Maximum	9 months in Corack Dam (only)
Extent		CORACK DAM (ONLY): up to 0.6 metres (112.2-112.8 m AHD) OVERTOP INCLUDING DAM NO. 1: minimum of 0.2 metres (~112.8 m AHD) in wetland bed and approx. 1.8 metres in Dam No. 1 (113 m AHD)
Variability		High- mimic natural variability by providing occasional watering events outside of the optimum timing (i.e. summer fill to mimic summer thunder storm event)
Estimated volume per event		At least 4.2 ML

[1] Under extremely dry catchment conditions and low to no allocations the application of prioritisation criteria in Section 3.5.4 will apply. This may result in a low priority ranking for the site, and as such insufficient water resources to maintain the minimum regime (i.e. thus the need to dry the site).
[2] Maintaining depth during wet years may increase the chance of natural flooding at Corack Lake by removing the need to initial fill the dam airspace.

5.8.4 Watering Regime

The optimum watering regime for Corack Dam is derived from the ecological and hydrological objectives presented in Sections 5.8.2 and 5.8.3. The regime should be managed adaptively to account for climatic variation and water availability.

Corack Dam optimum watering regime

Maintain permanent water with Intermittent- annual fill of dam with overtop 5 in every 10 years

Provide inflows in winter to fill and overtop Corack Dam (>112.8 m AHD). Once overtopped, continue to deliver to fill a small area of the wetland bed (to at least 0.2 metres depth) and fill Dam No. 1 (113 m AHD). Through spring and summer, maintain inundation with some variability before allowing Corack Dam (and wetland bed) to recede and dry by late summer/ autumn.

In following year, provide fresh inflows between August and October to fill, but not over top Corack Dam. Dam No. 1 should still maintain water from the previous year's fill event.

6 Creswick Swamp

6.1 Catchment Setting

Creswick Swamp is a 21 hectare (formerly 38 hectares in size however the western portion is now private land) natural wetland located on public land on the floodplain between the Avon and Richardson rivers within the Creswick Swamp Wildlife Reserve.

The wetland has a maximum depth of 0.6 metres (bed level of 138.6 m AHD) and is characterised as a freshwater meadow (D. Cook [Rakali Ecological Consulting Ecological Consulting], pers. comm., 21 August 2014), however flooding to the FSL (138 m AHD) inundates surrounding private land. There is no long term data regarding the frequency, duration and timing of fill events at the wetland, however based on its wetland characteristics, it is likely to have receiving water sporadically, predominately in winter and spring, in response to flooding in the Avon, Richardson and Wimmera Rivers (Rakali Ecological Consulting, 2014).

Two dams have been constructed in the bed of Creswick Swamp, with one situated at the south-east (Creswick Dam) and one at the north-west (Dam No. 2). Creswick Dam is connected to the WMP and is the focus for environmental water delivery.

6.2 Land Use

Creswick Swamp has a long history dating back to 1844 when the Creswick brothers first settled the York and Banyena Plains. The area was described as a wattle covered grassland with the Avon River sand banks supporting pine trees. A 'never-failing' waterhole was also present at the edge of a shallow reed covered swamp (now known as Creswick Swamp) known to the aboriginal people as 'Murt'. In 1866 at the height of the drought, the Creswick brothers dug a well at the boundary of the wetland based on the assumption that soakage from Creswick Swamp was being stored in an ancient creek bed below the surface. The well, which was dug to a depth of approximately six metres, became the only reliable water source for miles and was considered a saving grace for many residents in the district during severe drought times (*Rupanyup Spectator & Lubeck, Banyena, Rich Avon and Lallat Advertiser*, pp 2, 11 November 1915).

6.3 Hydrology

Through agricultural development almost half of the original wetland area of Creswick Swamp has now been lost to farmland, isolating Dam No. 2. A road was constructed through the center of the wetland to assist with watering carting during the Millennium Drought (J. Douglas [neighboring landholder] pers. comm., August 2012). The road sits at approximately the same elevation as that of the wetland bed (138.6 m AHD). As a result, the road floods almost immediately during low-level inundation. The maximum depth of flooding able to be achieved in the wetland area, without flooding the road or private property, is approximately 0.2 metres (~138.5 m AHD). This covers an area of approximately eight percent of the total reserve area.

Creswick Dam was connected to the WMP in early 2013 and received its first delivery of environmental water in spring and summer 2013 (see Table 25). At the time of delivery, the dam and wetland had completely dried after flooding in 2010-11 (North Central CMA, 2014a). The dam is approximately 830 m^2 in size and has a depth of approximately 1.5 metres (bed level 137 m AHD). The banks have a moderate rise of approximately 12.5 cm/metre and transitions into a spoil heap at the north-west and south-east boundary which are on average 1.5 metres above the full supply level of the dam (FSL of 138.8 m AHD). Appendix 2: Bathymetry and Capacity Tables, shows the bathymetry of Creswick Swamp and Figure 7 shows the location and key features described above.

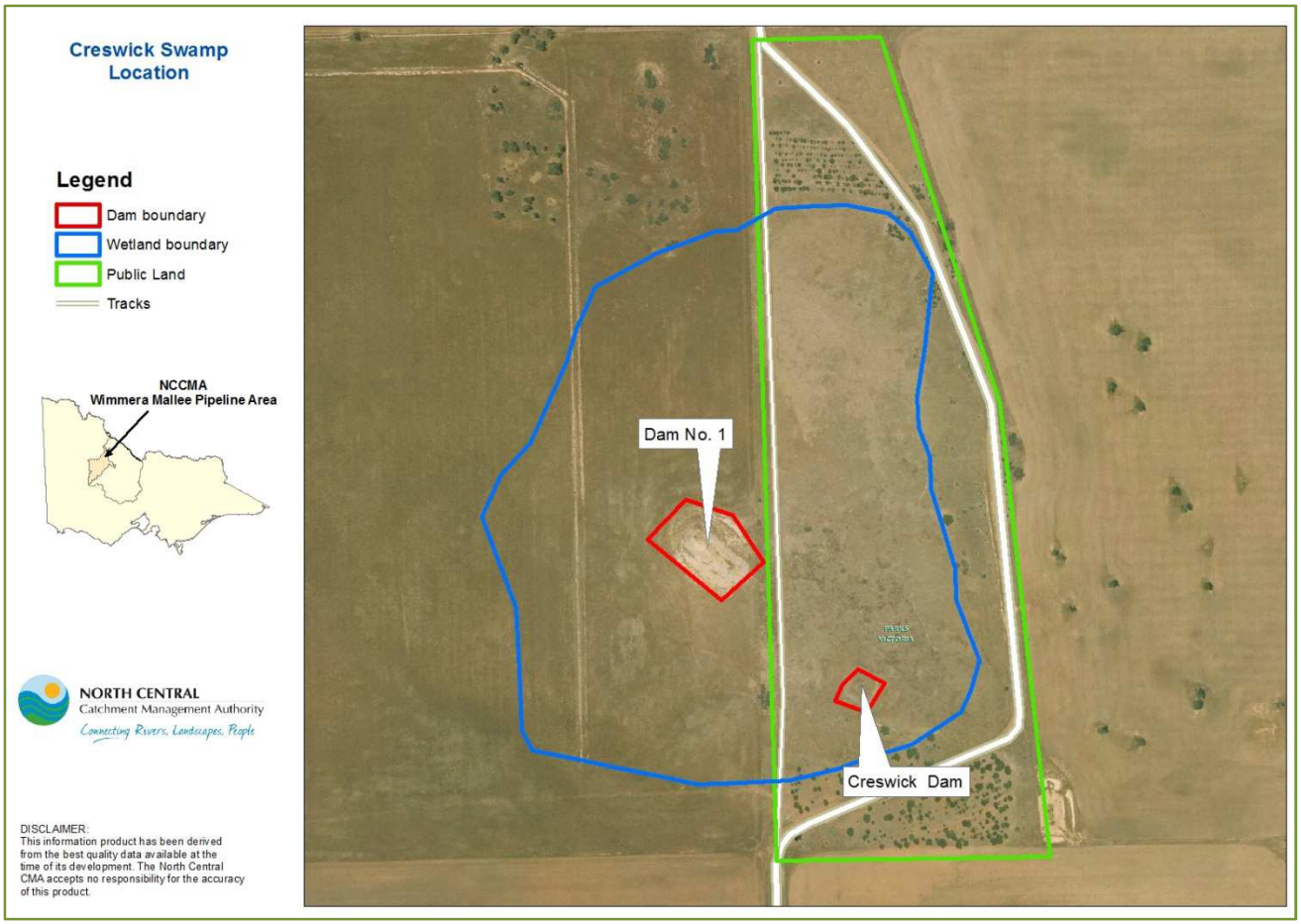


Figure 7. Creswick Swamp location map

Table 32. Watering history of Creswick Swamp

Watering History	Season							
	2010-2011[1]		2011-2012[1]		2012 -2013		2013-14	
	Wetland	Dam	Wetland	Dam	Wetland	Dam	Wetland	Dam
Status *	W	W	W	W	W-D	W-D	D	D-W-D
Water source #	F	F	-	-	-	-	-	E
Volume (ML)	U	U	0	0	0	0	0	1.085
Notes	Flooded in summer 2010-11		Wetland and dams inundated		Patches of water in wetland at end of season		Larger dam remained inundated from flood water. Small dam received fill and summer top-up. Dried by mid-summer	

KEY:

Unknown/ Environmental water allocation / Flood inundation

W Water for entire year
D Dry for entire year
W-D Wet at started of year, dried later
D-W-D Dried, filled then dried during the year

[1]Likely status as advised by Parks Victoria, landholders and general topographical understanding of the landscape

6.4 Water Dependent Values

6.4.1 Fauna

In total, 44 macroinvertebrates, five waterbirds, two frogs and one turtle species have been recorded at Creswick Swamp (DELWP, 2014e; Rakali Ecological Consulting, 2014; Howard et al., 2014). Two of these species have high

conservation significance- the data deficient Eastern Long-necked Turtle (*Chelodina longicollis*) (see Plate 10) and FFG listed Brolga (*Grus rubicundus*). Historically, the site was particularly important for Brolga, with twelve pairs sighted feeding and one nesting in the 1980s (see Appendix 6: Engagement Outcomes). Due to limited survey efforts, all other waterbird species have only been recorded in association with the dam: breeding Australasian Grebe (see Plate 10), Australian Wood Duck (*Chenonetta jubata*) and White-faced Heron (*Ardea novaehollandiae*). The significant water dependent species recorded at Creswick Swamp are shown in Table 33.

Creswick Dam also supports a number of frog species including Spotted Marsh Frog (*Limnodynastes tasmaniensis*) and Eastern Sign-bearing Froglet (*Crinia parinsignifera*) (Howard *et al.*, 2014; Rakali Ecological Consulting, 2014). The macroinvertebrate assemblage shows that the dam supports a high abundance (226 individuals) and richness (35 taxa) of macroinvertebrates. The majority of taxa are predatory species, although all feeding guilds are present in surveys (Howard *et al.*, 2014). Appendix 3: Fauna Species List shows the full species list for Creswick Swamp.

Eastern Long-necked Turtle, December 2013

Australasian Grebe (K. Howard [ARI], 2014)

Plate 10. Fauna of Creswick Swamp

Table 33. Significant water dependent fauna recorded at Creswick Swamp

Common name	Scientific name	Type	Last record	International agreement	EPBC status	FFG status	DELWP status
Brolga	*Grus rubicunda*	WB	1992			L	VU
Eastern Long-necked Turtle	*Chelodina longicollis*	RW	2014	N/A			DD

Legend
Type: Reptile Water dependent, Waterbird
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
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), DELWP (2014e), DSE (2013) and landholder records.

6.4.2 Flora and Vegetation Communities

Creswick Swamp is largely comprised of Plains Grassy Wetland- Lignum Swamp Complex (EVC A101). This EVC consists of an open shrubland of Tangled Lignum (*Duma florulenta*) with a grassy ground-layer including wetland dependent species such as Brown-back Wallaby–grass *(Rytidosperma duttonianum*), Common Nardoo (*Marisela drummondii*) and Swamp Billy-buttons (*Craspedia paludicola*). Of the 28 species recorded by Rakali Ecological Consulting (2014) 61 percent are native and 65 percent of these are considered water dependent. The EVC can be separated into two distinct zones, Zone 1 and Zone 2, based on condition.

The western side (Zone 2) occurs on private land and includes Dam No. 2. Zone 2 has been cultivated and native vegetation has been cleared. This zone no longer supports vegetation typical of this EVC and subsequently the condition is considered very poor. The eastern side (Zone 1) which is part of Creswick Swamp Wildlife Reserve is considered to be in moderate condition and supports a high diversity of threatened species. To date five significant water dependent species have been recorded as shown in Table 34, including Bluish Raspwort (*Haloragis glauca f. glauca*), Spiny Lignum (*Duma horrida subsp. horrida*) and a historical record of the FFG listed Marbled Marshwort (*Nymphoides spinulosperma*). The record of Marbled Marshwort is particularly important as it is known from only a few locations in Victoria, and Australia as a whole (ALA, 2014; Rakali Ecological Consulting, 2014). The soil in this zone has a strong gilgai profile and supports vegetation typical of the Plains Grassy Wetland component of this EVC whilst

the Tanged Lignum component is restricted to the more elevated ground of the gilgai puffs (Rakali Ecological Consulting, 2014).

The southern boundary of Plains Grassy Wetland-Lignum Swamp Complex- Zone 1 contains Creswick Dam which supports a high cover and structural diversity of submergent and emergent vegetation (83 percent of native species are water dependent), namely Water-milfoils (*Myriophyllum* spp.), Red Pondweed (*Potamogeton cheesemanii*), Water Ribbon (*Triglochin* spp.) and emergent grasses such as Southern Cane-grass (*Eragrostis infecunda*) and Common Blown-grass (*Lachnagrostis filiformis*) (Rakali Ecological Consulting, 2014; Howard et al., 2014). Plate 11 shows the water dependent EVC communities of Creswick Swamp and Table 35 summarises the conservation significance of these EVCs in the Wimmera Bioregion. Appendix 4: Ecological Vegetation Classes shows the extent of each EVCs present and Appendix 5: Flora Species List details the full species list for Creswick Swamp.

Table 34. Significant water dependent flora species recorded at Creswick Swamp

Common name	Scientific name	Type	Last record	EPBC status	FFG status	DELWP status	EVC found within
Bluish Raspwort	*Haloragis glauca f. glauca*	W	2013			k	A101
Long Eryngium	*Eryngium paludosum*	R, W	2013			v	A101
Marbled Marshwort	*Nymphoides spinulosperma*	W	1988		L	e	-
Pale Spike-sedge	*Eleocharis pallens*	R, W	2013			k	A101
Spiny Lignum	*Duma horrida subsp. horrida*	W	2013			r	A101

Legend
Type: Wetland dependent, River terrestrial
FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing
DELWP status: presumed eXtinct, , endangered, vulnerable, rare, near threatened, data deficient, poorly known
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), North Central CMA (2014b), DELWP (2014f), DSE (2005) and landholder records.

Plains Grassy Wetland- Lignum Swamp Complex (EVC A101)- Zone 1, June 2012

Plains Grassy Wetland- Lignum Swamp Complex (EVC A101)- Zone 2 (degraded), June 2012

Creswick Dam, December 2013 (K. Howard [ARI] 2014)

Plate 11. Vegetation communities of Creswick Swamp

Table 35. Conservation status of EVCs in Creswick Swamp

EVC no.	EVC name	Source	Wimmera Bioregional Conservation Status
A101	Plains Grassy Wetland - Lignum Swamp Complex	Rakali Ecological Consulting (2014)	Endangered
Source: Rakali Ecological Consulting (2014), Howard *et al.* , (2014), DELWP (2014d), DSE (2012)			

6.5 Terrestrial Species

6.5.1 Fauna

Creswick Swamp supports at least 11 terrestrial birds and one mammal species however none are listed as significant (DELWP, 2014e; Rakali Ecological Consulting, 2014; Howard et al. 2014). The full species list is shown in Appendix 3: Fauna Species List.

6.5.2 Flora and Vegetation Communities

Bordering the north-east to south-east boundary of Creswick Swamp is Plains Savanah (EVC 826) vegetation which is comprised of an open grassy plain with predominately scattered Buloke (*Allocasuarina luehmannii)* (Rakali Ecological Consulting, 2014) (see Plate 12). This zone supports four significant flora species, with Buloke (*Allocasuarina luehmannii*) and Turnip Copperburr (*Sclerolaena napiformis*) listed under the EPBC and FFG Act and Matted Flax-Lily (*Dianella amoena*) (see Plate 12) listed under the EPBC Act. Table 36 shows the conservation listing of each significant species at Creswick Swamp. A number of non-indigenous trees have been planted in this zone by Marnoo Landcare in 1989 as part of the Tree Victoria Grant (see Appendix 6: Engagement Outcomes for detail). Table 37 summarises the conservation significance of these EVCs in the Wimmera Bioregion, Appendix 4: Ecological Vegetation Classes shows the extent of each EVCs present and Appendix 5: Flora Species List details the full species list for Creswick Swamp.

Table 36. Significant terrestrial fauna species recorded at Creswick Swamp

Common name	Scientific name	Type	Last record	EPBC status	FFG status	DELWP status	EVC found within
Buloke	*Allocasuarina luehmannii*	T	2014	e[1]	L		826
Buloke Mistletoe	*Amyema linophylla subsp. orientale*	T	2013			v	826
Matted Flax-lily	*Dianella amoena*	T	2013	e		e	A101, 826
Turnip Copperburr	*Sclerolaena napiformis*	T	2013	e	L	e	826

Legend
Type: Terrestrial
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, , endangered, vulnerable, rare, near threatened, data deficient, poorly known
[1] Buloke (*Allocasuarina luehmannii*) is a principal species within the Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions community, a community that is listed as endangered under the EPBC Act 1999.
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), North Central CMA (2014b), DELWP (2014f), DSE (2005) and landholder records.

Matted Flax (D. Cook [Rakali Ecological Consulting] 2014) at Creswick Swamp

Plains Savanah (EVC 826) December 2013 on roadside near Creswick Swamp (D. Cook [Rakali Ecological Consulting] 2014)

Plate 12. Terrestrial vegetation of Creswick Swamp

Table 37. Conservation status of terrestrial EVCs in Creswick Swamp

EVC no.	EVC name	Source	Wimmera Bioregional Conservation Status
826	Plains Savannah	Rakali Ecological Consulting (2014)	Endangered
Source: Rakali Ecological Consulting (2014), Howard *et al.*, (2014), DELWP (2014d), DSE (2012)			

6.6 Current Condition and Threats

According to IWC assessment, Creswick Swamp is in moderate condition with an overall score of 68.4/100 (Table 38). The site scores poorly for wetland catchment and soil structure due to its history of clearing (farmland and roads), salinity (rising regional groundwater), illegal levee bank construction and drought. The biota component also scores poorly with a rating of 6.9/20. This is also due to the fact that more than half of its original area is now farmland. This zone, known as Zone 2, received a biota score of 2/20 compared to the neighboring Zone 1 (reserve area) that scored 15/20 (Rakali Ecological Consulting, 2014). The construction of the road has reduced the extend and depth of watering able to be achieved without inundating private property.

Table 38. IWC Assessment for Creswick Swamp

IWC sub-index	Wetland catchment	Physical form	Hydrology	Water properties	Soils	Biota	Overall IWC score
Score/ 20	9	16.5	15	15	6	6.9	**68.4**
Category	Poor	Good	Good	Good	Poor	Very poor	**Moderate**
Source: Rakali Ecological Consulting (2014)							

Chirrup Dam is however considered to be in moderate condition with good aquatic vegetation and water dependent fauna values (Table 39). However the fringing aquatic vegetation is considered limited reducing habitat and shelter for turtles and waterbirds.

Table 39. Condition of key attributes of Creswick Dam

Indicator	Aquatic vegetation	Fringing vegetation	Morphology	Water dependent fauna	Overall rating
Score/ 3	3	1	2	2	**8**
Category	Excellent	Poor	Moderate	Moderate	**Moderate**
Key					
Score	**Rating**	**Aquatic vegetation (no. of species)**	**Fringing vegetation (cover)**	**Morphology (bank steepness)**	**Water dependent fauna (no. of species)**
1	Poor	< 4 species	Sparse or no cover	>20 cm/ metre	<10 species
2	Moderate	4-10 species	Sparse to good cover	10-20 cm/ metre	10-20 species
3	Excellent	>10 species	high cover	<10 cm/ metre	>20 species

6.6.1 Condition Trajectory

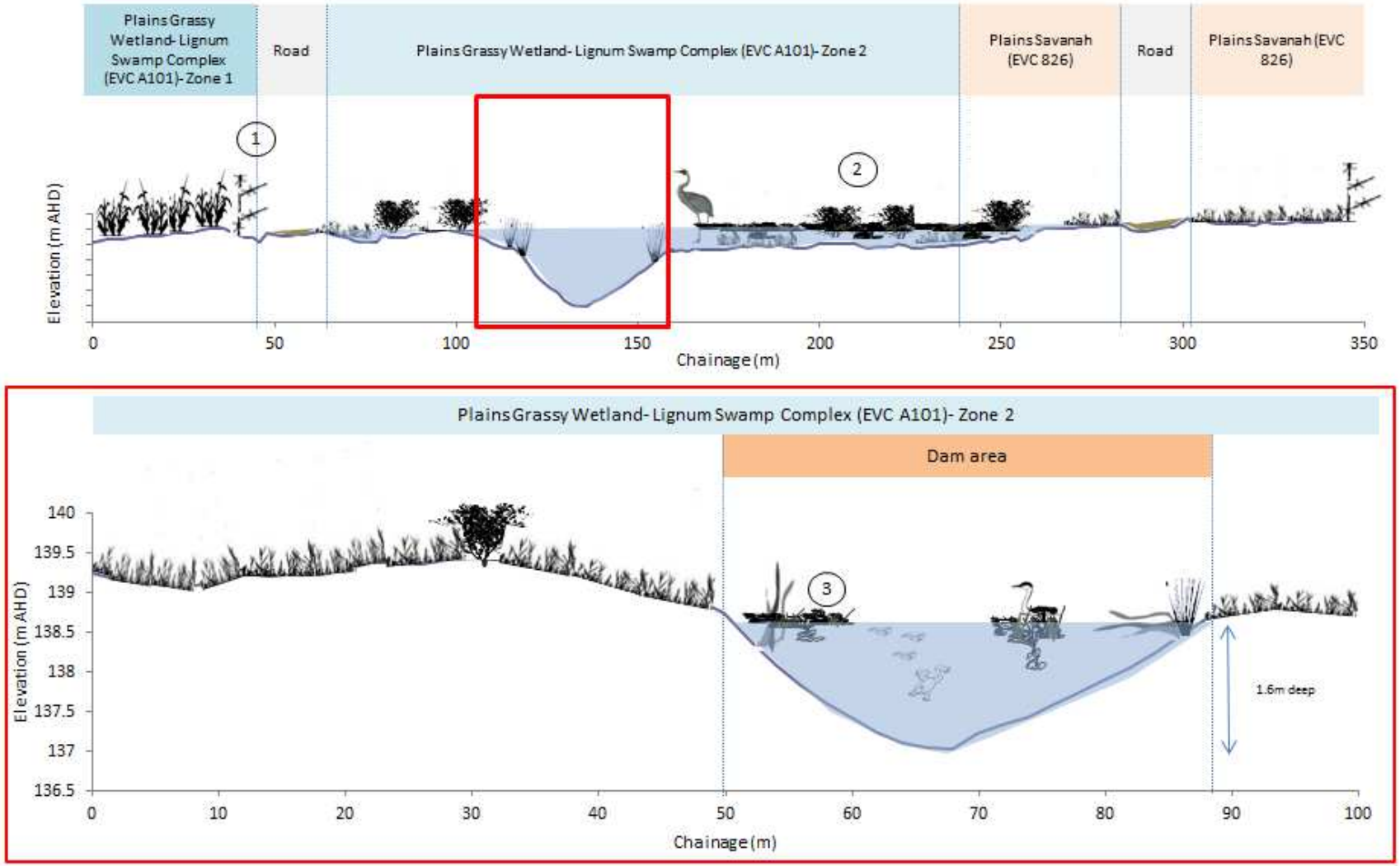
It is likely that the condition of Creswick Swamp will continue to decline into the future due to its highly modified nature. The area no longer floods as it would have naturally due to the construction of roads and levees in the region. Improvements to the wetland would require the construction of a ring levee, or the acquisition of the neighboring private land for rehabilitation. Both measures are considered costly and are unlikely to be funded. However Creswick Dam is likely to continue to maintain conditions that support water dependent fauna like frogs and turtles although these conditions will be intermittent.

6.6.1.1 Do Nothing

Creswick Dam maintains habitat for turtles and frogs due to its abundance of aquatic plants. Without the delivery of environmental water, these conditions will not be maintained. As detailed in see Section 3.4.3, compared to the other WMP sites Creswick Swamp has the greatest number of potential surrounding waterbodies. However the ability for species to recolonise these will is be dependent on climatic conditions and proximity.

Inundation of Creswick Dam may also provide a rare opportunity to re-establish the FFG listed Marbled Marshwort, which naturally occurred at the site. This species is unlikely to re-establish at the site naturally without the delivery of environmental water.

6.7 Conceptualisation of Site



N.B. cross section not to scale

Key descriptions:

1. The wetland has been severely impacted by agricultural development. Over half of its area is now farmland and a track has been constructed across the bed. These areas commence to flood at low inundation levels.
2. Lignum (on elevated gilgai puffs) and aquatic vegetation historically supported breeding and feeding brolga. This zone, which is also rich in threatened flora species, is promoted by wetting and drying and shows signs of water stress.
3. Creswick Dam supports a relatively high diversity of aquatic plants; however the littoral zone is sparse making water dependent fauna (i.e. turtles and waterbirds) vulnerable to predation. The aquatic food web is supported by vegetation diversity.

6.8 Management Objectives

6.8.1 Management Goal

A long-term management goal (i.e. ten years) for Creswick Swamp (Reserve component) and Creswick Dam has been developed based on the information derived from Rakali Ecological Consulting (2014) and Howard et al., (2014) and presented in Section 6. However, due to the size of Creswick Swamp, the current capacity restrictions of the WMP and the risk of flooding private land, this section will only focus on management of Creswick Dam and a small area of the wetland bed. Management objectives, ecological and hydrological objectives and a recommended watering regime for Creswick Swamp are presented in Appendix 10: Wetland Management Objectives. Please note that consideration has been given for wetland ecological objectives that may benefit (either fully or in part) from environmental water delivery to the dam. This includes opportunities to overtop dam banks to provide low-level inundation.

Creswick Dam environmental water management goal

Support a diversity of aquatic plants, including re-establishment of Marbled Marshwort that will provide refuge, feeding and breeding opportunities for frog and turtles at Creswick Dam.

6.8.2 Ecological Objectives

The ecological objectives and justification for the management goal presented in Section 6.8.2 are presented below in Table 40.

Table 40. Ecological objectives of Creswick Dam

Ecological objective	Justification
1. Maintain cover and density of **aquatic plants**	- Provide shelter, feeding and breeding opportunities for frogs, turtles and waterbirds - Assist with nutrient cycling (i.e. biofilms/bacteria on surface of plants) and filtering of water - Support wetland ecological objectives relating to aquatic plants and waterbirds *Objective may require active intervention i.e. revegetation, bank modification work to allow achievement (see Section 13).*
2. Increase diversity of **littoral vegetation** (i.e. emergent vegetation)	- Provide shelter, protection and feeding opportunities for waterbirds, frogs and turtles - Reduce predation by foxes on waterbirds and turtles - Provide organic material and protect soils from erosion - Support wetland ecological objectives relating to aquatic plants and waterbirds (see Appendix 10: Wetland Management Objectives)
3. Re-establish **Marbled Marshwort** in dam	- Species is rare in Victoria and historically existed at site - Facilitation of colonisation at the dam will safeguard population at Creswick Swamp (species required annual flooding)

Ecological objective	Justification
4. Maintain **frog and turtle breeding and feeding** opportunities	- Provide not only refuge but resources (i.e. shelter, feeding) to promote breeding and ensure long term survival as well as colonisation of Creswick Swamp should natural flooding occur - Provide food sources for waterbirds and turtles - Objective based on achievement of ecological objective 1

6.8.3 Hydrological Objectives

Hydrological objectives are based on the hydrological requirements of the ecological objectives detailed in Section 5.8.2 and shown below in Table 41. The information provided below is a summary of this information with specific detail and justification given in Appendix 8: Water Requirements for Values and Appendix 9: Hydrological Objectives.

Table 41. Hydrological objectives of Creswick Dam

		Description
Timing		Provide fresh inflows to fill Creswick Dam and overtop to inundate a small area of the wetland bed, most often in late winter/ early spring. In following year, fill Creswick Dam only between July and November (with variability in some years).
Watering frequency	Minimum[1]	Annual/ as required to maintain permanency in dam (no overtopping to occur).
	Optimum	Water Creswick Dam (only) annually/ as required to maintain permanency (10 in 10 years). Allow overtop 5 in every 10 years.
	Maximum	Water Creswick Dam (only) annually/ as required to maintain permanency (10 in 10 years). Allow overtop 7 in every 10 years.
Ponding duration	Minimum[1]	Permanent ponding in Creswick Dam (only) unless water is present in Dam No. 2 (the result of significant catchment runoff). Re-fill required prior to Dam No. 2 drying out.
	Optimum	Permanent ponding in Creswick Dam (only). Bed of wetland to be inundated for 1-6 months.
	Maximum	Permanent ponding in Creswick Dam (only)[2]. Bed of wetland to be inundated for 8-12 months.
Duration of dry between events	Minimum[1]	No drying at Creswick Dam (only) to occur unless there is significant natural flooding at Chirrup Swamp- duration would depend on long flood water is retained in Chirrup Swamp (aim is to not have them dry at same time).
	Optimum	
	Maximum	
Extent		CRESWICK DAM (ONLY): up to 1.6 metres (138.6 m AHD) OVERTOP: <0.2 m in wetland bed (138.6-138.8 m AHD)
Variability		Mimic natural variability by providing occasional watering events outside of the optimum timing (i.e. summer fill to mimic summer thunder storm event)
Estimated volume per event		At least 5.7 ML

[1] Under extremely dry catchment conditions and low to no allocations the application of prioritisation criteria in Section 3.5.4 will apply. This may result in a low priority ranking for the site, and as such insufficient water resources to maintain the minimum regime (i.e. thus the need to dry the site).

[2] Maintaining depth during wet years may increase the chance of natural flooding at Creswick Swamp by removing the need to initial fill the dam airspace.

6.8.4 Watering Regime

The optimum watering regime for Creswick Dam is derived from the ecological and hydrological objectives presented in Section 6.8. The regime should be managed adaptively to account for climatic variation and water availability.

Creswick Dam optimum watering regime

Permanent with variability

Provide fresh inflows between late winter and spring to fill Creswick Dam (138.6 m AHD), and if feasible overtop (138.8 m AHD) to inundate a small area of the wetland bed (maximum depth of 0.2 metres to ensure private property and road are not impacted). Provide top-ups to maintain depth, with variation, for approximately 6 months promoting frog and turtle breeding. Allow dam and wetland bed to drawdown; however maintain depth within Creswick Dam above 138 m AHD (1 metre) to ensure maintenance of turtle population.

In following year, provide fresh inflows to top-up Creswick Dam as required (preferably between July and November to promote plant growth and frog and turtle breeding) but do not overtop.

7 Davis Wetland

7.1 Catchment Setting

Davis Wetland is a 20 hectare natural wetland on private land located to the north of Lake Buloke, outside the ancient lunette system. Although there are no historical records, it is thought that a small dam, known as Davis Dam, was constructed shortly after the Morton Plains area was settled in the 1840s (N. Davis [landowner] pers. comm., 17 July 2014). During this time, squatters initially congregated around areas with reliable water sources (i.e. Watchem, Tchum and Marlbed Lakes in the Mallee) however as the number of pastoralists increased, land with less reliable water was taken up and catchment dams were built (McMahon et al., 2003). Davis Dam is connected to the WMP and is the focus of environmental water delivery.

7.2 Land Use

The property is surrounded by extensively cleared land utilised predominately for grazing and cropping. The current landholder recalls that the south west corner of the parcel was cropped up until 1979 and the entire parcel grazed by sheep until 1982 (N. Davis [landowner] pers. comm., 17 July 2014). In 2005 the parcel was crash grazed for approximately three weeks by 300 ewes as a means of controlling exotic species (i.e. Wild Oat). The landholder has continued to manage the area for pest plant and animals and in 2003 a Trust for Nature Covenant was applied to 33 hectares of the land parcel (Hutchinson, 2010).

7.3 Hydrology

The majority of Davis Wetland is relatively flat (bed level of ~106.8 m AHD) with a small lunette area to the east of the land parcel. When inundated, the wetland has a depth of approximately 0.6 metres (FSL of 107.4 m AHD). Davis Dam, which is approximately 740 m^2 in size and 0.8 metres deep (bed level of 106.4 m AHD), is located to the south-east of the main wetland area and was connected to the WMP in early 2013. The north, west and east banks of the dam are relatively steep with a rise of approximately 13 cm/metre to the FSL of 107.4 m AHD, whilst the southern boundary maintains a more gradual incline of approximately 8 cm/metre. The dam can be overtopped to provide low level inundation to a small area of the wetland. The landholder recalls that the dam only fills when the low-lying areas of the land parcel flood (N. Davis [landowner] pers. comm., 14 October 2014). The dam received its first delivery of environmental water in autumn 2014 (Table 42) (North Central CMA, 2014a). Appendix 2: Bathymetry and Capacity Tables, shows the bathymetry of Davis Wetland and Figure 8 below shows the location and key features described above.

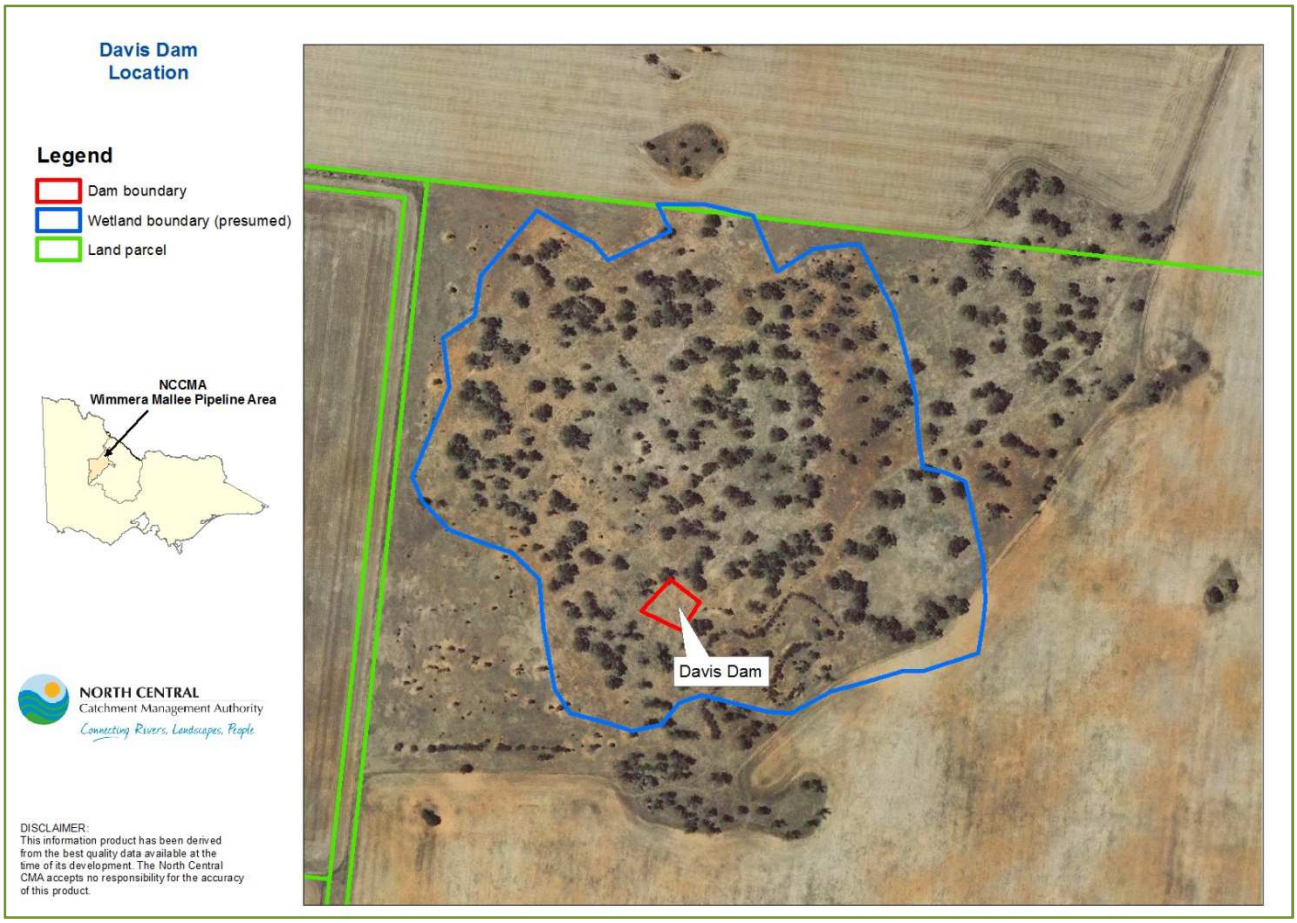


Figure 8. Davis Wetland location map

Table 42. Watering history of Davis Wetland

Watering History	Season							
	2010-2011[1]		2011-2012[1]		2012 -2013		2013-14	
	Wetland	Dam	Wetland	Dam	Wetland	Dam	Wetland	Dam
Status *	W	W	D	D	D	D	D	D-W
Water source #	F	F	-	-	-	-	-	E
Volume (ML)	U	U	0	0	0	0	0	0.614
Notes	Flooding in summer 2010-11		Dried by July-Aug 2011		Dry		Dam received fill from empty in autumn	
KEY:								
Unknown/ Environmental water allocation / Flood inundation								
W Water for entire year		D-W Dry at start of year, filled later			D Dry for entire year			
[1]Likely status as advised by Parks Victoria, landholders and general topographical understanding of the landscape								

7.4 Water Dependent Values

7.4.1 Fauna

A limited number of fauna surveys have been undertaken at Davis Wetland, and as result the only species recorded at the site are White-necked Heron (*Ardea pacifica)* (shown in Plate 13), Wood Duck (*Chenonetta jubata*), Grey Teal (*Anas gracilis*), Pacific Black Duck (*Anas superciliosa*) and Australian Shelduck (*Tadorna tadornoides)* (June 2014) (B. Bisset pers obs., 11 June 2014; N. Davis pers. comm., 2014). Frog, turtle and macroinvertebrate surveys have not been undertaken however a number of frogs have been heard calling by the landholder when the dam or Cane Grass

swamp area has been inundated (N. Davis pers. comm., 17 July 2014). A full species list in available in Appendix 3: Fauna Species List.

Plate 13. White-necked Heron, 11 June 2014 at Davis Wetland

7.4.2 Flora and Vegetation Communities

Prior to discussions with the landholder, Davis Wetland was mapped entirely as Plains Savanah (EVC 826) vegetation (Appendix 4: Ecological Vegetation Classes). However photographic evidence as well as accounts from the landholder suggests that sections of the land parcel are more representative of Black Box Wetland (EVC 369) and Cane Grass Wetland (EVC 291) vegetation. These areas support four significant species as shown in Table 43- Blue Burr-daisy (*Calotis cuneifolia*), Leafless Bluebush (*Maireana aphylla*), Three-nerve Wattle (*Acacia trineura)* and Cane Grass (*Eragrostis austrlasica*). The majority of the Cane Grass is located near the south and south-eastern boundaries of the land parcel (Hutchinson, 2010). Detailed assessment of the dam area has not been undertaken as the site was dried at the time of survey (Rakali Ecological Consulting, 2014). Table 43 summarises the conservation significance of these EVCs in the Wimmera Bioregion and Plate 14 shows the water dependent habitat types present at Davis Dam. Appendix 4: Ecological Vegetation Classes and Appendix 5: Flora Species List details the EVC and species recorded at Davis Dam.

Table 43. Significant water dependent species recorded at Davis Wetland

Common name	Scientific name	Type	Last record	EPBC status	FFG status	DELWP status	EVC found within
Blue Burr-daisy	*Calotis cuneifolia*	R	2010			r	-
Cane Grass	*Eragrostis australasica*	W	1994			v	-
Leafless Bluebush	*Maireana aphylla*	R	1994			k	-
Three-nerve Wattle	*Acacia trineura*	R	2010			v	-

Legend
Type: Wetland dependent, River terrestrial, Terrestrial,
DELWP status: presumed eXtinct, endangered, vulnerable, rare, near threatened, data deficient, poorly known
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), North Central CMA (2014b), DELWP (2014f), DSE (2005) and landholder records.

Davis Dam, June 2014

Cane Grass Swamp area
(photo supplied by N. & S. Davis, 2014)

Plate 14. Water dependent vegetation communities of Davis Wetland

Table 44. Conservation status of water dependent EVCs in Davis Wetland

EVC no.	EVC name	Source	Wimmera Bioregional Conservation Status
291	Cane Grass Wetland	D. Cook (Rakali Ecological Consulting) pers comm., 13 November 2014	Vulnerable
369	Black Box Wetland	D. Cook (Rakali Ecological Consulting) pers comm., 13 November 2014	Endangered
Source: D. Cook (Rakali Ecological Consulting) pers comm., (13 November 2014), DELWP (2014d), DSE (2012) Please note that Appendix XX has the original mapping of Plains Savanah (EVC 826)			

7.5 Terrestrial Species

7.5.1 Fauna

The majority of fauna records for Davis Wetland are for terrestrial species. This includes two mammal species the Common Brushtail Possum (*Trichosurus vulpecula*) and Eastern Grey Kangaroo (*Macropus giganteus*) as well as 18 native bird species (DELWP, 2014e; Rakali Ecological Consulting, 2014; Hutchinson, 2010). Of the bird species recorded, two are considered significant: the near threatened Brown Treecreeper and the vulnerable Black Falcon (*Falco subniger*) which are shown in Table 45. The recent environmental watering event at Davis Dam also attracted a number of native species such as the Wedge-tailed Eagle (*Aquila audax*) as shown in Plate 15.

The landholder also recalls observing the FFG listed Bush Stone Curlew (*Burhinus grallarius*) during in the mid-1970s before the land parcel was grazed (N. Davis pers. comm., 17 July 2014). It is also possible that the grassland habitat of the land parcel supports the near threatened Fat-tailed Dunnart (*Sminthopsis crassicaudata)* (Hutchinson, 2010) which favors open woodland, grassland and shrubland habitats with ample fallen timber and tree stumps (Morton, 1976). Appendix 3: Fauna Species List shows the full species list for Davis Wetland.

Plate 15. Wedge-tailed Eagle at Davis Dam (photo supplied by N. & S. Davis, 2014)

Table 45. Significant terrestrial fauna species recorded at Davis Wetland

Common name	Scientific name	Type	Last record	Inter-national agreement	EPBC status	FFG status	DELWP status
Brown Treecreeper	*Climacteris picumnus*	TB*	2010				NT
Black Falcon	*Falco subniger*	TB	2010				VU
Bush Stone Curlew	*Burhinus grallarius*	TB[1]	~1970			L	EN

Legend
Type: Terrestrial Bird
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
*Refers to species that are dependent on water dependent vegetation/ [1]Ancedotal record form landholder
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), DELWP (2014e), DSE (2013) and landholder records.

7.5.2 Flora and Vegetation Communities

Davis Wetland is mapped as predominately Plains Savanah (EVC 826) vegetation including scattered Black Box (*Eculayptus largiflorens*) and Buloke (*Allocasuarina leuhmannii*) (Rakali Ecological Consulting, 2014). The majority of these trees are old, full of hollows and of various sizes with a good amount of fallen timber supporting a variety of woodland birds, arboreal mammals and reptile species (Hutchinson, 2010). As shown in Table 46, five listed flora

species including the EPBC listed Chariot Wheels (*Maireana cheelii*) and vulnerable Buloke Mistletoe (*Amyema linophylla subsp. orientale)* and Winged New Holland Daisy (*Vittadinia pterochaeta*) as present at Davis Wetland. Direct-seeding of native species has also occurred at the site, which has increased the cover and diversity of species of the shrub-layer including Grey Mulga (*Acacia brachybotrya*), Manna Wattle (*Acacia microcarpa*) and Desert Cassia (*Senna artemisioides spp. agg*.). The understorey supports a diversity of natural occurring native grasses however herb diversity is low, an artefact of past grazing practices (Rakali Ecological Consulting, 2014). Table 46 summarises the conservation significance of these EVCs in the Wimmera Bioregion, Appendix 4: Ecological Vegetation Classes shows the extent of each EVCs present and Appendix 5: Flora Species List details the full species list for Davis Wetland.

Table 46. Significant terrestrial species recorded at Davis Wetland

Common name	Scientific name	Type	Last record	EPBC status	FFG status	DELWP status	EVC found within
Black Roly-poly	*Sclerolaena muricata*	T	2010			k	-
Buloke Mistletoe	*Amyema linophylla subsp. orientale*	T	2014			v	826
Chariot Wheels	*Maireana cheelii*	T	1994	v		v	-
Fuzzy New Holland Daisy	*Vittadinia cuneata var. hirsuta*	T	1994			r	-
Winged New Holland Daisy	*Vittadinia pterochaeta*	T	1994			v	-

Legend
Type: Terrestrial
EPBC status: EXtinct, CRitically endangered, ENdangered, VUlnerable, Conservation Dependent, Not Listed
DELWP status: presumed eXtinct, , endangered, vulnerable, rare, near threatened, data deficient, poorly known
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), North Central CMA (2014b), DELWP (2014f), DSE (2005) and landholder records.

Plains Savanah (EVC 826), June 2014

Buloke trees (photo supplied by N. & S. Davis, 2014)

Plate 16. Terrestrial EVCs of Davis Wetland

Table 47. Conservation status of EVCs in Davis Wetland

EVC no.	EVC name	Source	Wimmera Bioregional Conservation Status
826	Plains Savannah	Rakali Ecological Consulting (2014)	Endangered
Source: Rakali Ecological Consulting (2014), Howard *et al.*, (2014), DELWP (2014d), DSE (2012)			

7.6 Current Condition and Threats

7.6.1 Current Condition

Davis Wetland was not assessed as part of the Rakali Ecological Consulting (2014) IWC assessments, as it was originally determined to be terrestrial. However according to the methodology in Section 3.4.1, the dam area was identified to be in moderate condition (Table 48). The fringing vegetation scored high due to its diversity and abundance (based on visual analysis), whilst morphology and aquatic vegetation scored moderately. At the time of the assessment, the dam

was supporting a low diversity and abundance of water dependent fauna, with the majority of species using the dam being terrestrial.

Table 48. Condition of key attributes of Davis Wetland

Indicator	Aquatic vegetation	Fringing vegetation	Morphology	Water dependent fauna	Overall rating
Score/ 3	2	3	2	1	**8**
Category	Moderate	Excellent	Moderate	Poor	**Moderate**
Key					
Score	**Rating**	**Aquatic vegetation (no. of species)**	**Fringing vegetation (cover)**	**Morphology (bank steepness)**	**Water dependent fauna (no. of species)**
1	Poor	< 4 species	Sparse or no cover	>20 cm/ metre	<10 species
2	Moderate	4-10 species	Sparse to good cover	10-20 cm/ metre	10-20 species
3	Excellent	>10 species	high cover	<10 cm/ metre	>20 species

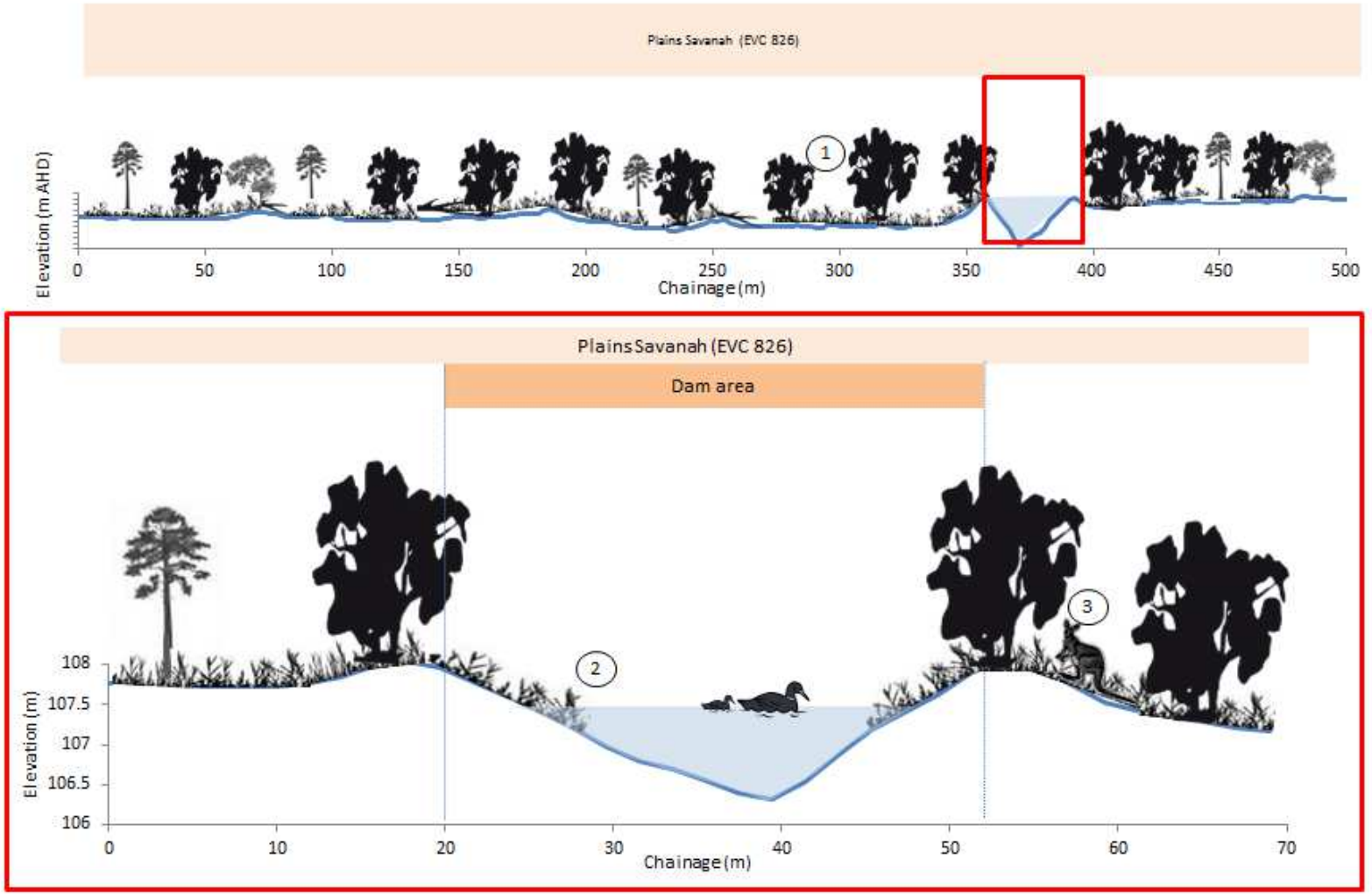
7.6.2 Condition Trajectory

The surrounding woodland/ grassland zone of Davis Dam is in relatively good condition, occasionally receiving inundation during high rainfall events. However due to extensive clearing, the land parcel is extremely isolated from other remnant vegetation patches and waterbodies in the landscape. The dam has higher importance as a watering point in the landscape during dry conditions when it may be one of only a handful of aquatic sites in the landscape.

