Nyah and Vinifera Environmental Water Management Plan

mallee catchment management authority

Department of Environment, Land, Water & Planning

State Government Victoria

DOCUMENT CONTROL

Revision and Distribution

Version no.	Description	Issued to	Issue date
1	Report structure updated following comments from EWR team	EWMP working group across CMAs and DSE	19 October 2010
2	Report structure updated following working group discussion	EWMP working group (northern Victorian CMAs)	2 February 2011
3	Report structure updated following working group discussion	EWMP working group (northern Victorian CMA's)	25 February 2011
4	Working draft distributed to accompany EWMP purpose document Working draft distributed at inception meeting for Basin Plan EWMP program	EWMP working group (State wide CMA' representatives, VEWH) Basin CMA's, VEWH and scientific panel (T Hillman and J Roberts)	27 June 2012 17 December 2013
5	Guidelines updated following feedback from 17 December meeting	Basin CMA's and scientific panel (T Hillman and J Roberts)	24 January 2014
6	Working draft		16 November 2015
8	External Review		
9	Updated Environmental Watering	Emma Healy	23 May 2017
10	Updated Environmental Watering and included the Broad Shelled Turtle finding in Nyah	Jane White	19 February 2018

Citation

Please cite this document as:

Mallee CMA (2015) *Nyah and Vinifera Environmental Water Management Plan*, Mallee CMA, Mildura Victoria

Contact

For further information on any of the information contained within this document contact:

Louise Searle

Coordinator Waterways

Mallee Catchment Management Authority

Executive summary

Environmental Water Management Plans (EWMPs) have been developed for key sites in the Mallee region. This EWMP covers two sites, Nyah Park and Vinifera Park, which are located adjacent to each other on the Murray River Floodplain. Whilst having similar ecological objectives the two sites have different water requirements and can be operated independently with the proposed infrastructure in place.

The Nyah Park floodplain is located 30 km north of Swan Hill between Nyah and Wood Wood. It comprises 637 ha, dominated by River Red Gum forest, wetlands and Black Box woodlands at higher floodplain elevations. The main watercourse in the Park is the Parnee Malloo Creek and adjacent floodplain depressions. Nyah Park is a low-lying floodplain that would have been inundated most years at Murray River flows of 25,000 ML/d. River regulation has reduced the flood frequency and duration resulting in a decline in the condition of floodplain health.

The Vinifera Park floodplain is located 20 km north-west of Swan Hill, in the Murray Fans bioregion comprising an area of 488 ha. The floodplain runs parallel to the Murray River, and is one of the most downstream areas of the central River Red Gum forests. The floodplain includes wetland, forest and woodland areas. Under a natural flow regime, the wetlands within the Vinifera floodplain would have been flooded almost annually and frequently remained flooded throughout the year.

A high diversity of native flora has been recorded in the Nyah-Vinifera area including 6 VROT[1]s listed species at Nyah Park and 12 VROTs listed species at Vinifera Park (one of these species is also listed under the FFG Act).

Threatened fauna species recorded within the Nyah-Vinifera Forest include Eastern Great Egret (*Ardea modesta*), Grey-crowned Babbler (*Pomatostomus temporalis*), Broad Shelled Turtle *(Chelodina expansa)*, Regent Parrot (*Polytelis anthopeplus monarchoides*), White-bellied Sea Eagle (*Haliaeetus leucogaster*) and Growling Grass Frog (*Litoria raniformis*).

Nyah Vinifera is of importance to the Wadi Wadi people and contains numerous cultural heritage sites including scarred trees, middens, earthen ovens and burial sites.

The Nyah and Vinifera Parks are included in the Basin Plan's Sustainable Diversion Limit (SDL) Adjustment Mechanism projects aimed at improving the efficiency of water delivery to water dependant ecosystems. This is achieved through infrastructure that will target water dependant habitat and assist with inundation at lower river flows.

The infrastructure proposed for Nyah and Vinifera aims to restore the integrity and productivity of the ecosystems by increasing the frequency and duration of floodplain inundation, and will provide for up to 476 ha of inundation of water dependant habitat at Nyah and 340 ha at Vinifera (Ecological Associates 2014a).