7.6.2.1 Do Nothing

Davis Dam is located in an area that experiences relatively low rainfall and is isolated in terms of nearby surrounding waterbodies. Without the delivery of environmental water it is likely that the survival of water dependent and terrestrial fauna, particularly those with low mobility or reliant on the surrounding woodland habitat, will be threatened. However the shallow depth and low water holding capacity of the dam, makes it an unlikely candidate for permanent inundation. Therefore the main objective for water supply is to provide aquatic refuge during summer or during dry years to complement the surrounding woodland habitat.

7.7 Conceptualisation of Site



N.B. cross section not to scale

Key descriptions:

1. Cane Grass support frogs and ground dwelling waterbirds that seek refuge in the highly productive woodland zone. Frogs, including tadpoles, provide an important food source for arboreal mammals such as the Fat-tailed Dunnart.
2. The diversity and abundance of aquatic plants is moderate and has simple habitat structure. The gently sloping southern bank is best suited for the growth and establishment of aquatic species.
3. A diverse range of waterbirds utilise the refuge created by the dam for feeding
4. Surrounding Black Box woodland zone supports a range of terrestrial species. Highly isolated nature of the land parcel combined with a lack of alternative water sources in the landscape; make the dam an important watering point.

7.8 Management Objectives

7.8.1 Management Goal

A long-term management goal (i.e. ten years) for Davis Wetland and Davis Dam have been developed based on the information derived from Rakali Ecological Consulting (2014) and Howard et al., (2014) and presented in Section 1. However, due to the current capacity restrictions of the WMP and the risk of flooding private land, this section will only focus primarily on management of Davis Dam and a small area of the adjoining wetland bed. Management objectives, ecological and hydrological objectives and a recommended watering regime for Davis Wetland are presented in Appendix 10: Wetland Management Objectives. Please note that consideration has been given for wetland ecological objectives that may benefit (either fully or in part) from environmental water delivery to the dam. This includes opportunities to overtop dam banks to provide low-level inundation.

Davis Dam environmental water management goal

Support the fauna (particularly that of the surrounding Black Box vegetation) of Davis Dam by providing drought refuge and a watering point for fauna (including mammals, reptiles and waterbirds).

7.8.2 Ecological Objectives

The ecological objectives and justification for the management goal presented in Section 7.8.1 are presented below in Table 49.

Table 49. Ecological objectives for Davis Dam

Ecological objective	Justification
1. Increase **aquatic and littoral vegetation**	- Provide shelter, feeding and breeding opportunities for water dependent fauna (i.e. waterbirds, frogs and turtles, macroinvertebrates) - Linked to wetland ecological objectives for waterbirds *Objective may require active intervention i.e. revegetation, bank modification work to allow achievement (see Section 13).*
2. Maintain **waterbird feeding** opportunities	- Aquatic vegetation provides plant material for feeding - Objective based on achievement of ecological objective 1
3. Provide a **watering point** for terrestrial species	- Support terrestrial fauna including near threatened Brown Treecreeper, vulnerable Black Falcon and potentially Bush Stone Curlew and Fat-tailed Dunnart - Isolated from other waterbodies in the landscape.

7.8.3 Hydrological Objectives

Hydrological objectives are based on the hydrological requirements of the ecological objectives detailed in Section 7.8.2. The information provided below is Table 50 summarises this information with specific detail and justification given in Appendix 8: Water Requirements for Values and Appendix 9: Hydrological Objectives.

Table 50. Hydrological objectives for Davis Dam

		Description
Timing		Provide fresh inflows to Davis Dam most often in winter to ensure overtopping to inundate a small area of the wetland bed can occur in spring. In following year, fill Davis Dam (only) most often between August and September and top-up as required as required to maintain depth target.
Watering frequency	Minimum[1]	Watering of Davis Dam (no overtopping to occur) 1-2 in every 10 years
	Optimum	Water Davis Dam (only) annually to maintain seasonal regime (10 in 10 years). Allow overtop to inundate small area of wetland 3 in every 10 years.
	Maximum	Water Davis Dam (only) annually to maintain seasonal regime (10 in 10 years). Allow overtop to inundate small area of wetland 5 in every 10 years.
Ponding duration	Minimum[1]	1-2 months in Davis Dam (no overtop).
	Optimum	4-6 months in Davis Dam (only) and 1-6 months in wetland bed
	Maximum	Permanent ponding in Davis Dam (only) and 3-9 months in wetland bed[2]
Duration of dry between events	Minimum[1]	3 months in Davis Dam (only)
	Optimum	6-8 months for Davis Dam (only) and 1-2 years for bed of wetland.
	Maximum	Permanent for Davis Dam and 2-3 years for bed of wetland
Extent		DAVIS DAM (ONLY): 0.5-2 metres (105.9-107.4 m AHD) OVERTOP: 0.4 metres in bed (107.2-107.4 m AHD)
Variability		High- mimic natural variability by providing occasional watering events outside of the optimum timing (i.e. summer fill to mimic summer thunder storm event
Estimated volume per event		At least 11 ML

[1] Under extremely dry catchment conditions and low to no allocations the application of prioritisation criteria in Section 3.5.4 will apply. This may result in a low priority ranking for the site, and as such insufficient water resources to maintain the minimum regime (i.e. thus the need to dry the site).
[2] Maintaining depth during wet years may increase the chance of natural flooding at Davis Wetland by removing the need to initial fill the dam airspace.

7.8.4 Watering Regime

The optimum watering regime for Davis Dam is derived from the ecological and hydrological objectives presented in Sections 7.8.2 and 7.8.3. The regime should be managed adaptively to account for climatic variation and water availability.

Davis Dam optimum watering regime

Intermittent- annual fill of dam with overtop occurring 3 in every 10 years

Provide fresh inflows to fill and overtop (~107.4 m AHD) Davis Dam to provide up to 0.4 metres of depth to a small area of the wetland bed during spring (107.2 m AHD). Maintain depth with variability for 4-6 months before allowing drawdown and retraction back to Davis Dam. Maintain depth in Davis Dam above 105.9 m AHD (0.5 metre) through summer (if catchment and resources conditions allow) to maintain as a watering point. Allow to drawdown and dry naturally through remainder of year.

In following year, provide top-ups (most often between August and September, but at other times are required) to maintain depth between 105.9-107.4 m AHD (0.5-1.5 metres) through summer (if catchment and resources conditions allow) in Davis Dam. Allow to drawdown and dry naturally through remainder of year. Allow surrounding wetland bed to remain dry for two to three years before overtopping again.

8 Falla Dam

8.1 Catchment Setting

Falla Dam is a constructed dam on private property located on the south-western edge of Lake Buloke. The entire surrounding Lake Buloke area would have been Plains Woodland or Forest vegetation before European settlement (DELWP, 2014a).

8.2 Land Use

There is no information regarding the history of Falla Dam prior to its purchase by the current landholder in the early 1950s. The dam was initially used for stock and domestic supply and serviced the adjacent chicken farm and farmhouse (across the road). In the 1990s a second farmhouse was built at the northern boundary of the dam. The dam was cleaned out in the late 1970s during drought conditions, and has an estimated depth of 3.8 meters. In the mid-2000s the dam was fully fenced to exclude all stock and to protect a number of non-indigenous shrubs and trees that were planted by the landholder. The dam is now no longer utilised for stock and domestic supply and has been retained by the landholder for wildlife provision. The dam dried shortly after the pipeline was completed and received runoff during the 2010-11 flooding event (D. Falla [landowner] pers. comm., 14 October 2014).

8.3 Hydrology

In early 2013, Falla Dam was connected to the WMP and received its first delivery of environmental water in autumn 2014 (Table 51). At the time, the dam was still retaining water from the 2010-11 floods at was at approximately ten percent capacity (North Central CMA, 2014a). It is bordered by a large spoil heap that rises to approximately 2.5 metres above the FSL of the dam (FSL of 117 m AHD). The dam is at least 1.8 metres deep (~115.2 m AHD, has banks that are extremely steep and an average rise of 27 cm/ metre. Appendix 2: Bathymetry and Capacity Tables, shows the bathymetry of Falla Dam and Figure 9 shows the location and key features described above.

Figure 9. Falla Dam location map

Table 51. Watering history of Falla Dam

Watering History	Season			
	2010-2011	2011-2012	2012 -2013	2013-14
	Dam	Dam	Dam	Dam
Status *	W	W	W	W
Water source #	F	-	-	E
Volume (ML)	U	0	0	1.63
Notes	Flooded in summer 2010-11	Remained inundated	Remained inundated	Received top-up in autumn
KEY:				
Unknown/ Environmental water allocation / Flood inundation				
W Water for entire year				
[1]Likely status as advised by Parks Victoria, landholders and general topographical understanding of the landscape				

8.4 Water Dependent Values

8.4.1 Fauna

There are no water dependent fauna species records in the Victorian Biodiversity Atlas (DELWP, 2014e) at Falla Dam. The recent Rakali Ecological Consulting (2014) and Howard *et al.,* (2014) surveys also failed to confirm the presence of any water dependent species, due to the site being dry at the time of survey. Anecdotally, the dam has supported water dependent Black-tailed Native-hen (*Tribonyx ventralis*), Pink-eared Duck (*Malacorhynchus membranaceus*), Wood Duck (*Chenonetta jubata*) (including juveniles) (shown in Plate 17), Australasian Grebe (*Tachybaptus novaehollandiae*) and Australian Shelduck (*Tadorna tadornoides*) when inundated (D. Falla pers. comm., 9 May 2014). Frog, turtle and macroinvertebrate surveys have not been undertaken at the site to date, however the landholder has

heart frog calling (D. Falla [landowner], 14 October 2014). Appendix 3: Fauna Species List shows the full species list for Falla Dam.

Plate 17. Wood Ducks (11 July 2014) at Falla Dam

8.4.2 Flora and Vegetation Communities

As Falla Dam is not part of a natural wetland area, EVCs were not mapped for the site. In April 2012 the aquatic species Pond Weed (*Potamogeton* spp.) was observed in Falla dam (B. Bisset [North Central CMA] pers. obs., 29 April 2014). This is the only water dependent flora species record for the site and was observed following the 2010-11 floods when water levels were below ten percent. Recent surveys following the delivery of environmental water in early winter 2014, failed to confirm the presence of the species (I. Higgins [North Central CMA], pers. comm., 8 June 2014). The landholder has recent advised that he has planted a number of rushes (*Juncus* spp.) at the water's edge in winter 2014 (D. Falla [landowner] pers. comm., 14 October 2014). Plate 18 shows the habitat types present with Appendix 5: Flora Species List summarizing the full species list for Falla Dam.

Falla Dam, June 2014

Pond Weed in dam (29 April 2012) at Falla Dam

Plate 18. Vegetation communities of Falla Dam

8.5 Terrestrial Species

8.5.1 Fauna

Although there are no terrestrial fauna records for the site it assumed that it is frequented by mobile species (i.e. mammals and birds) due to its position in the landscape and lack of surrounding water.

8.5.2 Flora and Vegetation Communities

A total of 50 terrestrial flora species have been identified at Falla Dam, 30 of which are considered native to Australia (DELWP, 2014f; North Central CMA, 2014b; Rakali Ecological Consulting, 2014). Eighteen of the native plants are non-indigenous (i.e. from Western Australia) small trees and shrubs species such as eucalyptus and wattles which have

been planted by the landholder (Rakali Ecological Consulting, 2014). Planted species include the rare Pearl Bluebush (*Maireana sedifolia*) and the FFG listed Salt Paperbark (*Melaleuca halmaturorum* subsp. *halmaturorum*) and Swamp Sheoak (*Casuarina obesa*) (North Central CMA, 2014b). Another species, which could only be identified in the field to the genus level (see Table 52), is likely to be either Riverine Flax-lily (*Dianella porracea)* or Pale Flax-lily (*Dianella* spp. aff. *longifolia* [Riverina]) both of which are considered vulnerable in Victoria. Table 52 shows the conservation status of significant species recorded at Falla Dam. A full species list is available in Appendix 5: Flora Species List.

Plate 19. *Dianella* spp., (2 July 2014) Falla Dam

Table 52. Significant terrestrial flora species recorded at Falla Dam

Common name	Scientific name	Type	Last record	EPBC status	FFG status	DELWP status	EVC found within
Pale Flax-lily[1]	*Dianella longifolia s.l.*	T	2014			v	-
Pearl Bluebush+	*Maireana sedifolia*	T	2014			r	-
Salt Paperbark+	*Melaleuca halmaturorum subsp. halmaturorum*	T	2014		L	v	-
Swamp Sheoak+	*Casuarina obesa*	T	2014		L	e	-

Legend
Type: Terrestrial
FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing
DELWP status: presumed eXtinct, , endangered, vulnerable, rare, near threatened, data deficient, poorly known
[1]Specimen has not been identified to species level, however likely to be Riverine Flax-lily (*Dianella porracea*) or Pale flax-lily (*Dianellla* sp. aff. *longifolia* [Riverina])/ + Non-indigenous species (i.e. planted)
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), North Central CMA (2014b), DELWP (2014f), DSE (2005) and landholder records.

8.6 Current Condition and Threats

8.6.1 Current Condition

Falla Dam was not assessed as part of the Rakali Ecological Consulting (2014) IWC assessments, as it was determined to be terrestrial. However according to the methodology in Section 3.4.1, the dam area is considered to be in poor condition due to the lack of aquatic and littoral vegetation, low water dependent fauna species diversity and its morphology (extremely steep sides and excessive depth) (Table 53). The landholder has begun to take the first steps to rehabilitate the site by planting native species around its edge.

Table 53. Condition of key attributes for Falla Dam

Indicator	Aquatic vegetation	Fringing vegetation	Morphology	Water dependent fauna	Overall rating
Score/ 3	1	1	1	1	**1**
Category	Poor	Poor	Poor	Poor	**Poor**
Key					
Score	**Rating**	**Aquatic vegetation (no. of species)**	**Fringing vegetation (cover)**	**Morphology (bank steepness)**	**Water dependent fauna (no. of species)**
1	Poor	< 4 species	Sparse or no cover	>20 cm/ metre	<10 species
2	Moderate	4-10 species	Sparse to good cover	10-20 cm/ metre	10-20 species
3	Excellent	>10 species	high cover	<10 cm/ metre	>20 species

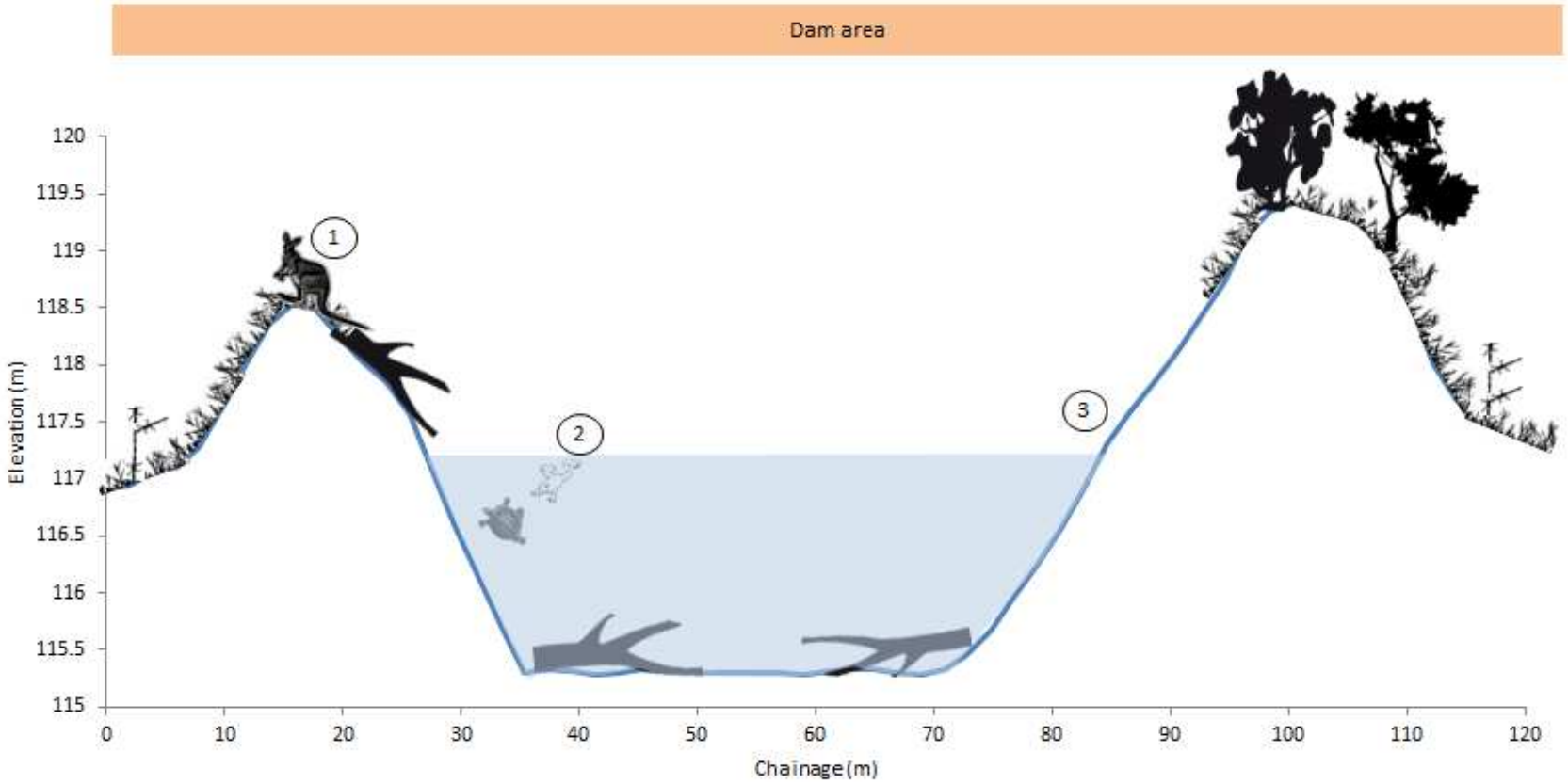
8.6.2 Condition Trajectory

Due to the current degraded nature of the dam, it is unlikely that the site will decline further. The landholder has advised of his plans to revegetation the banks and spoil heaps of the dam in an effort to increase diversity and improve habitat values for fauna.

8.6.2.1 Do Nothing

As per Section 8.6.2, Falla Dam is considered to be in poor condition and is unlikely to decline further without the delivery of environmental water. However given its size and water holding ability, and the expected habitat improvements from revegetation, the site may become an important refuge for water dependent species during drought conditions. The dam is also likely to support mobile terrestrial species moving between Lake Buloke, Little Lake Buloke and the Mallee to the west.

8.7 Conceptualisation of Site



N.B. cross section not to scale

Key descriptions:

1. Terrestrial fauna are likely to utilise the site as a watering point due to the lack of surrounding open water.
2. Frogs and turtles likely seek refuge in dam during dry periods
3. Low littoral and aquatic vegetation the result of extremely steep banks limits habitat available and may not support breeding of some water dependent species.

8.8 Management Objectives

8.8.1 Management Goal

A long-term management goal (i.e. ten years) for Falla Dam have been developed based on the information derived from Rakali Ecological Consulting (2014) and Howard et al., (2014) and presented in Section 8.

Falla Dam environmental water management goal

Provide a water regime that maintains Falla Dam as a watering point for terrestrial species and drought refuge for turtles and frogs during dry conditions.

8.8.2 Ecological Objectives

The ecological objectives and justification for the management goal presented in Section 8.8.1 are presented below in Table 54.

Table 54. Ecological objectives of Falla Dam

Ecological objective	Justification
1. Increase **aquatic vegetation** diversity and abundance	- Provide shelter, feeding and breeding opportunities for water dependent fauna (i.e. waterbirds, frogs and turtles) *Objective may require active intervention i.e. revegetation, bank modification work to allow achievement (see Section 13).*
2. Increase **frog and turtle feeding and breeding**[1]	- Provide not only refuge but resources (i.e. shelter, feeding) to promote breeding and ensure long term survival particularly during dry conditions - Provide food source for waterbirds - Objective based on achievement of ecological objective 1
3. Provide a **watering point** for terrestrial species	- Support terrestrial fauna in the landscape - Isolated from other waterbodies in the landscape.

[1]As frog and turtle surveys have not been undertaken at the site (see Section 8.4.1) objective is based on anecdotal landholder accounts and likelihood of presence based on vegetation. Further information is required to determine the appropriate trajectory for future management.

8.8.3 Hydrological Objectives

Hydrological objectives are based on the hydrological requirements of the ecological objectives detailed in Section 8.8.2 and shown in Table 54. The information provided below is a summary of this information with specific detail and justification given in Appendix 8: Water Requirements for Values and Appendix 9: Hydrological Objectives.

Table 55. Hydrological objectives of Falla Dam

		Description
Timing		Provide fresh inflows to Falla Dam most often between August and January and top-up as required to maintain depth target.
Watering frequency	Minimum[1]	Water Falla Dam 5 in every 10 years to maintain permanency
	Optimum	Annual/ as required to maintain permanency (10 in 10 years).
	Maximum	
Ponding duration	Minimum[1]	Permanent ponding.
	Optimum	Permanent ponding.
	Maximum	
Duration of dry between events	Minimum[1]	Permanently regime.
	Optimum	
	Maximum	
Extent		FALLA DAM: 1-4 metres (approximately 115-117 m AHD)
Variability		High- mimic natural variability by providing occasional watering events outside of the optimum timing (i.e. summer fill to mimic summer thunder storm event)
Estimated volume per event		At least 4 ML

[1] Under extremely dry catchment conditions and low to no allocations the application of prioritisation criteria in Section 3.5.4 will apply. This may result in a low priority ranking for the site, and as such insufficient water resources to maintain the minimum regime (i.e. thus the need to dry the site).

8.8.4 Watering Regime

The optimum watering regime for Falla Dam is derived from the ecological and hydrological objectives presented in Sections 8.8.2 and 8.8.3. The regime should be managed adaptively to account for climatic variation and water availability.

Falla Dam optimum watering regime

Permanent- with variability

Provide fresh inflows as required (preferably in late winter/spring) to maintain depth between 1-4 metres (115-117 m AHD) at Falla Dam, to encourage aquatic vegetation growth and stimulate frog and turtle breeding. Allow natural recession in autumn and winter but maintain depth above one metre (>115 m AHD) to ensure sites remains a watering point and aquatic fauna refuge.

9 Jeffcott Wetland

9.1 Catchment Setting

Jeffcott Wetland is 25-hectare public land wetland located within Jeffcott Wildlife Reserve in the foothills of Mt Jeffcott. The wetland has a maximum depth of approximately 1.4 metres (FSL of 127.6 m AHD) and is characteristic of a deep freshwater marsh (D Cook [Rakali Ecological Consulting Ecological Consulting] pers. comm., 21 August 2014). Although there is no longer term data regarding the frequency, duration and timing of fill events at the wetland, the characteristics of the wetland would suggest that it received sporadic fills in response to extended heavy rainfall in winter and spring and occasional summer storms (Rakali Ecological Consulting, 2014). Two dams are present; one on its north-east boundary (Jeffcott Dam) and second within the bed of the wetland (Dam No. 2) on what is now private property. Jeffcott Dam is connected to the WMP and is the focus of environmental water management.

9.2 Land Use

There is little information available regarding the history of Jeffcott Wetland prior to 1986 when it was listed as a Wildlife Reserve and grazing ceased (LCC, 1986). The physical changes to the natural wetland are however evident, with over half of its area lost to agricultural development (now private land) and the construction of a deep (over 2.5 metres deep) catchment dam, known at Jeffcott Dam. Up until the construction of the pipeline, the adjoining landholder had a license to use Jeffcott Dam for domestic house supply. The supply was considered highly reliable with the dam receiving runoff from drainage lines originating from properties in the foothills of Mt Jeffcott. Catchment run-off was particularly notable in 1972, when the dam banks were no longer visible due to the water height in the wetland. During drought in 2001, the dam was cleaned out marking the first time that the neighbouring landholder can recall it completely drying (see Appendix 6: Engagement Outcomes for detail).

9.3 Hydrology

The bathymetry of the Jeffcott Wetland shows a gradual bank slope at the west, and a steeper eastern bank that meets the deeper central area of the wetland (bed level of 125.8 m AHD). Water pools in the centre of the wetland during flood events resulting in a section of the private property flooding (the southern area of the natural wetland area). Jeffcott Dam, at the northeast of the wetland, is approximately three metres deep (FSL of 127.8 m AHD) and has moderately sloped banks with an average rise of 17 cm/ metre. The dam was connected to the Wimmera Mallee Pipeline in early 2013 and received its first delivery of environmental water in spring 2013 (see Table 56). At the time, the wetland was at approximately 50 percent capacity, holding water from the 2010-11 floods (North Central CMA, 2014a). Appendix 2: Bathymetry and Capacity Tables, shows the bathymetry of Jeffcott Wetland and Figure 10 shows the location and key features of the site.

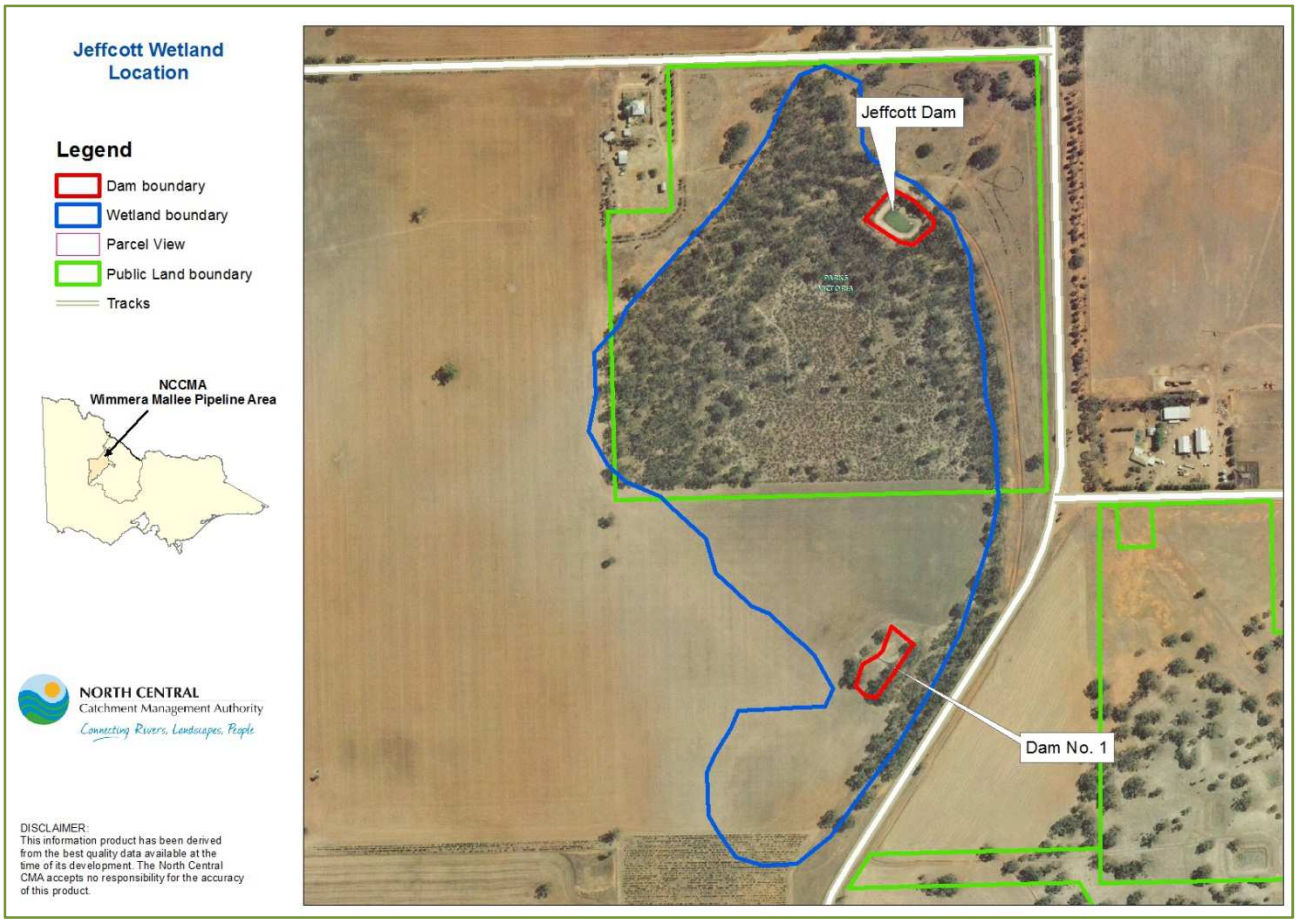


Figure 10. Jeffcott Wetland location map

Table 56. Watering history of Jeffcott Wetland

Watering History	Season							
	2010-2011[1]		2011-2012[1]		2012 -2013		2013-14	
	Wetland	Dam	Wetland	Dam	Wetland	Dam	Wetland	Dam
Status *	W	W	W	W	W-D	W	D	W
Water source #	F	F	-	-	-	-	-	E
Volume (ML)	U	U	0	0	0	0	0	5.803
Notes	Flooded in summer 2010-11		Wetland and dams remained inundated		Small patches of water remained in wetland		Spring & summer top-ups to dam	

KEY:

U̲nknown/ E̲nvironmental water allocation / F̲lood inundation

W	Water for entire year	D-W	Dry at start of year, filled later
W-D	Wet at started of year, dried later	D	Dry for entire year

[1]Likely status as advised by Parks Victoria, landholders and general topographical understanding of the landscape

9.4 Water Dependent Values

9.4.1 Fauna

Jeffcott Wetland supports 48 macroinvertebrates, seven waterbirds, four frogs and one turtle species (DELWP, 2014e; Rakali Ecological Consulting, 2014; Howard *et al.*, 2014). Of these species, two are listed on the DELWP Advisory list including Hardhead (*Aythya australis*) and Eastern Long-necked Turtle (*Chelodina longicollis*). Recent surveys undertaken at Jeffcott Dam resulted in the capture of a significantly large female weighting 1.92 kilograms (the largest

female captured to date by the surveyor). A raided nest and turtle remains were also observed surrounding the dam (Rakali Ecological Consulting, 2014; Howard *et al.*, 2014).

Other waterbird species observed utilising the Jeffcott Dam include Australasian Grebe (*Tachybaptus novaehollandiae*) (presence of juveniles, nests and unhatched eggs), Wood Duck (*Chenonetta jubata*), Dusky Moorhen (*Gallinula tenebrosa*), Grey Teal (*Anas gracilis*), Masked Lapwing (*Vanellus miles*) and Pacific Black Duck (*Anas superciliosa*) (Howard *et al.*, 2014; Rakali Ecological Consulting, 2014). The diversity of waterbirds is likely linked to the high diversity and abundance of frogs and macroinvertebrates present in the dam. Frog species present include Spotted Marsh Frog (*Limnodynastes tasmaniensis*), Eastern Sign-bearing Froglet (*Crinia parinsignifera*), Eastern Banjo Frog (*Limnodynastes dumerili*) and Peron's Tree Frog (*Litoria peronii*) (shown in Plate 20). The highest macroinverbrates abundance for all WMP sites was recorded at Jeffcott Dam, with individuals predominately belonged to predator (61 percent) and scraper/grazer (23 percent) feeding guilds. Table 56 shows the significant species recorded at their conservation status. A full species list is available in Appendix 3: Fauna Species List.

Plate 20. Peron's Tree Frog (D. Cook [Rakali Ecological Consulting] 2014) at Jeffcott Wetland

Table 57. Significant water dependent fauna species recorded at Jeffcott Wetland

Common name	Scientific name	Type	Last record	Inter-national agreement	EPBC status	FFG status	DELWP status
Eastern Long-necked Turtle	*Chelodina longicollis*	RD	2014	N/A			DD
Hardhead	*Aythya australis*	WB	2014				VU

Legend
Type:, Reptile Water dependent, Waterbird
DELWP status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), DELWP (2014e), DSE (2013) and landholder records.

9.4.2 Flora and Vegetation Communities

Jeffcott Wetland is comprised predominately of Lignum Swampy Woodland (EVC 823) vegetation which included Tangled Lignum (*Duma florulenta*), Cane Grass (*Eragrostis australasica*) and a low open canopy of Black Box (*Eculayptus largiflorens*). The ground to mid layer consists of a number of species promoted by intermittent inundation including Common Nardoo (*Marsilea drummondii*), Starry Goosefoot (*Scleroblitum atriplicinum*), Rigid Panic (*Walwhalleya proluta*) as well as five significant species including Bluish Raspwort (*Haloragis glauca f. glauca*), Pale Spike-sedge (*Eleocharis pallens*), Small Monkey-flower (*Mimulus prostratus*), Smooth Minuria (*Minuria integerrima*) and Spiny Lignum (*Muehlenbeckia horrida)* (as shown in Table 58).

This EVC can be separate into three distinct zones based on condition (see Section 9.6.2 for more information). Zone 1 occupies the Jeffcott Wetland (elevations of 125-126 m AHD) and is in excellent condition. It would have formerly extended to the south and west to what is now cleared, private property. Rakali Ecological Consulting (2014) recorded 41 flora species in this zone, 63 percent of which were native and 42 percent water dependent. This zone encompasses Jeffcott Dam which maintains a high cover and structural diversity of aquatic plants including floating species such as Common Nardoo (*Marsilea drummondii*) and submerged and emergent species such as Red Water-milfoil (*Myriophyllum verrucosum*), Southern Cane-grass (*Eragrostis infecunda*) and Pale Spike-sedge (*Eleocharis*

pallens). The banks of the dam are heavily vegetated and support a number of Black Box saplings as well as mature hollow bearing trees (Rakali Ecological Consulting, 2014; Howard et al., 2014).

Zone 2 is a small, deeper area (at approximately <126 m AHD) between the boundary of the Wildlife Reserve and the private property is referred to as Lignum Swampy Woodland (EVC 823). It is in poor condition due to a history of prolonged and deep flooding. Many of the individual Tangled Lignum plants have died and the structure and composition of the understory has been compromised.

Zone 3 is located on private property. It is in very poor condition, having been extensively cleared and used for cropping (Rakali Ecological Consulting, 2014).

Plate 21 shows the water dependent EVC zones of Jeffcott Wetland, Table 59 summarises the conservation significance of these EVCs in the Wimmera Bioregion, Appendix 4: Ecological Vegetation Classes shows the extent of each EVCs present and Appendix 5: Flora Species List details the full species list for Jeffcott Wildlife Reserve.

Table 58. Significant water dependent flora species recorded at Jeffcott Wetland

Common name	Scientific name	Type	Last record	EPBC status	FFG status	DELWP status	EVC found within
Bluish Raspwort	*Haloragis glauca f. glauca*	W	2014			k	803
Pale Spike-sedge	*Eleocharis pallens*	R, W	2014			k	823
Small Monkey-flower	*Mimulus prostratus*	R, W	2014			r	823
Smooth Minuria	*Minuria integerrima*	R	1997			r	-
Spiny Lignum	*Muehlenbeckia horrida*	W	1997			r	-

Legend
Type: Wetland dependent, River terrestrial
DELWP status: presumed eXtinct, endangered, vulnerable, rare, near threatened, data deficient, poorly known
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), North Central CMA (2014b), DELWP (2014f), DSE (2005) and landholder records.

Lignum Swampy Woodland (EVC 823)- Zone 1, December 2013 (D. Cook [Rakali Ecological Consulting] 2014)

Jeffcott dam, November 2013

Lignum Swampy Woodland (EVC 823)- Zone 2, June 2012

Plate 21. Vegetation communities of Jeffcott Wetland

Table 59. Conservation status of water dependent EVCs in Jeffcott Wetland

EVC no.	EVC name	Source	Wimmera Bioregional Conservation Status
823	Lignum Swampy Woodland	Rakali Ecological Consulting (2014)	Vulnerable
Source: Rakali Ecological Consulting (2014), Howard *et al.*, (2014), DELWP (2014d), DSE (2012)			

9.5 Terrestrial Species

9.5.1 Fauna

Jeffcott Wetland supports 22 terrestrial bird species, three mammals and one reptile species (DELWP, 2014e; Rakali Ecological Consulting, 2014; Howard *et al.*, 2014). Of these species, two – the endangered Lace Monitor (*Varanus varius*) and near threatened Brown Treecreeper (*Climacteris picumnus*) - are listed on the DELWP Advisory List. Both species have been observed utilise the woodland zone of the site (See Appendix 6: Engagement Outcomes for detail). This zone has also supported breeding activity from Magpie-lark (*Grallina cyanoleuca*) (nest and juveniles) (shown in Plate 20) and White-browed Woodswallow (*Artamus superciliosus*) (nest and juveniles) as noted during the recent Rakali Ecological Consulting (2014) and Howard et al., (2014) surveys. Table 60 details the significant terrestrial fauna species recorded at Jeffcott Wetland with a full species list in Appendix 3: Fauna Species List.

Plate 22. Magpie Lark nestlings (D. Cook [Rakali Ecological Consulting] 2014) at Jeffcott Wetland

Table 60. Significant terrestrial fauna species recorded at Jeffcott Wetland

Common name	Scientific name	Type	Last record	International agreement	EPBC status	FFG status	DELWP status
Brown Treecreeper	*Climacteris picumnus*	TB*	2013				NT
Lace Monitor	*Varanus varius*	R	A[1]				EN

Legend
Type: Reptile, Terrestrial Bird
DELWP status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known
*Refers to species that are dependent on water dependent vegetation/ [1]Ancedotal record from community (Appendix 6: Engagement Outcomes)
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), DELWP (2014e), DSE (2013) and landholder records.

9.5.2 Flora and Vegetation Communities

The north and eastern boundary of Jeffcott Wetland is classified as Plains Woodland (EVC 808) and is comprised of a grassy/ sedgy woodland dominated by scattered Black Box. This zone supports a lower abundance of Black Box trees compared to the deeper Lignum Swampy Woodland zones and has two significant species- Black Roly-poly (*Sclerolaena muricata*) and Plains Joyweed (*Alternanthera sp. 1* (Plains)) (see Plate 23) (Rakali Ecological Consulting, 2014). Plate 23 shows this EVC community, Table 62 summarises the conservation significance of these EVCs in the Wimmera Bioregion, Appendix 4: Ecological Vegetation Classes shows the extent of each EVCs present and Appendix 5: Flora Species List details the full species list for Jeffcott Wetland.

Table 61. Significant terrestrial flora species recorded at Jeffcott Wetland

Common name	Scientific name	Type	Last record	EPBC status	FFG status	DELWP status	EVC found within
Black Roly-Poly	*Sclerolaena muricata*	T	1997			k	-
Plains Joyweed	*Alternanthera sp. 1 (Plains)*	T	2014			k	823

Legend
Type: Terrestrial
DELWP status: presumed eXtinct, , endangered, vulnerable, rare, near threatened, data deficient, poorly known

Common name	Scientific name	Type	Last record	EPBC status	FFG status	DELWP status	EVC found within
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), North Central CMA (2014b), DELWP (2014f), DSE (2005) and landholder records.							

Plains Joyweed (D. Cook [Rakali Ecological Consulting], 2014) at Jeffcott Wildlife Reserve

Plains Woodland (EVC 803), June 2012

Plate 23. Terrestrial vegetation of Jeffcott Wetland

Table 62. Conservation status of terrestrial EVCs in Jeffcott Wetland

EVC no.	EVC name	Source	Wimmera Bioregional Conservation Status
803	Plains Woodland	Rakali Ecological Consulting (2014)	Endangered
Source: Rakali Ecological Consulting (2014), Howard *et al.*, (2014), DELWP (2014d), DSE (2012)			

9.6 Current Condition and Threats

9.6.1 Current Condition

According to IWC assessment, the Jeffcott Wetland is in moderate condition with an overall score of 80.6/100 (Table 63). The site received an excellent score (19/20) for physical form and good scores for hydrology and water properties (both 15/20) although it is likely that the presence of the two dams significantly alters the wetlands' ability to capture catchment runoff. However it received a very poor score for biota due to the impacts of widespread clearing. The three zones identified in the Lignum Swampy Woodland EVC, ranged from excellent (18/20) for Zone 1, poor (9.3/20) or Zone 2 and very poor (0/20) for Zone 3. Land-use practices such as unsolicited firewood collection, rubbish dumbing and the construction of an extensive motorcycling track at the north section has further impacted on the quality of the condition of the vegetation present.

Table 63. Assessment for Jeffcott Wetland

IWC sub-index	Wetland catchment	Physical form	Hydrology	Water properties	Soils	Biota	Overall IWC score
Score/ 20	12	19	15	15	12	7.6	**80.6**
Category	Moderate	Excellent	Good	Good	Moderate	Very poor	**Moderate**
Source: Rakali Ecological Consulting (2014)							

Jeffcott Dam, which was assessed using the method detailed in Section 3.4.1, received a high score for habitat values (Table 64). The dam supports a diversity of water dependent fauna, aquatic and fringing vegetation and has moderate bank steepness compared to the other WMP sites.

Table 64. Condition of key attributes of Jeffcott Wetland

Indicator	Aquatic vegetation	Fringing vegetation	Morphology	Water dependent fauna	Overall rating
Score/ 3	3	3	2	3	**11**
Category	Excellent	Excellent	Moderate	Excellent	**Excellent**
Key					
Score	**Rating**	**Aquatic vegetation (no. of species)**	**Fringing vegetation (cover)**	**Morphology (bank steepness)**	**Water dependent fauna (no. of species)**
1	Poor	< 4 species	Sparse or no cover	>20 cm/ metre	<10 species
2	Moderate	4-10 species	Sparse to good cover	10-20 cm/ metre	10-20 species
3	Excellent	>10 species	high cover	<10 cm/ metre	>20 species

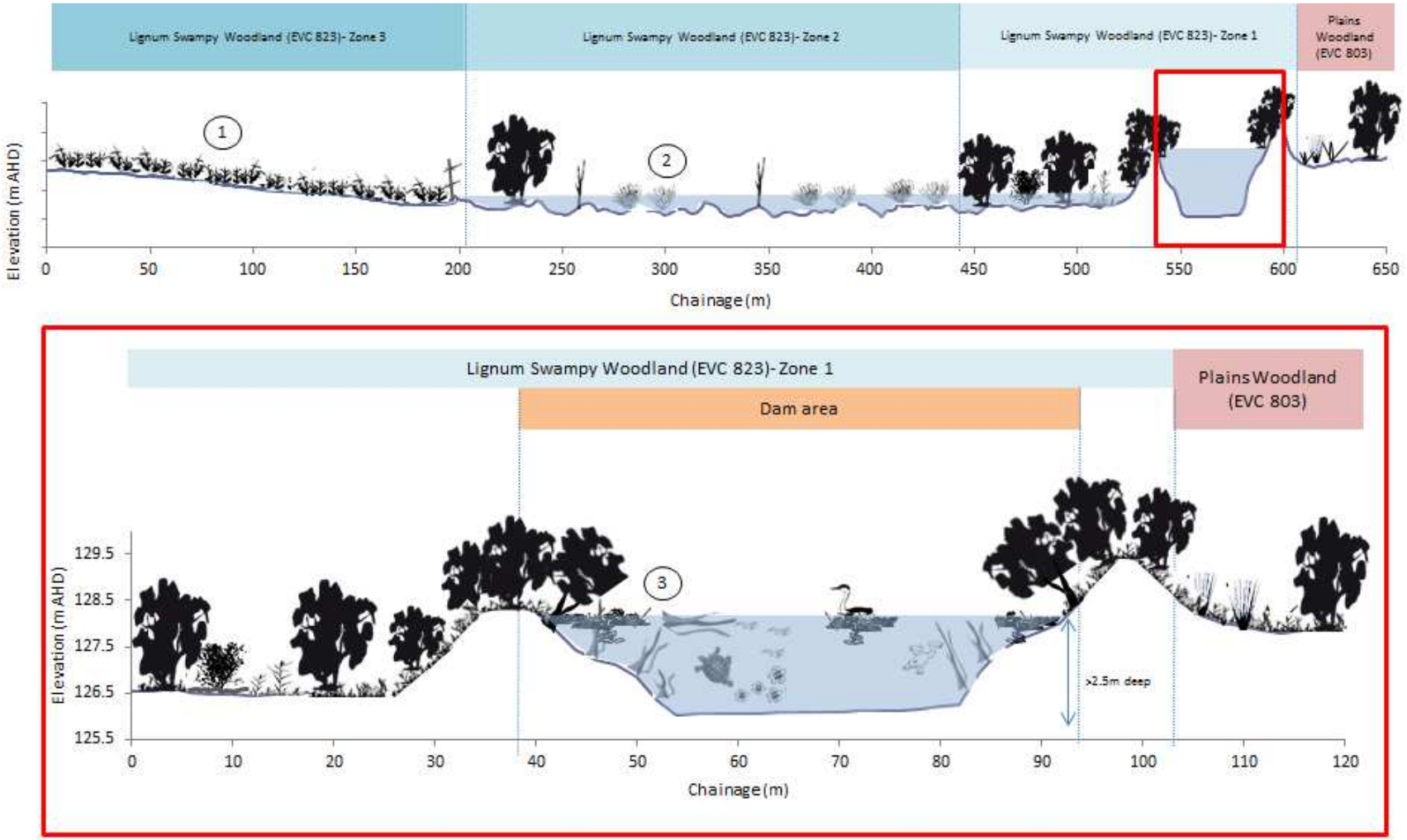
9.6.2 Condition Trajectory

Jeffcott Wetland is highly modified due to a history of intensive land use. It is unlikely that further damage to Zone 3 (on private property) will occur with this area no longer supporting any of its former values. Rehabilitation of this area would be costly and would require acquisition of the private farmland to the south and west of the reserve area. Zone 2, which is located within the reserve area of the wetland, may however continue to decline if prolonged inundation events continue to occur in the future. Zone 1, which includes the majority of the reserve wetland area, is considered to be in good condition and may continue to be supported into the future by natural events. Jeffcott Dam is also considered to be in excellent condition due to its high water holding capacity, morphology and catchment area. The dam is unlikely to dry unless there are consecutive years without inflows entering the dam. However maintenance of some species (i.e. turtles) will be dependent on whether adequate depth can be maintained.

9.6.2.1 Do Nothing

Historically the water depth in Jeffcott Dam has been maintained due to natural inflows and catchment runoff. Environmental water is therefore required to ensure that depth is maintained for water dependent fauna such as turtles, frogs and waterbirds, particularly during dry conditions. Without delivery of environmental water the high environmental values of the dam may be comprised resulting in the loss of a key habitat feature of the Avon-Richardson Catchment.

9.7 Conceptualisation of Site



N.B. cross section not to scale

Key descriptions:

1. A large proportion of the Jeffcott Wetland area has been lost to agricultural development (private property component). This area commences to flood at low inundation levels.
2. Prolonged inundation in the deeper zones of the wetland has resulted in a reduction in the abundance and diversity of understory species as well as the death of some Black Box trees and Lignum. These areas no longer support habitat values typical of Lignum Swampy Woodland. Including habitat for waterbird feeding and breeding.
3. High diversity of aquatic plants providing important shelter for turtles, frogs, waterbirds and macroinvertebrates. This includes a high abundance of turtles and frogs and a variety of waterbird species, which utilise the permanent dam for feeding and breeding.

9.8 Management Objectives

9.8.1 Management Goal

A long-term management goal (i.e. ten years) for Jeffcott Wetland and Jeffcott Dam has been developed based on the information derived from Rakali Ecological Consulting (2014) and Howard et al., (2014) and is presented in Section 9. However, due to the current capacity restrictions of the WMP, the risk of flooding private land and the size of the wetland, this section will only focus on management of Jeffcott Dam. Management objectives, ecological and hydrological objectives and a recommended watering regime for Jeffcott Wetland are presented in Appendix 10: Wetland Management Objectives. Please note that consideration has been given for wetland ecological objectives that may benefit (either fully or in part) from environmental water delivery to the dam. This includes opportunities to overtop dam banks to provide low-level inundation.

Jeffcott Dam environmental water management goal

Maintain the diversity of aquatic plants and provides refuge and breeding conditions for water dependent species such as frogs, macroinverbrates, turtles and waterbirds at Jeffcott Dam.

9.8.2 Ecological Objectives

The ecological objectives and justification for the management goal presented in Section 9.8.1 are presented below in Table 65.

Table 65. Ecological objectives of Jeffcott Dam

Ecological objective	Justification
1. Maintain high diversity of **aquatic plants**	- Provide shelter and breeding conditions for macroinvertebrates and frogs - Provide feeding opportunities for waterbirds - Filter water and promote aquatic biological activity *Objective may require active intervention i.e. revegetation, bank modification work to allow achievement (see Section 13).*
2. Maintain **turtle and frog feeding and breeding** opportunities	- Supports food sources and provides shelter for turtles and frogs (i.e. shelter for tadpoles, substrate for frog eggs to attach to etc.) - Provide food sources for waterbirds and turtles - Objective based on achievement of ecological objective 1
3. Maintain **waterbird feeding and breeding** opportunities	- Diversity of habitat types support a range of food sources including macroinvertebrates, frogs and plant matter (i.e. drawdown zones, fringing, littoral and open water) - Aquatic vegetation provides resources for nest establishment - Objective based on achievement of ecological objective 1
4. Provide a **watering point** for terrestrial species	- Support terrestrial fauna including near threatened Brown Treecreeper and endangered Lace Monitor - Isolated from other waterbodies in the landscape

9.8.3 Hydrological Objectives

Hydrological objectives are based on the hydrological requirements of the ecological objectives detailed in Section 9.8.2. Table 66 provides a summary of this information with specific detail and justification given in Appendix 8: Water Requirements for Values and Appendix 9: Hydrological Objectives.

Table 66. Hydrological objectives for Jeffcott Dam

		Description
Timing		Provide fresh inflows to Jeffcott Dam most often between August and January and top-up as required to maintain depth target.
Watering frequency	Minimum[1]	Annual/ as required to maintain permanency.
	Optimum	Annual/ as required to maintain permanency (10 in 10 years).
	Maximum	
Ponding duration	Minimum[1]	Permanent ponding.
	Optimum	Permanent ponding.
	Maximum	
Duration of dry between events	Minimum[1]	Permanently regime[2].
	Optimum	
	Maximum	
Extent		JEFFCOTT DAM: 1-3 metres (approximately 124.8-127.8 m AHD)
Variability		High- mimic natural variability by providing occasional watering events outside of the optimum timing (i.e. summer fill to mimic summer thunder storm event)
Estimated volume per event		At least 4 ML

[1] Under extremely dry catchment conditions and low to no allocations the application of prioritisation criteria in Section 3.5.4 will apply. This may result in a low priority ranking for the site, and as such insufficient water resources to maintain the minimum regime (i.e. thus the need to dry the site).
[2]Maintaining depth during wet years may increase the chance of natural flooding at Jeffcott Wetland by removing filling the dam airspace.

9.8.4 Watering Regime

The optimum watering regime for Jeffcott Dam is derived from the ecological and hydrological objectives presented in Sections 9.8.2 and 9.8.3. The regime should be managed adaptively to account for climatic variation and water availability.

Jeffcott Dam optimum watering regime

Permanent- with variability

Provide fresh inflows as required (preferably between August and January) to maintain depth between 1-3 metre (124.8- 127.8 m AHD) in Jeffcott Dam, to promote aquatic plant growth and stimulate frog and turtle breeding.

Allow natural recession in autumn and winter but maintain depth above one metre (>124.8 m AHD) to ensure sites remains refuge for aquatic fauna.

10 Jesse Swamp

10.1 Catchment Setting

Jesse Swamp is a ten-hectare natural wetland located on public land approximately five kilometres north of the Avon River. The wetland is isolated from the floodplain of the Avon River by a low ridge but receives runoff from the landscape to the south. Once filled, water would overtop the banks of Jesse Swamp and move northwards entering a series of scattered swamps that extend to the Cope Cope Wetlands (H. Barber [landowner] pers. comm., 10 July 2014).

Two dams have been constructed in the north-eastern section of the bed of Jesse Swamp. The most southerly dam referred to as Jesse Dam, is connected to the WMP and the focus of environmental water delivery. The other dam is referred to as Dam No. 1.

10.2 Land Use

The family of the current landholder has owned the property encompassing Jesse Swamp since early settler times. The area has experienced extensive clearing for cropping and grazing purposes and only small remnant patches of native vegetation remains. Although there is no information available on their history, it is probable that the two dams were constructed for stock watering during settler times.

Jesse Swamp has been fully fenced off for approximately 15 to 20 years and is no longer utilised for stock grazing. The current landholder was born in the area and recollects that the wetland has remained almost permanently inundated up until the recent drought (H. Barber [landowner] pers. comm., 10 July 2014). A channel (Darkbonee Channel/ Gre Gre Creek) traces the boundary of the elevated areas to the south of the wetland, and likely captures most small catchment runoff events.

10.3 Hydrology

Jesse Swamp has a relatively flat topography with a bed level of 158.4 m AHD and a depth of approximately 1 metre (FSL of 159.2 m AHD). A 0.5 metre high, ninety-metre long levee has also been constructed on the southern boundary of the wetland to reduce inflows into the wetland from the south. The levee separates the wetland from a small one-metre deep depression historically known as the Lily Pond. The Lily Pond now receives runoff from farmland to the south before conveying water to Jesse Swamp via a low point to the east of the levee. Once overtopped, water flows across Banyena Road and inundates a number of smaller swamps to the north of Jesse Swamp (H. Barber [landowner] pers. comm., 10 July 2014).

Jesse Dam, which was connected to the WMP in early 2013, has a relatively flat bed (bed level of 157.6 m AHD), gently sloping banks which rise on average by 8 cm/ metre and a maximum depth of approximately 0.5 metres (FSL of 158 m AHD). In autumn 2014, when it received its first delivery of environmental water, Jesse Dam, Dam No. 1 and the Lilly Pond were dry (see Table 67) (North Central CMA, 2014a). The dam can be overtopped to inundate a small section of the surrounding wetland bed. Appendix 2: Bathymetry and Capacity Tables, Figure 11 shows the bathymetry of Jesse Swamp and Figure 11 shows the location and the key features described above.

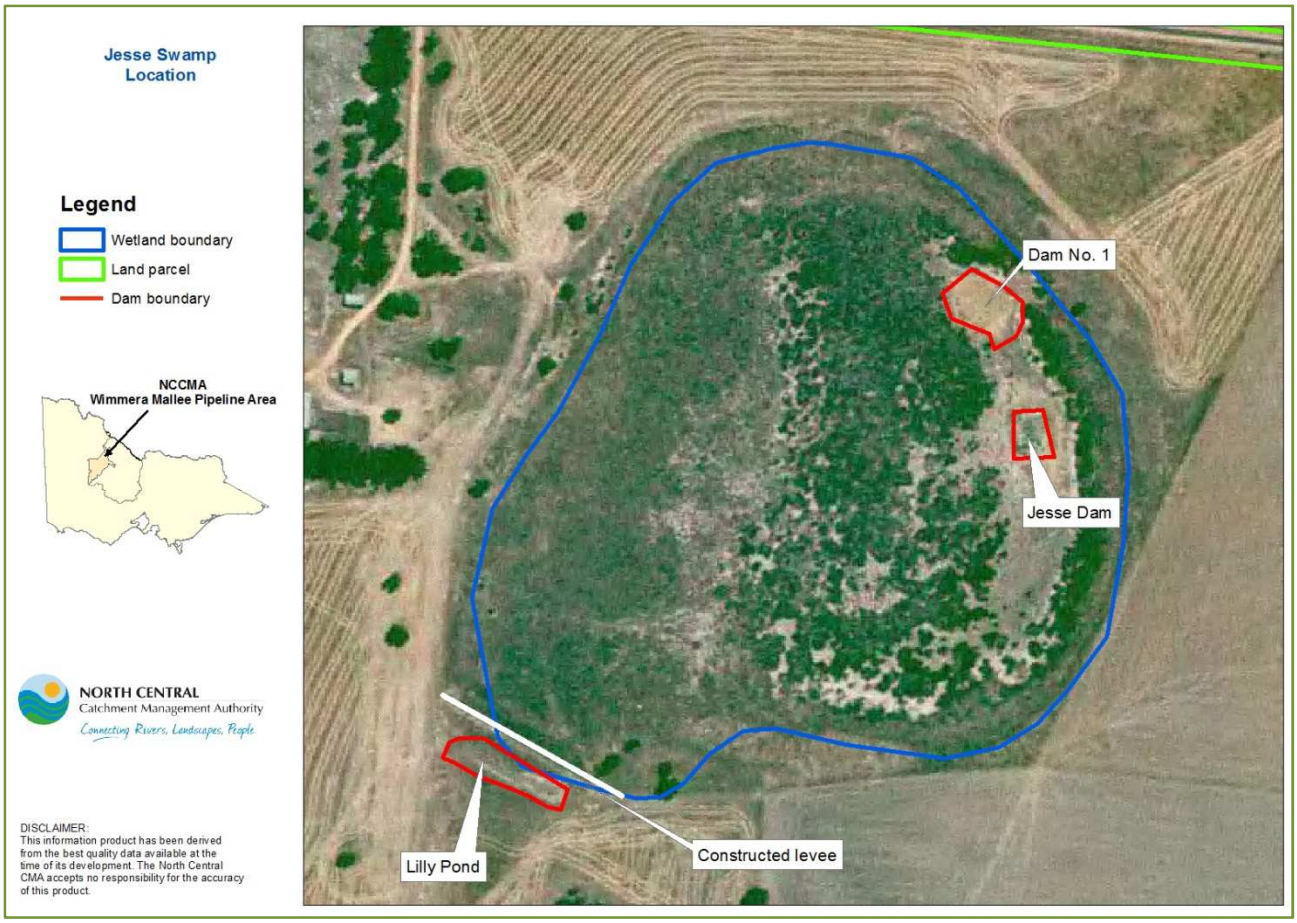


Figure 11. Jesse Swamp location map

Table 67. Watering history of Jesse Swamp

Watering History	Season							
	2010-2011[1]		2011-2012[1]		2012 -2013		2013-14	
	Wetland	Dam	Wetland	Dam	Wetland	Dam	Wetland	Dam
Status *	W	W	W-D	W-D	D	D	D	D-W
Water source #	F	F	-	-	-	-	D	E
Volume (ML)	U	U	0	0	0	0	-	0.541
Notes	Flooding in summer 2010-11		Dried after about a year of inundation		Wetland and dams dry		Filled from empty in autumn	

KEY:

Unknown/ Environmental water allocation / Flood inundation

W	Water for entire year	D-W	Dry at start of year, filled later	D-W-D	Dried, filled then dried during the year
W-D	Wet at started of year, dried later	D	Dry for entire year		

[1]Likely status as advised by Parks Victoria, landholders and general topographical understanding of the landscape

10.4 Water Dependent Values

10.4.1 Fauna

Limited fauna surveys have been undertaken at Jesse Swamp, with only five waterbird species recorded. This included the FFG listed Brolga (*Grus rubicunda*) (as shown in Plate 24) which prior to the construction of the pipeline, was known to frequent the site on an annual basis, even breeding at least once in the 1980s. Recently, a pair of Brolga has been observed utilising nearby wetlands (H. Barber [landowner] pers. comm., 9 May 2014), with one sighted on the boundary of Jesse Dam after the delivery of environmental water in winter 2014 (A. Russell [North Central CMA], pers.

comm., 4 November 2014). Black Swans (*Cygnus atratus*) have also attempted to breed at the site and it has also supported a large flock of feeding Egrets (unknown spp.) (As shown in Plate 24), Yellow-billed Spoonbills (*Platalea flavipes*) (up to twenty recorded in September 2011) (H. Barber [landowner] pers. comm., 9 May 2014).

Frog, turtle and macroinvertebrate surveys have not been undertaken at Jesse Swamp to date due to the site being dry at the time of survey. However a loud and strong choir of calling frogs was heard by the landholder during the onset of environmental water delivery to the dam in May 2014. This event attracted a number of waterbirds including Grey Teal (*Anas gracilis*), White-faced Heron (*Ardea novaehollandiae*), Pacific Black Duck (*Anas superciliosa*) (two pairs of young observed) and Wood Duck (*Chenonetta jubata*) as well as the FFG listed Grey Falcon (*Falco hypoleucos*) (H. Barber [landholder] pers. comm., 27 August 2014 and 15 January 2015). Table 68 shows the significant species recorded and conservation status. A full species list is available in Appendix 3: Fauna Species List.

A pair of Brolga near Jesse Swamp in October 1977 (photo supplied by H. Barber)

Egrets in 2011 (photo supplied by H. Barber)

Plate 24. Fauna of Jesse Swamp

Table 68. Significant water dependent fauna species recorded at Jesse Swamp

Common name	Scientific name	Type	Last record	Inter-national agreement	EPBC status	FFG status	DELWP status
Brolga	*Grus rubicunda*	WB	2014			L	VU

Legend
Type: Invertebrate, Fish, Amphibian, Reptile, Reptile Water dependent, Terrestrial Bird, Waterbird, Mammal
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
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), DELWP (2014e), DSE (2013) and landholder records.

10.4.2 Flora and Vegetation Communities

The majority of Jesse Swamp is classified as Plains Grassy Wetland (EVC 125) which is dominated by grassy-herbaceous flora species adapted to shallow seasonal inundation. The zone contains the two dams at its north-east corner and contains seven water dependent flora species including Southern Cane-grass (*Eragrostis infecunda*), Common Blown-grass (*Lachnagrostis filiformis* var. 1) and Common Swamp Wallaby-grass (*Amphibromus nervosus*).

A small strip of Freshwater Lignum - Cane Grass Swamp (EVC 954) exists on the north-east corner of the wetland. Dominant water dependent species include Tangled Lignum (*Duma florulenta*), Southern Cane-grass (*Eragrostis infecunda*), Common Spike-sedge (*Eleocharis acuta*), Rigid Panic (*Walwhalleya proluta*), Posion Pratia (*Lobelia concolor*) and Brown-backed Wallaby-grass (*Rytidosperma duttonianum*) (Rakali Ecological Consulting, 2014).

Remnant patches of Buloke *(Allocasuarina luehmannii)* adjacent to Jesse Swamp indicate that historically the surrounding vegetation would have been Plains Savanah (EVC 826). This zone has been lost through extensive agricultural clearing and with the exception of a few scattered trees, in devoid of overstorey. The Lily Pond historically supported a high abundance of the FFG listed Marbled Marshwort (*Nymphoides spinulosperma*) when inundated (DELWP, 2014; Rakali Ecological Consulting, 2014) (see Table 69). This record is considered particularly important as the species is only present in a few known locations in Victoria and Australia as a whole (ALA, 2014; Rakali Ecological

Consulting, 2014). The landholder recently advised that Marbled Marshwort was present in the bed of the wetland between the dam and Lily Pond during winter 2014 (H. Barber [landowner] pers. comm., 10 July 2014). Plate 25 shows the water dependent EVC communities of Jesse Swamp, Table 70 summarises the conservation significance of these EVCs in the Wimmera Bioregion, Appendix 4: Ecological Vegetation Classes shows the extent of each EVCs present and Appendix 5: Flora Species List details the full species list for Jesse Swamp.

Table 69. Significant water dependent flora species recorded at Jesse Swamp

Common name	Scientific name	Type	Last record	EPBC status	FFG status	DELWP status	EVC found within
Marbled Marshwort	*Nymphoides spinulosperma*	W	2013		L	e	-

Legend
Type: Wetland dependent, River terrestrial, Terrestrial,
FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing
DELWP status: presumed eXtinct, endangered, vulnerable, rare, near threatened, data deficient, poorly known
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), North Central CMA (2014b), DELWP (2014f), DSE (2005) and landholder records.

Plains Grassy Wetland (EVC 125), April 2013

Jesse Swamp dam, June 2014

Freshwater Lignum- Cane Grass Swamp (EVC 954) (D. Cook [Rakali Ecological Consulting] 2014)

Lilly Pond in 1986 (photo supplied by H. Barber)

Plate 25. Vegetation communities of Jesse Swamp

Table 70. Conservation status of EVCs in Jesse Swamp

EVC no.	EVC name	Source	Wimmera Bioregional Conservation Status
125	Plains Grassy Wetland	Rakali Ecological Consulting (2014)	Endangered
954	Freshwater Lignum - Cane Grass Swamp	Rakali Ecological Consulting (2014)	Vulnerable
Source: Rakali Ecological Consulting (2014), Howard *et al.*, (2014), DELWP (2014d), DSE (2012)			

10.5 Terrestrial Species

10.5.1 Fauna

Seven terrestrial bird species have been recorded at Jesse Swamp, with one - the FFG listed Grey Falcon (*Falco hypoleucos*) - anecdotally recorded, as shown in Table 71. A full species list is available in Appendix 3: Fauna Species List.

Table 71. Significant terrestrial fauna species recorded at Jesse Swamp

Common name	Scientific name	Type	Last record	Inter-national agreement	EPBC status	FFG status	DELWP status
Grey Falcon[1]	*Falco hypoleucos*	TB	2014			L	EN

Legend
Type: Invertebrate, Fish, Amphibian, Reptile, Reptile Water dependent, Terrestrial Bird, Waterbird, Mammal
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
[1]Ancedotal record from community (Appendix 6: Engagement Outcomes)
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), DELWP (2014e), DSE (2013) and landholder records.

10.5.2 Flora and Vegetation Communities

Jesse Swamp supports 19 terrestrial flora species, with one Buloke Mistletoe (*Amyema linophylla subsp. orientale*), listed as significant as shown in Table 72. A relatively high number of terrestrial plant species exist in the bed of the wetland, the relict of periods of extended dry. The EVC beyond the wetland area were not mapped during the Rakali Ecological Consulting (2014) surveys. A full species list is presented in Appendix 5: Flora Species List.

Table 72. Significant terrestrial flora species recorded at Jesse Swamp

Common name	Scientific name	Type	Last record	EPBC status	FFG status	DELWP status	EVC found within
Buloke Mistletoe	*Amyema linophylla subsp. orientale*	T	2013			v	125

Legend
Type: Wetland dependent, River terrestrial, Terrestrial
DELWP status: presumed eXtinct, endangered, vulnerable, rare, near threatened, data deficient, poorly known
Source: Rakali Ecological Consulting (2014), Howard et al., (2014), North Central CMA (2014b), DELWP (2014f), DSE (2005) and landholder records.

10.6 Current Condition and Threats

10.6.1 Current Condition

According to IWC assessment, Jesse Swamp is in moderate condition with an overall score of 86/100 (Table 73). The site received an excellent score (20/20) for soils and physical form (19.9/20) and good scores for hydrology and water properties (both 15/20). It however received a very poor score for wetland catchment (4/20) and a poor score for biota (12.1). The wetland no longer receives the frequency of inundation experienced in the past due to changed land use practices in the area (i.e. gypsum application) and the construction of levees and channels to divert and control movement of water. The biota component is based on the high exotic weed abundance in the Plains Grassy Wetland zone (67 percent of species) and the moderate abundance of weeds in the Freshwater Lignum-Cane Grass Swamp (41 percent of species).

Table 73. IWC Assessment of Jesse Swamp

IWC sub-index	Wetland catchment	Physical form	Hydrology	Water properties	Soils	Biota	Overall IWC score
Score/ 20	4	19.9	15	15	20	12.1	**86**
Category	Very poor	Excellent	Good	Good	Excellent	Poor	**Moderate**

Source: Rakali Ecological Consulting (2014)

Jesse Dam, which was assessed using the method detailed in Section 3.4.1, received a moderate score for habitat values (Table 74). This was based on poor aquatic and fringing vegetation and water dependent values at the time of assessment. The dam however scored highly for morphology, due to its depth and gentle sloping banks.

Table 74. Condition of key attributes of Jesse Dam

Indicator	Aquatic vegetation	Fringing vegetation	Morphology	Water dependent fauna	Overall rating
Score/ 3	1	1	3	1	**6**
Category	Poor	Poor	Excellent	Poor	**Moderate**
Key					
Score	**Rating**	**Aquatic vegetation (no. of species)**	**Fringing vegetation (cover)**	**Morphology (bank steepness)**	**Water dependent fauna (no. of species)**
1	Poor	< 4 species	Sparse or no cover	>20 cm/ metre	<10 species
2	Moderate	4-10 species	Sparse to good cover	10-20 cm/ metre	10-20 species
3	Excellent	>10 species	high cover	<10 cm/ metre	>20 species

10.6.2 Condition Trajectory

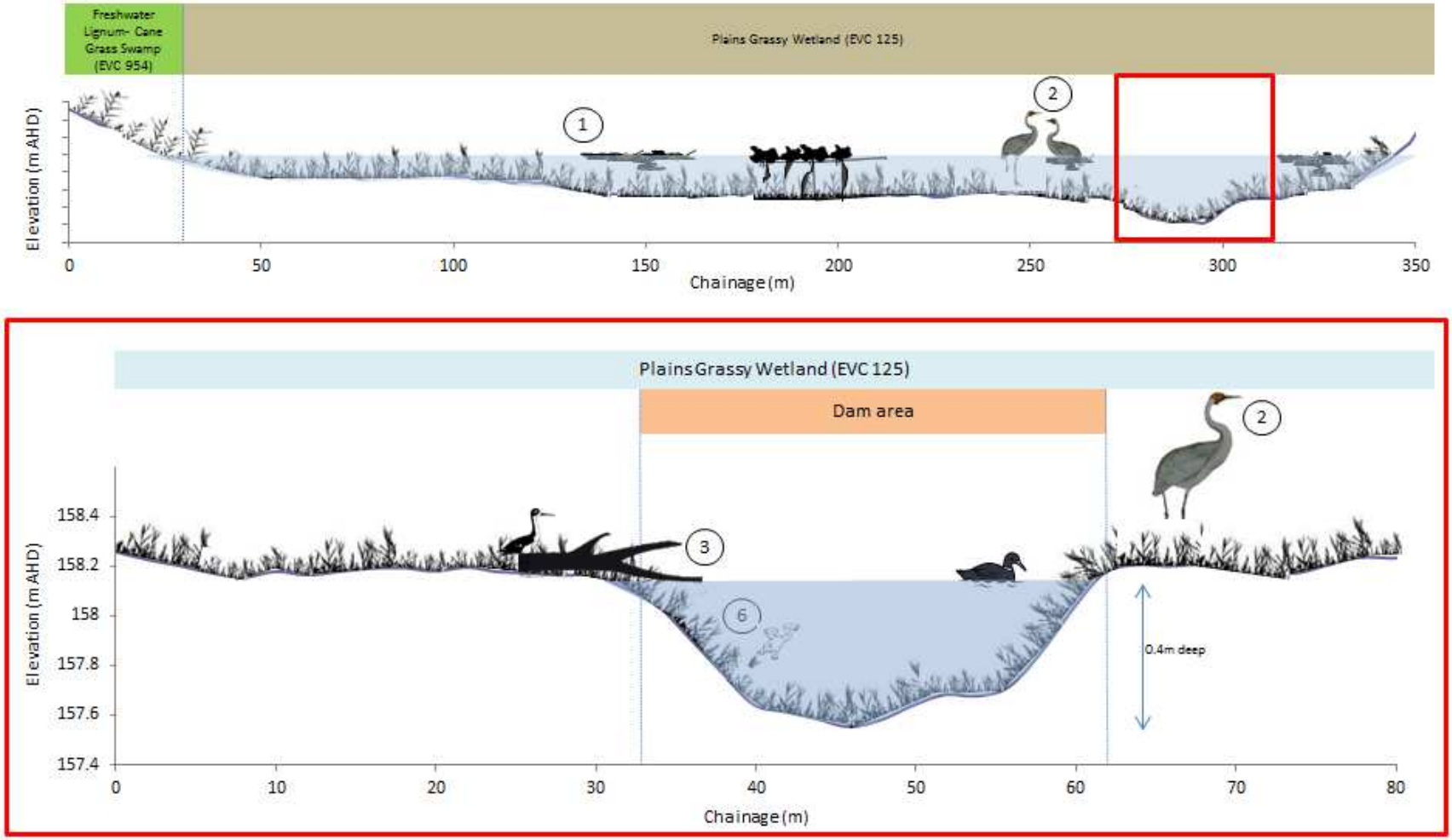
Jesse Swamp has historically provides habitat for the Brolga and has supported large populations of Black Swan and Yellow-billed Spoonbill. However as evidenced by the terrestrialisation of the bed of the wetland, the frequency of inundation has reduced due to changes in the catchment. It is likely that the condition of the site will continue to deteriorate without intervention.

Jesse Dam is considered to be in moderate condition, with the lack of aquatic and fringing vegetation limiting habitat values of the site. This is because the site has predominately remained terrestrial due to lack of natural inundation. However, recent observations have shown that the value of the site has increased through the delivery of environmental water, with significant species such as the Brolga utilising it for feeding.

10.6.2.1 Do Nothing

The recent observation of Brolga utilising Jesse Dam shows the importance of the site in supporting this significant species in the region. Without delivery of environmental water Brolga and other waterbird species will need to seek aquatic conditions elsewhere. This does not pose a significant risk in wet years when rainfall runoff will fill the wetland. However during dry conditions when surrounding waterbodies are dry, Jesse Dam may provide the only aquatic habitat in the region.

10.7 Conceptualisation of Site



N.B. cross section not to scale

Key descriptions:

1. High weediness in the bed of the wetland prevents the establishment of a diversity of native sedges, shrubs and emergent vegetation. These vegetation types provide habitat and resources for macroinvertebrates, frogs and waterbirds. This includes Marbled Marshwort which has been anecdotally recorded in the bed of the wetland. The species is particularly important being present in only a few locations in Victoria and Australia as a whole.
2. Jesse Swamp and the fringe of Jesse Dam, has historically supported feeding and breeding (wetland only) of brolga. This species is considered vulnerable in Victoria and is attracted to the site due to the open, shallow foraging opportunities.
3. Low structure and diversity of aquatic and fringing vegetation limits the habitat types available and the fauna species that utilise the site. The open grassland environmental also exposes fauna with low mobility to predation from foxes.

10.8 Management Objectives

10.8.1 Management Goal

A long-term management goal (i.e. ten years) for Jesse Swamp and Jesse Dam have been developed based on the information derived from Rakali Ecological Consulting (2014) and Howard et al., (2014) and presented in Section 10. However, due to the current capacity restrictions of the WMP and the size of the wetland, this section will only focus on management of Jesse Dam and a small area of the surrounding wetland bed. Management objectives, ecological and hydrological objectives and a recommended watering regime for Jesse Swamp are presented in Appendix 10: Wetland Management Objectives. Please note that consideration has been given for wetland ecological objectives that may benefit (either fully or in part) from environmental water delivery to the dam. This includes opportunities to overtop dam banks to provide low-level inundation.

Jesse Dam environmental water management goal

Promote native aquatic plant growth including re-establishment of Marbled Marshwort at Jesse Swamp dam and provides shallow foraging habitat for waterbirds (including Brolga) and feeding opportunities for frogs.

10.8.2 Ecological Objectives

The ecological objectives and justification for the management goal presented in Section 10.8 are presented below in Table 75.

Table 75. Ecological objectives of Jesse Dam

Ecological objective	Justification (value based)
1. Increase cover and structural diversity of **aquatic vegetation** (particularly in the wetland area immediately surrounding the dam)	- Provide important feeding habitat for turtles, frogs, waterbirds (including Brolga) and macroinvertebrates - Create habitat diversity to increase diversity of fauna species utilising dam *Objective may require active intervention i.e. revegetation, bank modification work to allow achievement (see Section 13).*
2. Re-establish **Marbled Marshwort** in or surrounding dam	- Marshwort is particularly important at Jesse Swamp being present at only a few locations in Victoria, and Australia as a whole - Facilitation of colonisation at the dam will safeguard population at Jesse Swamp (species required annual flooding) - Objective linked to ecological objective 1
3. Maintain/ increase **frog feeding** opportunities[1]	- Provide a diversity of habitat types as well as feeding opportunities to promote frog use - Frogs provide food source for waterbirds - Objective based on achievement ecological objective 1
4. Increase **waterbird feeding** opportunities (particularly	- Promote a diversity of habitat types through wetting and drying to a range of feeding opportunities, particular shoreline foraging waterbirds (i.e. through wetting

Ecological objective	Justification (value based)
shoreline foragers)	and drying) - Promote feeding of rare species including Brolga - Objective based on achievement ecological objective 1
[1]As frog and turtle surveys have not been undertaken at the site (see Section 8.4.1) objective is based on the vegetation communities present and the proximity to known populations. Further information is required to determine the appropriate trajectory for future management.	

10.8.3 Hydrological Objectives

Hydrological objectives are based on the hydrological requirements of the ecological objectives detailed in Section 10.8.1. Table 76 provides a summary of this information with specific detail and justification given in Appendix 8: Water Requirements for Values and Appendix 9: Hydrological Objectives.

Table 76. Hydrological objectives of Jesse Dam

		Description
Timing		Provide fresh inflows into Jesse Dam most often in winter to ensure overtopping to inundate a small area of the wetland bed can occur in spring. Ensure that the dam and wetland bed dries by summer in most years to prevent water couch dominance.
Watering frequency	Minimum[1]	Water Jesse Dam (only) 6 in every 10 years and allow overtop 3-5 in every 10 years.
	Optimum	Water Jesse Dam and overtop to inundate small area of wetland 6 in every 10 years.
	Maximum	Water Jesse Dam (only) annually to maintain a seasonal regime (i.e. 10 in every 10 years). Allow overtop to inundate small area of wetland 7 in every 10 years
Ponding duration	Minimum[1]	3 months in Jesse Dam (only).
	Optimum	6 months in Jesse Dam and wetland bed.
	Maximum	9 months in Jesse Dam and wetland bed[2].
Duration of dry between events	Minimum[1]	6 months in Jesse Dam and wetland bed.
	Optimum	1-2 years in Jesse Dam and wetland bed.
	Maximum	3 years in Jesse Dam and wetland bed.
Extent		JESSE DAM (ONLY): 157.6-158 m AHD (up to 0.4 metres) OVERTOP: 158-158.2 m AHD (0.2 m in wetland bed)
Variability		High- mimic natural variability by providing occasional watering events outside of the optimum timing (i.e. summer fill to mimic summer thunder storm event)
Estimated volume per event		At least 11 ML
[1] Under extremely dry catchment conditions and low to no allocations the application of prioritisation criteria in Section 3.5.4 will apply. This may result in a low priority ranking for the site, and as such insufficient water resources to maintain the minimum regime (i.e. thus the need to dry the site). [2]Maintaining depth during wet years may increase the chance of natural flooding at Jesse Wetland by removing filling the dam airspace.		

10.8.4 Watering Regime

The optimum watering regime for Jesse Dam is derived from the ecological and hydrological objectives presented in Sections 10.8.2 and 10.8.3. The regime should be managed adaptively to account for climatic variation and water availability.

Jesse Dam optimum watering regime

Intermittent- fill and overtop 6 in every 10 years

Provide fresh inflows six in every ten years during winter to fill and overtop Jesse Dam (>158 m AHD). Once overtopped, continue to deliver to inundate a small area of the bed of the wetland to a depth of at least 0.2 metres. Maintain inundation in wetland bed for 3-6 months (with variability) before allowing drawdown and complete drying in summer (to prevent dominance of water couch).

Allow wetland and dam to dry for one to two years before re-wetting.

11 Managing Risks to Achieving Objectives

A qualitative risk assessment has been undertaken for the Wimmera Mallee Pipeline Wetlands to assign the level of long-term risk associated with:

- delivery of environmental water; and
- at achieving set ecological objectives (i.e. factors outside delivery of environmental water inhibiting ability to achieve objective)

As shown in Table 77, the relationship between likelihood (probability of occurrence) and the severity (severity of the impact) provide the basis for evaluating the level of risk.

Table 77. Risk matrix

		Severity		
		Major	**Moderate**	**Minor**
Likelihood	**Probable**	High	High	Moderate
	Possible	High	Moderate	Low
	Improbable	Moderate	Low	Low

The results from the Wimmera Mallee Pipeline Wetlands risk assessment are presented in Table 78. Management measures relevant for the moderate to high-level risks are recommended and the residual risk is then recalculated using the same risk matrix.

Table 78. Potential risks to achieving objectives

Threat	Outcome	Relevant sites	Likelihood	Severity	Risk	Management Measure	Residual Risk
1. From environmental water							
1.1 Changes to frequency, duration and extent of flooding	*Exotic flora species*- Water Couch is considered a threat to site health being able to grow rapidly when conditions are moist and temperatures high (i.e. when inundated during summer). This species is also effective at excluding native species and can form thick mats reducing vegetation diversity and impact attenuation. Other exotic species can result in displacement of native species and changes to the composition of vegetation communities (DSE, 2009c). In the WMP Wetlands, exotic species make up on average 34% of the species recorded (Rakali Ecological Consulting, 2014).	Jesse Dam	Probable	Minor	Moderate	• Ensure sites dries prior to growth season at Jesse Swamp • Revegetate area surrounding the dam/wetlands to shade out Water Couch and maintaining native diversity • Monitor vegetation to detect new infestations of species. Undertake weed management works at onset.	Low- recommended water regime include requirement for summer dry
		All sites: *Aquatic vegetation in dam and wetland area*	Possible		Low		Low- no change to risk
	Changes to wetland type- Physical changes through construction of dams and roads, has changed the manageable depth and extent of inundation at many sites (for example Corack Lake can only receive shallow inundation although the wetland is a deep freshwater marsh).	Corack Lake, Creswick, Swamp, Jeffcott and Jesse Swamp	Probable	Moderate	High	• Explore options to enable increased delivery extent (i.e. levee, agreement for flooding of private land, increase pipeline capacity).	Moderate- Even under sub-optimum conditions (i.e. low-level inundation instead of deep), environmental water will provide a greater benefit to the system then not watering at all

Threat	Outcome	Relevant sites	Likelihood	Severity	Risk	Management Measure	Residual Risk
	Over colonisation of River Red Gums- Shallow, frequent inundation in the bed of some wetlands may increase the establishment of River Red Gums that would previously not establish due to the depth of the wetland.	Corack Lake, Creswick Swamp, Jesse Swamp and Davis Dam	Possible	Moderate	Moderate	• Manage watering of wetland area adaptively to ensure ecological objectives are not compromised (i.e. extend dry period to kill off unwanted saplings) • Undertake physical management (i.e. spraying)to reduce numbers • As per threat 2.1, over grazing may also reduce likelihood of risk.	Low- Management measures can be adopted as part of environmental water delivery.
1.2 Inability to sustain water level if watering triggers waterbird breeding event	Due to capacity restrictions and low water allocations, it is possible that follow-up watering will be insufficient to maintain depth should a waterbird breeding event be triggered in the wetland area.	Chirrup Swamp, Corack Lake, Creswick Swamp, Jeffcott Wetland and Jesse Swamp	Possible	Moderate	Moderate	• Monitor waterbirds during watering event to determine likelihood of breeding. Attempt to begin top-up early if evidence of breeding is recorded.	Low- It is unlikely that these areas will retain water for longer than a few months when watered. In most cases, the short duration will not align with the requirements (i.e. including lag time) of waterbird species.
1.3 Undesirable flooding of private land or infrastructure	There is the potential that an environmental water release could result in unauthorised inundation of private land and or flooding of assets/ infrastructure.	Creswick Swamp, Corack Lake and Jeffcott Wetland	Possible	Moderate	Moderate	• Enter into a deed of agreement with any landholders likely to be affected by environmental water • Monitor water extent and adaptively manage environmental water delivery	Low- Due to the low delivery volumes and the location of the dams at each site, it is unlikely that watering will result in private land inundation.

Threat	Outcome	Relevant sites	Likelihood	Severity	Risk	Management Measure	Residual Risk
2. To ecological objectives							
2.1 Stock access and grazing pressure	The sites are located within an intensive agricultural landscape with grazing a principal farming enterprise. Although there are no current grazing licenses on public land sites and all private sites are fully fenced, there is potential for stock to gain access. Reduced open water in landscape also has the potential to result in over colonisation/use of watered sites by terrestrial fauna. This may prevent establishment of emergent vegetation and recruitment of understorey and overstorey species within the riparian zones through physical grazing and pugging.	All sites: *vegetation in littoral and riparian zones*	Possible	Moderate	Moderate	• Funding to full fence (or repair fences) all sites is required to exclude stock access • Continued compliance monitoring is required by Parks Victoria on public land • Regular compliance checks on private land to ensure landholders are abiding to the Management Agreement and Deed of Agreement	Moderate- No change to risk due to lack of Parks Victoria resources to undertake compliance checks.
2.2 Introduced species	*Fish*- Although not investigated, it is likely that European Carp and Gambusia are present in the system; particularly post 2010-11 flooding. A high abundance of these species may limit the establishment of aquatic plants and reduce water quality. This has flow on impacts for the entire food web.	All sites: *vegetation in littoral and wetland areas*	Possible	Moderate	Moderate	• Drying of dam and wetland will manage Carp • The pipeline will limit the introduction of adult Carp to sites during watering. Risk increases when natural flooding occurs. • There is yet to be a broad scale method for control of European Carp, which is identified as a knowledge gap across the entire Murray-Darling Basin.	Low- Drying of dams and method of environmental water delivery likely to reduce risk.
	Foxes- Predation of turtles, waterbirds and mammals at sites or during movement between	All sites (particularly those isolated	Probable	Major	High	• Turtle predation in the form of raid nests is evident at many sites	High- Lack of funding for targeted fox works

Threat	Outcome	Relevant sites	Likelihood	Severity	Risk	Management Measure	Residual Risk
	sites.	or with low vegetation cover)				• Undertake fox control program • Improvement of riparian cover and longitudinal connectivity between sites is required	is likely to prohibit a reduction in risk.
	Rabbits- Herbivory of emergent vegetation as well as recruited understorey and overstorey species.	All sites	Probable	Moderate	High	• Grazing pressure is likely to continue due to lack of open water in landscape • Fencing may reduce colonisation of some species however risk is likely to remain the same	High- no change to risk
2.3 Lack of vegetated corridors	Connectivity has been significantly reduced in the WMP Wetlands due to the lack of habitat corridors, remnant vegetation patches and open water in the landscape (Buloke Shire Council, 2003). Although local Landcare groups have undertaken considerable work to create roadside habitat, areas of remnant vegetation are sparse, with little cover. This has significant implications for a range of species (i.e. risk of being stranded, predated on or injured through road vehicle accidents), particularly those that are water dependent and have low mobility (i.e. frogs and turtles).	All sites	Probable	Moderate	High	• Undertake further roadside habitat enhancement works • Create corridors between key habitat areas • Signage advising road users of wildlife	High- Lack of funding for large-scale revegetation works is likely to prohibit a reduction in risk
2.4 Chytrid Fungus	The fungus is present at least four of the sites and impairs osmoregulation in most frog species (Howard et al., 2014).	All sites including Jeffcott Wetland where	Probable	Moderate to minor	Moderate to high	• Zoospore counts at sites tested positive were considered low when compared to other regions in	Moderate to high- no change to risk

Threat	Outcome	Relevant sites	Likelihood	Severity	Risk	Management Measure	Residual Risk
	Mortality rate of up to 100% is common, with adults more vulnerable than tadpoles. Fungus is transferred through water and physical signs are often absent.	it has not yet been recorded				Victoria. This is likely attributed to the semi-arid nature of the region, with vivacity linked to wet and cold conditions • There has been some success with early stages of the infection, with sodium chloride and thermal manipulation found to reduce growth. There are however no current treatments for the terminal stage of the disease • Frog surveys to be undertaken using stringent hygiene measures to reduce spread (particularly important at sites that do not currently have the fungus) • No change to residual risk due to limited control measures available.	
2.5 Dryland salinity	Salinization to wetland and/ or surrounding farmland	All	Possible	Major	High	• Monitor local groundwater levels and adaptively manage delivery of environmental water • Residual risk reduced to moderate for severity however further research and monitoring required.	Moderate

12 Environmental Water Delivery Infrastructure

12.1 Constraints

The following section outlines the constraints to the delivery of environmental water to the WMP Wetlands.

12.1.1 Infrastructure and Operational Constraints

Infrastructure

As discussed in Section 2.6, the delivery rate (ML/day) of environmental water to the WMP Wetlands is constrained by the capacity of the pipeline and demand of other users. Between October and December 2013, the delivery rates to sites on public land ranged from 0.065-0.18 ML/day. At these rates, filling of a 25 ML site could take up a year making it impracticable to fill the entire wetland area. Therefore the focus of environmental water delivery in this EWMP is the dams adjacent to or in the wetlands.

Operation

In some cases, there may be opportunities to overtop the dams to provide low level inundation to the surrounding wetland area. The extent of this may however be limited by private property and impacts on access tracks. Section 16 discusses options to mitigate such impacts.

12.1.2 Entitlement Constraints

The volume of environmental water is constrained by the total entitlement volume and environmental water availability in the system. Average inflows in the 2013-14 season resulted in only 25 percent allocation of the 1,000 ML Wimmera and Glenelg Environmental Entitlement 2010 for wetlands. Even in years with high allocations, the total volume required to fill all 52 sites in Wimmera Mallee Wetland System would be far greater than the allocation. Integrated management between the three CMAs to consider environmental watering at a landscape scale is essential for future management of the complex. This will be facilitated by an Environmental Water Advisory Group (EWAG) which will be convened by all three CMAs, key stakeholders, private landholders and community members.

12.2 Infrastructure Recommendations

The following section outlines the recommended infrastructure and complimentary work to assist with achieving the WMP Wetlands ecological objectives.

There is potential to benefit the surrounding wetland areas by increasing the pipeline capacity (i.e. increase delivery rate). This would increase the area able to be influenced, the volume of water able to be delivered and would also reduce the fill time enabling more efficient and effective delivery of environmental water. Investigations to scope out the potential to increase the delivery capacity are yet to occur. However, it is anticipated that backbone infrastructure capacity, distance from the headwater source and head difference would impact the feasibility of increasing the capacity at each site.

The community has voiced concern regarding the geographical spread of sites in the region and has recommended that additional site connections be scoped, to ensure that all areas impacted by the Pipeline Project are safeguarded from future deterioration (Appendix 6: Engagement Outcomes), At the time of writing, GWMWater has advised that there is no funding for additional site connections. In addition, is unlikely that the entitlement volume is sufficient to meet the ecological objectives of the sites currently connected. It is recommended that a monitoring program be developed to assess whether delivery can meet the current demand, prior to the connection of additional sites.

13 Complementary Activities

Table 79 documents the recommended actions that should be adopted to complement the delivery of environmental water to the WMP Wetlands.

Table 79. Complementary actions

Activity	Rationale	Recommendation	Priority
Complex			
Exotic flora control	All sites were identified to contain a high diversity and abundance of exotic plant species that have the potential to disturb the function of native vegetation through displacement and competition. Exotic plants also impact on primary production within a system, which in turn feeds into all other food web interactions that take place within a system.	Undertake weed control such as manual removal and chemical application	Moderate
Revegetation works	Most of the sites in the WMP Wetlands have a low diversity and extent of surrounding native vegetation (the result of previous grazing/ land use practices). By increasing the habitat heterogeneity of the surrounding buffer zone, conditions will be improved for terrestrial species such as mammals, woodland/ grassland birds and reptiles. The dam sites are also void of native vegetation (both aquatic and fringing) due to their depth and the steepness of their banks. Revegetation works would assist with stabilising soils, reducing evaporation (i.e. shading water), increase organic matter and filtering catchment runoff. Future recruitment and success of planted species will be supported by earth works to improve the topography of the dams (see earth works).	Undertake revegetation works	Moderate
Fox control	Impact of foxes is evident at all of the Wimmera Mallee Pipeline Wetlands site. Observations include raided turtle nests and predation (i.e. waterbirds, native mammals, turtles etc.).	Undertake fox control measures such as baiting, fox drives and education activities to encourage compliance by surrounding landholders	Moderate
Rabbit control	Impact of rabbits is also evident at all of the WMP Wetlands site. Observations include rabbit warrens, over grazing etc. Upgrades to some of the fences within the WMP Wetlands are a required to ensure ongoing exclusion of rabbits particularly on sites surrounded by agricultural land.	Upgrade fences and undertake rabbit control measures such as warren fumigation, baiting and education activities to encourage compliance by surrounding landholders	Moderate
Fencing	The WMP Wetlands is located within a highly modified agricultural landscape with grazing a key farming enterprise. Although considered a pre-requisite for delivery of environmental water to the WMP Wetlands sites, many of the fences surrounding the sites are poorly maintained. Stock access results in over grazing, damage to native vegetation and pugging.	Upgrade fences	Low
Habitat improvements	Earth works- There are opportunities to improve the structural diversity of the dams by creating topographical variability. This could include excavation work to reduce the steepness of the banks, to create shallows, islands and backwaters, to reduce the height of surrounding spoil heaps to improve overtopping potential and to improve connectivity with neighboring water bodies (i.e. removal of the levee between the dams at Corack Lake).	Seek funding to undertake a dam enhancement works project.	High
	Increased habitat- Reinstatement of large wood debris and		

Activity	Rationale	Recommendation	Priority
Complex			
	placement of boulders/rocks in and around the dams is a cost effective method of improving habitat structural diversity for fauna species. This will also aid in capturing silt and forming variability as well as encourage the establishment of biofilms, providing additional food sources.		
Additional sites managed for environmental benefit	There are thousands of sites within the WMP Wetlands footprint that could be managed for ecological purposes by private landholders. Improvements might be as small as stock exclusion and minor regeneration works, to delivery of irrigation water to sites.	Undertake an educational campaign would assist with providing landholders with the resources and information required to manage their own sites for ecological purposes.	Moderate
Site specific			
Connection of Lily Pond at Jesse Swamp	Lilly Pond at Jesse Swamp has historically supported a high abundance of EPBC listed Marbled Marshwort. Environmental water delivery will increase the likelihood that this species is retained into future.	Investigate infrastructure options to connect Lilly Pond to pipeline	High
Connection of Corack Lake dams	The dams at Corack Lake provide different functions, with the larger providing refuge and the smaller providing high quality opportunistic conditions. Direct connection (i.e. breach in spoil heap between dams) of the two dams would significantly reduce the volume of water required to inundate the larger dam (would not need to flood small area of wetland) safeguarding it from drying.	Investigate earthworks options to connect two dams	High
Tracks at Creswick Swamp	Currently the tracks surrounding Creswick Swamp (particularly the western track) prevent the wetland from being filled. Even during low level natural flooding, the track and neighboring private land becomes inundated.	Investigate options to either flood road or construct a levee to retain water in the wetland area.	High
Translocation of Marbled Marshwort	Marbled Marshwort is rare in Victoria with only a few locations present. It is unknown whether environmental water delivery will promote natural re-establishment of the species at sites where it has previously been recorded.	Translocate Marbled Marshwort to Jesse Swamp dam and Creswick Swamp dam.	Moderate

14 Demonstrating Outcomes

Monitoring is required to enable the North Central CMA and VEWH to evaluate the effectiveness of environmental water in achieving environmental outcomes. Monitoring is undertaken to assist with determining the success of the hydrological outcome, in consideration of other limiting factors that may inhibit full realization.

DELWP is currently developing WetMAP (Wetlands Monitoring Assessment Program), which will be a long-term monitoring program aimed at assessing the effect of environmental water on Victorian wetlands. This program is currently in its early stages of development as a result only internal monitoring is currently undertaken by North Central CMA staff in the WMP Wetlands. The WMP Wetlands EWMP should be revised once the statewide monitoring program has been established.

14.1 Monitoring Priorities at the Site

14.1.1 Long-term Monitoring

Long term condition monitoring is required to evaluate any changes to the site values over time. It should be noted that condition monitoring is recommended to be conducted in conjunction with intervention monitoring to comprehensively evaluate any changes to the sites. An ongoing monitoring program to inform environmental water delivery and resource planning for the WMP Wetlands is conducted by the North Central CMA. This is undertaken as part of the implementation of the SWP and includes photopoint monitoring as well as rapid condition assessments. Each year, environmental water is delivered based on an assessment of the previous year's monitoring data, climatic conditions and water availability. However, due to the lack of resourcing, this is relatively limited and does not adequately cover the full suite of ecological objectives and their response to environmental water deliver. Appendix 11: Photopoint monitoring sites shows the current photopoint monitoring sites for the Wimmera Mallee Pipeline Wetlands.

14.1.2 Intervention Monitoring

Monitoring the response of key environmental values to the provision of environmental water is imperative in informing adaptive management of the recommended water regime. Monitoring will also assess the success of implementation and the achievement of ecological objectives outlined in this EWMP with results used to reassess and amend the recommended flow regime as required.

The following recommendations have been made for variables to be monitored in order to assess the response to the provision of environmental water and to inform adaptive management for the WMP Wetlands. It should be noted that these components are presented as recommendations only and the degree to which they are undertaken will be dictated by year to year funding circumstances.

Vegetation Condition and Distribution

It is recommended that the condition and distribution of vegetation communities, including exotic species, at each of the WMP Wetlands sites is regularly assessed.

Information on vegetation communities, including IWC assessments, has been gathered most recently by Rakali Ecological Consulting (2014) and has been digitalised using GIS to enable comparison in distribution over time.

Further to this quadrats should be established to monitor aquatic vegetation growth, particularly if revegetation and/or future earthworks are undertaken.

Additional methods that should be employed in the evaluation of change to vegetation condition and distribution over time include:

- Index of Wetland Condition (assessed against the wetland pre-European state)
- Habitat Hectares.

The below table summarises methods that could be adopted to monitor vegetation response:

Component	Method
Vegetation distribution	- Distribution mapping - Photo points - IWC
Vegetation condition	
Species diversity	Species list comparison

Waterbirds

The diversity and abundance of waterbirds in the WMP Wetlands sites needs to be monitored following watering in order to assess the success of implementation and achievement of objectives relating to waterbirds. Monthly monitoring will ensure changes in bird communities are captured. Baseline data has been captured during Rakali Ecological Consulting (2014) and Howard et al., 2014. The following information should be the focus of ongoing monitoring:

Component	Method
Species diversity	Monthly area and quadrat searches
Waterbird abundance	
Breeding	
Habitat availability	To be undertaken in conjunction with vegetation monitoring

Frogs

The diversity and abundance of frogs in the WMP Wetlands sites needs to be monitored following watering in order to assess the success of implementation and achievement of objectives relating to turtles. Continued swabbing for Chytrid Fungus should also be undertaken to ensure spread of the disease is managed, particularly relating to Jeffcott Wetland were the fungus was not recorded. Baseline data has been captured during Howard et al., (2014), with the following ongoing monitoring recommendations:

Component	Method
Species diversity	Wildlife Acoustic Song Meters (audio) and visual surveys
Species abundance	
Breeding	
Chytrid Fungus	Swabbing for Taqman real-time PCR assay analysis
Habitat availability	To be undertaken in conjunction with vegetation monitoring

Turtles

The diversity and abundance of turtles in the WMP Wetlands sites needs to be monitored following watering in order to assess the success of implementation and achievement of objectives relating to turtles. Baseline data has been captured during Howard et al., (2014), with the following ongoing monitoring recommendations:

Component	Method
Species diversity	Cathedral traps (deep water) and fyke nets (shallow water)
Species abundance	
Breeding	
Habitat availability	To be undertaken in conjunction with vegetation monitoring

Macroinvertebrates

Macroinvertebrates provide an important food source for a range of native fauna species including frogs, turtles and waterbirds and provide an effective indicator of system health. Baseline macroinvertebrate surveys were undertaken by Howard et al., (2014) and should be repeated regularly to inform objectives relating to feeding habitat/ conditions. The table below summarises the information that should be collect to inform such objectives:

Component	Method
Functional group diversity	Sweep netting/ Rapid Bioassessment protocol
Functional group abundance	

Water Quality and Level Monitoring

Regular water level and quality including turbidity, water temperature, dissolved oxygen, nutrients and pH should be undertaken to determine the condition of each site through time. This will inform the health and growth of aquatic

vegetation key ecological objectives for most sites. The information collected will inform the delivery of environmental water.