The long term management goal for Nyah and Vinifera is:

"To restore the key species, habitat components and functions of the Nyah and Vinifera Park ecosystem by providing the hydrological environments required by indigenous plant and animal species and communities".

To achieve this, ecological and hydrological objectives have been designed for four water regime classes at Nyah Park and five water regime classes at Vinifera Park (Ecological Associates 2014a). These have been developed to sustain various ecological components of the two parks and have

[1] Victorian Rare or Threatened species

been incorporated into minimum, optimal and maximum long-term watering regimes. The ecological objectives for both the Nyah and Vinifera parks are the same, and are outlined below:

- Restoring the vegetation structure of wetland plant communities;
- Re-establishing resident populations of frogs and small fish;
- Providing seasonal feeding and reproductive opportunities for riverine fish species;
- Providing reliable breeding habitat for waterbirds, including colonial nesting species;
- Restoring floodplain productivity to maintain resident populations of vertebrate fauna including Carpet Python, Sugar Glider and Grey-crowned Babbler; and
- Contributing to the carbon requirements of the River Murray channel ecosystem.

The ecological objectives will be achieved by providing water requirements of the Nyah and Vinifera floodplains.

This Environmental Water Management Plan (EWMP) sets out the long-term objectives for the priority environmental values of two sites; Nyah Park and Vinifera Park. It will help to guide future environmental watering activities for these areas; however significant infrastructure will be required to fully implement this EWMP. The infrastructure outlined in the document is proposed only and requires further design and funding. This EWMP is not a holistic management plan for Nyah and Vinifera but is focused on environmental water management. A regional context document has been created and provides further information on the region, and complements the Mallee CMAs EWMPs and should be read in conjunction with this document (Sunraysia Environmental, 2014).

Contents

Table index

Figure index

Appendices

Appendix 1 – Flora and Fauna Species List

Appendix 2 - Recent watering history

Appendix 3 - Index of Wetland Condition Assessment

.

Acknowledgements

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

1. Introduction

This Environmental Water Management Plan (EWMP) has been prepared to establish the long-term management goals for Nyah and Vinifera Parks.

The key purposes of EWMPs are to:

- Identify the long-term objectives and water requirements for the wetlands, identified as a high priority by the Mallee CMA;
- Establish links between identified ecological values and suggest appropriate environmental watering objectives supported by monitoring programs and the identification of specific knowledge gaps;
- Provide a vehicle for community consultation, including for the long-term objectives and water requirements of the wetlands;
- Inform the development of seasonal watering proposals and seasonal watering plans; and
- Inform long-term watering plans that will be developed under Murray-Darling Basin Plan requirements.

Key documents that support this Nyah Vinifera EWMP are shown in Table 1.

Table 1 - Key support documents to the Nyah Vinifera EWMP

Name	Author	Summary
Investigation of Water Management Options for the Murray River – Nyah to Robinvale	Ecological Associates 2007	• Identifies management units • Identifies ecological values • Develops objectives • Defines water regimes • Identifies threats • Proposes management actions
Water Management Options for the Murray River – Nyah to Robinvale, Stage II	Ecological Associates 2007	• Costs designs • Proposes alternative water management options • Documents environmental impacts • Documents Cultural heritage values
Mallee Waterway Strategy	Mallee CMA 2014	• Sets regional goals for waterway management that align with the Mallee RCSs broader objectives • Identifies high value waterways • Details strategic work programs for priority waterways • Identifies the roles and responsibilities of regional stakeholders • Establishes principles to guide the implementation
Regional Context Document for Environmental Water Management Plans; Mallee CMA Region	Sunraysia Environmental 2014	• Background context the region • Outlines significant wetlands and river • Sources of environmental water • Policy, legislative and planning frameworks

SDL Floodplain Watering Project Reports	Ecological Associates 2014	• Ecological Values • Ecological Objectives • Anticipated Ecological Benefits and Impacts • Hydrology of the Area and Environmental Water Requirements • Business Case • Risk Assessment
Concept designs	Jacobs 2014	• Hydrodynamic modelling • Advanced concept designs

2. Site Overview

The Mallee CMA region is located in the north-west of Victoria covering approximately 39,000 km² with an estimated regional population of 65,000. The catchment runs along the Murray River from Nyah to the South Australian border, and as far south as Birchip and Rainbow (MCMA 2014). Major towns include Mildura, Birchip, Sea Lake, Ouyen, Robinvale, Red Cliffs and Merbein. The region has a semi-arid climate, with an annual mean rainfall of around 250 mm and average daily temperatures (at Mildura) ranging from 32°C in summer to 15°C in winter (MCMA 2006).