Groundwater Monitoring

Long term monitoring of groundwater within the immediate vicinity of each WMP Wetlands site is recommended to identify potential risks associated with watering the sites. This is particularly important should natural flooding occur and the larger wetland area be inundated.

15 Consultation

The following consultation has been undertaken as part of the WMP Wetlands EWMP development:

Date	Description	Purpose	Who
8 May 2014	Initial EWMP workshop	Develop an understanding of the history, environmental, social, cultural and economic values, threats, risks and management objectives for the individual sites and wider complex	Community and stakeholders- see Appendix 6: Engagement Outcomes
21 October 2014	Technical workshop	Refine the management goals and ecological objectives for the draft Wimmera Mallee Pipeline Wetlands EWMP. The workshop considered outcomes from the community and agency workshop as well as values identified in Rakali Ecological Consulting (2014) and Howard et al., (2014).	Damien Cook- Rakali Ecological Consulting
11 December 2014	Final EWMP workshop	Review final management goals and ecological objectives from the draft EWMP. Participants were supplied with a copy of the draft EWMP one week prior to the meeting. Final comments and recommendations from the workshop were incorporated into the final EWMP.	Community and stakeholder-Appendix 6: Engagement Outcomes
January 2015	Traditional Owner Groups site visits	Develop an understanding of the key cultural values, land use practices and flora species that hold cultural significance at both a site specific and landscape scale.	Barenji Gadjin and Dja Dja Wurrung Traditional Owner Groups
May-December 2014	Email and telephone correspondence	As required to address site specific queries relating to the development of the EWMP.	Community and stakeholders
April 2016	Expert Review Panel	Expert review of content.	Marcus Cooling

A summary of the proceedings from each of the cultural, technical, community and agency workshops are presented in Appendix 6: Engagement Outcomes.

16 Knowledge Gaps and Recommendations

The WMP Wetlands EWMP has been developed using the best available information. However, a number of information and knowledge gaps exist which may impact on recommendations and/or information presented in the EWMP. The priority status of these are summarised in Table 80.

Table 80. Knowledge gaps and recommendations

Knowledge Gap	Rationale	Recommendation	Who	Priority
To address knowledge gaps				
Detailed bathymetric surveys	LiDAR provides an adequate representation of topography however accuracy is 0.2 metre and in some instances is impacted by the presence of water	Undertake bathymetric surveys with 0.1 metre accuracy to better understand topography and water requirements	Contractor on behalf of North Central CMA	Low
EVCs and IWC assessment of Davis Wetland	Rakali Ecological Consulting (2014) advised that parcel was not a natural occurring wetland, however landholder evidence (i.e. photos) suggest a history of intermittent flooding.	Resurvey EVCs and undertake IWC assessment of Davis Dam	Consultant on behalf of North Central CMA	Low
Depth of water	Gauge boards assist with water management by enabling officer to correlate depth with volume.	Installation of gauge boards in both the dam and wetland areas.	Contractor on behalf of North Central CMA	High
Groundwater	Groundwater surveys have not been undertaken for the Wimmera Mallee sites to date. This will enable a better understanding of the groundwater/surface water interactions and likely impacts of watering under different groundwater level scenarios.	Undertake groundwater investigations at sites	Internally or by consultant on behalf of North Central CMA	Low
Targeted macroinvertebrate, turtle and frog surveys at Davis, Jesse and Falla	Private sites were not surveyed by Howard et al., (2014) for macroinvertebrates, turtles and frogs. In most cases landholders have indicated presence however species diversity and abundance is unknown.	Undertake targeted surveys as per methodology adopted by Howard et al., (2014)	Consultant on behalf of North Central CMA	Low
Fauna and flora values	The majority of management goals and ecological objectives in this EWMP are based on limited fauna and flora records at the sites. Further surveys, particularly during different times of the year, will assist with providing a more holistic understanding of the values present at each site. This will inform future environmental water management.	Undertake detailed flora and fauna surveys	Consultant on behalf of North Central CMA	Moderate
To improve habitat values				
Additional water	Securing additional environmental water will assist with meeting environmental watering objectives (particularly those related to wetland watering). However the capacity restrictions of the pipeline may still limit the total volume able to be delivered to any one site.	Continue to monitor delivery of environmental water to understand how capacity restrictions may limit delivery of higher volumes.	North Central CMA and GWMWater	Moderate
Additional sites	The community has voiced their concern for the geographic spread and lack of connected sites in the North Central region. Additional connections would aid in ensuring that water is located throughout the landscape.	Continue to monitor delivery of both environmental water and recreational water in the landscape to understand geographical distribution of water. The North Central	North Central CMA, GWMWater and community	Low

Knowledge Gap	Rationale	Recommendation	Who	Priority
		CMA recommends that delivery to sites currently connected to the pipeline is prioritised over additional connections, to ensure that the current entitlement volume is sufficiently to meet ecological objectives.		

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18 Abbreviations

ARI	Arthur Rylah Institute for Research
BE	Bulk Entitlement
CEWH	Commonwealth Environmental Water Holder
CMA	Catchment Management Authority
DELWP	Department of Environment, Land, Water and Planning
DIWA	Directory of Important Wetlands In Australia
EVC	Ecological Vegetation Class
EWMP	Environmental Water Management Plan
FSL	Full Supply Level
GWMWater	Grampians Wimmera Mallee Water
IWC	Index of Wetland Condition
kL	Kilolitre (one thousand litres)
MDBA	Murray-Darling Basin Authority
ML	Megalitre (one million litres)
TSL	Targeted Supply Level
VEWH	Victorian Environmental Water Holder
WMP	Wimmera Mallee Pipeline

Appendix 1: Legislative Framework

International agreements and conventions

Ramsar Convention on Wetlands (Ramsar)

The Australian Government is a Contracting Party to the convention, which is an inter-governmental treaty whose mission is “the conservation and wise use of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world".

World Heritage Sites

Heritage includes places, values, traditions, events and experiences that capture where we've come from, where we are now and gives context to where we are headed as a community. The World Heritage Convention aims to promote cooperation among nations to protect heritage from around the world that is of such outstanding universal value that its conservation is important for current and future generations. It is intended that, unlike the seven wonders of the ancient world, properties on the World Heritage List will be conserved for all time (DEWHA ~2008a).

East Asian-Australasian Flyway Sites

Australia provides critical non-breeding habitat for millions of migratory waterbirds each year. Migratory waterbirds include species such as plovers, sandpipers, stints and curlews. The corridor through which these waterbirds migrate is known as the East Asian-Australasian Flyway.

To ensure their conservation, the Australian Government has fostered international cooperation through the recently launched East Asian-Australasian Flyway Partnership. Under the Flyway Partnership, the site network for shorebirds has been combined into a single network, referred to as the East Asian–Australasian Flyway Site Network.

Bilateral migratory bird agreements

Australia is a signatory to the following international bilateral migratory bird agreements:

- Japan-Australia Migratory Bird Agreement (JAMBA);
- China-Australia Migratory Bird Agreement (CAMBA); and
- Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

These agreements require that the parties protect migratory birds by:

- limiting the circumstances under which migratory birds are taken or traded;
- protecting and conserving important habitats;
- exchanging information; and
- building cooperative relationships.

Convention on the Conservation of Migratory Species of Wild Animals (Bonn)

This convention (known as the Bonn Convention or CMS) aims to conserve terrestrial, marine and avian migratory species throughout their range. It is an intergovernmental treaty, concluded under the aegis of the United Nations Environment Programme, concerned with the conservation of wildlife and habitats on a global scale. The Convention was signed in 1979 in Bonn, Germany, and entered into force in 1983.

Commonwealth legislation

Environment Protection and Biodiversity Conservation Act 1999 (EPBC)

This is the key piece of legislation pertaining to biodiversity conservation within Australia. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places - defined in the EPBC Act as matters of national environmental significance.

Water Act 2007 (Commonwealth Water Act)

This establishes the Murray-Darling Basin Authority (MDBA) with the functions and powers, including enforcement powers, needed to ensure that Basin water resources are managed in an integrated and sustainable way.

Aboriginal and Torres Strait Islander Heritage Protection Act 1984

This aims to preserve and protect areas and objects in Australia and Australian waters that are of particular significance to indigenous people from injury or desecration.

Nationally Important Wetlands

Victoria has a number of waterways of National importance as described in A Directory of Important Wetlands in Australia (Environment Australia, 2001).

There are 159 wetlands in Victoria listed in the Directory.

Living Murray Icon Sites

The Living Murray was established in 2002 in response to evidence that the health of the River Murray system is in decline. The Living Murray's first stage focuses on improving the environment at six 'icon sites' along the River:

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

The sites were chosen for their high ecological value—most are listed as internationally significant wetlands under the Ramsar convention—and also their cultural significance to Indigenous people and the broader community (MDBC, 2006).

HEVAE

Through National Water Initiative (NWI) commitments, a toolkit for identifying high ecological value aquatic ecosystems (HEVAE) has been developed so that national consistency may be applied. Five core criteria are used to develop HEVAE sites across a range of scales and ecosystems:

- Diversity
- Distinctiveness
- Vital habitat
- Naturalness
- Representativeness.

The HEVAE toolkit is saved at http://www.environment.gov.au/resource/aquatic-ecosystems-toolkit-module-3-guidelines-identifying-high-ecological-value-aquatic

National Heritage Sites

The National Heritage List has been established to list places of outstanding heritage significance to Australia. It includes natural, historic and Indigenous places that are of outstanding national heritage value to the Australian nation (DEWHA ~2008).

State legislation and listings

Flora and Fauna Guarantee Act 1988 (FFG)

This is the key piece of Victorian legislation for the conservation of threatened species and communities and for the management of potentially threatening processes.

Advisory lists of rare or threatened species in Victoria (DSE)

Three advisory lists are maintained by DSE for use in a range of planning process and in setting priorities for actions to conserve biodiversity. Unlike other threatened species lists, there are no legal requirements or consequences that flow from inclusion of a species on an advisory list. The advisory lists comprise:

- Advisory List of Rare or Threatened Plants In Victoria – 2005
- Advisory List of Threatened Vertebrate Fauna in Victoria - 2007
- Advisory List of Threatened Invertebrate Fauna in Victoria - 2009

Environmental Effects Act 1978

Potential environmental impacts of a proposed development are subject to assessment and approval under this Act. A structural works program and any associated environmental impacts would be subject to assessment and approval under the Act.

Planning and Environment Act 1987

This controls the removal or disturbance to native vegetation within Victoria by implementation of a three-step process of avoidance, minimisation and offsetting.

Water Act 1989 (Victorian Water Act)

This is the key piece of legislation that governs the way water entitlements are issued and allocated in Victoria. The Act also identifies water that is to be kept for the environment under the Environmental Water Reserve. The Act provides a framework for defining and managing Victoria's water resources.

Aboriginal Heritage Act 2006

All Aboriginal places, objects and human remains in Victoria are protected under this Act.

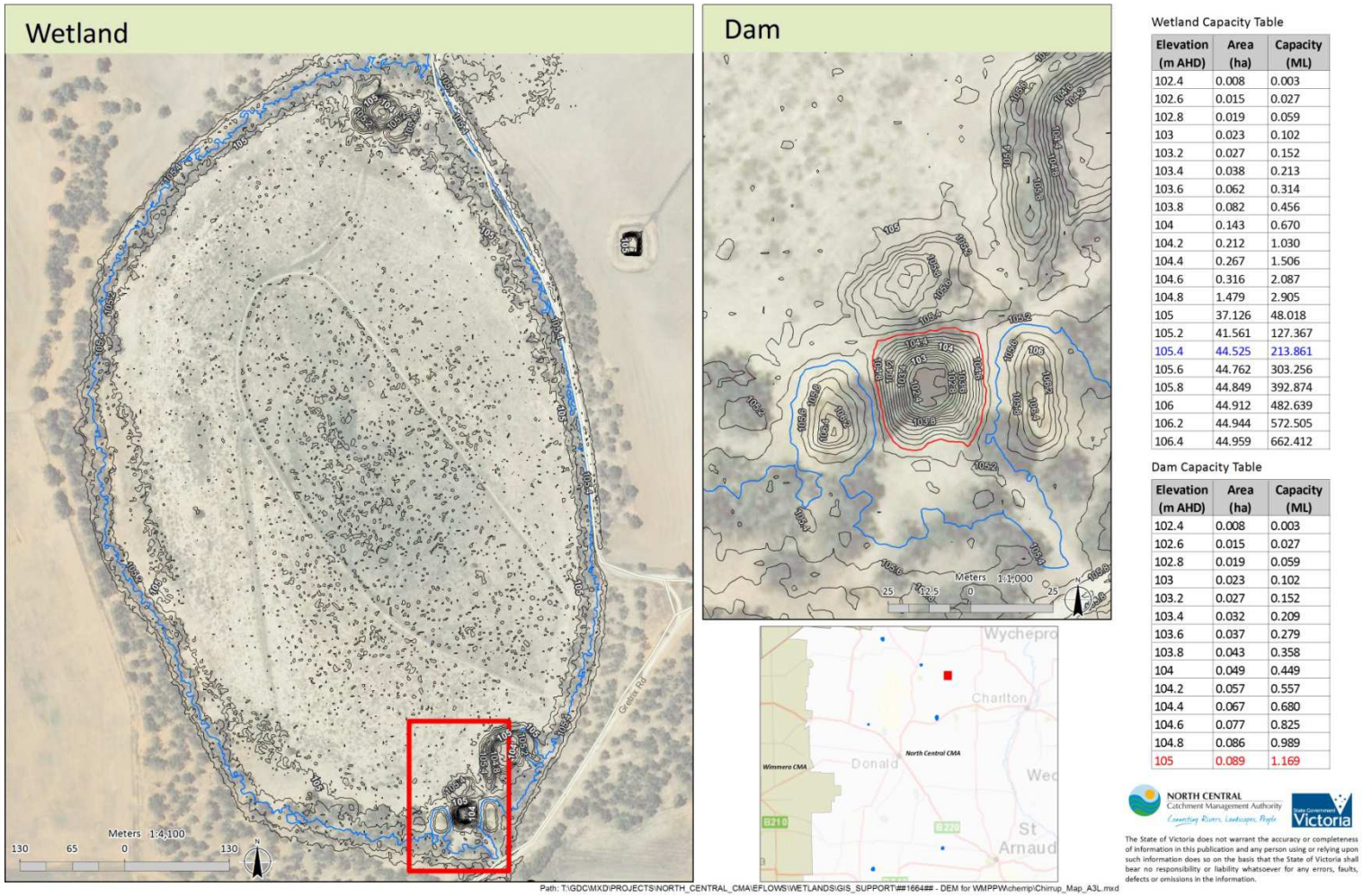
Other relevant legislation

The preceding legislation operates in conjunction with the following other Victorian legislation to influence the management and conservation of Victoria's natural resources as well as outline obligations with respect to obtaining approvals for structural works:

- Environment Protection Act 1970
- Catchment and Land Protection Act 1994
- Heritage Act 1995
- Conservation, Forests and Lands Act 1987
- Land Act 1958
- Heritage Rivers Act 1992
- Wildlife Act 1975
- Murray Darling Basin Act 1993
- National Parks Act 1975
- Parks Victoria Act 1998
- Forests Act 1958

Appendix 2: Bathymetry and Capacity Tables

Bathymetry for Chirrup Swamp



Wetland Capacity Table

Elevation (m AHD)	Area (ha)	Capacity (ML)
102.4	0.008	0.003
102.6	0.015	0.027
102.8	0.019	0.059
103	0.023	0.102
103.2	0.027	0.152
103.4	0.038	0.213
103.6	0.062	0.314
103.8	0.082	0.456
104	0.143	0.670
104.2	0.212	1.030
104.4	0.267	1.506
104.6	0.316	2.087
104.8	1.479	2.905
105	37.126	48.018
105.2	41.561	127.367
105.4	44.525	213.861
105.6	44.762	303.256
105.8	44.849	392.874
106	44.912	482.639
106.2	44.944	572.505
106.4	44.959	662.412

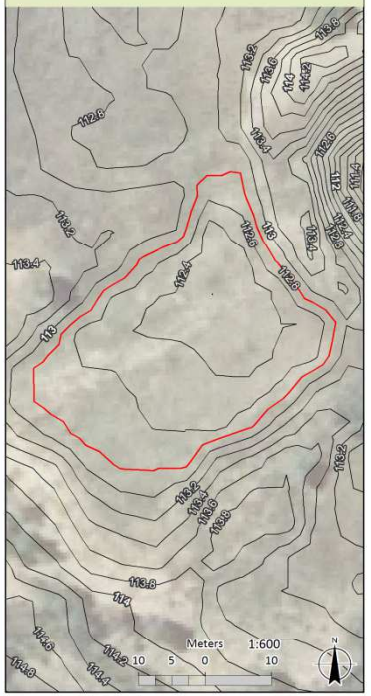
Dam Capacity Table

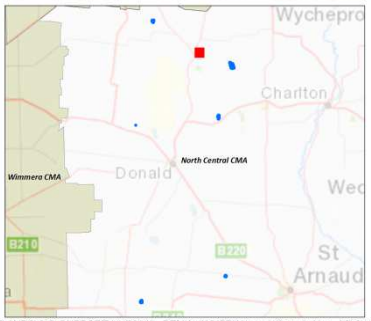
Elevation (m AHD)	Area (ha)	Capacity (ML)
102.4	0.008	0.003
102.6	0.015	0.027
102.8	0.019	0.059
103	0.023	0.102
103.2	0.027	0.152
103.4	0.032	0.209
103.6	0.037	0.279
103.8	0.043	0.358
104	0.049	0.449
104.2	0.057	0.557
104.4	0.067	0.680
104.6	0.077	0.825
104.8	0.086	0.989
105	0.089	1.169

Bathymetry for Corack Lake

Wetland

Dam





Wetland Capacity Table

Elevation (m AHD)	Area (ha)	Capacity (ML)
110.8	0.0174	0.0028
111	0.0355	0.0621
111.2	0.0419	0.1369
111.4	0.0481	0.2259
111.6	0.0546	0.3276
111.8	0.0616	0.4431
112	0.0692	0.5729
112.2	0.0776	0.7187
112.4	0.1214	0.9109
112.6	0.1916	1.2073
112.8	0.7288	2.0053
113	1.4443	4.2117
113.2	2.0284	7.6584
113.4	2.6040	12.3397
113.6	3.0387	17.9821
113.8	3.4277	24.4501
114	3.7972	31.6840
114.2	4.1203	39.6079
114.4	4.4379	48.1691
114.6	4.7334	57.3450
114.8	5.0432	67.1153
115	5.3214	77.4876
115.2	5.4560	88.3309

Dam Capacity Table

Elevation (m AHD)	Area (ha)	Capacity (ML)
112.2	0.0000	0.0000
112.4	0.0342	0.0268
112.6	0.0744	0.1335
112.8	0.1008	0.3206

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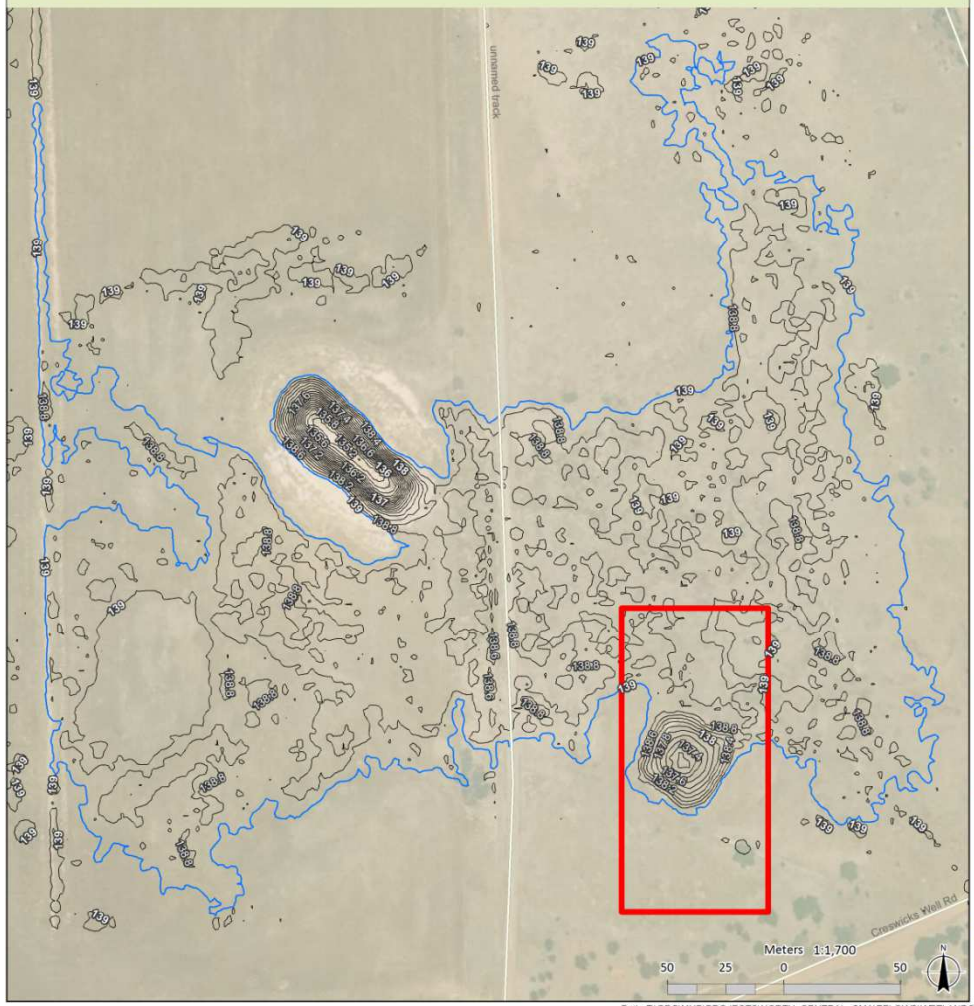
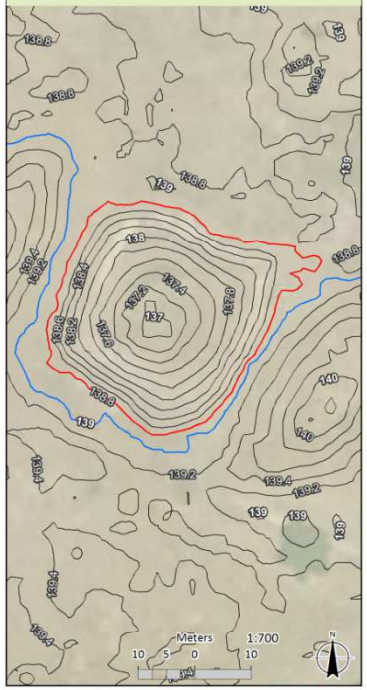
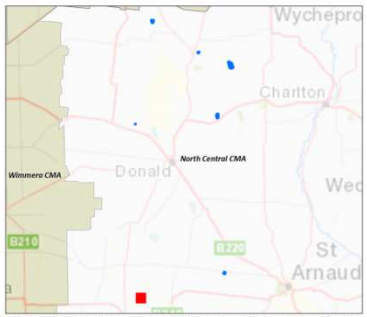
Bathymetry for Creswick Swamp

Wetland



Dam





Wetland Capacity Table

Elevation (m AHD)	Area (ha)	Capacity (ML)
135.2	0.0066	0.0033
135.4	0.0191	0.0256
135.6	0.0309	0.0738
135.8	0.0410	0.1446
136	0.0494	0.2325
136.2	0.0573	0.3393
136.4	0.0651	0.4590
136.6	0.0729	0.5965
136.8	0.0807	0.7497
137	0.0911	0.9177
137.2	0.1064	1.1154
137.4	0.1245	1.3457
137.6	0.1471	1.6152
137.8	0.1731	1.9353
138	0.2008	2.3084
138.2	0.2310	2.7399
138.4	0.2637	3.2334
138.6	0.3569	3.8109
138.8	2.4723	5.7102
139	5.3835	14.2997
139.2	5.6997	25.4503
139.4	5.8548	37.0503

Dam Capacity Table

Elevation (m AHD)	Area (ha)	Capacity (ML)
137	0.0022	0.0004
137.2	0.0088	0.0106
137.4	0.0176	0.0362
137.6	0.0303	0.0832
137.8	0.0453	0.1580
138	0.0603	0.2634
138.2	0.0755	0.3978
138.4	0.0902	0.5633
138.6	0.1006	0.7545
138.8	0.1040	0.9653

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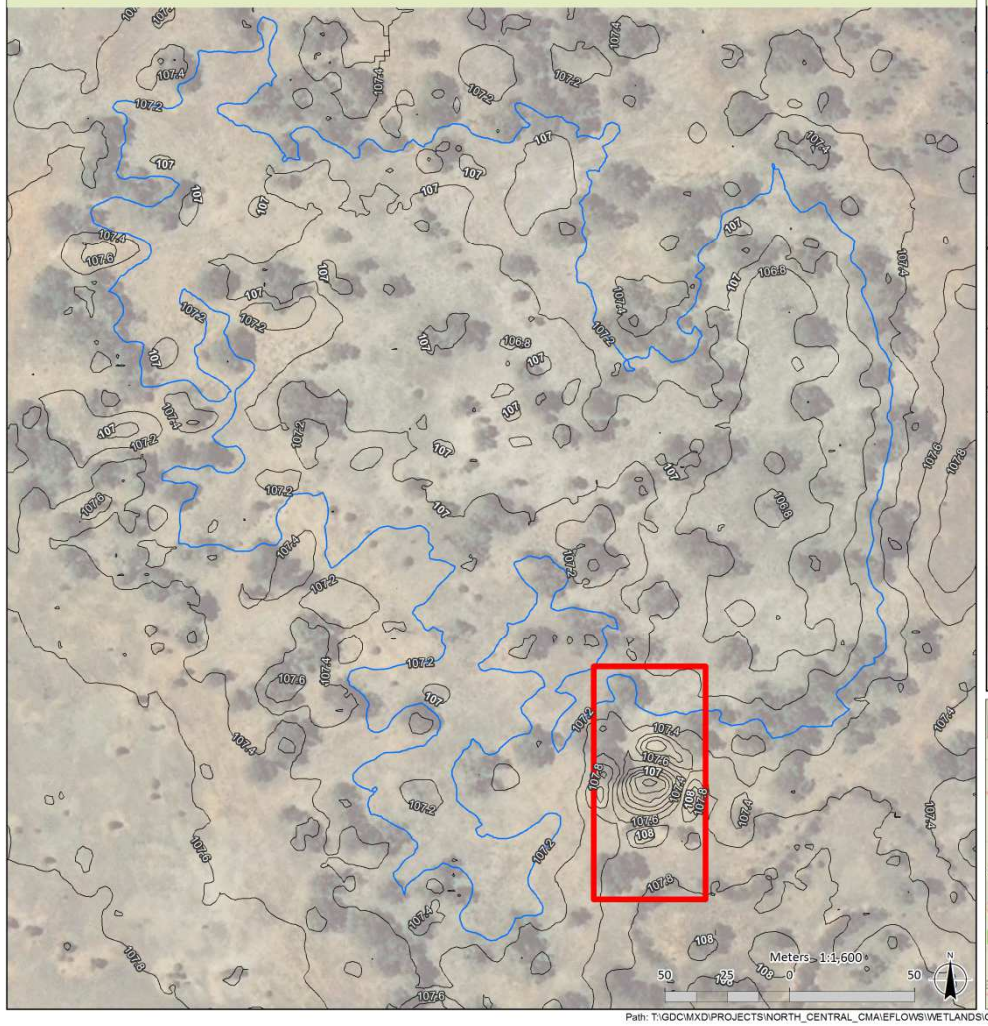
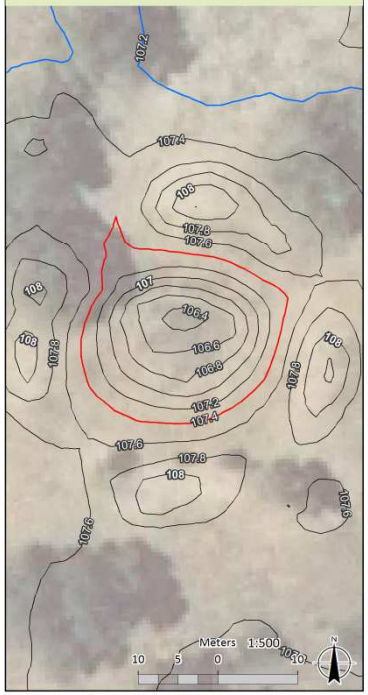
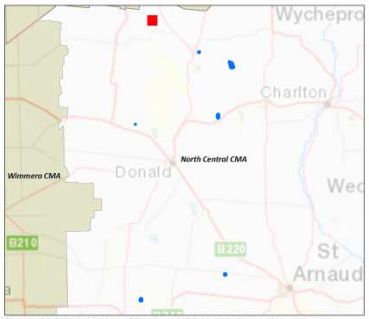
Bathymetry for Davis Dam

Wetland



Dam





Wetland Capacity Table

Elevation (m AHD)	Area (ha)	Capacity (ML)
106.8	0.53	0.33
107	2.58	3.12
107.2	5.13	10.89
107.4	5.28	21.38

Dam Capacity Table

Elevation (m AHD)	Area (ha)	Capacity (ML)
106.4	0.0011	0.0004
106.6	0.0069	0.0077
106.8	0.0141	0.0275
107	0.0218	0.0629
107.2	0.0307	0.1156
107.2	0.0307	0.1156
107.2	0.0307	0.1156
107.4	0.0360	0.1853

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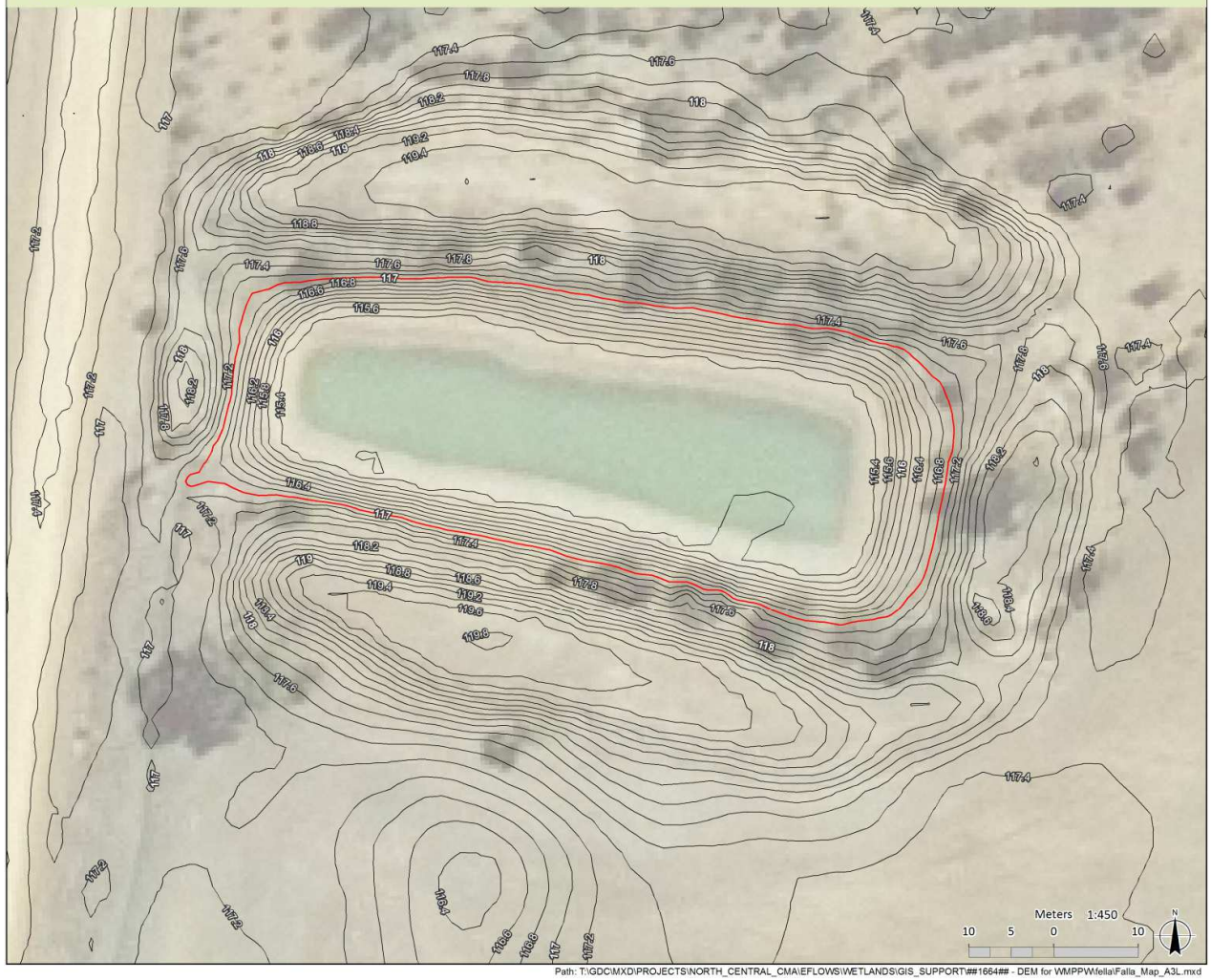
Bathymetry for Falla Dam

Dam



Dam Capacity Table

Elevation (m AHD)	Area (ha)	Capacity (ML)
115.2	0.0004	0.00001
115.4	0.1372	0.12428
115.6	0.1597	0.42333
115.8	0.1731	0.75361
116	0.1854	1.11220
116.2	0.1977	1.49409
116.4	0.2096	1.90003
116.6	0.2196	2.33023
116.8	0.2263	2.78218
117	0.2284	3.24176

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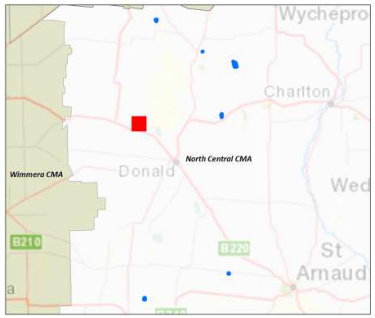
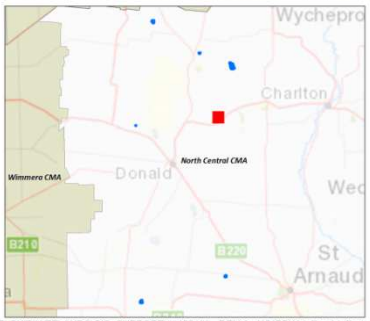


Bathymetry for Jeffcott WR

Wetland

Dam



Wetland Capacity Table

Elevation (m AHD)	Area (ha)	Capacity (ML)
123	0.0006	0.0002
123.2	0.0057	0.0060
123.4	0.0109	0.0217
123.6	0.0152	0.0473
123.8	0.0192	0.0806
124	0.0230	0.1225
124.2	0.0269	0.1713
124.4	0.0311	0.2288
124.6	0.0356	0.2948
124.8	0.0404	0.3706
125	0.0460	0.4569
125.2	0.0530	0.5556
125.4	0.0619	0.6702
125.6	0.0733	0.8060
125.8	0.0891	0.9665
126	0.4299	1.2952
126.2	2.9161	3.9710
126.4	7.9295	14.8130
126.6	11.4305	34.3909
126.8	14.0008	59.9956
127	16.2792	90.2554
127.2	18.4975	125.0393
127.4	21.2115	164.6486
127.6	24.3114	210.3020
127.8	24.5004	259.2490

Dam Capacity Table

Elevation (m AHD)	Area (ha)	Capacity (ML)
126.2	0.1128	0.1070
126.4	0.1287	0.3468
126.6	0.1402	0.6134
126.8	0.1522	0.9045
127	0.1695	1.2234
127.2	0.1931	1.5880
127.4	0.2130	1.9940
127.6	0.2354	2.4447
127.8	0.2476	2.9381

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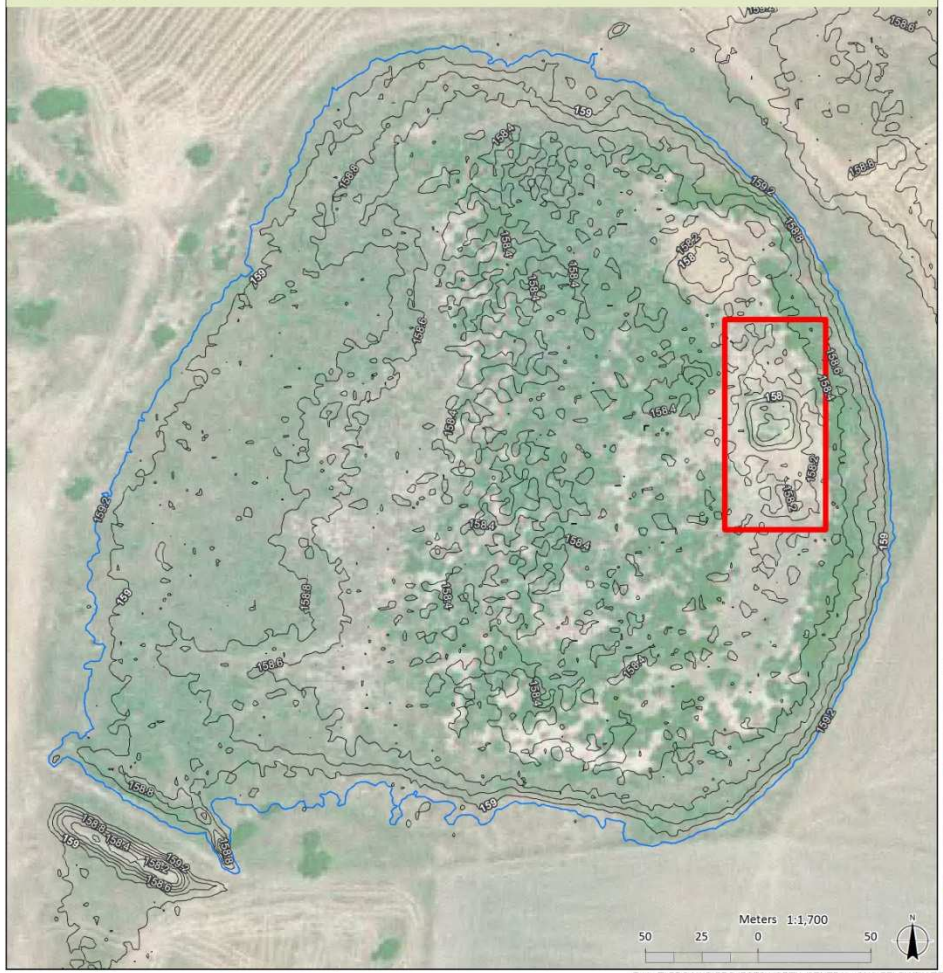
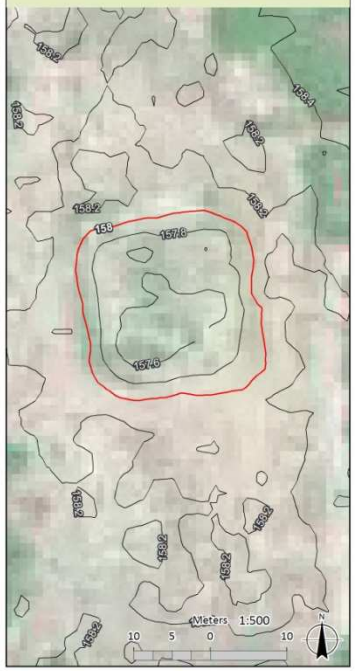
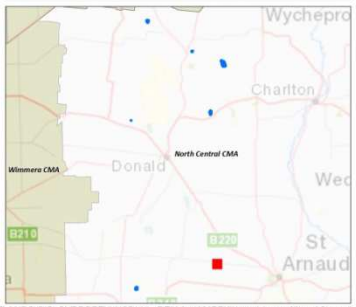
Bathymetry for Jesse Swamp

Wetland



Dam





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Wetland Capacity Table

Elevation (m AHD)	Area (ha)	Capacity (ML)
157.6	0.78	3.68
157.8	0.98	5.42
158	1.28	7.66
158.2	2.28	10.97
158.4	6.44	18.71
158.6	9.98	35.91
158.8	12.08	57.94
159	15.34	85.38
159.2	17.46	118.2

Dam Capacity Table

Elevation (m AHD)	Area (ha)	Capacity (ML)
157.6	0.01	0.0039
157.8	0.03	0.0487
158.0	0.04	0.1267

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Appendix 3: Fauna Species List

Fauna

Common name	Scientific name	EPBC	FFG	DELWP	Last Record	Reference
Chirrup Swamp						
Amphibians						
Common Spadefoot Toad	*Neobatrachus sudelli*				1995	DELWP, 2014
Eastern sign-bearing Froglet	*Crinia parinsignifera*				2014	Rakali, 2014
Froglet spp.	*Crinia sp*				2014	Howard *et al.*, 2014
Plains Froglet	*Crinia parinsignifera*				2013	Rakali, 2014
Spotted Marsh Frog	*Limnodynastes tasmaniensis*				2014	Rakali, 2014 & Howard *et al.*, 2004
Birds- terrestrial						
Australasian Pipit	*Anthus novaeseelandiae*				2013	Rakali, 2014
Australian Magpie	*Gymnorhina tibicen*				2014	Howard *et al.*, 2014
Australian Pipit	*Anthus novaeseelandiae*				2014	Howard *et al.*, 2014
Australian Raven	*Corvus coronoides*				2000	DELWP, 2014
Brown Falcon	*Falco berigora*				2013	Rakali, 2014
Brown Quail	*Coturnix ypsilophora*				-	anecdotal
Brown Treecreeper	*Climacteris picumnus*			NT	2014	Rakali, 2014 & Howard *et al.*, 2004
Common Bronzewing	*Phaps chalcoptera*				2000	DELWP, 2014
Crested Pigeon	*Ocyphaps lophotes*				2000	DELWP, 2014
Eastern Rosella	*Platycercus eximius*				2013	Rakali, 2014
Fairy Martin	*Petrochelidon ariel*				2013	Rakali, 2014
Galah	*Eolophus roseicapillus*				2013	Rakali, 2014
Hooded Robin	*Melanodryas cucullata cucullata*		L	NT	2000	DELWP, 2014
Little Raven	*Corvus mellori*				2013	Rakali, 2014
Magpie-lark	*Grallina cyanoleuca*				2013	Rakali, 2014
Noisy Miner	*Manorina melanocephala*				2013	Rakali, 2014
Pied Butcherbird	*Cracticus nigrogularis*				2013	Rakali, 2014
Red Wattlebird	*Anthochaera carunculata*				2013	Rakali, 2014
Red-rumped Parrot	*Psephotus haematonotus*				2014	Rakali, 2014 & Howard *et al.*, 2004
Rufous Songlark	*Cincloramphus mathewsi*				2013	Rakali, 2014
Wedge-tailed Eagle	*Aquila audax*				2014	Rakali, 2014 & Howard *et al.*, 2004
Welcome Swallow	*Hirundo neoxena*				2013	Rakali, 2014
White-plumed Honeyeater	*Lichenostomus penicillatus*				2013	Rakali, 2014 & Howard *et al.*, 2004
White-winged Chough	*Corcorax melanorhamphos*				2013	Rakali, 2014
Willie Wagtail	*Rhipidura leucophrys*				2013	Rakali, 2014
Birds- water dependent						
Australasian Grebe	*Tachybaptus novaehollandiae*				2013	Rakali, 2014
Australasian Shoveler	*Anas rhynchotis*			V	1995	DELWP, 2014
Australian Shelduck	*Tadorna tadornoides*				1995	DELWP, 2014
Australian Wood Duck	*Chenonetta jubata*				2013	Rakali, 2014
Black Swan	*Cygnus atratus*				1995	DELWP, 2014
Black-fronted Dotterel	*Elseyornis melanops*				2000	DELWP, 2014
Black-tailed Native-hen	*Tribonyx ventralis*				2013	Rakali, 2014
Black-winged Stilt	*Himantopus himantopus*				1995	DELWP, 2014
Grey Teal	*Anas gracilis*				1995	DELWP, 2014
Masked Lapwing	*Vanellus miles*				2000	DELWP, 2014
Pacific Black Duck	*Anas superciliosa*				2000	DELWP, 2014
Plumed Whistling-Duck	*Dendrocygna eytoni*				1989	DELWP, 2014
Purple Swamphen	*Porphyrio porphyrio*				1995	DELWP, 2014
Red-kneed Dotterel	*Erythrogonys cinctus*				1995	DELWP, 2014
Swamp Harrier	*Circus approximans*				1995	DELWP, 2014
White-faced Heron	*Ardea novaehollandiae*				2014	Howard *et al.*, 2014
Yellow-billed Spoonbill	*Platalea flavipes*				1995	DELWP, 2014
Mammals						
Common Brushtail Possum	*Trichosurus vulpecula*				2014	Howard *et al.*, 2014
Eastern Grey Kangaroo	*Macropus giganteus*				2013	Rakali, 2014
Reptiles						
Boulengers Skink	*Morethia boulengeri*				2013	Rakali, 2014 & Howard *et al.*, 2004
Eastern Long-necked Turtle	*Chelodina longicollis*			DD	2014	Howard *et al.*, 2014
Lace Monitor	*Varanus varius*				-	anecdotal
Other						
Australian Painted Lady	*Vanessa kershawi*				2013	Rakali, 2014
Exotic species						
Brown Hare	*Lepus capenis*				2013	Rakali, 2014
European Fox	*Vulpes vulpes*				2013	Rakali, 2014
European Rabbit	*Oryctolagus cuniculus*				2013	Rakali, 2014
House Mouse	*Mus musculus*				1995	DELWP, 2014

Common name	Scientific name	EPBC	FFG	DELWP	Last Record	Reference
House Sparrow	*Passer domesticus*				2013	Rakali, 2014
Sheep	*Ovis aries*				2014	Howard *et al.*, 2014
Corack Lake						
Amphibians						
Eastern Banjo Frog	*Limnodynastes dumerilii*				2014	Howard *et al.*, 2014
Eastern Sign-bearing Froglet	*Crinia parinsignifera*				2014	Howard *et al.*, 2014
Froglet spp.	*Crinia sp*				2014	Howard *et al.*, 2014
Spotted Marsh Frog	*Limnodynastes tasmaniensis*				2014	Howard *et al.*, 2014
unknown frog	*Unknown sp*				2014	Howard *et al.*, 2014
Birds- terrestrial						
Australian Magpie	*Gymnorhina tibicen*				2014	Rakali, 2014 & Howard *et al.*, 2004
Brown Quail	*Coturnix ypsilophora*				2013	Rakali, 2014
Eastern Rosella	*Platycercus eximius*				2014	Rakali, 2014 & Howard *et al.*, 2004
Fairy Martin	*Petrochelidon ariel*				2013	Rakali, 2014
Magpie-lark	*Grallina cyanoleuca*				2013	Rakali, 2014
Noisy Miner	*Manorina melanocephala*				2014	Rakali, 2014 & Howard *et al.*, 2004
Red Wattlebird	*Anthochaera carunculata*				2013	Rakali, 2014
Red-rumped Parrot	*Psephotus haematonotus*				2014	Rakali, 2014 & Howard *et al.*, 2004
Rufous Songlark	*Cincloramphus mathewsi*				2013	Rakali, 2014
Spotted Harrier	*Circus assimilis*			NT	2013	Rakali, 2014
Square-tailed Kite	*Lophoictinia isura*		L	V	2013	Rakali, 2014
Stubble Quail	*Coturnix pectoralis*				2014	Howard *et al.*, 2014
Welcome Swallow	*Hirundo neoxena*				2014	Howard *et al.*, 2014
White-plumed Honeyeater	*Lichenostomus penicillatus*				2013	Rakali, 2014 & Howard *et al.*, 2004
Willie Wagtail	*Rhipidura leucophrys*				2014	Rakali, 2014 & Howard *et al.*, 2004
Birds- water dependent						
Australasian Grebe	*Tachybaptus novaehollandiae*				2014	Rakali, 2014 & Howard *et al.*, 2004
Black-fronted Dotterel	*Elseyornis melanops*				2014	Rakali, 2014 & Howard *et al.*, 2004
Masked Lapwing	*Vanellus tricolor*				2014	Rakali, 2014 & Howard *et al.*, 2004
Sacred Kingfisher	*Todiramphus sanctus*				2013	Rakali, 2014
Unknown Egret	*unknown spp.*				2014	Howard *et al.*, 2014
White-faced Heron	*Egretta novaehollandiae*				2013	Rakali, 2014
White-fronted Chat	*Epthianura albifrons*				2014	Howard *et al.*, 2014
Mammals						
Eastern Grey Kangaroo	*Macropus giganteus*				2013	Rakali, 2014
Macropod sp.	*unknown*				2014	Howard *et al.*, 2014
Reptiles						
Eastern Long-necked Turtle	*Chelodina longicollis*			DD	2014	Rakali, 2014 & Howard *et al.*, 2004
Unidentified Snake	*unknown sp*				2014	Howard *et al.*, 2014
Other						
Common Grass Blue	*Zizina otis labradus*				2013	Rakali, 2014
Meadow Argus	*Junonia villida calybe*				2013	Rakali, 2014
Spotted Jezabel	*Delias aganippe*				2013	Rakali, 2014
Invasive species						
Brown Hare	*Lepus capensis*				2014	Howard *et al.*, 2014
European Fox	*Vulpes vulpes*				2014	Rakali, 2014 & Howard *et al.*, 2004
European Rabbit	*Oryctolagus cuniculus*				2013	Rakali, 2014
Creswick Swamp						
Amphibians						
Crinia sp	*N/A*				2014	Howard *et al.*, 2014
Eastern Sign-bearing Froglet	*Crinia parinsignifera*				2014	Howard *et al.*, 2014
Spotted Marsh Frog	*Limnodynastes tasmaniensis*				2014	Howard *et al.*, 2014
Birds- terrestrial						
Australian Magpie	*Gymnorhina tibicen*				2014	Howard *et al..*, 2014
Australian Pipit	*Anthus novaeseelandiae*				2014	Howard *et al.*, 2014
Brown Quail	*Coturnix ypsilophora*				-	anecdotal
Crested Pigeon	*Ocyphaps lophotes*				2013	Rakali, 2014
Horsfield's Bushlark	*Mirafra javanica*				2013	Rakali, 2014
Red-rumped Parrot	*Psephotus haematonotus*				2013	Rakali, 2014
Rufous Songlark	*Cincloramphus mathewsi*				2013	Rakali, 2014
Singing Honeyeater	*Lichenostomus virescens*				2013	Rakali, 2014
Stubble Quail	*Coturnix pectoralis*				2014	Howard *et al.*, 2014
White -browed Scrub Wren	*Sericornis frontalis*				2014	Howard *et al.*, 2014
Willie Wagtail	*Rhipidura leucophrys*				2014	Howard *et al.*, 2014
Birds- water dependent						
Australasian Grebe	*Tachybaptus novaehollandiae*				2014	Howard *et al.*, 2014
Australian Wood Duck	*Chenonetta jubata*				2014	Howard *et al.*, 2014
Brolga	*Grus rubicundus*			V	2013	Rakali, 2014
Unidentified Ducks	*unknown sp*				2014	Howard *et al.*, 2014
White faced Heron	*Ardea novaehollandiae*				2014	Howard *et al.*, 2014

Common name	Scientific name	EPBC	FFG	DELWP	Last Record	Reference
Mammals						
Eastern Grey Kangaroo	*Macropus giganteus*				2014	Howard *et al.*, 2014
Reptiles						
Eastern Long-necked Turtle	*Chelodina longicollis*			DD	2014	Howard *et al.*, 2014
other						
Freshwater Mussel	*Velesunio ambiguus*				2014	Howard *et al.*, 2014
Davis Dam						
Birds- terrestrial						
Australian hobby	*Falco longipennis*				2010	Hutchinson, 2010
Australian Magpie	*Cracticus tibicen*				2014	Rakali, 2014
Australian Owlet Nightjar	*Aegotheles*				2010	Hutchinson, 2010
barn owl	*Tyto alba*				2010	Hutchinson, 2010
black falcon	*Falco subniger*			V	2010	Hutchinson, 2010
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*				2014	Rakali, 2014
blue bonnet	*Northiella haematogaster*				2010	Hutchinson, 2010
Brown Falcon	*Falco berigora*				2010	Hutchinson, 2010
Brown Treecreeper	*Climacteris picumnnus*			NT	2010	Hutchinson, 2010
common starling	*sturnus vulgaris*				2010	Hutchinson, 2010
Crested Pigeon	*Ocyphaps lophotes*				2014	Rakali, 2014
Galah	*Eolophus roseicapilla*				2010	Hutchinson, 2010
Noisy Miner	*Manorina melanocephala*				2014	Rakali, 2014
Pied Butcherbird	*Cracticus nigrogularis*				2010	Hutchinson, 2010
Red-rumped Parrot	*Psephotus haematonotus*				2010	Hutchinson, 2010
Singing Honeyeater	*Lichenostomus virescens*				2014	Rakali, 2014
Wedge-tailed Eagle	*Aquila audax*				2014	Hutchinson, 2010 & N. Davis, pers. comm., 13 August 2014
White-plumed Honeyeater	*Lichenostomus penicillatus*				2010	Hutchinson, 2010
Birds- water dependent						
Australian Shelduck	*Tadorna tadornoides*				2014	B. Bisset, pers obs.
Australian Wood Duck	*Chenonetta jubata*				2014	B. Bisset, pers obs.
Grey Teal	*Anas gracilis*				2014	N. Davis pers. comm., 13 August 2014
Pacific Black Duck	*Anas superciliosa*				2014	N. Davis pers. comm., 13 August 2014
White-necked Heron	*Ardea pacifica*				2014	B. Bisset, pers obs.
Mammals						
Common Brushtail Possum	*Trichosurus vulpecula*				2010	Hutchinson, 2010
Eastern Grey Kangaroo	*Macropus giganteus*				2014	B. Bisset, pers obs.
Invasive species						
Brown Hare	*Lepus capensis*				2010	Hutchinson, 2010
European Fox	*Vulpes vulpes*				2010	Hutchinson, 2010
European Rabbit	*Oryctolagus cuniculus*				2010	Hutchinson, 2010
Falla Dam						
Birds- water dependent						
Black-tailed Native-hen	*Tribonyx ventralis*				2014	D. Falla, pers. comm., 14 October 2014
Pink-eared Duck	*Malacorhynchus membranaceus*				2014	D. Falla, pers. comm., 14 October 2014
Wood Duck	*Chenonetta jubata*				2014	D. Falla, pers. comm., 14 October 2014
Australasian Grebe	*Tachybaptus novaehollandiae*				2014	D. Falla, pers. comm., 14 October 2014
Australian Shelduck	*Tadorna tadornoides*				2014	D. Falla, pers. comm., 14 October 2014
Jeffcott Wetland						
Amphibians						
crinia spp.	*N/A*				2014	Howard *et al.*, 2014
Eastern Banjo Frog	*Limnodynastes dumerili*				2013	Rakali, 2014 & Howard *et al.*, 2004
Eastern Sign-bearing Froglet	*Crinia parinsignifera*				2013	Rakali, 2014 & Howard *et al.*, 2004
Birds- terrestrial						
Australian Magpie	*Cracticus tibicen*				2014	Rakali, 2014
Australian Owlet-nightjar	*Aegotheles cristatus*				2014	Rakali, 2014
Australian Raven	*Corvus coronoides*				2000	DELWP, 2014
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*				2014	Rakali, 2014 & Howard *et al.*, 2004
Brown Treecreeper	*Climacteris picumnus*			NT	2014	Rakali, 2014
Collared Sparrowhawk	*Accipiter cirrocephalus*				2014	Rakali, 2014
Crested Pigeon	*Ocyphaps lophotes*				2014	Rakali, 2014
Dusky Woodswallow	*Artamus cyanopterus*				2014	DELWP, 2014
Eastern Rosella	*Platycercus eximius*				2013	Rakali, 2014
Fairy Martin	*Petrochelidon ariel*				2013	Rakali, 2014
Galah	*Eolophus roseicapilla*				2000	DELWP, 2014
Laughing Kookaburra	*Dacelo novaeguineae*				2014	Howard *et* al., 2014
Magpie-lark	*Grallina cyanoleuca*				2013	Rakali, 2014
Noisy Miner	*Manorina melanocephala*				2013	Rakali, 2014
Red-rumped Parrot	*Psephotus haematonotus*				2014	Rakali, 2014 & Howard *et al.*, 2004
Rufous Songlark	*Cincloramphus mathewsi*				2013	Rakali, 2014
Tawny Frogmouth	*Podargus strigoides*				2013	Rakali, 2014

Common name	Scientific name	EPBC	FFG	DELWP	Last Record	Reference
Wedge-tailed Eagle	*Aquila audax*				-	anecdotal
Welcome Swallow	*Hirundo neoxena*				2014	Rakali, 2014 & Howard *et al.*, 2004
White-browed Woodswallow	*Artamus superciliosus*				2013	Rakali, 2014
White-plumed Honeyeater	*Lichenostomus penicillatus*				2013	Rakali, 2014
Willie Wagtail	*Rhipidura leucophrys*				2014	Rakali, 2014 & Howard *et al.*, 2004
Birds- water dependent						
Australasian Grebe	*Tachybaptus novaehollandiae*				2014	Rakali, 2014 & Howard *et al.*, 2004
Australian Wood Duck	*Chenonetta jubata*				2014	Rakali, 2014 & Howard *et al.*, 2004
Dusky Moorhen	*Gallinula tenebrosa*				2000	DELWP, 2014
Grey Teal	*Anas gracilis*				2014	Rakali, 2014 & Howard *et al.*, 2004
Hardhead	*Aythya australis*			VU	2014	Howard *et al..*, 2014
Masked Lapwing	*Vanellus miles*				2013	Rakali, 2014
Pacific Black Duck	*Anas superciliosa*				2000	DELWP, 2014
Mammals						
Eastern Grey Kangaroo	*Macropus giganteus*				2014	Howard *et al.*, 2014
Swamp Wallaby	*Wallabia bicolour*				2014	Howard *et al.*, 2014
White-striped Free-tailed Bat	*Tadarida australis*				2013	Rakali, 2014
Reptiles						
Eastern Long-necked Turtle	*Chelodina longicollis*			DD	2014	Rakali, 2014 & Howard *et al..*, 2004
Lace Monitor	*Varanus varius*				-	anecdotal
Peron's Tree Frog	*Litoria peronii*				2014	Rakali, 2014 & Howard *et al.*, 2004
Spotted Marsh Frog	*Limnodynastes tasmaniensis*				2014	Rakali, 2014 & Howard *et al.*, 2004
Other						
Australian Painted Lady	*Vanessa kershawi*				2014	Rakali, 2014
Common Grass Blue	*Zizina otis labradus*				2014	Rakali, 2014
Small Grass Yellow	*Eurema smilax*				2013	Rakali, 2014
Invasive species						
Brown Hare	*Lepus capensis*				2014	Howard *et al.*, 2014
European Fox	*Vulpes vulpes*				2013	Rakali, 2014
European Rabbit	*Oryctolagus cuniculus*				2013	Rakali, 2014
Jesse Swamp						
Birds- terrestrial						
Flame Robin	*Petroica phoenicea*				2014	H. Barber pers. comm.,, 27 August 2014
Galah	*Eolophus roseicapilla*				2013	Rakali, 2014
Grey Falcon	*Falco hypoleucos*		L	EN	2014	H. Barber pers. comm.,, 27 August 2014
Red-rumped Parrot	*Psephotus haematonotus*				2013	Rakali, 2014
Rufous Songlark	*Cincloramphus mathewsi*				2013	Rakali, 2014
White-fronted Chat	*Epthianura albifrons*				2013	Rakali, 2014
Willie Wagtail	*Rhipidura leucophrys*				2013	Rakali, 2014
Birds- water dependent						
Black Swan	*Cygnus atratus*				-	H. Barber pers. comm.,, 27 August 2014
Egret	*Unknown spp.*				-	H. Barber pers. comm.,, 27 August 2014
Eurasian Coot	*Fulica atra*				1990	DELWP, 2014
Brolga	*Grus rubicunda*		L	V	2014	A. Russell pers. comm., 4 November 2014
Purple Swamphen	*Porphyrio porphyrio*				1990	DELWP, 2014
Australian Shelduck	*Tadorna tadornoides*				1990	DELWP, 2014
Grey Teal	*Anas gracilis*				2014	H. Barber pers. comm., 27 August 2014
Pacific Black Duck	*Anas superciliosa*				2014	H. Barber pers. comm., 27 August 2014
Australian Wood Duck	*Chenonetta jubata*				2014	H. Barber pers. comm., 27 August 2014
Yellow-billed Spoonbill	*Platalea flavipes*				-	H. Barber pers. comm.,, 27 August 2014
White faced Heron	*Ardea novaehollandiae*				-	H. Barber pers. comm.,, 15 January 2015
Other						
Common Grass Blue	*Zizina otis labradus*				2013	Rakali, 2014
Invasive species						
European Fox	*Vulpes vulpes*				2014	H. Barber pers. comm.,, 27 August 2014
European Rabbit	*Oryctolagus cuniculus*				2014	H. Barber pers. comm.,, 27 August 2014

Macroinvertebrates

Order	Family	Common name	Species/genus name	Last record	reference
Cherrip Swamp					
Beetles	Dytiscidae	Diving beetles	Antiporus (A)	2014	Howard *et al.*, 2014
Beetles	Gyrinidae	Whirligig beetles	Macrogyrus (A+L)	2014	Howard *et al.*, 2014
Beetles	Dytiscidae	Diving beetles	Megaporus (A)	2014	Howard *et al.*, 2014
Bugs	Corixidae	Waterboatmen	Sigara	2014	Howard *et al.*, 2014
Bugs	Nepidae	Water scorpions	Laccotrephes tristis	2014	Howard *et al.*, 2014
Bugs	Corixidae	Waterboatmen	Agraptocorixa	2014	Howard *et al.*, 2014
Bugs	Notonectidae	Backswimmers	Anisops	2014	Howard *et al.*, 2014

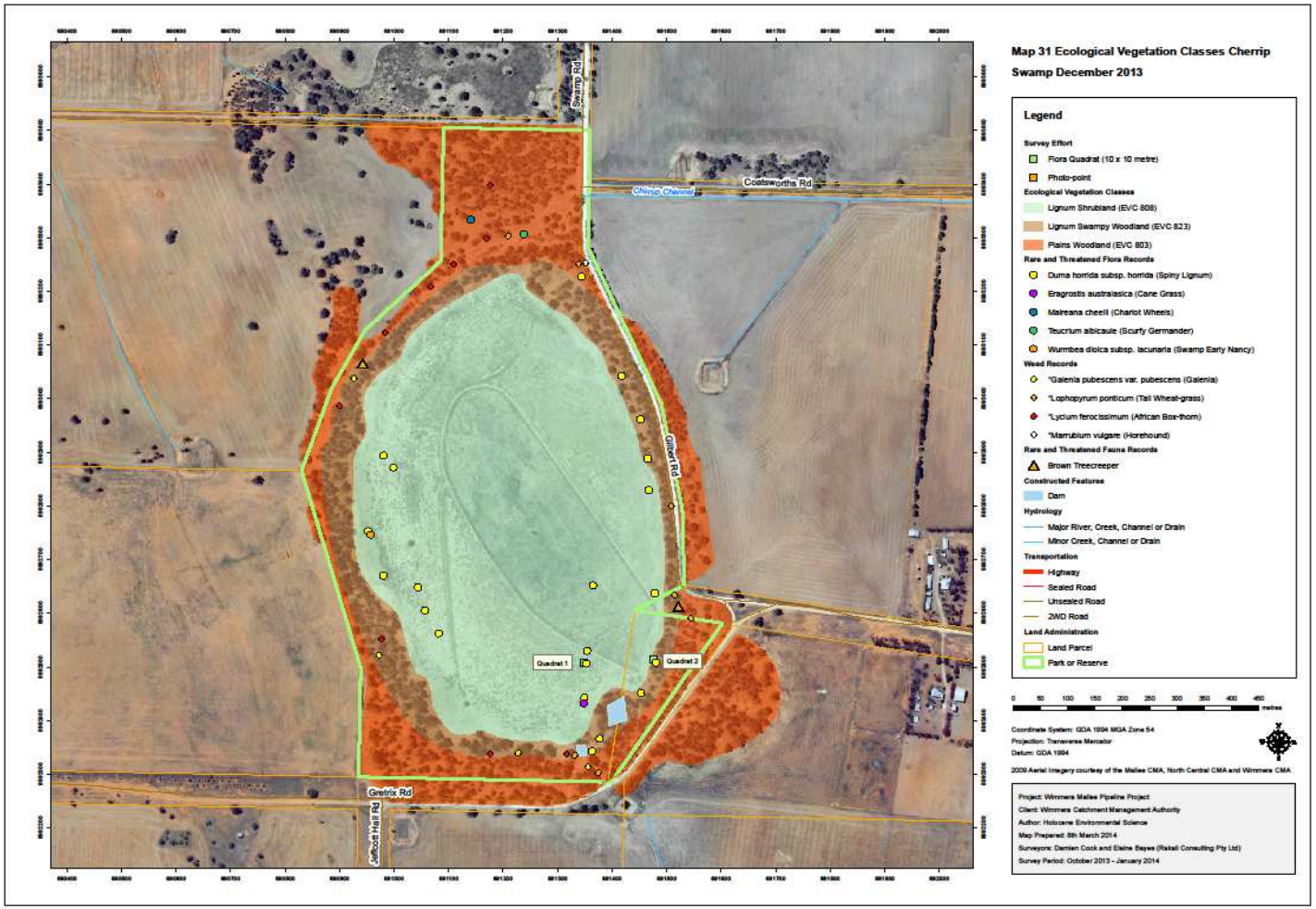
Order	Family	Common name	Species/genus name	Last record	reference
Bugs	Notonectidae	Backswimmers	immature	2014	Howard *et al.*, 2014
Bugs	Corixidae	Waterboatmen	immature	2014	Howard *et al.*, 2014
Bugs	Corixidae	Waterboatmen	Micronecta	2014	Howard *et al.*, 2014
Caddisflies	Leptoceridae	Stick caddis	Oecetis	2014	Howard *et al.*, 2014
Caddisflies	Leptoceridae	Stick caddis	Triplectides australis	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Damselfly	immature	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Aurora Bluetail	Ischnura aurora	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Red & Blue Damsel	Xanthagrion erythroneurum	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Eastern Billabongfly	Austroagrion watsoni	2014	Howard *et al.*, 2014
Decapod crustacea	Parastacidae	Yabby	Cherax destructor	2014	Howard *et al.*, 2014
Mayflies	Caenidae	Mayflies	immature	2014	Howard *et al.*, 2014
Mayflies	Baetidae	Mayflies	immature/damaged	2014	Howard *et al.*, 2014
Mayflies	Caenidae	Mayflies	Tasmanocoenis tillyardi	2014	Howard *et al.*, 2014
Mayflies	Baetidae	Mayflies	Cloeon	2014	Howard *et al.*, 2014
True flies	Chironomidae	Non-biting midges	Tanypodinae	2014	Howard *et al.*, 2014
True flies	Chironomidae	Non-biting midges	Chironominae	2014	Howard *et al.*, 2014
Water mites	Unident.	Water mites	Unident.	2014	Howard *et al.*, 2014
Corack Lake					
dam 1					
Aquatic caterpillars	Pyralidae	Aquatic caterpillars	Nymphulinae sp. 22	2014	Howard *et al.*, 2014
Beetles	Hydrophilidae	Water scavenger beetles	Berosus (A+L)	2014	Howard *et al.*, 2014
Beetles	Dytiscidae	Diving beetles	Hyphydrus (A+L)	2014	Howard *et al.*, 2014
Beetles	Dytiscidae	Diving beetles	Sternopriscus (A)	2014	Howard *et al.*, 2014
Bugs	Mesoveliidae	Water treaders	Mesovelia	2014	Howard *et al.*, 2014
Bugs	Notonectidae	Backswimmers	immature	2014	Howard *et al.*, 2014
Bugs	Veliidae	Small water striders	Microvelia	2014	Howard *et al.*, 2014
Bugs	Corixidae	Waterboatmen	Sigara	2014	Howard *et al.*, 2014
Bugs	Corixidae	Waterboatmen	immature	2014	Howard *et al.*, 2014
Bugs	Corixidae	Waterboatmen	Micronecta	2014	Howard *et al.*, 2014
Bugs	Notonectidae	Backswimmers	Anisops	2014	Howard *et al.*, 2014
Bugs	Corixidae	Waterboatmen	Agraptocorixa	2014	Howard *et al.*, 2014
Caddisflies	Leptoceridae	Stick caddis	Oecetis	2014	Howard *et al.*, 2014
Caddisflies	Leptoceridae	Stick caddis	Triplectides australis	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Eastern Billabongfly	Austroagrion watsoni	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Aurora Bluetail	Ischnura aurora	2014	Howard *et al.*, 2014
Damselflies	Lestidae	Blue Ringtail	Austrolestes annulosus	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Damselfly	immature	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Red & Blue Damsel	Xanthagrion erythroneurum	2014	Howard *et al.*, 2014
Dragonflies	Aeshnidae	Australian Emperor	Hemianax papuensis	2014	Howard *et al.*, 2014
Leeches	Glossiphoniidae	Freshwater leech	unidentified	2014	Howard *et al.*, 2014
Mayflies	Baetidae	Mayflies	immature/damaged	2014	Howard *et al.*, 2014
Mayflies	Baetidae	Mayflies	Cloeon	2014	Howard *et al.*, 2014
Snails	Planorbidae	Freshwater snail	Isidorella	2014	Howard *et al.*, 2014
Snails	Physidae	Freshwater snail	Physa acuta	2014	Howard *et al.*, 2014
True flies	Chironomidae	Non-biting midges	Chironominae	2014	Howard *et al.*, 2014
True flies	Chironomidae	Non-biting midges	Tanypodinae	2014	Howard *et al.*, 2014
True flies	Chironomidae	Non-biting midges	Orthocladiinae	2014	Howard *et al.*, 2014
Water mites	Unident.	Water mites	Unident.	2014	Howard *et al.*, 2014
Dam 2					
Aquatic caterpillars	Pyralidae	Aquatic caterpillars	Nymphulinae sp. 22	2014	Howard *et al.*, 2014
Beetles	Hydrophilidae	Water scavenger beetles	Berosus (A+L)	2014	Howard *et al.*, 2014
Beetles	Dytiscidae	Diving beetles	Hyphydrus (A+L)	2014	Howard *et al.*, 2014
Beetles	Dytiscidae	Diving beetles	Sternopriscus (A)	2014	Howard *et al.*, 2014
Bugs	Nepidae	Water scorpions	Laccotrephes tristis	2014	Howard *et al.*, 2014
Bugs	Notonectidae	Backswimmers	immature	2014	Howard *et al.*, 2014
Bugs	Corixidae	Waterboatmen	immature	2014	Howard *et al.*, 2014
Bugs	Corixidae	Waterboatmen	Micronecta	2014	Howard *et al.*, 2014

Order	Family	Common name	Species/genus name	Last record	reference
Bugs	Notonectidae	Backswimmers	Anisops	2014	Howard *et al.*, 2014
Bugs	Corixidae	Waterboatmen	Agraptocorixa	2014	Howard *et al.*, 2014
Caddisflies	Leptoceridae	Stick caddis	Oecetis	2014	Howard *et al.*, 2014
Caddisflies	Leptoceridae	Stick caddis	Triplectides australis	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Eastern Billabongfly	Austroagrion watsoni	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Aurora Bluetail	Ischnura aurora	2014	Howard *et al.*, 2014
Damselflies	Lestidae	Blue Ringtail	Austrolestes annulosus	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Damselfly	immature	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Red & Blue Damsel	Xanthagrion erythroneurum	2014	Howard *et al.*, 2014
Dragonflies	Aeshnidae	Dragonfly	immature	2014	Howard *et al.*, 2014
Mayflies	Baetidae	Mayflies	immature/damaged	2014	Howard *et al.*, 2014
Mayflies	Baetidae	Mayflies	Cloeon	2014	Howard *et al.*, 2014
Snails	Physid/Planorbid	Freshwater snail	immature	2014	Howard *et al.*, 2014
Snails	Planorbidae	Freshwater snail	Isidorella	2014	Howard *et al.*, 2014
Snails	Physidae	Freshwater snail	Physa acuta	2014	Howard *et al.*, 2014
True flies	Chironomidae	Non-biting midges	Chironominae	2014	Howard *et al.*, 2014
True flies	Chironomidae	Non-biting midges	Tanypodinae	2014	Howard *et al.*, 2014
True flies	Chironomidae	Non-biting midges	Orthocladinae	2014	Howard *et al.*, 2014
Water mites	Unident.	Water mites	Unident.	2014	Howard *et al.*, 2014
Creswick Swamp					
Aquatic caterpillars	Pyralidae	Aquatic caterpillars	Nymphulinae sp. 22	2014	Howard *et al.*, 2014
Beetles	Dytiscidae	Diving beetles	Liodessus (A)	2014	Howard *et al.*, 2014
Beetles	Dytiscidae	Diving beetles	immature (L)	2014	Howard *et al.*, 2014
Beetles	Gyrinidae	Whirligig beetles	Macrogyrus (A+L)	2014	Howard *et al.*, 2014
Beetles	Dytiscidae	Diving beetles	Allodessus (A)	2014	Howard *et al.*, 2014
Beetles	Dytiscidae	Diving beetles	Antiporus (A)	2014	Howard *et al.*, 2014
Beetles	Dytiscidae	Diving beetles	Onychohydrus (L)	2014	Howard *et al.*, 2014
Beetles	Dytiscidae	Diving beetles	Hyphydrus (A+L)	2014	Howard *et al.*, 2014
Beetles	Hydrophilidae	Water scavenger beetles	Berosus (A+L)	2014	Howard *et al.*, 2014
Beetles	Dytiscidae	Diving beetles	Sternopriscus (A)	2014	Howard *et al.*, 2014
Beetles	Dytiscidae	Diving beetles	Megaporus (A)	2014	Howard *et al.*, 2014
Bugs	Nepidae	Water scorpions	Ranatra dispar	2014	Howard *et al.*, 2014
Bugs	Corixidae	Waterboatmen	Sigara	2014	Howard *et al.*, 2014
Bugs	Corixidae	Waterboatmen	immature	2014	Howard *et al.*, 2014
Bugs	Notonectidae	Backswimmers	immature	2014	Howard *et al.*, 2014
Bugs	Corixidae	Waterboatmen	Agraptocorixa	2014	Howard *et al.*, 2014
Bugs	Corixidae	Waterboatmen	Micronecta	2014	Howard *et al.*, 2014
Bugs	Notonectidae	Backswimmers	Anisops	2014	Howard *et al.*, 2014
Caddisflies	Leptoceridae	Stick caddis	Oecetis	2014	Howard *et al.*, 2014
Caddisflies	Leptoceridae	Stick caddis	Notalina spira	2014	Howard *et al.*, 2014
Caddisflies	Leptoceridae	Stick caddis	Triplectides australis	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Common Bluetail	Ischnura heterosticta	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Damselfly	Ischnura sp (immature)	2014	Howard *et al.*, 2014
Damselflies	Lestidae	Slender Ringtail	Austrolestes analis	2014	Howard *et al.*, 2014
Damselflies	Lestidae	Wandering Ringtail	Austrolestes leda	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Red & Blue Damsel	Xanthagrion erythroneurum	2014	Howard *et al.*, 2014
Damselflies	Lestidae	Blue Ringtail	Austrolestes annulosus	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Damselfly	immature	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Aurora Bluetail	Ischnura aurora	2014	Howard *et al.*, 2014
Decapod crustacea	Parastacidae	Yabby	Cherax destructor	2014	Howard *et al.*, 2014
Dragonflies	Hemicorduliidae	Tau Emerald	Hemicordulia tau	2014	Howard *et al.*, 2014
Dragonflies	Libellulidae	Dragonfly	immature	2014	Howard *et al.*, 2014
Dragonflies	Aeshnidae	Australian Emperor	Hemianax papuensis	2014	Howard *et al.*, 2014
Dragonflies	Libellulidae	Scarlet Percher	Diplacodes haematodes	2014	Howard *et al.*, 2014
Mayflies	Caenidae	Mayflies	immature	2014	Howard *et al.*, 2014
Mayflies	Leptophlebiidae	Mayflies	Atalophlebia australis	2014	Howard *et al.*, 2014
Mayflies	Caenidae	Mayflies	Tasmanocoenis tillyardi	2014	Howard *et al.*, 2014
Mayflies	Caenidae	Mayflies	Tasmanocoenis sp. B	2014	Howard *et al.*, 2014
Mayflies	Baetidae	Mayflies	immature/damaged	2014	Howard *et al.*, 2014

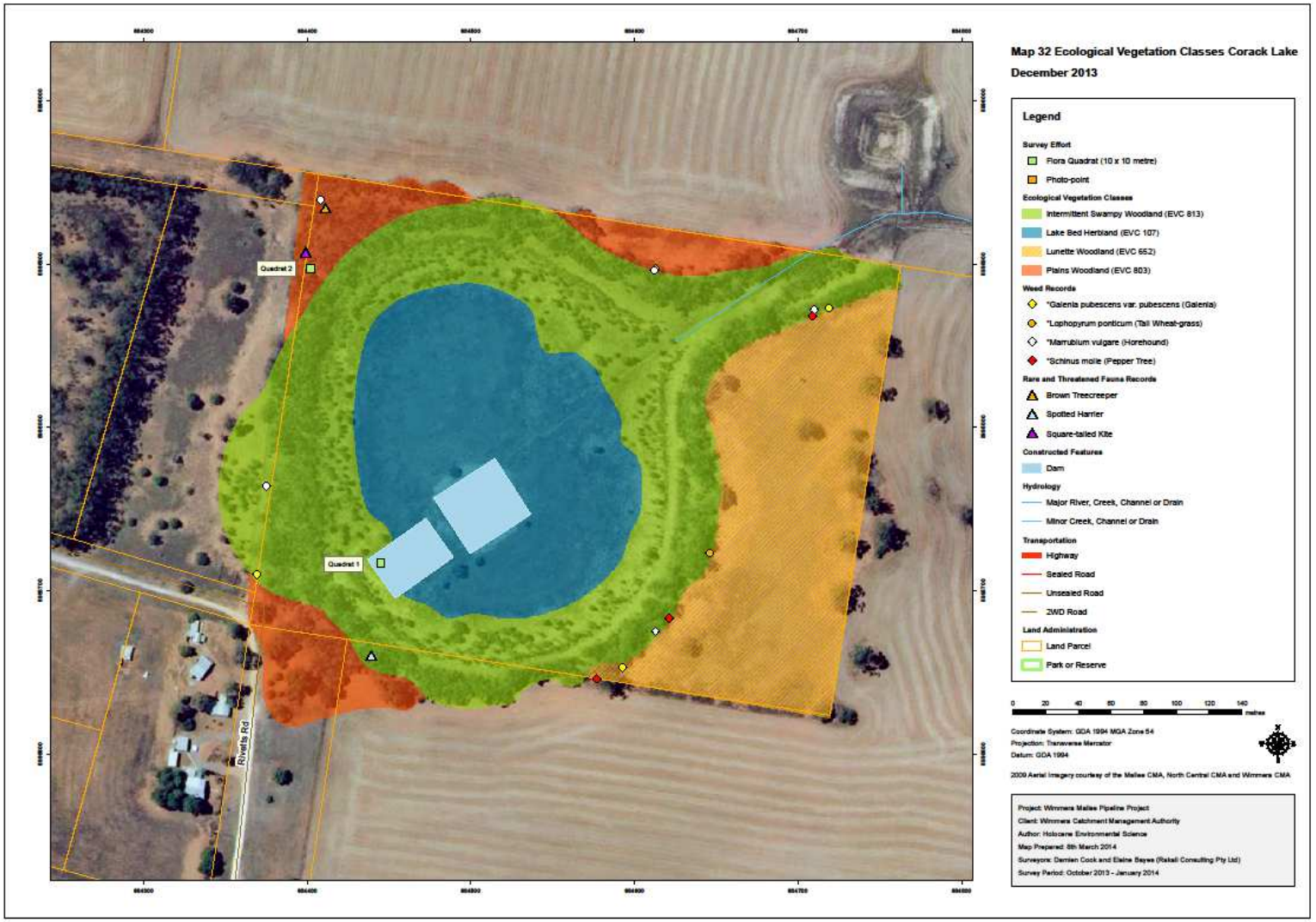
Order	Family	Common name	Species/genus name	Last record	reference
Mayflies	Baetidae	Mayflies	Cloeon	2014	Howard *et al.*, 2014
Snails	Planorbidae	Freshwater snail	Isidorella	2014	Howard *et al.*, 2014
True flies	Chironomidae	Non-biting midges	Orthocladinae	2014	Howard *et al.*, 2014
True flies	Chironomidae	Non-biting midges	Chironominae	2014	Howard *et al.*, 2014
Water mites	Unident.	Water mites	Unident.	2014	Howard *et al.*, 2014
Jeffcott Wetland					
Aquatic caterpillars	Pyralidae	Aquatic caterpillars	Nymphulinae sp. 22	2014	Howard *et al.*, 2014
Beetles	Dytiscidae	Diving beetles	Rhantus (L)	2014	Howard *et al.*, 2014
Beetles	Dytiscidae	Diving beetles	Sternopriscus (A)	2014	Howard *et al.*, 2014
Beetles	Hydrophilidae	Water scavenger beetles	Hydrophilus (A)	2014	Howard *et al.*, 2014
Beetles	Dytiscidae	Diving beetles	Necterosoma (A)	2014	Howard *et al.*, 2014
Beetles	Dytiscidae	Diving beetles	Antiporus (A)	2014	Howard *et al.*, 2014
Beetles	Dytiscidae	Diving beetles	Hyphydrus (A+L)	2014	Howard *et al.*, 2014
Beetles	Dytiscidae	Diving beetles	Onychohydrus (L)	2014	Howard *et al.*, 2014
Bugs	Corixidae	Waterboatmen	Sigara	2014	Howard *et al.*, 2014
Bugs	Naucoridae	Creeping water bugs	Naucoris congrex	2014	Howard *et al.*, 2014
Bugs	Nepidae	Water scorpions	Ranatra dispar	2014	Howard *et al.*, 2014
Bugs	Corixidae	Waterboatmen	Agraptocorixa	2014	Howard *et al.*, 2014
Bugs	Notonectidae	Backswimmers	immature	2014	Howard *et al.*, 2014
Bugs	Corixidae	Waterboatmen	Micronecta	2014	Howard *et al.*, 2014
Bugs	Corixidae	Waterboatmen	immature	2014	Howard *et al.*, 2014
Bugs	Notonectidae	Backswimmers	Anisops	2014	Howard *et al.*, 2014
Caddisflies	Leptoceridae	Stick caddis	Notalina spira	2014	Howard *et al.*, 2014
Caddisflies	Leptoceridae	Stick caddis	Oecetis	2014	Howard *et al.*, 2014
Caddisflies	Leptoceridae	Stick caddis	Triplectides australis	2014	Howard *et al.*, 2014
Damselflies	Lestidae	Slender Ringtail	Austrolestes analis	2014	Howard *et al.*, 2014
Damselflies	Lestidae	Blue Ringtail	Austrolestes annulosus	2014	Howard *et al.*, 2014
Damselflies	Lestidae	Wandering Ringtail	Austrolestes leda	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Eastern Billabongfly	Austroagrion watsoni	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Damselfly	immature	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Red & Blue Damsel	Xanthagrion erythroneurum	2014	Howard *et al.*, 2014
Damselflies	Coenagrionidae	Aurora Bluetail	Ischnura aurora	2014	Howard *et al.*, 2014
Decapod crustacea	Parastacidae	Yabby	Cherax destructor	2014	Howard *et al.*, 2014
Decapod crustacea	Atyidae	Freshwater shrimp	Paratya australiensis	2014	Howard *et al.*, 2014
Dragonflies	Aeshnidae	Australian Emperor	Hemianax papuensis	2014	Howard *et al.*, 2014
Dragonflies	Hemicorduliidae	Tau Emerald	Hemicordulia tau	2014	Howard *et al.*, 2014
Dragonflies	Aeshnidae	Blue-spotted Hawker	Adversaeschna brevistyla	2014	Howard *et al.*, 2014
Dragonflies	Aeshnidae	Dragonfly	immature	2014	Howard *et al.*, 2014
Dragonflies	Libellulidae	Dragonfly	immature	2014	Howard *et al.*, 2014
Dragonflies	Libellulidae	Blue Skimmer	Orthetrum caledonicum	2014	Howard *et al.*, 2014
Dragonflies	Libellulidae	Scarlet Percher	Diplacodes haematodes	2014	Howard *et al.*, 2014
Mayflies	Caenidae	Mayflies	immature	2014	Howard *et al.*, 2014
Mayflies	Baetidae	Mayflies	immature/damaged	2014	Howard *et al.*, 2014
Mayflies	Caenidae	Mayflies	Tasmanocoenis tillyardi	2014	Howard *et al.*, 2014
Mayflies	Baetidae	Mayflies	Cloeon	2014	Howard *et al.*, 2014
Snails	Physid/Planorbid	Freshwater snail	immature	2014	Howard *et al.*, 2014
Snails	Physidae	Freshwater snail	Physa acuta	2014	Howard *et al.*, 2014
True flies	Chironomidae	Non-biting midges	Orthocladinae	2014	Howard *et al.*, 2014
True flies	Chironomidae	Non-biting midges	Tanypodinae	2014	Howard *et al.*, 2014
True flies	Chironomidae	Non-biting midges	Chironominae	2014	Howard *et al.*, 2014
Water mites	Unident.	Water mites	Unident.	2014	Howard *et al.*, 2014

Appendix 4: Ecological Vegetation Classes

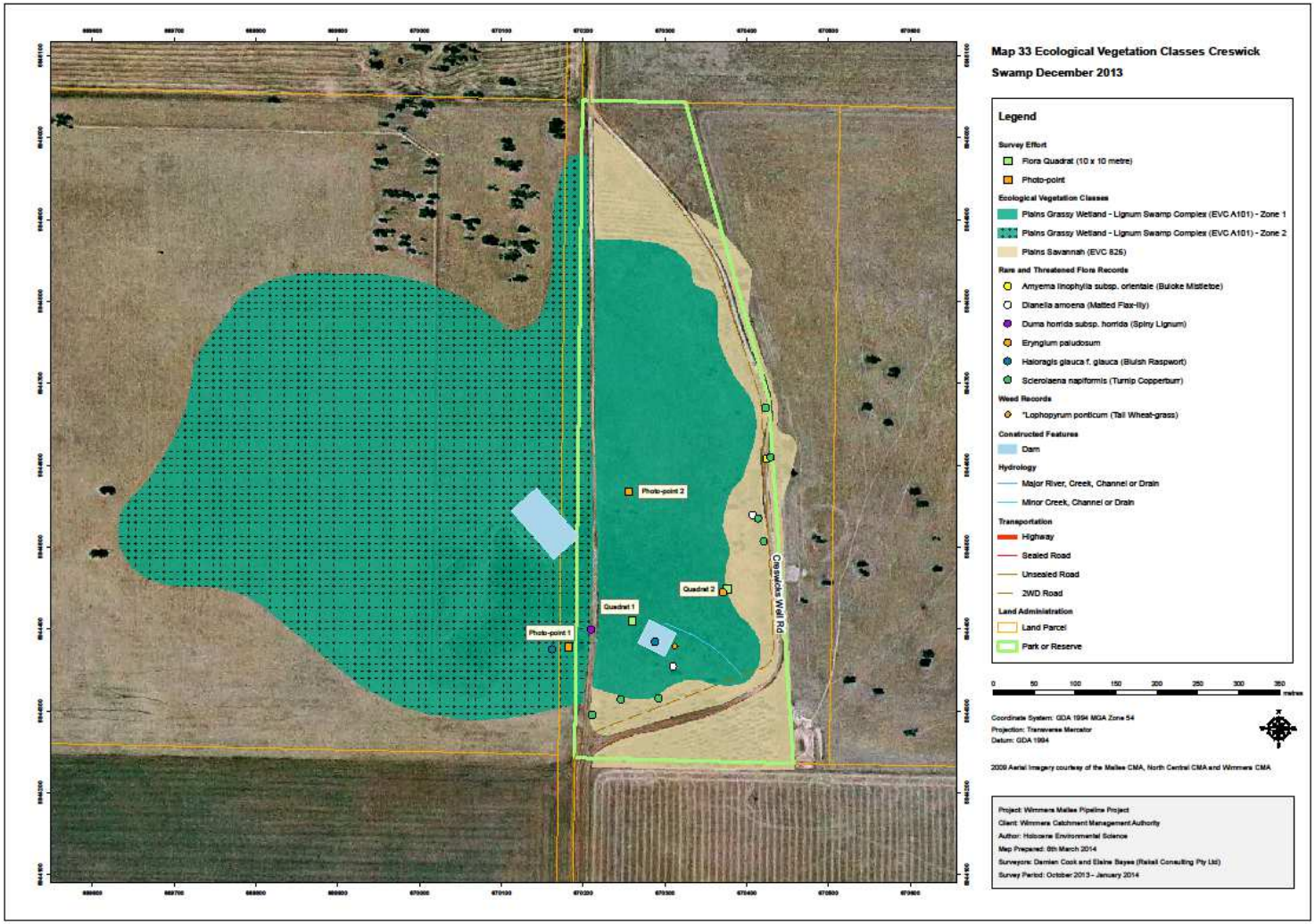
Chirrup Swamp



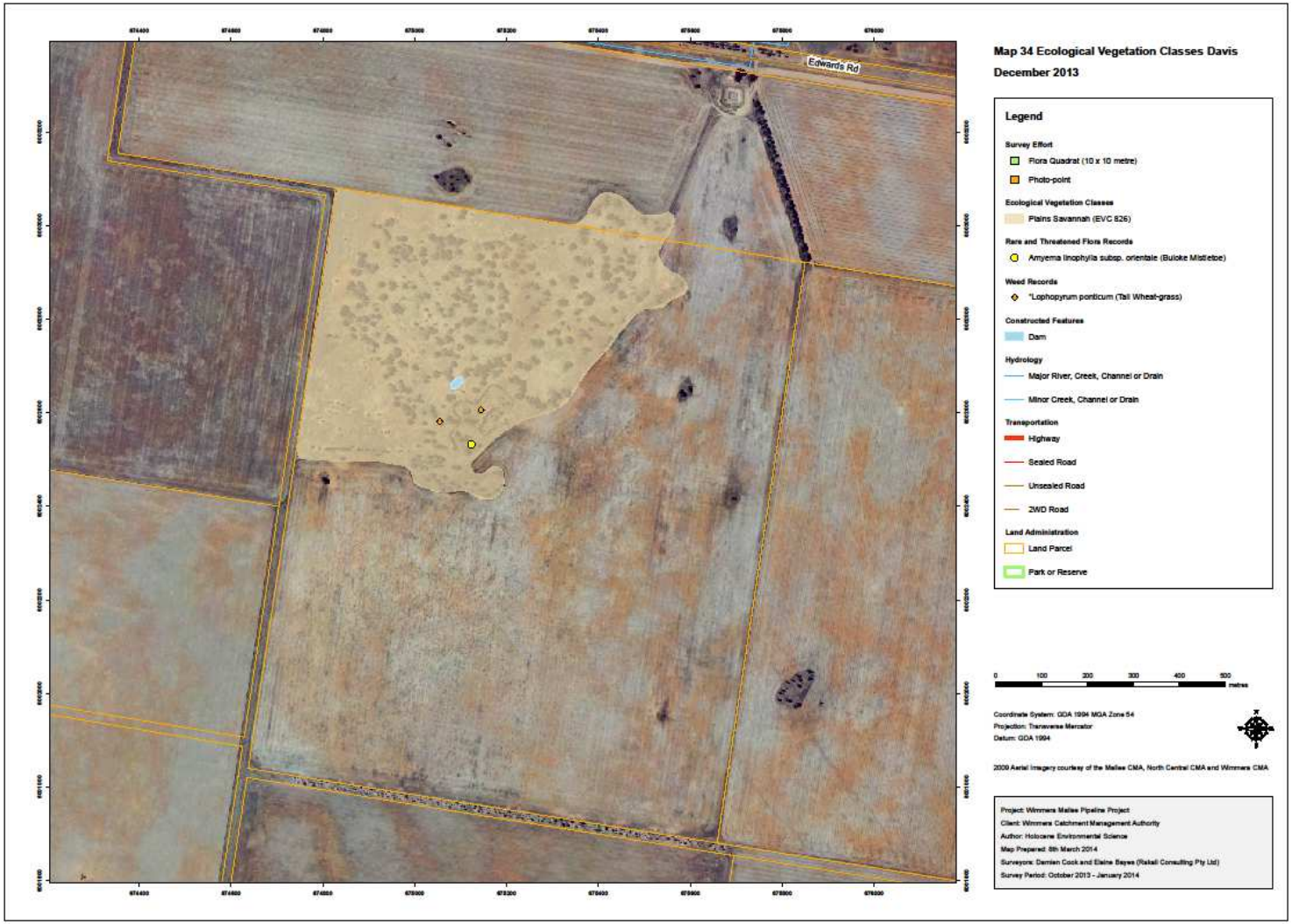
Corack Lake


Map 32 Ecological Vegetation Classes Corack Lake
December 2013
Legend
Survey Effort
Flora Quadrat (10 x 10 metre)
Photo-point
Ecological Vegetation Classes
Intermittent Swampy Woodland (EVC 813)
Lake Bed Herbland (EVC 107)
Lunette Woodland (EVC 652)
Plains Woodland (EVC 803)
Weed Records
*Galenia pubescens var. pubescens (Galenia)
*Lophopyrum ponticum (Tall Wheat-grass)
*Marrubium vulgare (Horehound)
*Schinus molle (Pepper Tree)
Rare and Threatened Fauna Records
Brown Treecreeper
Spotted Harrier
Square-tailed Kite
Constructed Features
Dam
Hydrology
Major River, Creek, Channel or Drain
Minor Creek, Channel or Drain
Transportation
Highway
Sealed Road
Unsealed Road
2WD Road
Land Administration
Land Parcel
Park or Reserve
0 20 40 60 80 100 120 140
metres
Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994
2009 Aerial Imagery courtesy of the Mallee CMA, North Central CMA and Wimmera CMA
Project: Wimmera Mallee Pipeline Project
Client: Wimmera Catchment Management Authority
Author: Holocene Environmental Science
Map Prepared: 8th March 2014
Surveyors: Damien Cook and Elaine Bayes (Rakali Consulting Pty Ltd)
Survey Period: October 2013 - January 2014
Quadrat 2
Quadrat 1
Rivers Rd

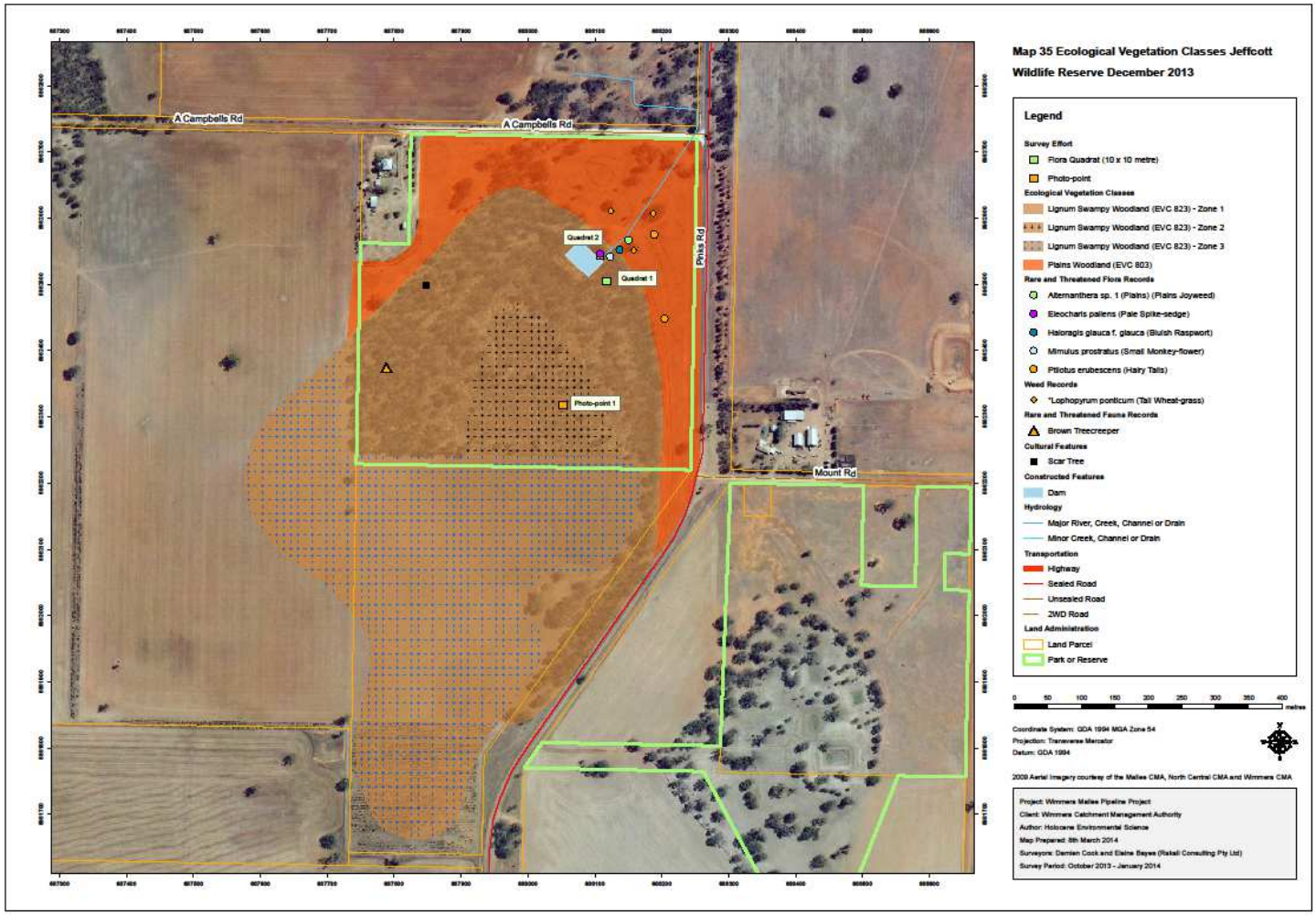
Creswick Swamp



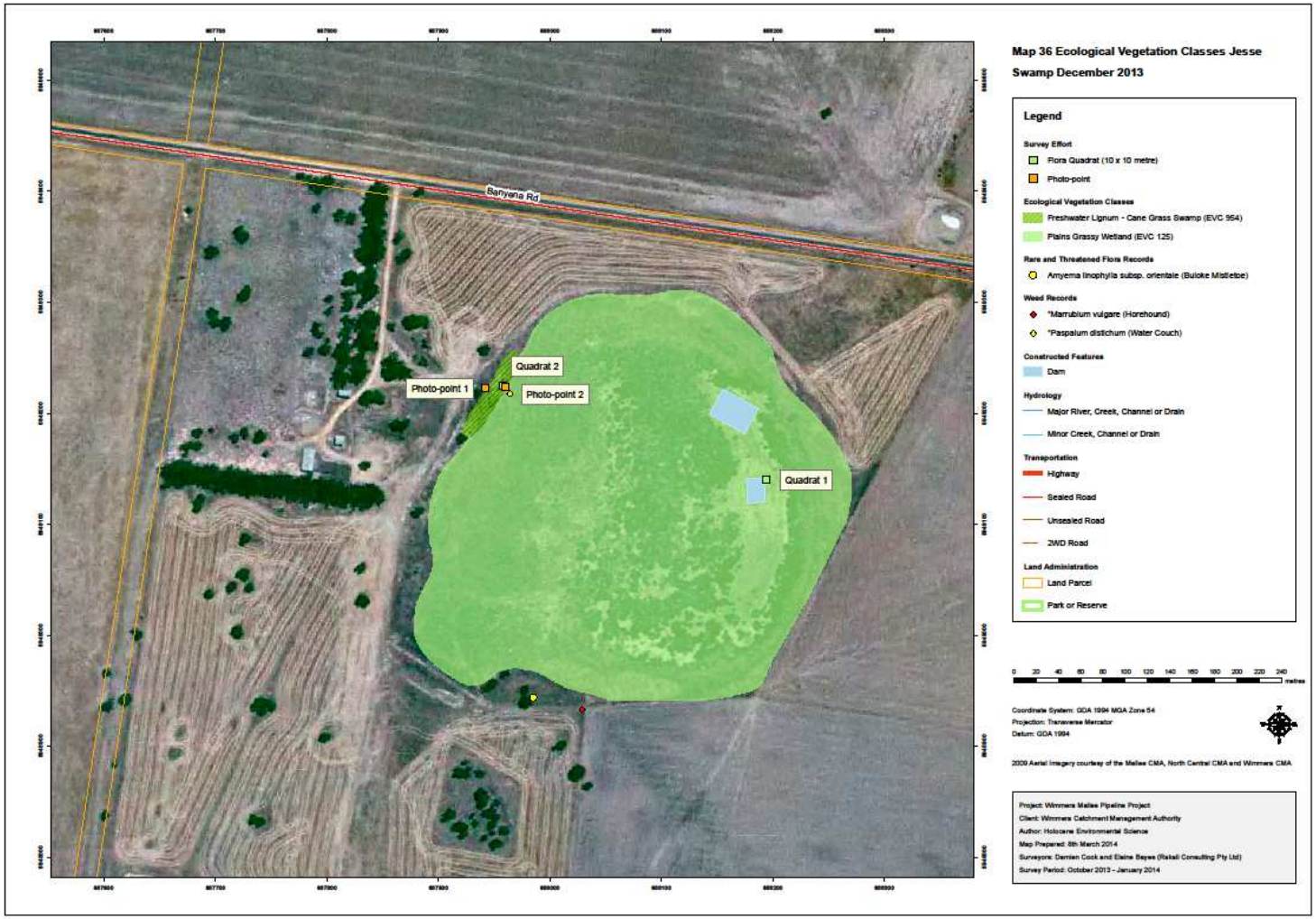
Davis Dam


Edwards Rd
Map 34 Ecological Vegetation Classes Davis
December 2013
Legend
Survey Effort
Flora Quadrat (10 x 10 metre)
Photo-point
Ecological Vegetation Classes
Plains Savannah (EVC 826)
Rare and Threatened Flora Records
Amyema linophylla subsp. orientale (Buloke Mistletoe)
Weed Records
*Lophopyrum ponticum (Tall Wheat-grass)
Constructed Features
Dam
Hydrology
Major River, Creek, Channel or Drain
Minor Creek, Channel or Drain
Transportation
Highway
Sealed Road
Unsealed Road
2WD Road
Land Administration
Land Parcel
Park or Reserve
0 100 200 300 400 500
metres
Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994
2009 Aerial Imagery courtesy of the Mallee CMA, North Central CMA and Wimmera CMA
Project: Wimmera Mallee Pipeline Project
Client: Wimmera Catchment Management Authority
Author: Holocene Environmental Science
Map Prepared: 6th March 2014
Surveyors: Damien Cook and Elaine Beyes (Rakali Consulting Pty Ltd)
Survey Period: October 2013 - January 2014