The mean annual rainfall at Nyah is 303 mm with average daily temperatures (at Swan Hill) ranging from 33°C in summer to 14.7°C in winter (Bureau of Meteorology 2015).

The Mallee CMA region consists of 38% public land which is mainly national parks, reserves and large reaches of riverine and dryland state forest. The rest of the region is important for dryland farming of cereal crops and sheep; and irrigated horticulture.

In 2006 the Mallee CMA engaged consultants Ecological Associates to investigate water management options for the Murray River floodplain from Nyah to Robinvale. One of the major outcomes of these investigations was the development of a system of floodplain Management Units (WMUs). These divide the floodplain into management units in which water regimes can be managed independently of another WMUs are relatively consistent in their ecological values and land uses. The Mallee CMA has used WMUs to inform planning and development of environmental water management plans to achieve more effective management of hydrologically connected systems. In addition to this, the Mallee CMA has also used individual WMUs or groupings of WMUs to form Waterway Management Units (WMU) for planning within its Mallee Waterway Strategy (MCMA 2014). Nyah and Vinifera Parks are within the Nyah WMU (Figure 1).

The Nyah floodplain is located between 1341 and 1356 River Murray km. The neighbouring Vinifera floodplain is located between 1356 and 1367 River Murray km.

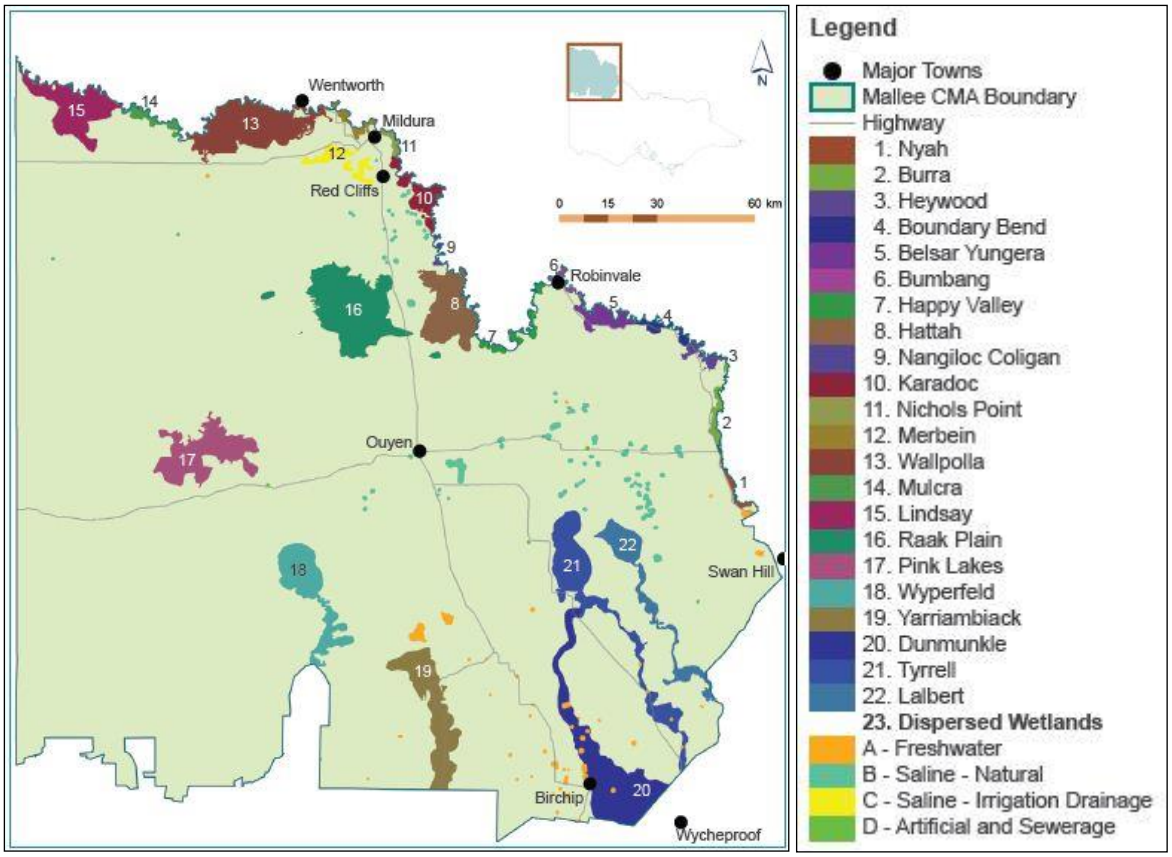


Figure 1 - Mallee Water Management Units (Mallee CMA, 2014)

2.4 Catchment Setting

Nyah and Vinifera Parks are located in the Murray Fans bioregion. The Murray Fans bioregion is characterised by a flat to gently undulating landscape on recent unconsolidated sediments with evidence of former stream channels, old river meanders and palaeochannels and broad floodplain areas associated with major river systems and prior steams (known as braided / anastomosing streams). Alluvium deposits from the Cainozoic period gave rise to the red brown earths and texture contrast soils (Dermosols, Kurosols, Chromosols and Sodosols).