Jeffcott Wetland



Jesse Swamp


Banyena Rd
Quadrat 2
Photo-point 1
Photo-point 2
Quadrat 1
Map 36 Ecological Vegetation Classes Jesse Swamp December 2013
Legend
Survey Effort
Flora Quadrat (10 x 10 metre)
Photo-point
Ecological Vegetation Classes
Freshwater Lignum - Cane Grass Swamp (EVC 954)
Plains Grassy Wetland (EVC 125)
Rare and Threatened Flora Records
Amyema linophylla subsp. orientale (Buloke Mistletoe)
Weed Records
*Marrubium vulgare (Horehound)
*Paspalum distichum (Water Couch)
Constructed Features
Dam
Hydrology
Major River, Creek, Channel or Drain
Minor Creek, Channel or Drain
Transportation
Highway
Sealed Road
Unsealed Road
2WD Road
Land Administration
Land Parcel
Park or Reserve
0 20 40 60 80 100 120 140 160 180 200 220 240
metres
Coordinate System: GDA 1994 MGA Zone 54
Projection: Transverse Mercator
Datum: GDA 1994
2009 Aerial Imagery courtesy of the Mallee CMA, North Central CMA and Wimmera CMA
Project: Wimmera Mallee Pipeline Project
Client: Wimmera Catchment Management Authority
Author: Holocene Environmental Science
Map Prepared: 8th March 2014
Surveyors: Damien Cook and Elaine Bayes (Rakali Consulting Pty Ltd)
Survey Period: October 2013 - January 2014

Appendix 5: Flora Species List

Common Name	Scientific name	Type	EPBC	FFG	DELWP	Last record	Reference
Chirrup Swamp							
Native species							
Berry Saltbush	*Atriplex semibaccata*					2013	Rakali, 2014
Black Box	*Eucalyptus largiflorens*	WD				2013	Rakali, 2014
Black Cotton-bush	*Maireana decalvans*					2013	Rakali, 2014
Black Roly-poly	*Sclerolaena muricata*				k	1991	DELWP, 2014
Bluebush	*Maireana spp.*	WD				1997	DELWP, 2014
Blushing Bindweed	*Convolvulus angustissimus*					2013	Rakali, 2014
Bottle Bluebush	*Maireana excavata*					2013	Rakali, 2014
Bristly Wallaby-grass	*Rytidosperma setaceum*					2013	Rakali, 2014
Brome	*Bromus spp.*					1990	DELWP, 2014
Buttercup	*Ranunculus spp.*	WD				1990	DELWP, 2014
Cane Grass	*Eragrostis australasica*	WD			v	2013	Rakali, 2014
Chariot Wheels	*Maireana cheelii*		v	L	v	2013	Rakali, 2014
Clay Plantain	*Plantago cunninghamii*					2013	Rakali, 2014
Common Blown-grass	*Lachnagrostis filiformis*	WD				2013	Rakali, 2014
Common Cotula	*Cotula australis*					1997	DELWP, 2014
Common Duckweed	*Lemna disperma*	WD				1990	DELWP, 2014
Common Swamp Wallaby-grass	*Amphibromus nervosus*	WD				2013	Rakali, 2014
Common Wallaby-grass	*Rytidosperma caespitosum*					2013	Rakali, 2014
Dense Crassula	*Crassula colorata*					2013	Rakali, 2014
Dock	*Rumex spp.*	WD				1990	DELWP, 2014
Ferny Small-flower Buttercup	*Ranunculus pumilio*	WD				2013	Rakali, 2014
Frosted Goosefoot	*Chenopodium desertorum*					2013	Rakali, 2014
Fuzzy New Holland Daisy	*Vittadinia cuneata*					1997	DELWP, 2014
Gold Rush	*Juncus flavidus*	WD				1991	DELWP, 2014
Golden Sunray	*Hyalosperma glutinosum subsp. glutinosum*					2013	Rakali, 2014
Grassland Wood-sorrel	*Oxalis perennans*					1997	DELWP, 2014
Grey Copperburr	*Sclerolaena diacantha*					2013	Rakali, 2014
Grey Roly-poly	*Sclerolaena muricata var. villosa*					2013	Rakali, 2014
Hairy Bluebush	*Maireana pentagona*					2013	Rakali, 2014
Hairy Willow-herb	*Epilobium hirtigerum*					1986	DELWP, 2014
Hard-head Daisy	*Brachyscome lineariloba*					2013	Rakali, 2014
Hedge Saltbush	*Rhagodia spinescens*					2013	Rakali, 2014
Knob Sedge	*Carex inversa*	WD				2013	Rakali, 2014
Leek Lily	*Bulbine semibarbata*					2013	Rakali, 2014
Mousetail	*Myosurus australis*	WD				2013	Rakali, 2014
Native Sea-spurrey	*Spergularia brevifolia*					2013	Rakali, 2014
Nitre Goosefoot	*Chenopodium nitrariaceum*	WD				2013	Rakali, 2014
Nitre-bush	*Nitraria billardierei*					1997	DELWP, 2014
Nodding Saltbush	*Einadia nutans subsp. nutans*					2013	Rakali, 2014
Paper Sunray	*Rhodanthe corymbiflora*					2013	Rakali, 2014
Prickly Saltwort	*Salsola tragus subsp. tragus*					2013	Rakali, 2014
Pussy Tails	*Ptilotus spathulatus f. spathulatus*					1997	DELWP, 2014
Rosinweed	*Cressa australis*					2013	Rakali, 2014
Rough Spear-grass	*Austrostipa scabra*					2013	Rakali, 2014
Ruby Saltbush	*Enchylaena tomentosa var. tomentosa*					2013	Rakali, 2014
Saltbush	*Atriplex spp.*					1997	DELWP, 2014
Scurfy Germander	*Teucrium albicaule*				k	2013	Rakali, 2014
Sieber Crassula	*Crassula sieberiana s.l.*					2013	Rakali, 2014
Slender-fruit Saltbush	*Atriplex leptocarpa*					2013	Rakali, 2014
Small-flower Goodenia	*Goodenia pusilliflora*					2013	Rakali, 2014
Southern Cane-grass	*Eragrostis infecunda*	WD				2013	Rakali, 2014
Spider Grass	*Enteropogon acicularis*					2013	Rakali, 2014
Spiked Centaury	*Centaurium spicatum*					2013	Rakali, 2014
Spiny Lignum	*Duma horrida subsp. horrida*	WD			r	2014	Rakali, 2014
Star Bluebush	*Stelligera endecaspinis*					2013	Rakali, 2014
Starry Goosefoot	*Scleroblitum atriplicinum*	WD				2013	Rakali, 2014
Stiff Cup-flower	*Pogonolepis muelleriana*					2013	Rakali, 2014
Swamp Early Nancy	*Wurmbea dioica subsp. lacunaria*	WD			k	2013	Rakali, 2014
Squirrel-tail Fescue	*Vulpia bromoides*					2013	Rakali, 2014
Tall Fireweed	*Senecio runcinifolius*	WD				2013	Rakali, 2014
Tangled Lignum	*Duma florulenta*	WD				2013	Rakali, 2014
Umbrella Wattle	*Acacia oswaldii*					2013	Rakali, 2014
Variable Plantain	*Plantago varia*					1997	DELWP, 2014
Variable Sida	*Sida corrugata*					2013	Rakali, 2014

Variable Willow-herb	*Epilobium billardierianum*					1990	DELWP, 2014
Wallaby Grass	*Danthonia s.l. spp.*					1997	DELWP, 2014
Water Mat	*Lepilaena spp.*	WD				1997	DELWP, 2014
Water Milfoil	*Myriophyllum spp.*	WD				1990	DELWP, 2014
Wingless Bluebush	*Maireana enchylaenoides*					2013	Rakali, 2014
Woolly New Holland Daisy	*Vittadinia gracilis*					1986	DELWP, 2014
Exotic species							
African Box-thorn	*Lycium ferocissimum*					2014	Rakali, 2014
Annual Beard-grass	*Polypogon monspeliensis*					1991	DELWP, 2014
Aster-weed	*Aster subulatus*					1990	DELWP, 2014
Barley-grass	*Critesian murinum s.l.*					2013	Rakali, 2014
Bocconi's Sand-spurrey	*Spergularia bocconii*					2013	Rakali, 2014
Bulbous Meadow-grass	*Poa bulbosa*					2013	Rakali, 2014
Burr Medic	*Medicago polymorpha*					2013	Rakali, 2014
Clover	*Trifolium spp.*					1997	DELWP, 2014
Coast Barb-grass	*Parapholis incurve*					2013	Rakali, 2014
Common Peppercress	*Lepidium africanum*					2013	Rakali, 2014
Common Sow-thistle	*Sonchus oleraceus*					2013	Rakali, 2014
Ferny Cotula	*Cotula bipinnata*					2013	Rakali, 2014
Fescue	*Vulpia spp.*					1990	DELWP, 2014
Galenia	*Galenia pubescens var. Pubescens*					2014	Rakali, 2014
Golden-top	*Lamarckia aurea*					2013	Rakali, 2014
Great Brome	*Bromus diandrus*					2013	Rakali, 2014
Horehound	*Marrubium vulgare*					2013	Rakali, 2014
Lesser Canary-grass	*Phalaris minor*					2013	Rakali, 2014
Little Medic	*Medicago minima*					2013	Rakali, 2014
London Rocket	*Sisybrium irio*					2013	Rakali, 2014
Marsh Fox-tail	*Alopecurus geniculatus*					2013	Rakali, 2014
Ox-tongue	*Helminthotheca echioides*					1990	DELWP, 2014
Paradoxical Canary-grass	*Phalaris paradoxa*					2013	Rakali, 2014
Perennial Rye-grass	*Lolium perenne*					1997	DELWP, 2014
Prickly Lettuce	*Lactuca serriola*					2013	Rakali, 2014
Rat's-tail Fescue	*Vulpia myuros*					2013	Rakali, 2014
Red Brome	*Bromus rubens*					2013	Rakali, 2014
Red Sand-spurrey	*Spergularia rubra s.l.*					1997	DELWP, 2014
Sea Barley-grass	*Hordeum marinum*					1991	DELWP, 2014
Spear Thistle	*Cirsium vulgare*					2013	Rakali, 2014
Water Crassula	*Crassula natans var. minus*					2013	Rakali, 2014
Wild Radish	*Raphanus raphanistrum*					1997	DELWP, 2014
Willow-leaf Lettuce	*Lactuca saligna*					2013	Rakali, 2014
Wimmera Rye-grass	*Lolium rigidum*					2013	Rakali, 2014
Winged Sea-lavender	*Limonium lobatum*					2013	Rakali, 2014
Woolly Clover	*Trifolium tomentosum var. Tomentosum*					2013	Rakali, 2014
Corack Lake							
Native species							
Austral Mudwort	*Limosella australis*	WD				2013	Rakali, 2014
Black Box	*Eucalyptus largiflorens*	WD				2013	Rakali, 2014
Blue Rod	*Stemodia florulenta*	WD				2013	Rakali, 2014
Box Mistletoe	*Amyema miquelii*					1986	DELWP, 2014
Bristly Wallaby-grass	*Rytidosperma setaceum*					2013	Rakali, 2014
Clammy Goosefoot	*Chenopodium pumilio*	WD				2013	Rakali, 2014
Common Blown-grass	*Lachnagrostis filiformis*	WD				2013	Rakali, 2014
Common Nardoo	*Marsilea drummondii*	WD				2013	Rakali, 2014
Common Sneezeweed	*Centipeda cunninghamii*	WD				2013	Rakali, 2014
Common Spike-sedge	*Eleocharis acuta*	WD				2013	Rakali, 2014
Common Wallaby-grass	*Rytidosperma caespitosum*					2013	Rakali, 2014
Cotton Fireweed	*Senecio quadridentatus*					2013	Rakali, 2014
Creeping Knotweed	*Persicaria prostrata*	WD				2013	Rakali, 2014
Dense Crassula	*Crassula colorata*					2013	Rakali, 2014
Desert Cassia	*Senna artemisioides spp. agg.*					2013	Rakali, 2014
Finger Rush	*Juncus subsecundus*	WD				2013	Rakali, 2014
Flat Spurge	*Chamaesyce drummondii*					1986	DELWP, 2014
Gold Rush	*Juncus flavidus*	WD				1986	DELWP, 2014
Gold Rush	*Juncus flavidus*	WD				2013	Rakali, 2014
Golden Wattle	*Acacia pycnantha*					1986	DELWP, 2014
Hairy Willow-herb	*Epilobium hirtigerum*					2013	Rakali, 2014
Jersey Cudweed	*Pseudognaphalium luteoalbum*					2013	Rakali, 2014
Kneed Spear-grass	*Austrostipa bigeniculata*					2013	Rakali, 2014
Knob Sedge	*Carex inversa*	WD				2013	Rakali, 2014
Lesser Joyweed	*Alternanthera denticulata s.l.*	WD				2013	Rakali, 2014
Narrow-leaf Dock	*Rumex tenax*	WD				2013	Rakali, 2014

Native Verbena	*Verbena officinalis var. gaudichaudii*	WD				2013	Rakali, 2014
Nitre Goosefoot	*Chenopodium nitrariaceum*	WD				2013	Rakali, 2014
Nodding Chocolate-lily	*Arthropodium fimbriatum*					2013	Rakali, 2014
Nodding Saltbush	*Einadia nutans subsp. nutans*					2013	Rakali, 2014
Plains Sedge	*Carex bichenoviana*	WD				2013	Rakali, 2014
Prickly Saltwort	*Salsola tragus*					2013	Rakali, 2014
Red Water-milfoil	*Myriophyllum verrucosum*	WD				2013	Rakali, 2014
River Red-gum	*Eucalyptus camaldulensis*	WD				2013	Rakali, 2014
Rough Spear-grass	*Austrostipa scabra*					2013	Rakali, 2014
Ruby Saltbush	*Enchylaena tomentosa var. Tomentosa*					2013	Rakali, 2014
Sieber Crassula	*Crassula sieberiana s.l.*					2013	Rakali, 2014
Small Knotweed	*Polygonum plebeium*	WD				2013	Rakali, 2014
Small Loosestrife	*Lythrum hyssopifolia*	WD				2013	Rakali, 2014
Spider Grass	*Enteropogon acicularis*					2013	Rakali, 2014
Spiny Flat-sedge	*Cyperus gymnocaulos*	WD				2013	Rakali, 2014
Spreading Goodenia	*Goodenia heteromera*	WD				1986	DELWP, 2014
Tangled Lignum	*Duma florulenta*	WD				2013	Rakali, 2014
Toad Rush	*Juncus bufonius*	WD				2013	Rakali, 2014
Variable Sida	*Sida corrugata*					2013	Rakali, 2014
Wingless Bluebush	*Maireana enchylaenoides*					2013	Rakali, 2014
Yellow Gum	*Eucalyptus leucoxylon*					2013	Rakali, 2014
Yellow Twin-heads	*Eclipta platyglossa*	WD				2013	Rakali, 2014
Exotic species							
African Box-thorn	*Lycium ferocissimum*					2013	Rakali, 2014
Annual Beard-grass	*Polypogon monspeliensis*					2013	Rakali, 2014
Bearded Oat	*Avena barbata*					2013	Rakali, 2014
Bulbous Meadow-grass	*Poa bulbosa*					2013	Rakali, 2014
Burr Medic	*Medicago polymorpha*					2013	Rakali, 2014
Common Peppercress	*Lepidium africanum*					2013	Rakali, 2014
Common Sow-thistle	*Sonchus oleraceus*					2013	Rakali, 2014
Creeping Heliotrope	*Heliotropium supinum*					2013	Rakali, 2014
Curled Dock	*Rumex crispus*					2013	Rakali, 2014
Flaxleaf Fleabane	*Conyza bonariensis*					2013	Rakali, 2014
Galenia	*Galenia pubescens var. pubescens*					2013	Rakali, 2014
Great Brome	*Bromus diandrus*					2013	Rakali, 2014
Hairy Fiddle-neck	*Amsinckia calycina*					2013	Rakali, 2014
Hare's-foot Clover	*Trifolium arvense var. arvense*					2013	Rakali, 2014
Horehound	*Marrubium vulgare*					2013	Rakali, 2014
Knotted Clover	*Trifolium striatum*					2013	Rakali, 2014
London Rocket	*Sisymbrium irio*					2013	Rakali, 2014
Narrow-leaf Clover	*Trifolium angustifolium var. angustifolium*					2013	Rakali, 2014
Pepper Tree	*Schinus molle*					2013	Rakali, 2014
Prickly Lettuce	*Lactuca serriola*					2013	Rakali, 2014
Prostrate Knotweed	*Polygonum aviculare s.l.*					2013	Rakali, 2014
Pygmy Mosses	*fam. Pottiaceae gen. Acaulon*	WD				1986	DELWP, 2014
Rat's-tail Fescue	*Vulpia myuros*					2013	Rakali, 2014
Small-flower Mallow	*Malva parviflora*					2013	Rakali, 2014
Spear Thistle	*Cirsium vulgare*					2013	Rakali, 2014
Trailing Verbena	*Verbena supina*					2013	Rakali, 2014
Wimmera Rye-grass	*Lolium rigidum*					2013	Rakali, 2014
Winged Sea-lavender	*Limonium lobatum*					2013	Rakali, 2014
Creswick Swamp							
Native species							
Annual Cudweed	*Euchiton sphaericus*					2013	Rakali, 2014
Berry Saltbush	*Atriplex semibaccata*					1991	DELWP, 2014
Black Cotton-bush	*Maireana decalvans*					2013	Rakali, 2014
Blue Devil	*Eryngium ovinum*					2013	Rakali, 2014
Bluish Raspwort	*Haloragis glauca f. glauca*	WD			k	2013	Rakali, 2014
Blushing Bindweed	*Convolvulus angustissimus subsp. angustissimus*					2013	Rakali, 2014
Bottle Bluebush	*Maireana excavata*					1991	DELWP, 2014
Bristly Wallaby-grass	*Rytidosperma setaceum*	WD				2013	Rakali, 2014
Brown-back Wallaby-grass	*Rytidosperma duttonianum*	WD				2013	Rakali, 2014
Bulbine Lily	*Bulbine bulbosa*	WD				1991	DELWP, 2014
Buloke	*Allocasuarina luehmannii*					2013	Rakali, 2014
Buloke Mistletoe	*Amyema linophylla subsp. orientale*				v	2013	Rakali, 2014
Clammy Goosefoot	*Chenopodium pumilio*	WD				1981	DELWP, 2014
Common Blown-grass	*Lachnagrostis filiformis*	WD				2013	Rakali, 2014
Common Bog-sedge	*gen. Schoenus gen. Apogon*	WD				1991	DELWP, 2014
Common Nardoo	*Marsilea drummondii*	WD				2013	Rakali, 2014

Common Sneezeweed	*Centipeda cunninghamii*	WD				2013	Rakali, 2014
Common Spike-sedge	*Eleocharis acuta*	WD				2013	Rakali, 2014
Common Swamp Wallaby-grass	*Amphibromus nervosus*	WD				2013	Rakali, 2014
Common Wallaby-grass	*Rytidosperma caespitosum*					2013	Rakali, 2014
Common Woodruff	*Asperula conferta*	WD				2013	Rakali, 2014
Copperburr	*Sclerolaena spp.*					1981	DELWP, 2014
Cotton Fireweed	*Senecio quadridentatus*					2013	Rakali, 2014
Creeping Knotweed	*Persicaria prostrata*	WD				2013	Rakali, 2014
Creeping mint	*Mentha satureioides*	WD				2013	Rakali, 2014
Dark Plantain	*Plantago drummondii*					1991	DELWP, 2014
Dense Crassula	*Crassula colorata*					2013	Rakali, 2014
Dwarf Bluebush	*Maireana humillima*					2013	Rakali, 2014
Feather Heads	*Ptilotus macrocephalus*					2013	Rakali, 2014
Flat Spurge	*Chamaesyce drummondii*					1991	DELWP, 2014
Floating Pondweed	*Potamogeton tricarinatus s.l.*	WD				1981	DELWP, 2014
Fuzzy New Holland Daisy	*Vittadinia cuneata*					2013	Rakali, 2014
Gold Rush	*Juncus flavidus*	WD				2013	Rakali, 2014
Grass Bindweed	*Convolvulus remotus*					2013	Rakali, 2014
Grassland Wood-sorrel	*Oxalis perennans*					2013	Rakali, 2014
Grey Copperburr	*Sclerolaena diacantha*					2013	Rakali, 2014
Grey Willow-herb	*Epilobium billardierianum subsp. cinereum*					1981	DELWP, 2014
Hairy Bluebush	*Maireana pentagona*					2013	Rakali, 2014
Hairy Willow-herb	*Epilobium hirtigerum*					2013	Rakali, 2014
Harlequin Mistletoe	*Lysiana exocarpi*					2013	Rakali, 2014
Hoary Rush	*Juncus radula*	WD				1981	DELWP, 2014
Hollow Rush	*Juncus amabilis*	WD				1981	DELWP, 2014
Jersey Cudweed	*Pseudognaphalium luteoalbum*					2013	Rakali, 2014
Lemon Beauty-heads	*Calocephalus citreus*					2013	Rakali, 2014
Long Eryngium	*Eryngium paludosum*	WD			v	2013	Rakali, 2014
Marbled Marshwort	*Nymphoides spinulosperma*	WD		L	e	1988	DELWP, 2014
Matted Flax-lily	*Dianella amoena*		e	L	e	2013	Rakali, 2014
Mulla Mulla	*Ptilotus exaltatus*					1991	DELWP, 2014
Narrow Plantain	*Plantago gaudichaudii*					2013	Rakali, 2014
Pale Flax-lily	*Dianella longifolia var. longifolia s.l.*					1981	DELWP, 2014
Pale Spike-sedge	*Eleocharis pallens*	WD			k	2013	Rakali, 2014
Paper Sunray	*Rhodanthe corymbiflora*					1991	DELWP, 2014
Pink Bindweed	*Convolvulus erubescens spp. agg.*					1991	DELWP, 2014
Plump Spear-grass	*Austrostipa aristiglumis*					2013	Rakali, 2014
Poison Pratia	*Lobelia concolor*	WD				2013	Rakali, 2014
Poong'ort	*Carex tereticaulis*	WD				2013	Rakali, 2014
Prickly Woodruff	*Asperula scoparia*	WD				1991	DELWP, 2014
Red Pondweed	*Potamogeton cheesemanii*	WD				2013	Rakali, 2014
Rigid Panic	*Walwhalleya proluta*	WD				2013	Rakali, 2014
River Red-gum	*Eucalyptus camaldulensis*	WD				2013	Rakali, 2014
Rough Raspwort	*Haloragis aspera*	WD				2013	Rakali, 2014
Rough Spear-grass	*Austrostipa scabra subsp. scabra*					1991	DELWP, 2014
Ruby Saltbush	*Enchylaena tomentosa var. tomentosa*					2013	Rakali, 2014
Scaly Buttons	*Leptorhynchos squamatus*	WD				1991	DELWP, 2014
Short Wallaby-grass	*Austrodanthonia carphoides*					1991	DELWP, 2014
Short-fruit Nardoo	*Marsilea hirsuta*	WD				1981	DELWP, 2014
Slender Dock	*Rumex brownii*					2013	Rakali, 2014
Small Loosestrife	*Lythrum hyssopifolia*	WD				2013	Rakali, 2014
Small Spike-sedge	*Eleocharis pusilla*	WD				2013	Rakali, 2014
Small Vanilla-lily	*Arthropodium minus*					1991	DELWP, 2014
Southern Cane-grass	*Eragrostis infecunda*	WD				2013	Rakali, 2014
Southern Swamp Wallaby-grass	*Amphibromus neesii*	WD				1981	DELWP, 2014
Spider Grass	*Enteropogon acicularis*					2013	Rakali, 2014
Spiny Lignum	*Duma horrida subsp. horrida*	WD			r	2013	Rakali, 2014
Spreading Crassula	*Crassula decumbens var. decumbens*					1991	DELWP, 2014
Spreading Goodenia	*Goodenia heteromera*	WD				2013	Rakali, 2014
Star Fruit	*Damasonium minus*	WD				2013	Rakali, 2014
Swamp Billy-buttons	*Craspedia paludicola*	WD				2013	Rakali, 2014
Tall Fireweed	*Senecio runcinifolius*	WD				2013	Rakali, 2014
Tangled Lignum	*Duma florulenta*	WD				2013	Rakali, 2014
Tufted Bluebell	*Wahlenbergia communis s.l.*					2013	Rakali, 2014
Turnip Copperburr	*Sclerolaena napiformis*		e	L	e	2013	Rakali, 2014
Variable Sida	*Sida corrugata*					2013	Rakali, 2014
Wallaby Grass	*Danthonia s.l. spp.*					1985	DELWP, 2014
Windmill Grass	*Chloris truncata*					2013	Rakali, 2014
Wingless Bluebush	*Maireana enchylaenoides*					2013	Rakali, 2014
Wiry Dock	*Rumex dumosus*					1981	DELWP, 2014

Woodland Swamp-daisy	*Brachyscome basaltica var. gracilis*	WD				2013	Rakali, 2014
Woolly Buttons	*Leiocarpa panaetioides*					2013	Rakali, 2014
Woolly New Holland Daisy	*Vittadinia gracilis*					2013	Rakali, 2014
Yellow Twin-heads	*Eclipta platyglossa*	WD				2013	Rakali, 2014
Exotic species							
Aster-weed	*Aster subulatus*					2013	Rakali, 2014
Barley-grass	*Critesian murinum s.l.*					2013	Rakali, 2014
Bearded Oat	*Avena barbata*					2013	Rakali, 2014
Cape weed	*Arctotheca calendula*					1991	DELWP, 2014
Capitate Rush	*Juncus capitatus*	WD				1991	DELWP, 2014
Common Sow-thistle	*Sonchus oleraceus*					2013	Rakali, 2014
Crimson Clover	*Trifolium incarnatum var. incarnatum*					1991	DELWP, 2014
Curled Dock	*Rumex crispus*					2013	Rakali, 2014
False Brome	*Brachypodium distachyon*					2013	Rakali, 2014
Flatweed	*Hypochaeris radicata*					2013	Rakali, 2014
Great Brome	*Bromus diandrus*					2013	Rakali, 2014
Hare's-foot Clover	*Trifolium arvense var. arvense*					2013	Rakali, 2014
Knotted Clover	*Trifolium striatum*					2013	Rakali, 2014
Mediterranean Barley-grass	*Hordeum hystrix*					1981	DELWP, 2014
Narrow-leaf Clover	*Trifolium angustifolium var. angustifolium*					2013	Rakali, 2014
Onion Grass	*Romulea rosea*					2013	Rakali, 2014
Ox-tongue	*Helminthotheca echioides*					2013	Rakali, 2014
Paradoxical Canary-grass	*Phalaris paradoxa*					2013	Rakali, 2014
Perennial Rye-grass	*Lolium perenne*					1991	DELWP, 2014
Prickly Lettuce	*Lactuca serriola*					2013	Rakali, 2014
Prickly Sow-thistle	*Sonchus asper*					2013	Rakali, 2014
Prostrate Knotweed	*Polygonum aviculare s.l.*					2013	Rakali, 2014
Silvery Hair-grass	*Aira caryophyllea*					1991	DELWP, 2014
Smooth Cat's-ear	*Hypochaeris glabra*					1991	DELWP, 2014
Spear Thistle	*Cirsium vulgare*					2013	Rakali, 2014
Squirrel-tail Fescue	*Vulpia bromoides*					2013	Rakali, 2014
Subterranean Clover	*Trifolium subterraneum*					1991	DELWP, 2014
Tall Wheat-grass	*Lophopyrum ponticum*					2013	Rakali, 2014
Toowoomba Canary-grass	*Phalaris aquatica*					2013	Rakali, 2014
Wild Oat	*Avena fatua*					1991	DELWP, 2014
Wild Sage	*Salvia verbenaca*					2013	Rakali, 2014
Wimmera Rye-grass	*Lolium rigidum*					2013	Rakali, 2014
Davis Dam							
Native species							
Berry Saltbush	*Atriplex semibaccata*					2014	Rakali, 2014
Black Box	*Eucalyptus largiflorens*	WD				2014	Rakali, 2014
Black Roly-poly	*Sclerolaena muricata*				k	2010	Hutchinson, 2010
Blue Burr-daisy	*Calotis cuneifolia*				r	2010	Hutchinson, 2010
Bottle Bluebush	*Maireana excavata*					1994	DELWP, 2014
Bristly Wallaby-grass	*Rytidosperma setaceum*					2014	Rakali, 2014
Brome	*Bromus spp.*					1994	DELWP, 2014
Buloke	*Allocasuarina luehmannii*					2014	Rakali, 2014
Buloke Mistletoe	*Amyema linophylla subsp. orientale*				v	2014	Rakali, 2014
Cane Grass	*Eragrostis infucunda*	WD			v	2010	Hutchinson, 2010
Chariot Wheels	*Maireana cheelii*		v	L	v	1994	DELWP, 2014
Common Wallaby-grass	*Austrodanthonia caespitosa*					1994	DELWP, 2014
Common Woodruff	*Asperula conferta*	WD				1994	DELWP, 2014
Corkscrew Spear-grass	*Austrostipa setacea*					2014	Rakali, 2014
Dense Crassula	*Crassula colorata*					2014	Rakali, 2014
Desert Cassia	*Senna artemisioides spp. agg.*					2014	Rakali, 2014
Early Nancy	*Wurmbea spp.*					2010	Hutchinson, 2010
Flat Spurge	*Chamaesyce drummondii*					1994	DELWP, 2014
Fuzzy New Holland Daisy	*Vittadinia cuneata var. hirsuta*				r	1994	DELWP, 2014
Gold-dust Wattle	*Acacia acinacea s.l. (DS)*					2014	Rakali, 2014
Golden Billy-buttons	*Pycnosorus chrysanthes*					1994	DELWP, 2014
Grey Germander	*Teucrium racemosum s.l.*					1994	DELWP, 2014
Grey Mulga	*Acacia brachybotrya (DS)*					2014	Rakali, 2014
Hairy Bluebush	*Maireana pentagona*					1994	DELWP, 2014
Harlequin Mistletoe	*Lysiana exocarpi*					2014	Rakali, 2014
Hedge Saltbush	*Rhagodia spinescens*					2014	Rakali, 2014
Knotty Spear-grass	*Austrostipa nodosa*					1994	DELWP, 2014
Leafless Bluebush	*Maireana aphylla*				k	1994	DELWP, 2014
Manna Wattle	*Acacia microcarpa s.l. (DS)*					2014	Rakali, 2014
Noding Saltbush	*Einadia nutans subsp. nutans*					2010	Hutchinson, 2010
Onion Grass	*Romulea rosea*					2014	Rakali, 2014
Paper Sunray	*Rhodanthe corymbiflora*					2014	Rakali, 2014

Pink Bindweed	*Convolvulus erubescens spp. agg.*					1994	DELWP, 2014
Plump Spear-grass	*Austrostipa aristiglumis*					1994	DELWP, 2014
Prickly Saltwort	*Salsola tragus subsp. tragus*					2010	Hutchinson, 2010
Rigid Panic	*Walwhalleya proluta*	WD				2014	Rakali, 2014
Rough Spear-grass	*Austrostipa scabra*					2014	Rakali, 2014
Ruby Saltbush	*Enchylaena tomentosa var. tomentosa*					2014	Rakali, 2014
Saloop	*Einadia hastata*					2010	Hutchinson, 2010
Short-leaf Bluebush	*Maireana brevifolia*					2014	Rakali, 2014
Slender Cypress-pine	*Callitris gracilis subsp. murrayensis*					2014	Rakali, 2014
Slender-fruit Saltbush	*Atriplex leptocarpa*					2014	Rakali, 2014
Small Vanilla Lilly	*Arthropofium minus*					2010	Hutchinson, 2010
Spider Grass	*Enteropogon acicularis*					2014	Rakali, 2014
Streaked Copperburr	*Sclerolaena tricuspis*					2010	Hutchinson, 2010
Sunray	*Rhodanthe spp.*					2010	Hutchinson, 2010
Three-nerve Wattle	*Acacia trineura*				v	2010	Hutchinson, 2010
Umbrella Wattle	*Acacia oswaldii (DS)*					2014	Rakali, 2014
Variable Sida	*Sida corrugata*					2014	Rakali, 2014
Wallaby Grass	*Danthonia s.l. spp.*					2010	Hutchinson, 2010
Wild Oat	*Avena fatua*					2010	Hutchinson, 2010
Windmill Grass	*Chloris truncata*					2010	Hutchinson, 2010
Winged New Holland Daisy	*gen. Vittadinia gen. Pterochaeta*				v	1994	DELWP, 2014
Wingless Bluebush	*Maireana enchylaenoides*					2014	Rakali, 2014
Wiry Dock	*Rumex dumosus*					2014	Rakali, 2014
Woolly Buttons	*Leiocarpa panaetioides*					1994	DELWP, 2014
Woolly New Holland Daisy	*Vittadinia gracilis*					2014	Rakali, 2014
Yellow Star	*Hypoxis glabella s.l.*					2010	Hutchinson, 2010
Exotic species							
African Box-thorn	*Lycium ferocissimum*					2014	Rakali, 2014
Barley Grass	*Critesian murinum s.l.*					2010	Hutchinson, 2010
Barrel Medic	*Medicago truncatula*					1994	DELWP, 2014
Bearded Oat	*Avena barbata*					2014	Rakali, 2014
Bulbous Meadow-grass	*Poa bulbosa*					2010	Hutchinson, 2010
Cape Weed	*Arctotheca calendula*					2010	Hutchinson, 2010
Common Heron's-bill	*Erodium cicutarium*					2010	Hutchinson, 2010
Common Peppercress	*Lepidium africanum*					2014	Rakali, 2014
Common Sow-thistle	*Sonchus oleraceus*					1994	DELWP, 2014
Great Brome	*Bromus diandrus*					2014	Rakali, 2014
Horehound	*Marrubium vulgare*					2014	Rakali, 2014
London Rocket	*Sisymbrium irio*					2014	Rakali, 2014
Medic	*Medicago spp.*					2010	Hutchinson, 2010
Mustard	*Sisymbrium spp.*					2010	Hutchinson, 2010
Onion Grass	*Romulea rosea*					2010	Hutchinson, 2010
Ox-tongue	*Helminthotheca echioides*					1994	DELWP, 2014
Prickly Lettuce	*Lactuca serriola*					2014	Rakali, 2014
Rat's-tail Fescue	*Vulpia myuros*					2014	Rakali, 2014
Red Brome	*Bromus rubens*					2014	Rakali, 2014
Rough Spear-grass	*Austrostipa scabra*					2010	Hutchinson, 2010
Rye Grass	*Lolium spp.*					2010	Hutchinson, 2010
Scorzonera	*Scorzonera laciniata*					1994	DELWP, 2014
Small-flower Mallow	*Malva parviflora*					2014	Rakali, 2014
Wild Sage	*Salvia verbenaca*					1994	DELWP, 2014
Wimmera Rye-grass	*Lolium rigidum*					2014	Rakali, 2014
Woolly Clover	*Trifolium tomentosum var. tomentosum*					1994	DELWP, 2014
Falla Dam							
Native species							
Berry Saltbush	*Atriplex semibaccata*					2014	Higgins, 2014
Broombush	*Melaleuca uncinata*					2014	Higgins, 2014
Buloke	*Allocasuarina luehmannii*					2014	Higgins, 2014
Creeping Saltbush	*Rhagodia spinescens*					2014	Higgins, 2014
Flinders Range Wattle	*Acacia iteaphylla*					2014	Higgins, 2014
Gold-dust Wattle	*Acacia acinacea s.l.*					2014	Higgins, 2014
Lightwood	*Acacia implexa*					2014	Higgins, 2014
Nitre Goosefoot	*Chenopodium nitrariaceum*					2014	Higgins, 2014
Old-man Saltbush	*Atriplex nummularia*					2014	Higgins, 2014
Pale Flax-lily	*Dianella longifolia s.l.*				v	2014	Higgins, 2014
Pearl Bluebush	*Maireana sedifolia*				r	2014	Higgins, 2014
Pond Weed	*Potamogeton spp.*	WD				2014	B. Bisset pers obs., 29 April 2012
Prickly Saltwort	*Salsola tragus*					2014	Higgins, 2014
River Red-gum	*Eucalyptus camaldulensis*					2014	Higgins, 2014
Ruby Saltbush	*Enchylaena tomentosa var. tomentosa*					2014	Higgins, 2014
Salt Paperbark	*Melaleuca halmaturorum subsp.*			L	v	2014	Higgins, 2014

	halmaturorum						
Shoestring acacia	*Acacia stenophylla*					2014	Higgins, 2014
Short-leaf Bluebush	*Maireana brevifolia*					2014	Higgins, 2014
Silver Needlewood	*Hakea leucoptera subsp. leucoptera*					2014	Higgins, 2014
Spear Grass	*Austrostipa spp.*					2014	Higgins, 2014
Spider Grass	*Enteropogon acicularis*					2014	Higgins, 2014
Swamp Oak	*Casuarina glauca*					2014	Higgins, 2014
Swamp Sheoak	*Casuarina obesa*			L	e	2014	Higgins, 2014
Wallaby Grass	*Austrodanthonia spp.*					2014	Higgins, 2014
Wedge-leaf Hop-bush	*Dodonaea viscosa subsp. cuneata*					2014	Higgins, 2014
Weeping Pittosporum	*Pittosporum angustifolium*					2014	Higgins, 2014
Willow Wattle	*Acacia salicina*					2014	Higgins, 2014
	Maireana spp.					2014	Higgins, 2014
	Plantago spp.					2014	Higgins, 2014
	Brachychiton populneus subsp. populneus					2014	Higgins, 2014
	Senna artemisioides spp. agg.					2014	Higgins, 2014
Exotic species							
African Box-thorn	*Lycium ferocissimum*					2014	Higgins, 2014
Annual Brome Grass	*Bromus spp.*					2014	Higgins, 2014
Annual Ryegrass	*Lolium spp.*					2014	Higgins, 2014
Brassicacea spp.	*Brassicacea spp.*					2014	Higgins, 2014
Bulbous Meadow-grass	*Poa bulbosa*					2014	Higgins, 2014
Burr Medic	*Medicago polymorpha*					2014	Higgins, 2014
Cape Weed	*Arctotheca calendula*					2014	Higgins, 2014
Common Vetch	*Vicia sativa subsp. sativa*					2014	Higgins, 2014
Fox-tail Fescue	*Vulpia myuros f. megalura*					2014	Higgins, 2014
Mallow of Nice	*Malva nicaeensis*					2014	Higgins, 2014
Musky Heron's-bill	*Erodium moschatum*					2014	Higgins, 2014
Narrow-leaf Clover	*Trifolium angustifolium var. angustifolium*					2014	Higgins, 2014
Onion Grass	*Romulea rosea*					2014	Higgins, 2014
Ox-tongue	*Helminthotheca echioides*					2014	Higgins, 2014
Sea Barley-grass	*Hordeum marinum*					2014	Higgins, 2014
Soft Brome	*Bromus hordeaceus subsp. hordeaceus*					2014	Higgins, 2014
Soursob	*Oxalis pes-caprae*					2014	Higgins, 2014
Spear Thistle	*Cirsium vulgare*					2014	Higgins, 2014
Wild Oat	*Avena spp.*					2014	Higgins, 2014
Wild Sage	*Salvia verbenaca*					2014	Higgins, 2014
Jeffcott Wetland							
Native species							
Annual Cudweed	*Euchiton sphaericus*					2014	Rakali, 2014
Australian Piert	*Aphanes australiana*					2014	Rakali, 2014
Berry Saltbush	*Atriplex semibaccata*					2014	Rakali, 2014
Black Box	*Eucalyptus largiflorens*	WD				2014	Rakali, 2014
Black Roly-poly	*Sclerolaena muricata*				k	1997	DELWP, 2014
Bluish Raspwort	*Haloragis glauca f. glauca*	WD			k	2014	Rakali, 2014
Blushing Bindweed	*Convolvulus angustissimus*					2014	Rakali, 2014
Box Mistletoe	*Amyema miquelii*					2014	Rakali, 2014
Bristly Wallaby-grass	*Rytidosperma setaceum*					2014	Rakali, 2014
Bronze Bluebell	*Wahlenbergia luteola*					2014	Rakali, 2014
Broughton Pea	*Swainsona procumbens*					1997	DELWP, 2014
Brown-back Wallaby-grass	*Rytidosperma duttonianum*	WD				2014	Rakali, 2014
Common Blown-grass	*Lachnagrostis filiformis*	WD				2014	Rakali, 2014
Common Cotula	*Cotula australis*					2014	Rakali, 2014
Common Nardoo	*Marsilea drummondii*	WD				2014	Rakali, 2014
Common Sneezeweed	*Centipeda cunninghamii*	WD				2014	Rakali, 2014
Common Swamp Wallaby-grass	*Amphibromus nervosus*	WD				2014	Rakali, 2014
Common Wallaby-grass	*Rytidosperma caespitosum*					2014	Rakali, 2014
Common Wheat-grass	*Elymus scaber var. scaber*					1997	DELWP, 2014
Common Woodruff	*Asperula conferta*	WD				1997	DELWP, 2014
Corkscrew Spear-grass	*Austrostipa setacea*					2014	Rakali, 2014
Cotton Fireweed	*Senecio quadridentatus*					2014	Rakali, 2014
Daisy's	*ord. Asterales fam. Asteraceae*					1997	DELWP, 2014
Dense Crassula	*Crassula colorata*					2014	Rakali, 2014
Dwarf Bluebush	*Maireana humillima*					2014	Rakali, 2014
Frosted Goosefoot	*Chenopodium desertorum*					2014	Rakali, 2014
Fuzzy New Holland Daisy	*Vittadinia cuneata*					2014	Rakali, 2014
Gold Rush	*Juncus flavidus*	WD				2014	Rakali, 2014
Gold-dust Wattle	*Acacia acinacea s.l. (DS)*					2014	Rakali, 2014
Golden Wattle	*Acacia pycnantha (DS)*					2014	Rakali, 2014

Goodenia	*Goodenia spp.*	WD				1997	DELWP, 2014
Grassland Wood-sorrel	*Oxalis perennans*					2014	Rakali, 2014
Grey Copperburr	*Sclerolaena diacantha*					2014	Rakali, 2014
Grey Germander	*Teucrium racemosum s.l.*					2014	Rakali, 2014
Grey Mulga	*Acacia brachybotrya (DS)*					2014	Rakali, 2014
Grey Roly-poly	*Sclerolaena muricata var. villosa*					2014	Rakali, 2014
Grey Willow-herb	*Epilobium billardierianum subsp. cinereum*					2014	Rakali, 2014
Hairy Bluebush	*Maireana pentagona*					2014	Rakali, 2014
Jersey Cudweed	*Pseudognaphalium luteoalbum*					2014	Rakali, 2014
Knob Sedge	*Carex inversa*	WD				2014	Rakali, 2014
Knotty Spear-grass	*Austrostipa nodosa*					1997	DELWP, 2014
Lesser Joyweed	*Alternanthera denticulata s.l.*	WD				2014	Rakali, 2014
Narrow-leaf Dock	*Rumex tenax*	WD				2014	Rakali, 2014
Native Verbena	*Verbena officinalis var. gaudichaudii*	WD				2014	Rakali, 2014
Nodding Chocolate-lily	*Arthropodium fimbriatum*					2014	Rakali, 2014
Nodding Saltbush	*Einadia nutans subsp. nutans*					2014	Rakali, 2014
Oondoroo	*Solanum simile*					2014	Rakali, 2014
Pale Goodenia	*Goodenia glauca*	WD				2014	Rakali, 2014
Pale Spike-sedge	*Eleocharis pallens*	WD			k	2014	Rakali, 2014
Paper Sunray	*Rhodanthe corymbiflora*					1997	DELWP, 2014
Plains Everlasting	*Chrysocephalum sp. 1*					2014	Rakali, 2014
Plains Joyweed	*Alternanthera sp. 1 (Plains)*				k	2014	Rakali, 2014
Plump Spear-grass	*Austrostipa aristiglumis*					2014	Rakali, 2014
Prickly Saltwort	*Salsola tragus subsp. tragus*					2014	Rakali, 2014
Pussy Tails	*Ptilotus spathulatus f. spathulatus*					2014	Rakali, 2014
Raspwort	*Haloragis spp.*	WD				1997	DELWP, 2014
Red Water-milfoil	*Myriophyllum verrucosum*	WD				2014	Rakali, 2014
Rigid Panic	*Walwhalleya proluta*	WD				2014	Rakali, 2014
River Red-gum	*Eucalyptus camaldulensis*	WD				2014	Rakali, 2014
Rough Raspwort	*Haloragis aspera*	WD				2014	Rakali, 2014
Rough Spear-grass	*Austrostipa scabra*					2014	Rakali, 2014
Ruby Saltbush	*Enchylaena tomentosa var. tomentosa*					2014	Rakali, 2014
Rush	*Juncus spp.*	WD				1997	DELWP, 2014
Scented Mat-rush	*Lomandra effusa*					1997	DELWP, 2014
Silky Rice-flower	*Pimelea micrantha*					1997	DELWP, 2014
Slender-fruit Saltbush	*Atriplex leptocarpa*					2014	Rakali, 2014
Small Loosestrife	*Lythrum hyssopifolia*	WD				2014	Rakali, 2014
Small Monkey-flower	*Mimulus prostratus*	WD			r	2014	Rakali, 2014
Smooth Minuria	*Minuria integerrima*	WD?			r	1997	DELWP, 2014
Southern Cane-grass	*Eragrostis infecunda*	WD				2014	Rakali, 2014
Spear Grass	*Austrostipa spp.*					1997	DELWP, 2014
Spider Grass	*Enteropogon acicularis*					2014	Rakali, 2014
Spiny Lignum	*Muehlenbeckia horrida subsp. horrida*	WD			r	1997	DELWP, 2014
Spreading Goodenia	*Goodenia heteromera*	WD				2014	Rakali, 2014
Stalked Plover-daisy	*Leiocarpa websteri*					1997	DELWP, 2014
Sticky Hop-bush	*Dodonaea viscosa (DS)*					2014	Rakali, 2014
Tall Fireweed	*Senecio runcinifolius*	WD				2014	Rakali, 2014
Tangled Lignum	*Duma florulenta*	WD				2014	Rakali, 2014
Tussock Grass	*trib. Poeae gen. Poa*					1997	DELWP, 2014
Umbrella Wattle	*Acacia oswaldii (DS)*					2014	Rakali, 2014
Variable Sida	*Sida corrugata*					2014	Rakali, 2014
Wallaby Grass	*Danthonia s.l. spp.*					1997	DELWP, 2014
Willow Wattle	*Acacia salicina (DS)*					2014	Rakali, 2014
Wingless Bluebush	*Maireana enchylaenoides*					2014	Rakali, 2014
Woolly New Holland Daisy	*Vittadinia gracilis*					2014	Rakali, 2014
Yellow Twin-heads	*Eclipta platyglossa*	WD				2014	Rakali, 2014
Invasive species							
African Box-thorn	*Lycium ferocissimum*					2014	Rakali, 2014
Barley	*Hordeum vulgare s.l.*					1997	DELWP, 2014
Barley-grass	*Critesian murinum s.l.*					2014	Rakali, 2014
Bearded Oat	*Avena barbata*					2014	Rakali, 2014
Black Nightshade	*Solanum nigrum s.s.*					2014	Rakali, 2014
Bulbous Meadow-grass	*Poa bulbosa*					2014	Rakali, 2014
Burr Medic	*Medicago polymorpha*					2014	Rakali, 2014
Cape weed	*Arctotheca calendula*					1997	DELWP, 2014
Clover	*Trifolium spp.*					1997	DELWP, 2014
Cluster Clover	*Trifolium glomeratum*					2014	Rakali, 2014
Common Heron's-bill	*Erodium cicutarium*					2014	Rakali, 2014
Common Peppercress	*Lepidium africanum*					2014	Rakali, 2014
Common Sow-thistle	*Sonchus oleraceus*					2014	Rakali, 2014
Common Vetch	*Vicia sativa*					2014	Rakali, 2014

Curled Dock	*Rumex crispus*					2014	Rakali, 2014
False Brome	*Brachypodium distachyon*					2014	Rakali, 2014
Golden Thistle	*Scolymus hispanicus*					2014	Rakali, 2014
Great Brome	*Bromus diandrus*					2014	Rakali, 2014
Hairy Fiddle-neck	*Amsinckia calycina*					1997	DELWP, 2014
Hare's-foot Clover	*Trifolium arvense var. arvense*					2014	Rakali, 2014
Horehound	*Marrubium vulgare*					1997	DELWP, 2014
London Rocket	*Sisymbrium irio*					2014	Rakali, 2014
Mediterranean Turnip	*Brassica tournefortii*					2014	Rakali, 2014
Narrow-leaf Clover	*Trifolium angustifolium var. angustifolium*					2014	Rakali, 2014
Oat	*Avena sativa*					2014	Rakali, 2014
Onion Grass	*Romulea rosea*					2014	Rakali, 2014
Ox-tongue	*Helminthotheca echioides*					2014	Rakali, 2014
Paradoxical Canary-grass	*Phalaris paradoxa*					2014	Rakali, 2014
Perennial Rye-grass	*Lolium perenne*					1997	DELWP, 2014
Prickly Lettuce	*Lactuca serriola*					2014	Rakali, 2014
Prostrate Knotweed	*Polygonum aviculare s.l.*					2014	Rakali, 2014
Rat's-tail Fescue	*Vulpia myuros*					2014	Rakali, 2014
Red Brome	*Bromus rubens*					2014	Rakali, 2014
Red Sand-spurrey	*Spergularia rubra s.l.*					1997	DELWP, 2014
Smooth Cat's-ear	*Hypochaeris glabra*					2014	Rakali, 2014
Soft Brome	*Bromus hordeaceus subsp. hordeaceus*					1997	DELWP, 2014
Spear Thistle	*Cirsium vulgare*					2014	Rakali, 2014
Wild Oat	*Avena fatua*					1997	DELWP, 2014
Wild Sage	*Salvia verbenaca*					2014	Rakali, 2014
Wimmera Rye-grass	*Lolium rigidum*					2014	Rakali, 2014
Jesse Swamp							
Native species							
Blushing Bindweed	*Convolvulus angustissimus*					2014	Rakali, 2014
Bristly Wallaby-grass	*Rytidosperma setaceum*					2014	Rakali, 2014
Brown-back Wallaby-grass	*Rytidosperma duttonianum*	WD				2014	Rakali, 2014
Buloke	*Allocasuarina luehmannii*					2014	Rakali, 2014
Buloke Mistletoe	*Amyema linophylla subsp. orientale*				v	2014	Rakali, 2014
Clammy Goosefoot	*Chenopodium pumilio*	WD				2014	Rakali, 2014
Common Blown-grass	*Lachnagrostis filiformis*	WD				2014	Rakali, 2014
Common Nardoo	*Marsilea drummondii*	WD				2014	Rakali, 2014
Common Sneezeweed	*Centipeda cunninghamii*	WD				2014	Rakali, 2014
Common Spike-sedge	*Eleocharis acuta*	WD				2014	Rakali, 2014
Common Swamp Wallaby-grass	*Amphibromus nervosus*	WD				2014	Rakali, 2014
Common Wallaby-grass	*Rytidosperma caespitosum*					2014	Rakali, 2014
Cotton Fireweed	*Senecio quadridentatus*					2014	Rakali, 2014
Creeping Knotweed	*Persicaria prostrate*	WD				2014	Rakali, 2014
Finger Rush	*Juncus subsecundus*	WD				2014	Rakali, 2014
Flat Spurge	*Chamaesyce drummondii*					2014	Rakali, 2014
Gold Rush	*Juncus flavidus*	WD				2014	Rakali, 2014
Grassland Wood-sorrel	*Oxalis perennans*					2014	Rakali, 2014
Hairy Willow-herb	*Epilobium hirtigerum*					2014	Rakali, 2014
Harlequin Mistletoe	*Lysiana exocarpi*					2014	Rakali, 2014
Jersey Cudweed	*Pseudognaphalium luteoalbum*					2014	Rakali, 2014
Marbled Marshwort	*Nymphoides spinulosperma*	WD		L	e	2014	DELWP, 2014
Narrow-leaf Dock	*Rumex tenax*	WD				2014	Rakali, 2014
Plump Spear-grass	*Austrostipa aristiglumis*					2014	Rakali, 2014
Poison Pratia	*Lobelia concolor*	WD				2014	Rakali, 2014
Quena	*Solanum esuriale*					2014	Rakali, 2014
Rigid Panic	*Walwhalleya proluta*	WD				2014	Rakali, 2014
Small Knotweed	*Polygonum plebeium*	WD				2014	Rakali, 2014
Southern Cane-grass	*Eragrostis infecunda*	WD				2014	Rakali, 2014
Spider Grass	*Enteropogon acicularis*					2014	Rakali, 2014
Spreading Crassula	*Crassula decumbens var. Decumbens*					2014	Rakali, 2014
Spurred Spear-grass	*Austrostipa gibbosa*					2014	Rakali, 2014
Tangled Lignum	*Duma florulenta*	WD				2014	Rakali, 2014
Variable Sida	*Sida corrugata*					2014	Rakali, 2014
Wiry Dock	*Rumex dumosus*					2014	Rakali, 2014
Woolly New Holland Daisy	*Vittadinia gracilis*					2014	Rakali, 2014
Invasive spercies							
Annual Beard-grass	*Polypogon monspeliensis*					2014	Rakali, 2014
Barley	*Hordeum vulgare s.l.*					2014	Rakali, 2014
Barley-grass	*Critesian murinum s.l.*					2014	Rakali, 2014
Bearded Oat	*Avena barbata*					2014	Rakali, 2014
Big Heron's-bill	*Erodium botrys*					2014	Rakali, 2014

Cape Weed	*Arctotheca calendula*					2014	Rakali, 2014
Common Peppercress	*Lepidium africanum*					2014	Rakali, 2014
Common Sow-thistle	*Sonchus oleraceus*					2014	Rakali, 2014
Creeping Heliotrope	*Heliotropium supinum*					2014	Rakali, 2014
Curled Dock	*Rumex crispus*					2014	Rakali, 2014
False Brome	*Brachypodium distachyon*					2014	Rakali, 2014
Great Brome	*Bromus diandrus*					2014	Rakali, 2014
Hare's-foot Clover	*Trifolium arvense var. arvense*					2014	Rakali, 2014
Horehound	*Marrubium vulgare*					2014	Rakali, 2014
Knotted Clover	*Trifolium striatum*					2014	Rakali, 2014
Lucerne	*Medicago sativa subsp. sativa*					2014	Rakali, 2014
Narrow-leaf Clover	*Trifolium angustifolium var. Angustifolium*					2014	Rakali, 2014
Onion Grass	*Romulea rosea*					2014	Rakali, 2014
Ox-tongue	*Helminthotheca echioides*					2014	Rakali, 2014
Paddy Melon	*Cucumis myriocarpus subsp. Leptodermis*					2014	Rakali, 2014
Paradoxical Canary-grass	*Phalaris paradoxa*					2014	Rakali, 2014
Prickly Lettuce	*Lactuca serriola*					2014	Rakali, 2014
Prostrate Knotweed	*Polygonum aviculare s.l.*					2014	Rakali, 2014
Rough Sow-thistle	*Sonchus asper s.l.*					2014	Rakali, 2014
Small-flower Mallow	*Malva parviflora*					2014	Rakali, 2014
Soft Brome	*Bromus hordeaceus subsp. Hordeaceus*					2014	Rakali, 2014
Spear Thistle	*Cirsium vulgare*					2014	Rakali, 2014
Squirrel-tail Fescue	*Vulpia bromoides*					2014	Rakali, 2014
Stemless Thistle	*Onopordum acaulon*					2014	Rakali, 2014
Trailing Verbena	*Verbena supine*					2014	Rakali, 2014
Water Couch	*Paspalum distichum*					2014	Rakali, 2014
Wimmera Rye-grass	*Lolium rigidum*					2014	Rakali, 2014

Appendix 6: Engagement Outcomes

Community and stakeholder consultation meeting No. 1: data gathering

9 May 2014- Donald Community Centre (5-7.30 pm)

Attendees:

Name	Representative
Julie Slater (Chair)	North Central CMA Board member and local community representative
Andrea Keleher	DELWP
Kym Wilson	GWMWater
Rob Loats	North Central CMA NRMC member and local community representative
Greg Nunn	Field and Game and local community representative
Liz Russell	local community representative and member of Donald and District Landcare Group
Ann Dustan	local community representative, member of the Donald and District Landcare Group and former NRMC member
Trevor Campbell	local community representative, member of the Donald and District Landcare Group and Waterwatch volunteer
Leo Tellefson	local community representative and Shire of Buloke Counsellor
Adam Campbell	local community representative with property bordering Jeffcott Wildlife Reserve
Lindsay Ezard	Consultant and community member from St Arnaud
Neil and Sue Davis	private dam owner, President (Neil) of Donald and District Landcare Group
Keith and Helen Barber	private dam owner and members of Birchip Landcare Group
David Falla	private dam owner and Chairman of Donald and District Landcare Group
Bree Bisset (facilitator)	North Central CMA

Overall project comments

- Aim of project was to compensate for dams that were to be closed down due to pipeline.
- Pipeline dams/wetlands were to ensure sufficient water in the landscape for fauna (either directly or indirectly)

Creswick Swamp

History:

- Creswick's Well constructed by the Creswick Brothers in 1866 and is about 20 feet deep (6 metres)
- Dam was constructed after the well as a means of collecting catchment runoff
- Trees on the southern (and possibly northern) boundary was planted in 1989 by Marnoo Landcare (non-indigenous species planted through the Tree Victoria Grant)
- Wetland filled in 1995 and in the 2011 floods
- Area considered to be 'pretty poor country' and historical was not a favorable location for farming.

Environmental values:

- Site known to support brolga when inundated
    - 12 pairs photographed by Ken Newell (unknown date)
    - Returning pair are not considered a breeding pair
    - Pair also utilise the Cope Cope Lakes area
- Wetland is noted to support the significant Turnip Cooperburr
- Brown Quail also noted to inhabit the area (and is the subject of hunting)

Social and cultural values:

- Yabbying and duck hunting
- Possibly tourism due to Creswick's Well historical marker (Creswick Well is also depicted in a mural in Marnoo and is important to local community)
- site of first settlement in the region (i.e. Creswick's Well)

- Close to cemetery where Creswick brothers are buried (European heritage)

Threats and risk:

- Rising regional groundwater - capillary action could impact on area when dam dries
- Illegal banks- many banks are constructed in the area (including the swamp) to control flow of surface water. This as well as the removal of the open cut channel will impact on the hydrology of the area (info may be available in Marnoo area flood studies)
- Foxes- threat to wildlife including waterbirds. Fox shooting undertaken regularly by landholders in area
- Illegal rubbish dumping in the reserve
- Weeds- i.e. Ox Tongue
- Hares- the area is 'hare country' and rabbits are not as much of a problem
- Risk that some species may over populate (i.e. grebes) due to the removal of other open water in the landscape

Management objectives:

- The wetland itself would have undergone wetting and drying cycles naturally, caused by catchment runoff and flooding in the river.
- The wetland/dam will now provide a landscape link to other wetlands/dams in the region and is therefore integral for connection between the river and the York Plains.
- The wetland/ dam should function as a watering point and landscape refuge (drought and dry weather) as there is now a lack of open water in the landscape.
- If the river isn't running the closest large body of water is approximately 5 kilometres away in Marnoo
- The isolated nature (i.e. lack of houses etc.) of the wetland reduces the risk of fauna being spooked
- Watering of the dam would be most effective when the region is dry (i.e. river, York Plains etc.) and there is a need for open water in the landscape.

Follow up:

- Speak to Bob Anderson and Charlie Newell (Ken Newell for brolga photo)
- Ask Anne for title of Creswick Well history book
- Ask Trevor for 1995 flooding aerial footage
- Check Marnoo Flood studies
- Did Major Mitchell go through area?

<u>Jesse Swamp</u>

History:

- Helen grew up in the area and the property was originally owned by her father
- Dam (and swamp) have been present for as long as Helen's father can remember
- Historically the wetland was full most of the time and receives water naturally via a chain of wetlands in the area (water now crosses Banyena road)
- There is also a dam located on the other side of the road and a smaller swamp (neither of these areas are fences off from grazing)
- Swamp is a shallow open grassland
- Wetland filled in 2011-12 during floods
- The wetland never received water from the open cut channel.
- Originally a dam located near to the swamp was nominated, however pipeline was too far away. The swamp dam was considered an alternative option.

Environmental values:

- Waterbirds numbers were always high at Jesse Swamp
    - Long history of brolga utilise the area:
        - Use to eat sheep grain in neighboring paddocks

        - Bred in 1980s
        - For two consecutive years they attempted to nest on the roadside after the fence was constructed (fence design was mindful of brolga)
        - Brolga continued to return for a few weeks at a time each year up until about 2-3 years ago
    - Swan nests noted in the past
    - 20 egrets noted feeding in the swamp in September 2011 (after floods)
    - Spoonbills and a variety of ducks frequent site when inundated
- Buloke trees fringe the wetland area- these are fully fenced off from sheep
- The wetland contains some reeds as well as open plains areas
- Whole swamp area is fenced off and is not grazed (this was undertaken approximately 15-20 years ago)
- A number of tree plantings have been undertaken by the Barber's close to the swamp area
- Kangaroos often utilise the open plains area of the swamp.

Social and cultural values:

- Popular talking point for locals travelling along Banyena Road
- Helen has received multiple phone calls during inundation periods, advising her of the condition of the wetland.

Threats and risk:

- Hunting- the wetland has a number of no shooting sign present
- Lack of water- i.e. loss of refuge in area due to changed farming practices, construction and now removal of open cut channel etc.
- Foxes and cats (rabbits are not considered a major issue to lack of cover at the wetland)

Management objectives:

- Overtopping to provide some benefit to wetland area would be beneficial for waterbirds
- Wetland provides landscape connectivity and refuge for waterbirds moving through the landscape (i.e. pelicans noted there previously)
- Wetland has supported waterbird breeding in the past (over topping dam may provide enough of a trigger)
- Filling in winter is a better use of water at Jesse Swamp as the soil profile will already be moist

Other:

- The Barber's are keen to pay for a flora and fauna study once water has been delivered to the wetland
- The Barber's are hoping to do more work with their local Landcare group on the property
- Dam is very shallow and has silted up- should be made about 4-5 feet deeper to hold water for longer

Jeffcott Wetland

History:

- The dam was originally utilised for house supply and was also part of the open channel system. This ceased when the pipeline was connected to the property.
- The wetland/dam was filled via catchment runoff through the 1970s. In 1972 the dam was not visible due to the water level in the swamp
- The dam was cleaned out in 2001 during the drought
- The dam has a heavy clay and holds water well
- The dam has remained inundated for most of the surrounding landholders memory
- Planting has been undertaken in the reserve area (direct seeding etc.)
- The dam and wetland filled during the 2011 floods
- Historically due to the position of the dam in the landscape and the number of channels directing water towards it, the dam received a lot of the catchment runoff. It is unknown how much water the dam will now receive with the removal of the open channel system.

Environmental values:

- The area has a number of habitat linkages (i.e. remnant patches/roadside vegetation). There are also a number of wildlife ponds in the immediate area.
- Wedge tail eagles have been seen at the swamp.
- Goanna's also noted to utilise the area
- Reserve noted to have some of the best native vegetation in the Buloke Shire (understory and overstorey)
- A variety of woodland and waterbird species utilise the reserve and dam area
- Bats noted to utilise the woodland area

Social and cultural values:

- A number of scar trees and middens noted in the reserve.

Threats and risk:

- Previously noted to contain a Class 1 noxious weed- however no one has seen it on the reserve (is however located further up the road)
- Boxthorn is a major issue.
- Rabbits- numbers reduced immediately after the floods but have now recovered. Difficult to manage as so much cover in the reserve.
- Foxes- predate on fauna (i.e. turtles)

Management objectives:

- The dam holds water well and is unlikely to require top ups each year.
- The wetland provides an important permanent refuge spot
- During fill times, water in the feeding channel also provides benefits to surrounding trees.

Falla Dam

History:

- Last time the wetland was cleaned it was about 17 foot deep (5 metres)
- Dam has been fenced off from more than 10 years now
- David plans to fill another dam (approximately 3 kilometres away) with his own water and also had a small frog pond less than 1 kilometre from the dam
- David originally nominated a different site; however it was too far away from the pipeline.

Environmental value:

- House yard (to north) has a lot of native vegetation and supports woodland birds that also utilise the dam.
- Every year northern water hens (to confirm) utilise the dam
- There is some planted vegetation around the dam
- David has added a number of logs to increase habitat diversity of the dam
- Grebes have nested in the dam
- Shelducks often seen feeding

Social and cultural value:

- None noted

Threats and risk:

- Cats are an issue in the area
- Weeds such as Ox Tongue
- The dam is located in close proximity to a house and the road, however the elevated lunettes of the dam bank provides protection

Management objectives:

- The dam holds water extremely well and would not require water each year
- Birds often use it for feeding and provides an important watering point in the landscape

Other:

- David will be planting other species around the dam (i.e. creeping salt bush to help reduce dust)

Corack Lake

History:

- Bore pipe approximately 300 metres under the road to get to the site
- Wetland noted to flood in 1941 (newspaper article)

Environmental value:

- Lots of ducks utilise the site
- Bats noted to utilise the woodland area

Social and cultural value:

- Utilised for hunting, picnicking, yabbying, camping fishing, swimming and water skiing.

Threats and risk:

- Ducking hunting is permitted
- Landholder extracting water from the back dam- Lindsay noted that the landholder checks the dam nightly
- Boxthorn and peppercorn trees
- Rabbits

Management objectives:

- Investigate options to connect small and larger dam to provide benefit to both.

Follow up:

- Follow up extraction from back dam

Davis Dam

History:

- The dam is very old and would have been constructed during selection times
- The swamp (33 hectare) is shallow and does not fill regularly. It did fill during the 2010-11 floods and held water for about a year thereafter.
- There is also a small cane grass swamp on the property which fills more regularly
- There are a number of lunettes on the property which direct water into the swamp
- The dam (about 0.5 ML in volume) is used to drain water off the swamp. When inundated, it does not hold water for long.
- The area has been fenced off since the 1980s and has a Trust for Nature Covenant. The fencing now required upgrading.
- The dam was not connected to the previous open supply channel.

Environmental value:

- Lots of tree hollows for woodland birds
- Good intact groundstory which has not be invaded by introduced grasses
- A number of native plants have been planted by the landholder
- Lots of box trees which have recruited after the floods (probably looking a bit dry however)
- Chariot Wheels noted to occur
- Some bird breeding noted

Social and cultural values:

- Likely to be scar trees located within the property
- The area has a lot of cultural heritage noted (i.e. in paddocks)

Threats and risk:

- Hunting
- Kangaroos- the area is currently infested with 33 kangaroos
- Buloke are under stress
- Foxes
- Boxthorn
- Fire (the paddock came close to burning in 2013)
- Farming practices in the area- i.e. introduction of exotic species etc.

Management objectives:

- The area is isolated and provides refuge for wildlife
- The nearest swamp about 2-3 kilometers away and there are a number of catchment dams. The Mallee also has a watered wetland about 5 kilometers away.

Chirrup Swamp

History:

- The wetland is shallow and does not hold water for long due to cane grass

Environmental values:

- Cane grass is rare- noted to be in pretty good condition and is supported by rainfall and some catchment runoff
- Goanna's and Brown quail often seen
- Red Rumped Galah- use the wire mesh in the dam (old fence line) to drink from
- Magnificent spot for waterbirds when inundated
- Some of the best remnant vegetation in the area
- Old nests within cane grass in the swamp (i.e. black swan)
- Bats noted to utilise the woodland area

Social and cultural values:

- Yabbying, camping (lots of people stop there)
- Lots of cultural heritage in the area

Threats and risk:

- Rabbits
- Boxthorn
- Use to be deer but haven't seen them in years
- Dog prints- hunting?
- Rubbish dumping- i.e. campers and fire pit rubbish (could get 'loved to death')

Management objectives:

- There a quiet a few catchment dams and wildlife ponds in the area (due to active Landcare group)
- Area gets good runoff and would probably not require top-ups each year

Other:

- Currently about half full
- Suggested the need for signage asking for visitors to take their rubbish with them

Follow up:

- Discuss with Leo who camps at site.

Additional community comments

- There is extremely concerned about the lack of sites and the number of gaps in the landscape (for example few sites in Wycheproof area or between Donald and Jesse Swamp)
- The general community believed that the process was run by the Mallee CMA and that the North Central CMA should have held workshops to collate the connection list.

- The community is very unhappy that 1,000 ML entitlement cannot be secured (i.e. Lack of water in most years due to allocations) particularly because the Wimmera River is flowing.
  Community is also unhappy with the size of the pipeline.
- Community would like to press for more environmental water and more connections
- Community would like CMA to organize a workshop to scope sites to be put up should additional funding become available.
- Box Swamp should be added to the list.

Community and stakeholder consultation meeting No. 2: ecological objectives and watering regimes

11 December 2014- Donald Community Centre (5-7.30 pm)

Attendees:

Name	Representative
Julie Slater (Chair)	North Central CMA Board member and local community representative
Chloe Wiesenfeld	VEWH
Kym Wilson	GWMWater
Rob Loats	North Central CMA NRMC member and local community representative
Liz Russell	Local community representative, member of the Donald and District Landcare Group
Anne Dustan	Local community representative, member of the Donald and District Landcare Group and former NRMC member
Trevor Campbell	Local community representative, member of the Donald and District Landcare Group and Waterwatch volunteer
Neil and Sue Davis	Private dam land owner, President (Neil) of Donald and District Landcare Group
David Falla	Private dam owner and Chairman of Donald and District Landcare Group
Amy Russell	North Central CMA
Bree Bisset (facilitator)	North Central CMA

Purpose of workshop

- Recap on work undertaken thus far and steps required to finalise EWMP
- Outlined that dams are the focus of environmental watering due to capacity constraints and wetland size (watering of the wetland bed possible at some sites)
- Explained that ecological objectives and flow regimes will undergo expert review- any changes will be communicated back to the Community Advisory Group prior to the completion of the EWMP
- Overview of EWMP document structure and content and focal points for meeting

Complex overview

- **Values:** Summary of values including- Watering points in a dry landscape, patches of remnant vegetation (i.e. many within Wildlife Reserves), recreational, cultural, social and economic benefits.
- **Current condition and threats: Summary of factors that have impacted condition including l**oss of open water and remnant vegetation in the landscape through a history of hydrological change (i.e. Past history- River regulation, construction of channels, levees and dams, recent history-decommissioning of open channel network and construction of Wimmera Mallee Pipeline). If no environmental water supply there is the potential for a crash in biodiversity at both the local and landscape scale.
- **Management goal:** Maintain a spread of open water in the landscape to provide refuge, shelter, watering points and feeding opportunities for waterbirds, turtles, frogs and terrestrial fauna species in the region
- **Ecological objectives:** Re-establish a spread of water in the landscape and provide watering point for terrestrial species
- **Watering regime:** Achievement of objectives and goal is reliant on strategic management of individual sites within the complex. Therefore water regimes are set at the site specific scale to achieve individual site management goals and objectives and to contribute to the larger overarching complex goal

Creswick Swamp

- **Current condition and values:**
  - Wetland:
    - Half of wetland lost to farmland
    - Road dissects wetland into two components- Road is also at the same height as the wetland = almost immediate flooding upon low level flooding
    - Diversity of plants including Marbled Marshwort (threatened) and historical feeding and breeding site for brolga- sanctioned as a Wildlife Reserve and listed under the Directory of Important Wetlands in Australia
  - Dam:
    - Moderately steep banks = limited potential for natural regeneration
    - Good aquatic plant diversity= able to support frogs, turtles, macroinvertebrates, generalist duck species
    - Low fringing diversity = low cover for more cryptic species (increased risk of predation by foxes)
    - Low potential to overtop- flood risk requires adaptive management to ensure not impact to private land or public infrastructure (i.e. road). The construction of a levee alongside the road would mitigate the flood risk and improve ecological benefit of environmental watering (by increasing the depth of inundation)- currently no funding for work
- **Management goal:** Support a diversity of aquatic plants, including re-establishment of Marbled Marshwort, that will provide refuge, feeding and breeding opportunities for frogs and turtles at Creswick Dam
- **Ecological objectives:** Maintain high diversity of aquatic plants, increase diversity of littoral vegetation (i.e. emergent vegetation), re-establish Marbled Marshwort in dam and maintain frog and turtle breeding and feeding opportunities
- **Proposed watering regime:** Permanent regime with variability (overtop 7 in every 10 years)
  - Overtop to a maximum of 20 cm and hold for up to 6 months (maximum)
  - Regime aimed at encouraging wetland plants to establish around boundary of the dam and encourage feeding waterbirds
  - Minimum depth of 1 metre to be maintained in dam to support turtle refuge
  - Under wet conditions (i.e. water in river)- inundation may not be required

Jesse Swamp

- **Current condition and value:**
  - Wetland:
    - Floods less frequently due to changes to the wetland catchment
    - High cover of exotic weeds due to surrounding farmland (highest for all WMP sites)
    - Moderate diversity of aquatic plants including Marbled Marshwort (threatened)
    - Historical feeding and breeding site for Brolga and Yellow-billed Spoonbill
  - Dam:
    - Shallow and gentle slopping banks- dam acts as an extension of the bed of the wetland
    - Potential to overtopping – risk of flooding private land is very small due to size and shape of wetland
    - Supports waterbirds (Brolga observed feeding at edges) and frogs
- **Management goal:** Promote native aquatic plant growth including re-establishment of Marbled Marshwort at Jesse Dam and provides shallow foraging habitat for waterbirds (including Brolga) and feeding opportunities for frogs
  - **Ecological objectives:** Increase cover and structural diversity of aquatic vegetation (particularly in the wetland area surrounding the dam), re-establish Marbled Marshwort in or surrounding dam, maintain/ increase frog feeding opportunities and increase waterbird feeding opportunities
- **Proposed watering regime:** Intermittent regime with a fill and overtop every 6 in 10 years

- Overtop to approximately 20 cm and hold for up to 5 months (maximum)- Dry by mid-summer to prevent water couch spread (only site with this species recorded)
- Regime aimed at supporting shallow foraging opportunities for waterbirds and to encourage reestablishment of wetland vegetation at boundary of dam (shallow depth supports a range of waterbirds that would not utilise the deeper dams)
- Not to be managed as a permanent refuge due to depth and low water holding capacity
- Under wet conditions- delivery as per above regime to reduce airspace required to be filled (= larger inundation for wetland area)

Jeffcott Wetland

- **Current condition and value:**
  - Wetland:
    - Half of wetland area lost to farmland
    - Deep dam catches majority of catchment runoff
    - Mixed vegetation quality (southern side poor, northern side healthy and intact)
    - Overtopping potential limited due to private land flooding
    - Excellent lignum and woodland area- supports reptiles and a range of waterbirds\
    - No grazing within reserve area for approximately 25 years
  - Dam:
    - Moderately sloping banks with high water holding capacity (due to depth)
    - Good abundance and diversity of aquatic and fringing vegetation
    - Highest diversity of water dependent species (compared to all of the Wimmera Mallee Pipeline Wetlands sites)
- **Management goal:** Maintain the diversity of aquatic plants and provide refuge and breeding conditions for water dependent species such as frogs, macroinvertebrates, turtles and waterbirds at Jeffcott Dam
- **Ecological objectives:** Maintain high diversity of aquatic plants, maintain turtle and frog feeding and breeding opportunities (largest turtle caught on site), maintain waterbird feeding and breeding opportunities and provide a watering point for terrestrials species
- **Proposed watering regime:** Permanent regime with variability
    - Fluctuations in water level aimed at cuing frog and waterbird breeding (i.e. rise in late winter/ spring)
    - Regime aimed at maintaining current aquatic assemblage and biota
    - Site would be considered a priority for environmental water during dry years due to its water holding capacity and high environmental value

Falla Dam

- **Current condition and value:**
  - Steepest banks and very deep- excellent water holding capacity
  - Due to shape, dam would benefit from the construction of benches and island
  - Low abundance of aquatic plants (other than those planted by landholder) and a range of generalist waterbirds utilised site
  - Located within a relatively dry landscape
  - Stock and domestic use in the past-supplied water to the adjacent chicken farm and farmhouse
- **Management goal**: Provide a watering regime that maintains Falla Dam as a watering point for terrestrial species and drought refuge for turtles and frogs during dry conditions.
- **Ecological objectives:** Increase aquatic vegetation diversity and abundance, increase frog and turtle feeding and breeding and provide a watering point for terrestrial species.
- **Proposed watering regime:** Permanent regime with variability
  - Regime aimed at maintain drought refuge (able to support water dependent and terrestrial species)
  - Fluctuations in water level aimed at cuing frog breeding (i.e. rise in late winter/ spring)

Chirrup Swamp

- **Current condition and value:**
  - Wetland:
    - Excellent physical form with rare Cane Grass bed- important for a range of waterbirds
    - Intact fringing Black Box woodland zone- supports a range of terrestrial threatened species
    - Low to moderate exotic species abundance
    - Large and unable to be influenced by overtopping of dam
  - Dam:
    - Low abundance and diversity of fringing and aquatic vegetation
    - This is evidenced by majority of macroinvertebrates belonging to predatory feeding groups
    - Poor morphology- steep banks and deep
    - Supports an abundance of frogs and turtles (however more adults then juveniles present)
    - May provide a sanctuary for frogs and turtles during dry phases in wetland- however lack of vegetation may not support breeding. This theory needs to be tested over a longer time period (i.e. ongoing monitoring) to assess if resources are insufficient for breeding.
- **Management goal:** To maintain Chirrup Dam as a refuge for water dependent fauna (particularly frogs and turtles) and provide a point source for recolonisation of Chirrup Swamp when it is naturally inundated
- **Ecological objectives:** Improve aquatic and littoral vegetation cover and diversity, increase turtle and frog breeding and feeding opportunities, increase diversity of macroinvertebrate functional group assemblages, maintain as a point source for recolonisation of nearby waterbodies and maintain as a watering point for terrestrial species.
- **Proposed watering regime:** Maintain permanent regime with variability
  - Regime aimed at maintain current assemblage and providing cues for frog and turtle breeding in the absence of flooding in the wetland
  - Maintenance of dam population should support recolonisation when Chirrup Swamp naturally floods
  - Site would benefit from complementary actions (i.e. benches and revegetation) to support a higher abundance and diversity of aquatic plants
  - The pros and cons of maintaining a population that may not be self-sufficient (i.e. breeding is not occurring) needs to be assessed when allocating limited water resources (i.e. during drought years) - however difficult to determine due to limited surveys to date.

Corack Lake

- **Current condition and value:**
  - Wetland:
    - Recruitment of River Red Gum evident post flooding
    - Good morphology with the exception of the larger dam (this captures a large proportion of the catchment runoff)
    - Good Black Box and River Red Gum fringe- supports a range of terrestrial species
    - Diversity of semi-aquatic and aquatic plants in bed of wetland
    - Dramatic change to channel system in this area of the catchment- wetland now likely to get less water
  - Dam:
    - Two dams- most with good aquatic vegetation and overtopping potential
    - One provides nursery habitat for juvenile turtles, other just supports adults
    - Larger dam has a pipe connected to it- Bree B to investigate whether water is still be extracted
    - Potential to overtop Corack Dam and providing low level inundation to bed of wetland to inundate larger dam from north-west corner
    - Depth in larger dam may be maintained by seepage from the smaller dam

- **Management goal:** Provide conditions that support an abundance of aquatic plants that promote refuge and nursery habitat for turtles and frogs and a variety of feeding condition
- **Ecological objectives:** Maintain/ increase cover and structural diversity of aquatic vegetation particularly in the wetland area immediately surrounding Corack Dam, maintain nursery habitat for juvenile turtles and frogs in Corack Dam, maintain permanent refuge conditions for turtles and frogs in Corack Dam No. 2, increase waterbird feeding opportunities and provide watering point for terrestrial fauna
- **Proposed watering regime:** Intermittent regime with annual fill of dam and overtop 5 in every 10 years
  - Regime aimed at supporting nursery habitat annually and re-filling permanent refuge as required
  - Regime will further encourage shallow foraging waterbirds to utilise inundated wetland area and promote aquatic plant growth
  - Discussed opportunities to save water through direct connection of the dams

Davis Wetland

- **Current condition and value:**
  - Wetland:
    - Main area of the land parcel original assessed as Plains Savanah (terrestrial vegetation community). Photographic evidence from landholder used to re-classify as Black Box Wetland and Cane Grass Wetland vegetation communities
    - Intact and diverse woodland zone (healthy and old Black Box and Buloke trees) with a high load of woody debris that supports (and has the potential to support) a range of threatened terrestrial species
    - Located within a dry area of the catchment
  - Dam:
    - Good morphology (i.e. shallow and gentle sloping banks)
    - Provides an important water source for the surrounding woodland fauna
    - Overtopping is possible due to shape and size of wetland area
    - Variety of waterbirds and terrestrial fauna observed utilising dam
    - Habitat value at Davis Dam is different to other sites (i.e. Jesse Swamp) because the site supports primarily terrestrial fauna. Landscape is also drier in north of catchment.
- **Management goal:** Support the surrounding Black Box vegetation of Davis Dam by providing drought refuge and a watering point for fauna (including mammals, reptiles and waterbirds)
- **Ecological objectives:** Increase aquatic and littoral vegetation, maintain waterbird feeding opportunities and provide a watering point for terrestrial species
- **Proposed watering regime:** Intermittent regime with an annual fill of the dam and an overtop every 3 in 10 years
  - Regime aimed at supporting fringing Black Box and maintaining key habitat feature for terrestrial fauna
  - Inundation of dam to occur until mid to late summer, to ensure that water is available through the highest risk period for fauna
  - Dam cannot be maintained permanent due to depth and water holding capacity- the dam will dry very quickly when temperatures rise

Season to season management

- Dams will be prioritised on a year to year basis based on proximity to other waterbodies, presence of significant water dependent species (i.e. Marbled Marshwort) or populations (i.e. self-sufficient turtle population vs. one with only adults present) and water holding potential (i.e. deep dams hold water better then shallow ones)
- Initial planning/ prioritisation will be undertaken by the North Central CMA and provided to the Victorian Environmental Water Holder (VEWH) as a recommendation in the Seasonal Watering Proposal. Final allocation of water is undertaken by the VEWH.

Risks and threats

- Changes to frequency, duration and extent of flooding (i.e. water couch spread, changes to wetland type, over colonisation of River Red Gum etc.)- actions include manipulation of water regime (i.e. drying) to reduce optimal growth conditions

- Inability to sustain water levels if waterbird breeding event is triggered (i.e. providing shallow freshwater marsh conditions at Corack Lake instead of natural deep freshwater marsh conditions) - actions include monitoring aimed at early detection of waterbird breeding behavior. NOTE: Unlikely to occur as depth and duration likely to be insufficient to trigger event.
- Motor vehicle accident (i.e. increased use of sites by kangaroos) - actions include road signage. NOTE: unlikely to occur as ample water troughs in landscape
- Stock access and grazing pressure (i.e. both exotic and native)- actions include repair to fences, compliance monitoring by Parks Victoria
- Introduced species (i.e. carp, foxes and rabbits)- actions include exotic fauna control works
- Lack of vegetated corridors- actions include seeking funding for roadside revegetation works
- Chytrid fungus (i.e. terminal amphibian disease) - currently no cure for disease.

Other

- GMW covers cost of delivery charges with 15% of carried over water lost
- Discussion regarding GWMWater position on subsidizing water prices for farmers who wish to utilise a portion of their entitlement for environmental use. Discussed David Falla utilising his own entitlement for watering of private dams on his own property. Landcare group to write letter GWMWater regarding this query
- Draft EWMP to be distributed with minutes- comments due by COB 2 January 2015.

Barenji Gadjin Land Council Field Trip

7 May 2015 at Jeffcott Wetland, Chirrup Swamp, Corack Lake and Davis Dam

Attendees:

Name	Representative
Darren Griffin	Barengi Gadjin Land Council RAP Manager
Bree Bisset (facilitator)	North Central CMA
Amy Russell	North Central CMA

Jeffcott Wetland

- Scar on trees are a mix of small canoe and bowl/dish slabs (utilise to carry resources either by foot or when wading through water) as well as larger shelter slabs
- Bark extraction was undertaken between October and November (mostly likely in the morning) when conditions were the perfect mix of wet and warm. An axe was used to cut a rectangle around the desired section of bark before plying it away from the body of the tree using sticks and other tools.
- Aboriginal people would have resided at this site for months at a time due to the depth and water holding capacity. When conditions dried, groups would have moved to other sites in the area.
- Green stone and steel axe marks present. It is likely that steel was traded into the area around the 1860s.
- Quartz artefacts noted at the north boundary of the wetland. These have been exposed by the construction of a motorcycle track through section of this part of the reserve. Quartz was used for a variety of purposes including the construction of knives as well as spear heads.

Chirrup Swamp

- Due to the shallow nature of the wetland it is likely that it was exploited opportunistically and on a temporary basis.

Corack Lake

- The depth of Corack Lake and its water holding ability would suggest that the wetland was utilised on a more permanent basis. Aboriginal people would have constructed shelters on the wetlands lunette.
- Evidence of quartz artifacts noted.

Davis Dam

- Six scar trees noted at the site during the field visits including both small canoe and shelter slab scars
- Both steel and stone axe marks noted at the site.

Appendix 7: Distribution of Traditional Owner Groups

Source: Derived from Horton, 1994 as cited in White et al., 2003

Appendix 8: Water Requirements for Values

Key values	Example spp. present	Example site	Broad requirements		
			Habitat	Breeding	Water requirements
Water dependent fauna					
Dabbling ducks	Grey Teal Pacific Black Duck	Chirrup Swamp and Jeffcott Wetland	• Seasonal to permanent wetlands with fringing vegetation and open water • filter-feeder in open water or soft mud-primarily on insects, macros an some plant material • rest amongst dense vegetation or on deep open water	• stimulated by flooding and/or season and breed between June-Feb (3-4 month breeding duration) • ideally require flood duration 5-9 months	• Flood required ideally in winter/spring to stimulate breeding • Inundation to be maintained for up to 9 months although permanent conditions are preferred • Fringing vegetation and open water required
	Australasian Shoveler	Chirrup Swamp			
Fish eating waterbirds	Australasian Grebe	Chirrup Swamp, Corack Swamp, Creswick Swamp and Jeffcott Wetland	• Observed at a range of habitat types (including shallow and deep) • Forage in open areas for fish, macros, insects, frogs and some plant material • Roost beside or in wetlands	• Stimulated by flooding/ season and usually breed between Aug- Oct (3 month breeding duration) or Oct-May (3-4 month duration) for Egrets • Ideally require flood duration of 8-10 or 6-12 months for egrets at depth.	• Flood required in spring to stimulate breeding • Sufficient littoral vegetation and open water required
	White-faced Heron	Chirrup Swamp, Corack Swamp and Creswick Swamp			
	White-necked Heron	Chirrup Swamp and Davis Dam			
	Egrets	Corack Lake			
Grazing waterfowl	Australian Wood Duck	Chirrup Swamp, Creswick Swamp, Davis Dam and Jeffcott Wetland	• Observed in a range of habitats although prefer deep permanent wetlands with fringing vegetation and surrounding grassland and/or woodland for foraging • Forages amongst short grass, herbs, emergent vegetation or on aquatic plants at edge • Some species nest in tree hollows whilst others utilise open banks (will abandon nest if threatened by floodwater)	• Stimulated by rainfall/ season and usually breed between July-Dec or Sept-Jan for Plumed Whistling Duck (4 month breeding duration) • Ideally require flood duration of 5-8 months	• Flood required in winter/spring to stimulate plant growth and breeding • Inundation to be maintained for up to 8 months although permanent conditions are preferred • Fringing woodland/grassland areas preferred for foraging • Greater breeding success report following drying cycles
	Australian Shelduck	Davis Dam, Chirrup Swamp, Jesse Swamp			
	Plumed Whistling Duck	Chirrup Swamp			
Shoreline foraging waterbirds	Masked Lapwing	Chirrup Swamp, Corack Lake and Jeffcott Wetland	• Considered opportunistic and are observed in a range of habitats • prefer dense clumps of vegetation, reeds or sparsely wooded areas for roosting and nesting (will however abandon nest if flooded) • Forage at edge of wetlands amongst emergent vegetation and mud • Diet consists of plant material, insects, frogs, lizards other birds, eggs and	• Stimulated by flood/rainfall/season and usually breed between July-Dec (for up to 3 months duration) • Ideally require flood duration of more than 4 months	• Flood required in winter/spring to stimulate breeding • Inundation to be maintained for up to 4 months • Changes in water depth create foraging opportunities at water edge.
	Black-tailed Native Hen Purple Swamphen	Chirrup Swamp			
	Dusky Moorhen	Jeffcott Wetland			
	Eurasian Coot	Jesse Swamp			

Key values	Example spp. present	Example site	Broad requirements		
			Habitat	Breeding	Water requirements
			small mammals. • Opportunistic breeding		
Small wading waterbirds	Black-fronted Dotterel	Chirrup Swamp and Corack Lake	• Frequents shallow open wetlands predominately with exposed margins • Roost in shallow water and on banks • Forage in shallow water or on muddy margins • Nest on ground and breed in range of habitat types including grassy banks, sedges, rushes, driftwood, fallen timber etc. • Diet consists of invertebrates and occasional seeds and other vegetation matter.	• Stimulated by flood and/or season and breed between Aug-Jan (2-3 month breeding duration) • Ideally require up to 6 months of inundation	• Flood required in late winter/spring to stimulate breeding • Inundation to be maintained for up to 6 months • Changes in water depth create foraging opportunities at water edge. • Require surrounding vegetation for food and shelter
	Black-winged Stilt Red-kneed Dotterel	Chirrup Swamp			
Deep water foraging waterbirds	Black Swan	Chirrup Swamp	• Exhibits preference for large open water with abundant aquatic vegetation • Forage in shallow or deep open water or wetland margins with exposed mudflats • Black Swan commonly breeds at ephemeral wetlands and build nest in shallow water whilst Hardhead prefers to construct nests within dense vegetation • diet consisting of aquatic plants and some aquatic animals	• Stimulated by flood/season and breed between April-Oct for Black Swan (7-8 month breeding duration) and Aug-Dec for Hardhead (3-5 month breeding duration) • Ideally require 5-9 months of inundation	• Flood required between April-Dec (depending on species) to stimulate breeding • Inundation to be maintained for up to 9 months • Good aquatic vegetation required.
	Hardhead*	Jeffcott Wetland			
Large wading waterbirds	Yellow-billed Spoonbill	Chirrup Swamp	• Preference for shallow swamps with abundant aquatic flora or wet grasslands/meadows • Forages in open water or amongst tall emergent vegetation at depths of <0.4 metres with sand, mud or clay substrate • Roosts in tree stumps or on ground or banks • Nest in trees over water or build nest on shallow water • Diet consists of insects, fish, plant material (including crops), reptiles and frogs.	• Stimulated by flood/season between Nov-May for Yellow-billed Spoonbill (2-3 month breeding duration) and July-Nov (3-4 month breeding duration) • Ideally require between, 4-9 months of inundation • Brolga require shallow water (0.24-0.72 metres depth)	• Flood timing dependent on target species • Inundation to be maintained for up to 9 months • Surrounding trees required for spoonbill nesting.
	Brolga	Creswick Swamp and Jesse Swamp			
Amphibians	Eastern sign-bearing Froglet	All sites	• Widely distributed species that are	• Breed in spring and summer and lay eggs	• Retain pooled water for at least 6

Key values	Example spp. present	Example site	Broad requirements		
			Habitat	Breeding	Water requirements
	Spotted Marsh Frog Eastern Banjo Frog		highly adapted to a range of habitats, although prefer wetlands with ample fringing vegetation and fallen timber • Most are able to readily colonise any waterbody • Prefer to breed in diverse aquatic vegetation or submerged grasses	in slow moving/ still water or terrestrial habitat • Tadpole development time of 2-6 months depending on the species • All species appear to be more productive in wetlands with longer hydroperiods (i.e. >6 months or permanent conditions) • The timing of inundation dictates which species are able to successfully recruit and also impacts tadpole development time	weeks if flooded in spring/summer and 3 months for winter • Some species will burrow when wetlands dry (i.e. Eastern Sign-bearing Froglet) whilst other have a limited burrowing capacity (Spotted Marsh frog) • More productive in environments with ample aquatic and fringing vegetation with fallen timber.
	Peron's Tree Frog	Jeffcott Wetland			
Reptiles	Eastern Long-necked Turtle*	All sites	• Typically occupy ephemeral or semi-permanent water bodies and avoid competition with other turtles and fish • Will retreat to permanent water during drought or periods of low rainfall • Adapted to overland migration and can move over 5 kilometers (although these events are rare) • Rely on terrestrial environments as habitat corridors • Diet consists primarily of fish, insects, tadpoles, frogs, yabbies' and other crustaceans.	• Eggs laid during spring and early summer in an excavation in the bank of a wetland/dam (prefer sandy conditions) • Young catch over incubation period of 3 to 8 months • Eggs are at risk of predation by foxes	• Providing nearby water sources are available ephemeral or semi-permanent waterbodies are preferred. If site is isolated permanent conditions are required. • Can cover themselves in mud or soil in dried up water bodies during dry months
Macro-invertebrates	Predators	All sites	• Feed on other consumers	• Life histories of invertebrates are tied to food availability i.e. macroinvertebrates that eat algae scrapers/ grazers) are most abundant in the summer when algae production is at its highest • Immature macroinvertebrates are most numerous during periods when dissolved oxygen levels are high (i.e. winter) • The majority of macroinvertebrates in the Wimmera Mallee Wetlands are highly mobile due to their winged adult stage and can readily colonise permanent and temporary waterbodies across the landscape	• Provide a diversity of habitat types and food sources (i.e. aquatic vegetation, fallen timber/ leaf litter, substrates etc.) to support a range of macroinvertebrates across the four key functional feeding groups
	Scraper/ grazers		• Consume algae, bacteria, fungi and associated material from the surface of rocks, sediments, plants etc.		
	Shredders		• Consume live and dead coarse particulate organic matter (CPOM) including leaf litter, macrophtyes and wood		
	Collectors		• Decompose fine particulate organic matter (FPOM) from the water column using a variety of filters (i.e. body parts, nets or my gathering) • Often associated with sandy or muddy substrates		
Terrestrial based fauna					
Woodland/ grassland birds	Black Falcon*	Davis	• Mainly over grassland and lightly	• Nest in trees (i.e. hollows or constructed	• Most species not directly dependent

Key values	Example spp. present	Example site	Broad requirements		
			Habitat	Breeding	Water requirements
	Brown Falcon	Cherrip Swamp and Davis	wooded areas • Nest in trees • Some prey on mammals, others probe trees for insects or forage on the ground.	nests)	on water however require watering points in the landscape • Brown Treecreeper is dependent on vegetation reliant on flooding.
	Swamp Harrier Hooded Robin	Cherrip Swamp			
	Brown Treecreeper*	Cherrip Swamp, Davis Dam and Jeffcott Wetland			
	Square-tailed Kite Spotted Harrier	Corack Lake			
Ground-welling birds	Bush Stone Curlew*	Davis Dam	• Predominately occupy lowland grassy woodland and open forest remnants • Curlews and pipits prefer low ground cover and sparse native grasses and shrubs whilst quails require dense vegetation for shelter • Diet consists of seeds, fruits, insects, invertebrates, frogs and reptiles • Nest on ground amongst trees, branches or in the open area for high visibility	• Typically nest on ground at edge of woodland environments • Extremely vulnerable to predation by foxes	• Not dependent on water however frogs are a preferred source of food Curlew s.
	Brown Quail	Chirrup Swamp and Corack Lake			
Mammals	Common Brushtail Possum Eastern Grey Kangaroo	Likely to be present at most sites	• Varies habitat requirement depending on the species (from grasslands to woodland environments) • Fat-tailed Dunnart prefer open habitats in grasslands with fallen timber and ample insects	• Varies depending on the species • Fat-tailed Dunnart breeds between May-June and nest in cavities beneath rocks or logs	• Most species not directly dependent on water however require watering points in the landscape
	Fat-tailed Dunnart*	Davis Dam			
Reptiles	Lace Monitor*	Chirrup Swamp Corack Lake	• Diet consist of reptiles and small mammals, nesting birds and carrion • Foragers in trees and on the ground	• Lay eggs in termite mounds particularly in trees during spring and summer	• Most species not directly dependent on water however require watering points in the landscape

EVC	Example		Broad requirements				Broad ecological service
	Example site	Significant species present	Category	Frequency	Duration	Depth	
Water dependent vegetation communities (EVC)							
Lignum Shrubland (EVC 808)	Cherrip Swamp	Cane Grass*, Spiny Lignum*, Swamp Earl Nancy*	Episodic	<3 in 10 years	< 6 months	<.5 metres	• Key waterbird habitat- trees (i.e. hollows, fallen branches and shade), shrubs, reeds and grasses • Key waterbird feeding habitat • Source of seed for further recruitment • Highly productive through
Lignum Swampy Woodland (EVC 823)	Cherrip Swamp	Spiny Lignum*, Cane Grass*	Intermittent/ episodic	3-7 in 10 years / <3 in 10 years	<4 months	0.3-1 metre	
	Jeffcott Wetland	Plains Spike-sedge*, Small Monkey-flower*					
Plains Grassy Wetland- Lignum Swamp Complex	Creswick Swamp	Spiny Lignum*, Pale Spike-sedge*, Long Eryngium	Intermittent/ seasonal	3-7 in 10 years/ 8-10 in 10	<6 months	<0.3 metres	

EVC	Example		Broad requirements				Broad ecological service
	Example site	Significant species present	Category	Frequency	Duration	Depth	
(A101)				years			wetting and drying cycles
Plains Grassy Wetland (EVC 125)	Jesse Swamp	Buloke Mistletoe*, Marbled Marshwort*	Intermittent/ seasonal	3-7 in 10 years/ 8-10 in 10 years	<6 months	<0.3 metres	
Intermittent Swampy Woodland (EVC 813)	Corack Lake	N/A	Intermittent/ episodic	3-7 in 10 years / <3 in 10 years	1-6 months	0.8 metres	
Lake Bed Herbland (EVC 107)	Corack Lake	N/A	Intermittent/ episodic	3-7 in 10 years / <3 in 10 years	1-12 months	>0.3 metres	• Filters water • adds biological activity • fauna habitat • fauna refuge • nesting and feeding for waterbirds
Freshwater Lignum- Cane Grass Swamp (EVC 954)	Jesse Swamp	Marbled Marshwort*	Intermittent	3-7 in 10 years	<6 months	0.30-1 metre	
Dams	All	Bluish Raspwort* (Creswick Swamp only)	Artificial waterbody	N/A	N/A	0.4 to >4 metres	• refuge and nursery habitat • feeding for turtles frogs and waterbirds • watering points for fauna • breeding sites for some waterbird spp. (Australasian Grebe) • nutrient cycling and water filtration
Terrestrial vegetation communities (EVC)							
Plains Woodland (EVC 803)	Cherrip Swamp	Chariots Wheels*, Scrufy Germander*	N/A	N/A	N/A	N/A	• Open woodland foraging zone for fauna • Nesting and shelter for fauna • Habitat for Brown Treecreeper and Square-tailed Kite • Source of organic material and debris
	Corack Lake	N/A	N/A	N/A	N/A	N/A	
	Jeffcott Wetland	Hairy Tails*, Plains Joyweed*, Bluish Rapswort*	N/A	N/A	N/A	N/A	
Lunette Woodland (EVC 652)	Corack Lake	N/A	N/A	N/A	N/A	N/A	
Plains Savanah (EVC 826)	Creswick Swamp	Buloke Mistletoe*, Matted Flax-lily*, Turnip Copperburr*	N/A	N/A	N/A	N/A	• Open grassland foraging zone for

EVC	Example		Broad requirements				Broad ecological service
	Example site	Significant species present	Category	Frequency	Duration	Depth	
	Davis Dam	Buloke Mistletoe*	N/A	N/A	N/A	N/A	fauna • shelter for grown-dwelling fauna • Habitat for Curlews
Source: Howard et al., 2014; Rakali Ecological Consulting, 2014; 2013; DSE, 2012a; DSE, 2012b; Rogers & Ralph, 2011; Roberts & Marston, 2011.							