Two aquifers are present in the area, the uppermost Channel Sands which is restricted to the Murray River trench, and the lower Parilla Sand which is of regional extent. Within the trench the two aquifers are locally separated by a discontinuous layer of Blanchetown Clay, allowing considerable hydraulic connection between the two layers. Regional groundwater flow is westerly around Nyah, and to the west of Nyah it has a steep westerly gradient away from the river towards the Towan Plain groundwater discharge basin.

The regional groundwater salinity in the Parilla Sand aquifer exceeds 40,000 EC near Nyah. Salinities exceeding 60,000 EC are associated with groundwater discharge zones at Towan Plain west of Nyah, and Bailey's Plains west of Piangil. A zone of less saline groundwater in the Parilla Sand aquifer parallels the river, but extends only 3 to 5 kilometres to the west. Groundwater dilution is more pronounced where greater hydraulic connection exists between the deep and shallow aquifers near the river. During the time of this study, irrigation impact on groundwater was not considered as a major concern with the existing groundwater gradient away from the river. Poor irrigation techniques could result in the displacement of large salt loads to the river however maintaining or improving current irrigation practices should prevent this occurring (MCMA 2012).

2.4 Site Descriptions

Nyah Park

Nyah Park is located north of the locality of Nyah, 30 km north of Swan Hill. The Nyah Park floodplain includes 913 ha of wetland, forest and woodland areas. The floodplain is a shallow basin aligned parallel to the River Murray. It is formed between the high ground of natural levee along the river bank in the east and the terrestrial landscape to the west. Parnee Malloo Creek is an intermittently flowing anabranch that meanders through the floodplain over a distance of 16 km. The creek departs from the River Murray near Nyah at 1353 river km and re-joins the river near Wood Wood at 1346 river km. Shallow wetland depressions adjacent to the creek are filled by water spilling from the creek and by minor effluents in the river levee (Ecological Associates 2006). See Figure 2.