Appendix 9: Hydrological Objectives

Component	Ecological objective	Water mgt area	Hydrological objectives													
			Recommended number of events in 10 years			Duration of ponding (months)			Duration of dry between rewetting (years)			Most frequent timing of inflows[1]	Opt depth for site (metres)	Additional information	TSL (m AHD)	Vol. to fill to TSL (ML)
			Min	Opt	Max	Min	Opt	Max	Min	Opt	Max					
1. Complex																
1.1 All	1.1.1 Re-establish a spread of **open water** in the landscape	All sites	See ecological objectives 2, 3, 4, 5, 6, 7 and													
	1.1.2 Provide **watering point** for terrestrial species	All sites	Variable- frequency, duration, timing and depth is dependent on the status of nearby waterbodies in the landscape (i.e. lack of open water during very dry years may increase need for permanency). Management to be adaptive and consider other waterbodies in the landscape.													
2. Chirrup Swamp																
2.1 Wetland	2.1.1 Maintain extent and health of **Cane Grass**	Bed	1	2-3	5-7	1	6	9	1	2	7	Aug- Oct	0.2	Species is considered drought tolerant and has a persistent rootstock. Flooding to replenish seed stock is needed every seven years, based on seed longevity.	Up to 105	45
	2.1.2 Maintain extent and health **of fringing vegetation**	Bed/ riparian zone	1	3	7	1	3	6	1	2	7	Aug- Oct	0.4	Flooding for regeneration should follow Black Box seed drop (as seed bank does not form) and/or 9-12 months post establishment of lignum seedling to increase success.	Up to 105.4	167
	2.1.3 Maintain **waterbird feeding and breeding** opportunities	Bed/ riparian zone	See ecological objectives 2.1.1, 2.1.2 and 2.1.5. Wetting and drying promotes a diversity of habitat types and food sources (i.e. mudflats, fringing zones etc.)											Waterbird feeding opportunities are based on ensuring a range of habitat and food sources are available through appropriate wetting and drying (as per 2.1.1, 2.2.1 and 2.1.5) - See Appendix 8 for general feeding requirements.	See 2.1.1, 2.1.2 and 2.1.5	
		Bed/ riparian zone	Variable			4	6-7	10	Productivity increases with wetting and drying and flooding stimulates breeding			Aug-Oct	Variable	Waterbird breeding opportunities based on ensuring a range of habitat types (as per 2.1.1 and 2.2.1) as well as appropriate flooding cues to stimulate breeding- See Appendix 8 for general breeding requirements. *NB. Hydrological objectives are generalised to suit a range of species present.*	See 2.1.1 and 2.2.1	
	2.1.4 Maintain opportunistic **frog and turtle feeding and breeding** opportunities[1]	Bed/ Riparian	Variable however prefer permanent to semi-permanent conditions			2	3-6	12	Variable- some species able to burrow during dry periods others limited			Variable depending on species	Variable	Frog feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 2.1.1 and 2.1.2) and appropriate cues to stimulate breeding- see Appendix 8 for general requirements.	See 2.1.1 and 2.2.1	

Component	Ecological objective	Water mgt area	Hydrological objectives									Most frequent timing of inflows[1]	Opt depth for site (metres)	Additional information	TSL (m AHD)	Vol. to fill to TSL (ML)
			Recommended number of events in 10 years			Duration of ponding (months)			Duration of dry between rewetting (years)							
			Min	Opt	Max	Min	Opt	Max	Min	Opt	Max					
		Bed/ riparian	Prefer ephemeral or semi-permanent waterbodies but will retreat to permanent conditions when there is a lack of water in the landscape									Spring/ summer	Variable	Turtle feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 2.1.1 and 2.1.2) and appropriate cues to stimulate breeding- see Appendix 8 for general requirements. Please note that control of foxes is also required to achieve objective.	See 2.1.1 and 2.2.1	
2.2 Dam	2.2.1 Improve a**quatic and littoral vegetation** cover and diversity	Dam	Variability and fluctuations in water level important for promoting a diversity of species. Australian wetland species generally have long-lived seed banks (at least 15 years for many species)									Aug- Oct	Variable- up to 2.6 metres	Objective aimed at promoting aquatic and littoral plant growth in the absence of significant constraints. In reality, the achievement of this ecological objective would require modifications to the morphology of the dam and revegetation (to introduce diversity).	≤105	≤1.2
	2.2.2 Increase/ improve **frog and turtle breeding and feeding** opportunities	Dam	Variable- dependent on 2.2.5 (opportunities for recolonisation) i.e. only maintain dam as a permanent system when Cherrip Swamp is dry. During flood events, the dam may drawdown.									Spring/ summer	1-2.6	Turtle feeding and breeding based on promoting aquatic habitat, food sources (as per 2.2.1 and 2.2.4) and appropriate cues to stimulate breeding. Please note that control of foxes is also required to achieve objective. At least 1 metre depth recommended for maintenance of turtle population unless alternative sites are present (see 2.2.5)	103.4-105	0.2-1.2
		Dam and fringe	Variable- dependent on 2.2.5 (opportunities for recolonisation)			2	3-6	12	Variable- some species able to burrow during dry periods others limited			Spring/ summer	Variable dependin g on species	Frog feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 2.2.1 and 2.2.4) and appropriate cues to stimulate breeding- see Appendix 8 for general requirements.	Up to 105	Up to 1.2
	2.2.3 Improve **macroinvertebrate** assemblage	Dam	See ecological objective 2.2.1. Improving and increasing aquatic vegetation will promote return of grazer/ scraper and shredder macroinvertebrates, improving the macroinvertebrate assemblage.											Macroinvertebrate diversity relies on promoting a range of habitat and feeding opportunities for macroinvertebrates (as per 2.2.1) - see Appendix 8 for general requirements.	Up to 105	Up to 1.2
	2.2.4 Maintain a point source for **recolonisation** of nearby waterbodies	Dam	Maintain permanent conditions (with fluctuations) until flooding of Chirrup Swamp or other nearby (i.e. less than <2-3 km away) occurs to facilitate recolonisation											Management to be adaptive and consider other waterbodies in the landscape.	Up to 105	Up to 1.2
	2.2.5 Maintain a **watering point** for terrestrial fauna	Dam														

Component	Ecological objective	Water mgt area	Hydrological objectives													
			Recommended number of events in 10 years			Duration of ponding (months)			Duration of dry between rewetting (years)			Most frequent timing of inflows[1]	Opt depth for site (metres)	Additional information	TSL (m AHD)	Vol. to fill to TSL (ML)
			Min	Opt	Max	Min	Opt	Max	Min	Opt	Max					
2 Corack Lake																
3.1 Wetland	3.1.1 Maintain/ increase diversity of native **amphibious species and aquatic species** associated with the wetland bed	Bed	3	5	7	6	12	24	0.5	2	5	Aug- Sept	0.8	Variability will dictate which species are present at any one time	Up to 113.4	12 ML
	3.1.2 Maintain health, recruitment and diversity of **River Red Gum and Black Box** age classes	River Red Gum- Bed/ fringe	3	5	7	3-6	9-12	18	0.5	2	5	Aug- Sept	<1.2	Flood recession in spring (or later) to provide warm and moist conditions for germination and seed establishment (no seed bank maintained)	Up to 113.8	24 ML
		Black Box- Riparian	3	5	7	1	3	6	0.5	3	12	Aug- Sept	1.2	Flooding for regeneration should follow seed drop as seed bank does not form	Up to 115	77 ML
	3.1.3 Maintain **waterbird breeding and feeding** opportunities	Bed/ riparian zone	Variable			See ecological objectives 3.1.1, 3.1.2 and 3.1.4. Wetting and drying promotes habitat variability (i.e. mudflats, open water, fringing zones etc.)							Variable	Waterbird feeding opportunities based on ensuring a range of habitat and food sources (as per 3.1.1, 3.1.2 and 3.1.4) as well as appropriate wetting and drying to expose habitats - See Appendix 8 for general requirements.	See 3.1.1, 3.1.2 and 3.1.4	
		Bed/ riparian zone	Variable			>4	6-8	12	Productivity increases with wetting and drying- Flooding stimulates breeding			Aug- Oct	Variable	Waterbird feeding opportunities based on ensuring a range of habitat and food sources (as per 3.1.1, 3.2.1 and 3.1.5) as well as appropriate wetting and drying to expose habitats - See Appendix 8 for general feeding requirements	See 3.1.1, 3.1.2 and 3.1.5	
	3.1.4 Maintain opportunistic **frog and turtle feeding and breeding** opportunities[1]	Bed	Variable however prefer permanent to semi-permanent conditions			2	3-6	12	Variable- some species able to burrow during dry periods others limited			Spring/ summer	Variable dependin g on species	Frog feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 3.1.2) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements.	See 3.1.2	
		Bed/ riparian zone	Prefer ephemeral or semi-permanent waterbodies but will retreat to permanent conditions when there is a lack of water in the landscape * *Control of foxes required to achieve turtle objective*									Spring/ summer	Variable	Turtle feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 3.1.2) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements.	See 3.1.2	
3.2 Dam	3.2.1 Maintain/ increase cover and structural diversity of **aquatic vegetation**	Dam and fringe	Variability and fluctuations in water level important for promoting a diversity of species									Aug- Sept	Variable- up to 0.6	Opportunity to overtop dam to partially achieve 3.1.2	≤112.8	≤0.3

Component	Ecological objective	Water mgt area	Hydrological objectives													
			Recommended number of events in 10 years			Duration of ponding (months)			Duration of dry between rewetting (years)			Most frequent timing of inflows[1]	Opt depth for site (metres)	Additional information	TSL (m AHD)	Vol. to fill to TSL (ML)
			Min	Opt	Max	Min	Opt	Max	Min	Opt	Max					
	3.2.2 Maintain nursery habitat for juvenile **turtles and frogs**	Dam	Variable- dependent on 3.2.5 (opportunities for recolonisation) ** Control of foxes required to achieve turtle objective*									Spring/ summer	Up to 0.6	Juvenile turtle habitat facilitated through appropriate aquatic habitat and food sources (as per 3.2.1 and 3.2.3).	See 3.2.1 and 3.2.3	
		Dam and fringe	Variable- dependent on 3.2.5 (opportunities for recolonisation)			2	3-6	12	Variable- some species able to burrow during dry periods others limited			Spring/ summer	Variable depending on species	Frog feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 3.2.1 and 3.2.4) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements.	See 3.2.1 and 3.2.3	
	3.2.3 Maintain permanent refuge conditions **for turtles and frogs** in Dam No. 2	Dam and fringe	See above													
	3.2.4 Increase **waterbird feeding** opportunities (particularly shoreline foragers)	Dam and fringe	Variable			See ecological objectives 3.2.1 and 3.2.3 Wetting and drying promotes habitat variability (i.e. mudflats, fringing zones etc.)						Variable		Waterbird feeding opportunities based on ensuring a range of habitat and food sources (as per 3.1.1, 3.2.1 and 3.1.5) as well as appropriate wetting and drying to expose habitats - See Appendix 8 for general feeding requirements.	See 3.2.1 and 3.2.3	
3 Creswick Swamp																
4.1 Wetland (reserve component only)	4.1.1 Maintain diversity of **aquatic vegetation**	Bed	3	6	7	3	6	9	0.5	2	3	July- Sept	<0.4	Objective may be currently unachievable due to road and risk of flooding private land (see Section 16 for recommendations)	<139	14
	4.1.2 Increase/re-establish extent of **Marbled Marshwort** in bed of wetland	Bed	3	6	7	3	6	9	0.5	2	3	July- Sept	<0.4	Ideal flood frequency, duration, timing and depth are unknown. Requirements are therefore based on Plains Grassy Wetland-Lignum Swamp Complex EVC. Objective may be currently unachievable due to road and risk of flooding private land (see Section 16 for recommendations)	<139	14
	4.1.3 Increase health and recruitment of **shrubs**	Bed	3	5	7	3	5	7	1	2	7	May-Aug for germination	<0.4	Follow up flooding required within 9-12 months after seed establishment. Objective may be currently unachievable due to road and risk of flooding private land (see Section 16 for recommendations)	<139	14
	4.1.4 Re-establish **waterbird feeding and breeding** opportunities, in particularly Brolga	Bed	Variable- although Brolgas prefer ephemeral and semi-permanent wetlands for			4	6	9	Productivity increases with wetting and drying- Flooding stimulates breeding			July- Nov	prefer 0.3-0.4	Waterbird breeding opportunities based on ensuring a range of suitable habitat types (as per 4.1.1, 4.1.2 and 4.1.3) as well as appropriate cutes to stimulate breeding-	139	14

Component	Ecological objective	Water mgt area	Hydrological objectives													
			Recommended number of events in 10 years			Duration of ponding (months)			Duration of dry between rewetting (years)			Most frequent timing of inflows[1]	Opt depth for site (metres)	Additional information	TSL (m AHD)	Vol. to fill to TSL (ML)
			Min	Opt	Max	Min	Opt	Max	Min	Opt	Max					
			breeding)											See Appendix 8 for general breeding requirements. *N.B. hydrological objectives are based on requirements of Brolga.* Objective may be currently unachievable due to road and risk of flooding private land (see Section 16 for recommendations)		
		Bed	Variable			See ecological objectives 4.1.1, 4.1.2 and 4.1.3. Wetting and drying promotes habitat variability (i.e. mudflats, shallow meadows etc.)							Variable	Waterbird feeding opportunities based on ensuring a range of habitat and food sources (as per 4.1.1, 4.1.2 and 4.1.3) as well as appropriate wetting and drying to expose habitats - See Appendix 8 for general feeding requirements.	See 4.1.1, 4.1.2 and 4.1.3	
4.2 Dam	4.2.1 Maintain high diversity of **aquatic plants**	Dam	Variability and fluctuations in water level important for promoting a diversity of species									Aug-Oct	Variable up to 1.6	Variability in water level to encourage a diversity of species	138.6	0.8
	4.2.2 Increase **diversity of littoral vegetation** (i.e. emergent vegetation)	Fringe	Variability and fluctuations in water level important for promoting a diversity of species **Modifications to the morphology of the dam combined with revegetation would be required to achieve objective*									Aug-Oct	Variable 1.6-1.8	Opportunity to overtop dam to partially 4.1.1/4.1.2	138.6-138.8	0.8-1
	4.2.3 Re-establish **Marbled Marshwort** in dam	Dam	3	6	8	3	6	9	0.5	2	3	July- Sept	Variable/ likely to establish in shallow fringe	Ideal flood frequency, duration, timing and depth are unknown. Requirements are therefore based on Plains Grassy Wetland-Lignum Swamp Complex EVC	138.6	0.8
	4.2.4 **Maintain turtle and frog breeding and feeding** opportunities	Dam and fringe	Variable- dependent on 4.2.5 (opportunities for recolonisation)			2	3-6	12	Variable- some species able to burrow during dry periods others limited			Spring/ summer	Variable dependin g on species	Frog feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 4.2.1 and 4.2.2) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements.	Up to 138.6	0.8
		Dam and fringe	Prefer ephemeral or semi-permanent waterbodies but will retreat to permanent conditions when there is a lack of water in the landscape. ** Control of foxes required to achieve turtle objective*									Spring/ summer	1-1.6	Turtle feeding and breeding based on promoting aquatic habitat, food sources (as per 4.2.1 and 4.2.2) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements. At least 1 metre depth recommended for maintenance of turtle population unless alternative sites are present (see 4.2.5)	138-138.6	0.2-0.8
4 Davis Dam																
5.1 Wetland	5.1.1 Maintain **Cane Grass**	Bed	1	2-3	5-7	1	6	9	1	2	7	Aug- Oct	0.4	Intermittent watering required	107	3

Component	Ecological objective	Water mgt area	Hydrological objectives												
			Recommended number of events in 10 years			Duration of ponding (months)			Duration of dry between rewetting (years)			Most frequent timing of inflows[1]	Opt depth for site (metres)	Additional information	TSL (m AHD)	Vol. to fill to TSL (ML)
			Min	Opt	Max	Min	Opt	Max	Min	Opt	Max					
	vegetation															
	5.1.2 Maintain and promote recruitment of **Black Box** vegetation	Riparian	1	3	7	1	3	6	0.5	3	12	Aug- Sept	0.3	Flooding for regeneration should follow seed drop as seed bank does not form	107.2	11
	5.1.3 Maintain **frog breeding and feeding** opportunities[1]	Bed/ riparian	Variable however prefer permanent to semi-permanent conditions			2	3-6	12	Variable- some species able to burrow during dry periods others limited			Spring/ summer	Variable depending on species	Frog feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 5.1.1) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements.	See 5.1.1 and 5.2.1	
5.2 Dam	5.2.1 Increase **aquatic and littoral vegetation**[3]	Dam and fringe	Variability and fluctuations in water level important for promoting a diversity of species **Modifications to the morphology of the dam combined with revegetation may be required to achieve objective*									Aug-Sept	1	Opportunity to overtop dam to partially achieve 4.1.1 and/or 4.1.2	107.4	0.2
	5.2.2 Maintaining **waterbird feeding** opportunities	Dam and fringe	Variable			See ecological objectives 5.2.1. Wetting and drying promotes habitat variability							Variable	Waterbird feeding opportunities based on ensuring a range of habitat and food sources (as per 5.2.1) as well as appropriate wetting and drying to expose habitats - See Appendix 8 for general requirements	See 5.2.1	
	5.2.3 Provide a **watering point** for terrestrial species	Dam	Variable- frequency, duration, timing and depth is dependent on the status of nearby waterbodies in the landscape (i.e. lack of open water during very dry years may increase need for permanency)											Management to be adaptive and consider other waterbodies in the landscape	Up to 107.4	0.2
5 Falla Dam																
6.1 Dam	6.1.1 Increase **aquatic vegetation** diversity and abundance[3]	Dam and fringe	Variability and fluctuations in water level important for promoting a diversity of species **Modifications to the morphology of the dam combined with revegetation would be required to achieve objective*									Aug- Oct	Variable- up to 4	Lack of aquatic species currently present	117	5
	6.1.2 Increase **frog and turtle feeding and breeding**[1]	Dam and fringe	Variable however prefer permanent to semi-permanent conditions			2	3-6	12	Variable- some species able to burrow during dry periods others limited			Spring/ summer	Variable depending on species	Frog feeding and breeding based on promoting habitat and feeding opportunities (as per 5.1.1) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements.	See 6.1.1	
		Dam and fringe	Variable- dependent on 6.1.4 (opportunities for recolonisation) ** Control of foxes required to achieve turtle objective*									Spring/ summer	Variable	Turtle feeding and breeding based on promoting aquatic habitat, food sources (as per 6.1.1) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements. At least 1 metre depth recommended for maintenance of turtle population unless alternative sites are present (see 6.1.4)	116.2-117	2-5
	6.1.3 Provide a **watering**	Dam	Variable- frequency, duration, timing and depth is dependent on the status of nearby waterbodies in											Management to be adaptive and consider	Up to 117	Up to 5

Component	Ecological objective	Water mgt area	Hydrological objectives													
			Recommended number of events in 10 years			Duration of ponding (months)			Duration of dry between rewetting (years)			Most frequent timing of inflows[1]	Opt depth for site (metres)	Additional information	TSL (m AHD)	Vol. to fill to TSL (ML)
			Min	Opt	Max	Min	Opt	Max	Min	Opt	Max					
	point for terrestrial species		the landscape (i.e. lack of open water during very dry years may increase need for permanency)											other waterbodies in the landscape		
6 Jeffcott Wetland																
7.1 Wetland (reserve component only)	7.1.1 Increase health of **understorey vegetation**	Bed	3	5	7	1	3	6	0.6	2	4	Aug-Oct	0.8	Objective currently unachievable due to flooding of private land (see Section 16 for recommendations)	<126.6	34
	7.1.2 Maintain/ increase health of **Black Box**	Bed/ riparian	3	5	7	1	3	6	0.5	2	5	Aug- Sept	1	Objective currently unachievable due to flooding of private land (see Section 16 for recommendations)	126.6-127.6	34-260
	7.1.3 Maintain **waterbird feeding and breeding** opportunities	Bed/ riparian	Variable			5	7-8	12	Productivity increases with wetting and drying- Flooding stimulates breeding Wetting and drying promotes habitat variability (i.e. mudflats, shallow meadows etc.)			Aug-Oct	Variable	Waterbird feeding and breeding opportunities based on ensuring a range of habitat and food sources (as per 7.1.1, 7.1..2 and 7.1.4) as well as appropriate wetting and drying to expose habitats - See Appendix 8 for general feeding requirements	See 7.1.1, 7.1.2 and 7.1.4	
	7.1.4 Maintain **frog and turtle breeding and feeding** opportunities[1]	Bed/ fringe	Variable however prefer permanent to semi-permanent conditions			2	3-6	12	Variable- some species able to burrow during dry periods others limited			Spring/ summer	Variable dependin g on species	Frog feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 7.1.1) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements.	See 7.1.1	
		Bed/ fringe	Prefer ephemeral or semi-permanent waterbodies but will retreat to permanent conditions when there is a lack of water in the landscape ** Control of foxes required to achieve turtle objective*									Spring/ summer	Variable	Turtle feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 7.1.2) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements.	See 7.1.1	
7.2 Dam	7.2.1 Maintain high diversity of **aquatic plants**	Dam and fringe	Variability and fluctuations in water level important for promoting a diversity of species **Modifications to the morphology of the dam combined with revegetation would be required to achieve objective*									Aug- Oct	Variable- up to 3	Good aquatic vegetation present	127.8	4-6
	7.2.2 Maintain **turtle and frog feeding and breeding** opportunities	Dam and fringe	Variable- dependent on 7.2.6 (opportunities for recolonisation) ** Control of foxes required to achieve turtle objective*									Spring/ summer	Variable	Turtle feeding and breeding based on promoting aquatic habitat, food sources (as per 7.2.1) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements. At least 1 metre depth recommended for maintenance of turtle population unless alternative sites are present (see 7.2.6)	124.8-127.8	4-6
		Dam and	Variable however prefer			2	3-6	12	Variable- some species able			Spring/	Variable	Frog feeding and breeding based on	See 7.2.1	

Component	Ecological objective	Water mgt area	Hydrological objectives												
			Recommended number of events in 10 years			Duration of ponding (months)			Duration of dry between rewetting (years)			Most frequent timing of inflows[1]	Opt depth for site (metres)	Additional information	TSL (m AHD)	Vol. to fill to TSL (ML)
			Min	Opt	Max	Min	Opt	Max	Min	Opt	Max					
		fringe	permanent to semi-permanent conditions						to burrow during dry periods others limited			summer	depending on species	promoting habitat and feeding opportunities (as per 7.1.1) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements.		
	7.2.3 Maintain **waterbird feedin**g opportunities	Dam and fringe	Variable			See ecological objectives 7.2.1 and 7.2.3 Wetting and drying promotes habitat variability particularly at fringe							Variable	Waterbird feeding opportunities based on ensuring a range of habitat and food sources (as per 7.2.1 and 7.2.3) as well as appropriate wetting and drying to expose habitats - See Appendix 8 for general requirements	See 7.2.1 and 7.2.3	
	7.2.4 Provide a **watering point** for terrestrial fauna	Dam	Variable- frequency, duration, timing and depth is dependent on the status of nearby waterbodies in the landscape (i.e. lack of open water during very dry years may increase need for permanency)											Management to be adaptive and consider other waterbodies in the landscape	Up to 127.8	4-6
7 Jesse																
8.1 Wetland	8.1.1 Improve diversity of **grassy-herbaceous flora species**	Bed	3	5	7	3	6	9	0.5	3	5	Aug-Oct	0.8	Variability will dictate which species are present at any one time. Improved native diversity will further assist with reducing weed cover.	159.2	118
	8.1.2 Improve diversity and health of **sedge, shrub and emergent vegetation**	Bed and fringe	3	5	7	2	3-4	6	0.5	3	5	Aug-Oct	0.2		159-159.2	85-118
	8.1.3 Reinstate extent of **Marbled Marshwort** in the 'Lily Pond' and throughout the wetland bed	Bed	3	6	8	3	6	9	0.5	2	3	July- Sept	0.8	Ideal flood frequency, duration, timing and depth are unknown Requirements are therefore based on Plains Grassy Wetland-Lignum Swamp Complex EVC	159.2	118
	8.1.4 Re-establish **waterbird feeding and breeding** opportunities, in particularly Brolga	Bed and fringe	Variable- although Brolgas prefer ephemeral and semi-permanent wetlands for breeding)			4	6	9	Productivity increases with wetting and drying- Flooding stimulates breeding			July- Nov	prefer 0.3-0.4	Waterbird breeding opportunities based on ensuring a range of suitable habitat types (as per 8.1.1 and 8.1.3) as well as appropriate cutes to stimulate breeding- See Appendix 8 for general breeding requirements. *N.B. hydrological objectives are based on requirements of Brolga*	<159.2	<118
		Bed and fringe	Variable			See ecological objectives 8.1.1, 8.1.3, 8.1.4 Wetting and drying promotes habitat variability (i.e. mudflats, open water, grasslands etc.)							Variable	Waterbird feeding opportunities based on ensuring a range of habitat and food sources (as per 8.1.1, 8.1.3, 8.1.4) as well as appropriate wetting and drying to expose habitats - See Appendix 8 for general feeding requirements.	See 8.1.1, 8.1.3, 8.1.4	
8.2 Dam	8.2.1 Increase cover and	Dam and	Variability and fluctuations in water level important for promoting a diversity									Aug-Oct	Variable	Opportunity to overtop dam to partially	158	0.2

Component	Ecological objective	Water mgt area	Hydrological objectives												
			Recommended number of events in 10 years			Duration of ponding (months)			Duration of dry between rewetting (years)			Most frequent timing of inflows[1]	Opt depth for site (metres)	Additional information	TSL (m AHD)	Vol. to fill to TSL (ML)
			Min	Opt	Max	Min	Opt	Max	Min	Opt	Max					
	structural diversity of **aquatic vegetation** (particularly in the wetland area immediately surrounding the dam)[2]	fringe	of species.										up to 0.4	achieve 8.1.1. However, ensure that the site dries by summer to prevent dominance of water couch (only site with this species recorded).		
	8.2.2 Re-establish **Marbled Marshwort** in dam	Dam	3	6	8	3	6	9	0.5	2	3	July- Sept	Variable/ likely to establish in shallow fringe	Ideal flood frequency, duration, timing and depth are unknown Requirements are therefore based on Plains Grassy Wetland-Lignum Swamp Complex EVC	158	0.2
	8.2.3 Maintain/ increase **frog feeding and breeding** opportunities[1]	Dam and fringe	Variable- dependent on 8.2.4 (opportunities for recolonisation)			2	3-6	12	Variable- some species able to burrow during dry periods others limited			Spring/ summer	Variable dependin g on species	Frog feeding and breeding based on promoting a range of habitat and feeding opportunities (as per 8.2.1) and appropriate cues to stimulate breeding- see Appendix 8 for general feeding/ breeding requirements.	Up to 158	Up to 0.2
	8.2.4 Increase **waterbird feeding opportunities** (particularly shoreline foragers)	Dam and fringe	Variable			See ecological objectives 8.2.1. Wetting and drying promotes habitat variability							Variable	Waterbird feeding opportunities based on ensuring a range of habitat and food sources (as per 8.2.1) as well as appropriate wetting and drying to expose habitats - See Appendix 8 for general requirements	See 8.2.1	

[1]For the purpose of this EWMP timing is depicted as the range of months considered the most optimum for the ecological objective. However, natural variability should be maintained by providing fills/ top-ups outside of this period from time to time.
Sources: D. Cook (pers. comm., 21 August 2014), Rakali Ecological Consulting (2014), Howard et al., (2014), DELWP (2012), DSE (2012), Roberts & Marston (2011), Rogers & Ralph (2011).

Appendix 10: Wetland Management Objectives

As per Section 1.2, management objectives for the wetland component of each WMP Wetlands site has been developed to inform environmental water management should delivery constraints be alleviated in the future. As detailed in Sections 4.7 to 10.8, dam objectives that align with those detailed below (either in full or in part) have been included in the scope of environmental water management.

1. Chirrup Swamp

Management Goal

To maintain Chirrup Swamp as a Cane Grass dominated shallow freshwater marsh able to support a diversity of feeding and breeding opportunities for waterbirds, turtles and frogs through the provision of an appropriate water regime.

Ecological Objectives

Ecological objective	Justification
1. Maintain extent and health of **Cane Grass**	- Provides habitat (i.e. sanctuary for waterfowl, frogs and macroinvertebrates and nesting material for waterbirds) - Provides food for herbivorous species (i.e. growth tips consumed provides harbour for waterbird food sources) and their food sources (i.e. frogs, macroinvertebrates etc.) - Listed vulnerable in Victoria with populations limited in north-west Victoria
2. Maintain extent and health of **fringing vegetation**	- Shrub layer provides nesting, roosting/ shelter and feeding habitat for waterbirds - Shrub layer is effective at catching silt and debris allowing recolonisation by other species - Tree layer supports roosting, feeding and breeding (i.e. nests, hollows, fallen timber) for waterbirds and terrestrial fauna (i.e. Lace Monitor, FFG Hooded Robin and near threatened Brown Treecreeper) - Black Box flowers are rich in nectar and pollen providing a valuable food source for native birds, insects and other wildlife - Vegetation of this zone aids in filtering nutrients and runoff and follows a boom and bust pattern in response to flooding
3. **Maintain waterbird feeding and breeding** opportunities	- Provision of a range of terrestrial and aquatic food sources including insects, macroinvertebrates, frogs and plant matter and habitat types (i.e. drawdown zones, herbs, woodland and emergent vegetation) to maintain waterbird diversity - The Lignum Shrubland (EVC 808) has historically supported breeding Black Swan (use Cane Grass for nesting) and potential a range of other waterbird species when inundated - Appropriate watering (i.e. including duration, timing and extent) will provide a range of habitat types suitable for waterbird nesting, resting and breeding
4. Maintain opportunistic **frog and turtle feeding and breeding** opportunities[1]	- Wetting and drying provides high quality opportunistic feeding for turtles and frogs and provides food sources for waterbirds

[1] Frog and turtle surveys have not been undertaken at the wetland. Therefore, frog and turtle objectives are based on the vegetation communities present and the proximity to known populations (i.e. dam). Further information is required to determine the appropriate trajectory for future management.

Hydrological Objectives

Timing		Fresh inflows most often between August and October (with variability outside of this timing in some years)
Watering frequency	Minimum	1 in every 10 years
	Optimum	3 in every 10 years
	Maximum	7 in every 10 years
Ponding	Minimum	1 month

duration	Optimum	FRINGE: 3 months BED: 6 months
	Maximum	FRINGE: 6 months BED: 9 months
Duration of dry between events	Minimum	1 year of dry between events
	Optimum	2 years of dry between events
	Maximum	7 years of dry between events
Depth		FRINGE: 0.2-0.4 metres (105-105.4 m AHD) BED: Up to 0.2 metres (105 m AHD)
Variability		High- mimic natural variability by providing occasional watering events outside of the optimum timing (i.e. summer fill to mimic summer thunder storm event)
Estimated volume per event		At least 214 ML

Water Regime

Provide inflows between August and October targeting 105.4 m AHD, three in every ten years to inundate the bed and fringing zones. Allow depth to be maintained between 105-105.4 m AHD for approximately three months (August to October preferred), before drawing down completely over the following three to six months.

Allow between one and two years of complete dry before re-wetting to maintain the health of the Cane Grass, Tangled Lignum and Black Box and to promote high quality feeding opportunities for waterbirds.

2. Corack Lake

Management Goal

To maintain Corack Lake as a deep freshwater marsh able to support a diversity of habitat types (i.e. fringing, littoral and open water zones) and aquatic plants as well as fringing Black Box and River Red Gum recruitment and survival.

Ecological Objectives

Ecological Objective	Justification
1. Maintain/ increase diversity of native **amphibious and aquatic species** associated with the wetland bed	- Provide shelter and feeding opportunities for macroinvertebrates, frogs, turtles and waterbirds - Filters water and assists with nutrient cycling (i.e. bacteria on surface film of plants) - Assist with reducing the cover and diversity of exotic grasses in the wetland bed during dry phases
2. Maintain health, recruitment and diversity of **River Red Gum and Black Box** age classes	- Red Gum and Black Box trees support roosting, feeding and breeding (i.e. nests, hollows, fallen timber) for waterbirds and terrestrial fauna (i.e. FFG listed Square-tailed Kite and near threatened Spotted Harrier) - Over colonisation (i.e. large thickets) can have a negative impact on the diversity of other vegetation communities
3. Maintain **waterbird breeding and feeding** opportunities	- Diversity of habitat types support a range of food sources including macroinvertebrates, frogs and plant matter (i.e. drawdown zones, fringing, littoral and open water) - Diversity of vegetation communities support a range of habitat types suitable for waterbird nesting, resting and breeding (including fringing Black Box and River Red Gum woodland)
4. Maintain opportunistic **frog and turtle** feeding and breeding opportunities[1]	- Amphibious flora species provides shelter, feeding opportunities and a substrate for frogs to attach eggs too - Wetting and drying provides high quality opportunistic feeding for turtles and frogs

[1] Frog and turtle surveys have not been undertaken at the wetland. Therefore, frog and turtle objectives are based on the vegetation communities present and the proximity to known populations (i.e. dam). Further information is required to determine the appropriate trajectory for future management.

Hydrological Objectives

Timing		Fresh inflows most often between August and September(with variability outside of this timing in some years)
Watering frequency	**Minimum**	3 in every 10 years
	Optimum	5 in every 10 years
	Maximum	7 in every 10 years
Ponding duration	**Minimum**	FRINGE: 1 month BED: 3-6 months
	Optimum	FRINGE: 3 months BED: 9-12 months
	Maximum	FRINGE: 6 months BED: 18-24 months
Duration of dry between events	**Minimum**	0.5 year of dry between events
	Optimum	2 years of dry between events
	Maximum	5 years of dry between events
Extent		FRINGE: 1.2 metres (115 m AHD) BED: 0.8-1.2 metres (113.4-113.8 m AHD)
Variability		High- mimic natural variability by providing occasional watering events outside of the optimum timing (i.e. summer fill to mimic summer thunder storm event)
Estimated volume per event		At least 88 ML

Watering Regime

Provide fresh inflows between August and September targeting 115 m AHD (1.2 m depth), five in every ten years to inundate the bed and fringing Black Box zone. Allow depth to recede below Black Box zone (i.e. < 113.8 m AHD) over approximately three months before maintaining the water level with variability over the following 6 to 9 months.

Allow the bed to dry for approximately one to two years before re-watering to promote aquatic plant growth and courage feeding breeding of waterbirds, frogs and turtles.

3. Creswick Swamp

Management Goal

To provide a water regime at Creswick Swamp that supports habitat for waterbirds, in particular breeding and feeding opportunities for Brolga, recruitment of Tangled Lignum and a diversity of native grasses and herb species typical of a Plains Grassy Wetland.

Ecological Objective

Ecological objectives	Justification
1. Maintain diversity of **aquatic vegetation**	- Provide important waterbird feeding, breeding and nesting habitat as well as shelter for frogs and macroinvertebrates - Filters water and assists with nutrient cycling (i.e. bacteria on surface film of plants) - Maintains habitat for a range of threatened plant species
2. Increase extent of **Marbled Marshwort** in bed of wetland	- Marshwort is particularly important at Creswick Swamp being present at only a few locations in Victoria, and Australia as a whole
3. Maintain health and recruitment of **shrubs**	- Shrubs will provide breeding habitat for waterbirds and sanctuary for waterfowl, frogs and macroinvertebrates. Lignum is also effective at catching silt and debris (i.e. contributing to gilgai formation)
4. Re-establish **waterbird breeding and feeding** opportunities, in particularly Brolga	- The herb meadow area of Chirrup Swamp is an historical breeding and feeding ground for Brolga when inundated - Herb-meadow vegetation will provide breeding habitat for waterbirds, particularly ground-nesting species

Hydrological Objective

Timing		Fresh inflows between May and September (with variability outside of this timing in some years)
Watering frequency	Minimum	3 in every 10 years
	Optimum	5 in every 10 years
	Maximum	7 in every 10 years
Ponding duration	Minimum	4 months
	Optimum	6 months
	Maximum	9 months
Duration of dry between events	Minimum	0.5-1 year of dry between events
	Optimum	2 years of dry between events
	Maximum	3 years of dry between events
Extent		0.2-0.4 metres (138.8-139 m AHD) **extent currently unachievable due to road and risk of flooding private land*
Variability		High to moderate- mimic natural variability by providing occasional watering events outside of the optimum timing (i.e. summer fill to mimic summer thunder storm event) however manage wetland in response to waterbird breeding (i.e. Brolga).
Estimated volume per event		At least 14.3 ML

Water Regime

Provide fresh inflows five in every ten years between May and September (earlier in season if targeting lignum germination) targeting 138.8-139 m AHD (0.2-0.4 metres depth). Maintain depth (with variation) for approximately 6-9 months, in response to waterbird breeding.

To promote establishment of lignum seedling, re-wet briefly after 9-12 months of dry. Once established re-wet after 1 to 2 years of dry.

4. Davis Wetland

Management Goal

Provide a water regime that support Black Box and Cane Grass recruitment and support frogs and waterbirds at Davis Wetland

Ecological Objectives

Ecological objective	Justification
1. Maintain **Cane Grass** vegetation	- Provides habitat for ground-nesting waterbirds and frogs - Filters water and adds biological activity
2. Maintain and promote recruitment of **Black Box** vegetation	- Black Box trees support roosting, feeding and breeding (i.e. nests, hollows, fallen timber) for waterbirds and terrestrial fauna (i.e. near threatened Brown Treecreeper and vulnerable Black Falcon)
3. Maintain **frog breeding and feeding** opportunities[1]	- Provision of appropriate habitat to support breeding and feeding

[1] Frog and turtle surveys have not been undertaken at the wetland. Therefore, frog and turtle objectives are based on the vegetation communities present and the proximity to known populations. Further information is required to determine the appropriate trajectory for future management

Hydrological Objectives

Timing		Fresh inflows between August and October (with variability outside of this timing in some years) to ensure inundation in spring
Watering frequency	Minimum	1 in every 10 years
	Optimum	3 in every 10 years
	Maximum	7 in every 10 years

Ponding duration	Minimum	1 months
	Optimum	BED: 6 months FRINGE: 3 months
	Maximum	BED: 9 months FRINGE: 6 months
Duration of dry between events	Minimum	0.5 to 1 year of dry between events
	Optimum	2-3 years of dry between events
	Maximum	7-12 years of dry between events
Extent		0.2-0.4 metres (107-107.2 m AHD)
Variability		High- mimic natural variability by providing occasional watering events outside of the optimum timing (i.e. summer fill to mimic summer thunder storm event
Estimated volume per event		At least 11 ML

Water Regime

Provide fresh inflows three in every ten years between August and October targeting 107.2 m AHD (0.4 metres deep). Maintain inundation with variation for 3-6 months before allowing summer recession. To promote establishment of Black Box, provide shallow follow up inundation, otherwise maintain dry for two to three years before re-wetting.

5. Jeffcott Wetland

Management Goal

To provide a water regime at Jeffcott Wetland that supports healthy Tangled Lignum and Black Box, Cane Grass vegetation and open water typical of a deep freshwater marsh.

Ecological Objectives

Ecological objective	Justification
1. Increase condition of **understorey vegetation**	- Provide breeding habitat for waterbirds and sanctuary for waterfowl, frogs and macroinvertebrates. Lignum is also effective at catching silt and debris - This will assist with reducing the cover and diversity of exotic grasses and promoting an increase in the diversity of native species
2. Maintain/ increase health of **Black Box**	- Black Box provide important fauna habitat (i.e. live, hollows or as woody debris) - Black Box flowers are rich in nectar and pollen providing a valuable food source for native birds, insects and other wildlife
3. Maintain **waterbird feeding and breeding** opportunities	- Diversity of habitat types support a range of food sources including macroinvertebrates, frogs and plant matter and habitat types (i.e. drawdown zones, fringing, littoral and open water)
4. Maintain **frog breeding and feeding** opportunities[1]	- Provision of appropriate habitat to support breeding and feeding
5. Increase **turtle breeding and feeding** opportunities[1]	- Provision of appropriate habitat to support breeding and feeding

[1] Frog and turtle surveys have not been undertaken at the wetland. Therefore, frog and turtle objectives are based on the vegetation communities present and the proximity to known populations (i.e. dam). Further information is required to determine the appropriate trajectory for future management.

Hydrological Objectives

Timing		Fresh inflows between August and October (with variability outside of this timing in some years)
Watering frequency	Minimum	3 in every 10 years
	Optimum	5 in every 10 years
	Maximum	7 in every 10 years

Ponding duration	Minimum	1 month
	Optimum	3 months
	Maximum	6 months
Duration of dry between events	Minimum	0.5 years of dry between events
	Optimum	2 years of dry between events
	Maximum	4-5 years of dry between events
Extent		Up to 1.8 metres (125.8-127.6 m AHD) - not including dam on private property. **extent currently unachievable due to risk of flooding private land*
Variability		High- mimic natural variability by providing occasional watering events outside of the optimum timing (i.e. summer fill to mimic summer thunder storm event)
Estimated volume per event		At least 210 ML

Water Regime

Provide fresh inflows five in every ten years between August and October to target the fringing Black Box zone (up to 127.6 m AHD). Allow water level to recede over following 2-5 months only providing top-ups in response to waterbird breeding.

Allow wetland to remain dry for approximately one to two years before re-watering

6. Jesse Swamp

Management Goal

To provide a water regime that restores Jesse Swamp as a shallow freshwater marsh, dominated by aquatic herbs and grasses (including re-establishment of Marbled Marshwort) and able to support feeding and breeding waterbirds, in particular Brolga.

Ecological Objectives

Ecological objective	Justification
1. Improve diversity of **grassy-herbaceous** flora species	- Provide important waterbird feeding, breeding and nesting habitat - Provides shelter for frogs and macroinvertebrates - Filters water and promotes biological activity
2. Improve diversity and health of **sedge, shrub and emergent vegetation**	- Provide shelter, feeding and breeding opportunities for water dependent fauna (i.e. waterbirds, frogs and turtles) - Filters water and adds biological activity
3. Reinstate extent of **Marbled Marshwort** in the 'Lily Pond' and throughout the wetland bed	- Marshwort is particularly important at Jesse Swamp being present at only a few locations in Victoria, and Australia as a whole
4. Re-establish **waterbird breeding** opportunities, in particularly Brolga	- The Plains Grassy Wetland area of Jesse Swamp is a historical breeding and feeding ground for Brolga when inundated - Plains Grassy Wetland vegetation will provide breeding habitat for waterbirds, particularly ground-nesting species
5. Re-establish **waterbird feeding** opportunities, particularly Brolga	- Plains Grassy Wetland vegetation provides shallow foraging opportunities for waterbirds, and is particularly productive following periods of dry. - Historically supported Brolga, Black Swan and Yellow-billed Spoonbills

Hydrological Objectives

Timing		Fresh inflows between July and October (with variability outside of this timing in some years)
Watering frequency	Minimum	3 in every 10 years
	Optimum	5 in every 10 years
	Maximum	7 in every 10 years
Ponding	Minimum	FRINGE (Freshwater Lignum- Cane Grass Swamp area): 2 months

duration		BED: 3 months
	Optimum	FRINGE (Freshwater Lignum- Cane Grass Swamp area): 3-4 months BED: 6 months
	Maximum	FRINGE (Freshwater Lignum- Cane Grass Swamp area): 6 months BED: 9 months
Duration of dry between events	Minimum	0.5 years of dry between events
	Optimum	2 years of dry between events
	Maximum	3-4 years of dry between events
Extent		FRINGE (Freshwater Lignum- Cane Grass Swamp area): 0.2 metres (159-159.2 m AHD) BED: up to 1.4 metres deep (157.6-159 m AHD)
Variability		Moderate- mimic natural variability by providing occasional watering events outside of the optimum timing (i.e. summer fill to mimic summer thunder storm event), however manage in response to waterbird breeding i.e. brolga.
Estimated volume per event		At least 118 ML

Water Regime

Provide fresh inflows five in every ten years between July and October to inundate the bed and fringing zone (approximately 159.2 m AHD). Maintain at approximately 159-159.2 m AHD for 2-4 months before allowing wetland to recede over following 4-9 months. Provide top-ups in spring, if required to maintain conditions for waterbird breeding.

Allow wetland to remain dry for approximately 1-3 years before rewetting

Appendix 11: Photopoint monitoring sites

Chirrup Swamp
DESCRIPTION: At opening of track to dam

Corack Lake
DESCRIPTION: At opening of track to dam

Creswick Swamp
DESCRIPTION: At opening of track to dam

Davis Dam
DESCRIPTION: Centre of south edge

Falla Dam
DESCRIPTION: At top of ridge near road

Jeffcott Wetland
DESCRIPTION: Next to inlet to dam

Jesse Swamp
DESCRIPTION: At southern edge of dam (to right of fallen tree)

Appendix 12: Long term recommended watering regime

		Historical watering			Possible future environmental water delivery (next ten years)									
		2012-13	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Chirrup Swamp	Wetland	W-D	D	D	Dependent on natural flooding									
	Dam	W	W	W	W	W	W	W	W	W				
Corack Lake	Wetland	W-D	D	D	D	DWD	D	DWD	DWD	DWD	D	DWD	DWD	DWD
	Dam	W	W-D	DWD	DWD	DWD	DWD	DWD	DWD	DWD	DWD	DWD	DWD	DWD
Creswick Swamp	Wetland	W	W-D	D	D	DWD	D	DWD	D	DWD	D	DWD	D	DWD
	Dam	W	W-D	DWD	W	W	W	W	W	W	W	W	W	W
Davis Dam	Wetland	D	D	D	DWD	D	D	D	DWD	D	D	D	D	DWD
	Dam	D	D	D-W	W	W	W	W	W	W	W	W	W	W
Falla Dam	Wetland	W	W	W	W	W	W	W	W	W				
Jeffcott Wetland	Wetland	W	W-D	D	Dependent on natural flooding									
	Dam	W	W	W	W	W	W	W	W	W				
Jesse Swamp	Wetland	W-D	D	D	DWD	D	DWD	D	DWD	D	DWD	D	DWD	DWD
	Dam	W-D	D	D-W	DWD	D	DWD	D	DWD	D	DWD	D	DWD	DWD