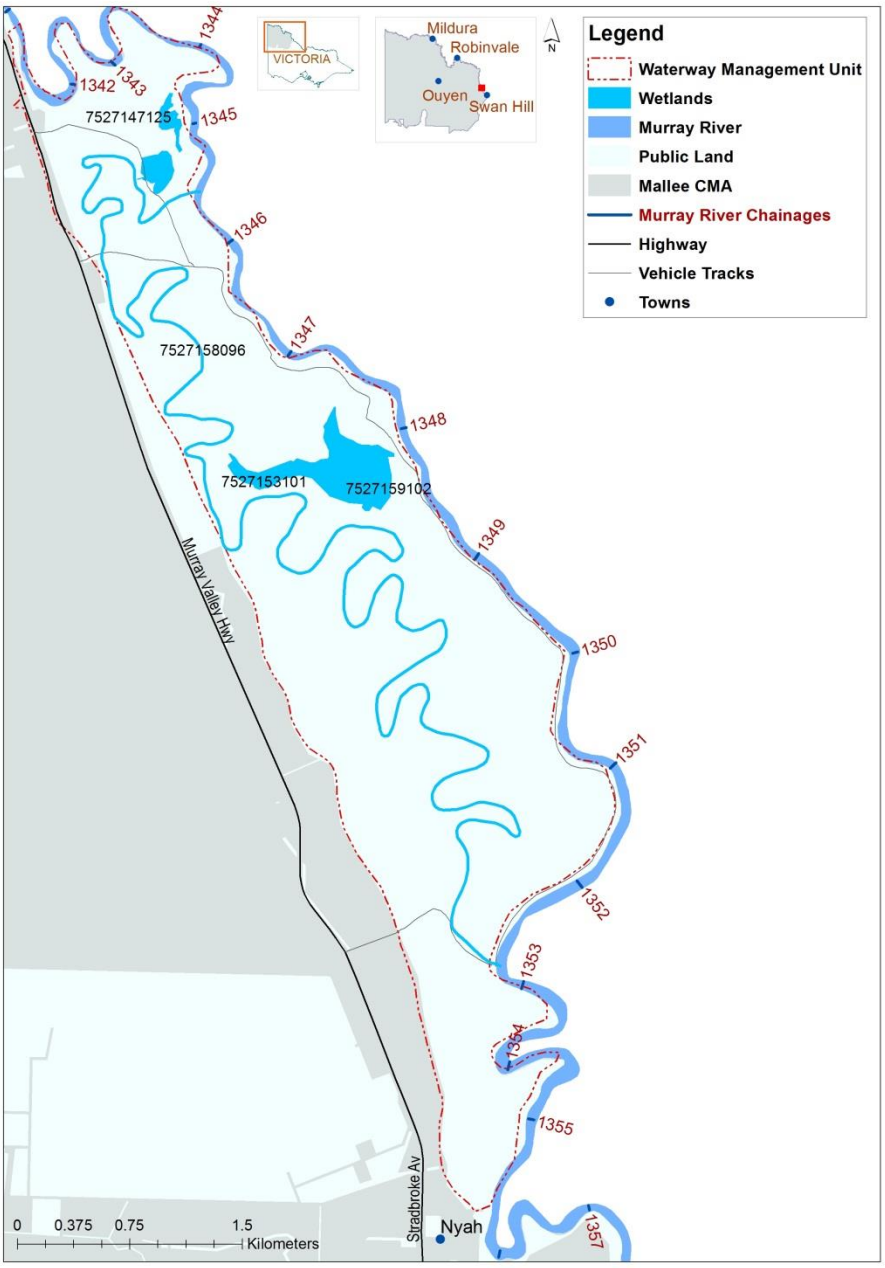


Figure 2 - Wetlands within Nyah Park

Vinifera Park

Vinifera Park is located between Nyah and Swan Hill, downstream of Nyah Park. The Vinifera floodplain spans across 638 ha and is an elongate basin aligned parallel to the River Murray. The basin is formed between the terrestrial landscape to the south and the natural levee of the river bank to the north. An artificial levee has been constructed at the eastern boundary of the Park and reduces private land flooding upstream by isolating it from the flooding in the Vinifera Park (Ecological Associates, 2014a).

The floodplain is a network of waterways, wetlands and inundation-dependent woodlands that receive water from the River Murray via Vinifera Creek. Historically the creek was an anabranch of the Murray River however modifications to the upstream end of the creek means it now functions as a separate wetland (Ecological Associates, 2014a). See Figure 3.

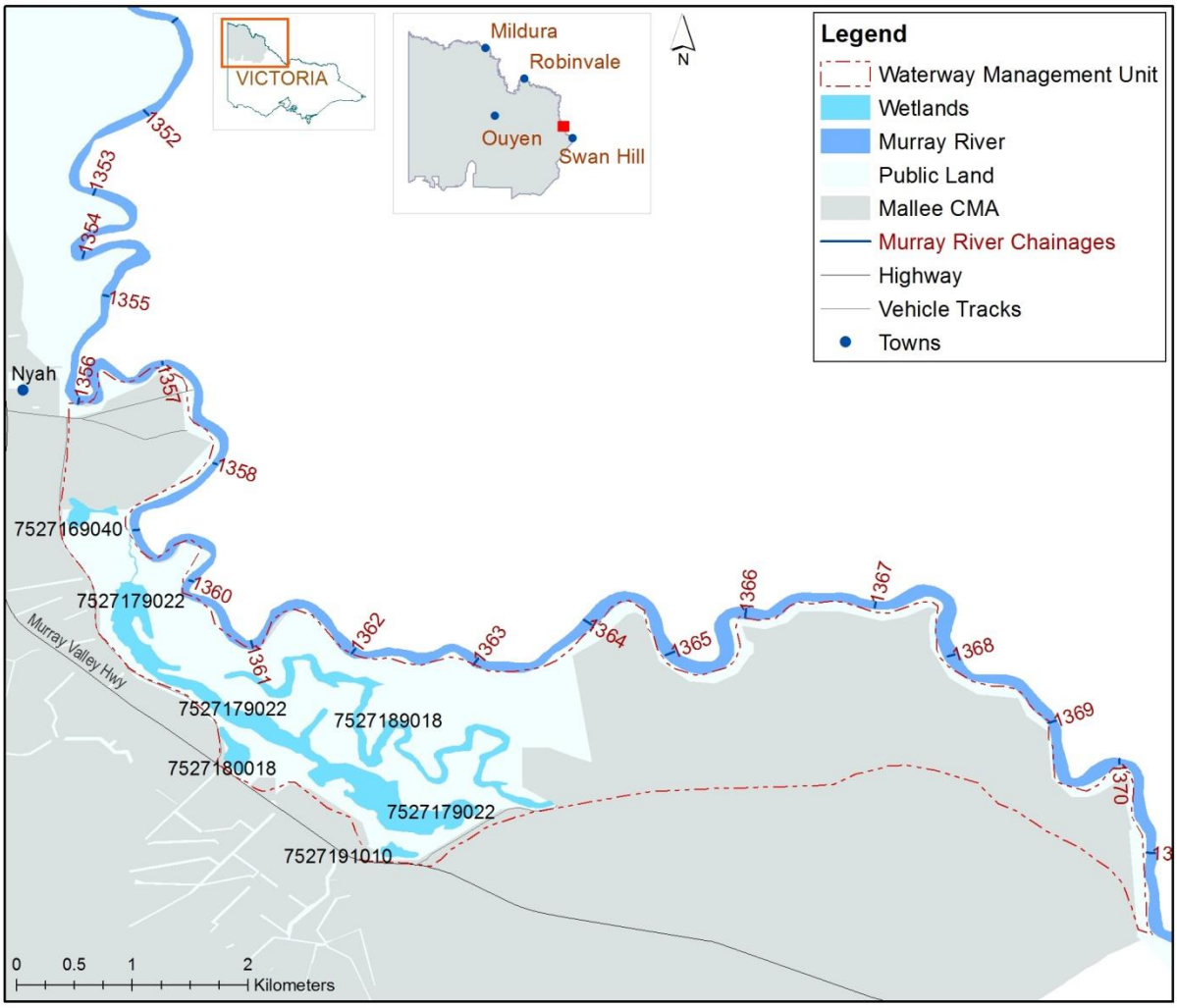


Figure 3 - Wetlands within Vinifera Park

2.2 Conceptualisation of the Site

Conceptual models of both Nyah Park (Figure 4) and Vinifera Park (Figure 5) have been developed. These models provide a visual representation of the main features and processes that are discussed throughout this document. The models highlight the changing elevation of the landscape and where significant values are present. Ecological objectives have been set to protect these values. Water regimes classes have been used to group ecological vegetation classes with common water requirements, based on their elevation in the landscape (see Table 2 and Table 3 for additional details on watering class regimes).

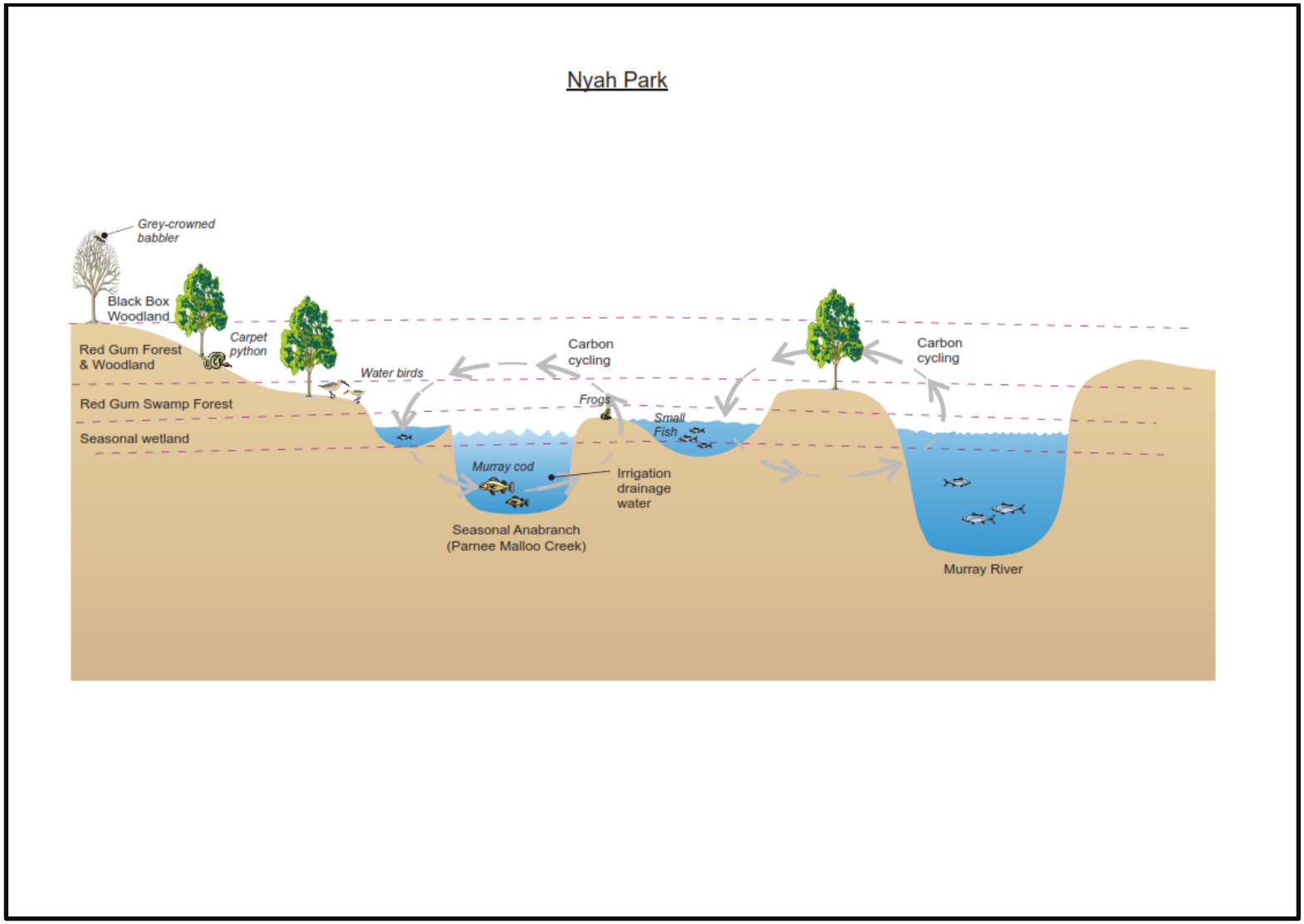


Figure 4 - Conceptual model of the Nyah landscape

Table 2 - Nyah Park Water Regime Classes and water dependant ecological values

Water Regime Class	Ecological values
Seasonal Anabranch	River Red Gum Aquatic macrophytes Murray Cod
Seasonal Wetland	River Red Gum Aquatic macrophytes Native fish Native frogs Murray Cod Habitat for waterbirds, including colonial nesting species
Red Gum Swamp Forest	River Red Gum Habitat for waterbirds, including colonial nesting species Carpet Python, Sugar Glider and Grey-crowned Babbler Organic carbon
Red Gum Forest and Woodland	River Red Gum Habitat for waterbirds, including colonial nesting species Carpet Python, Sugar Glider and Grey-crowned Babbler Organic carbon

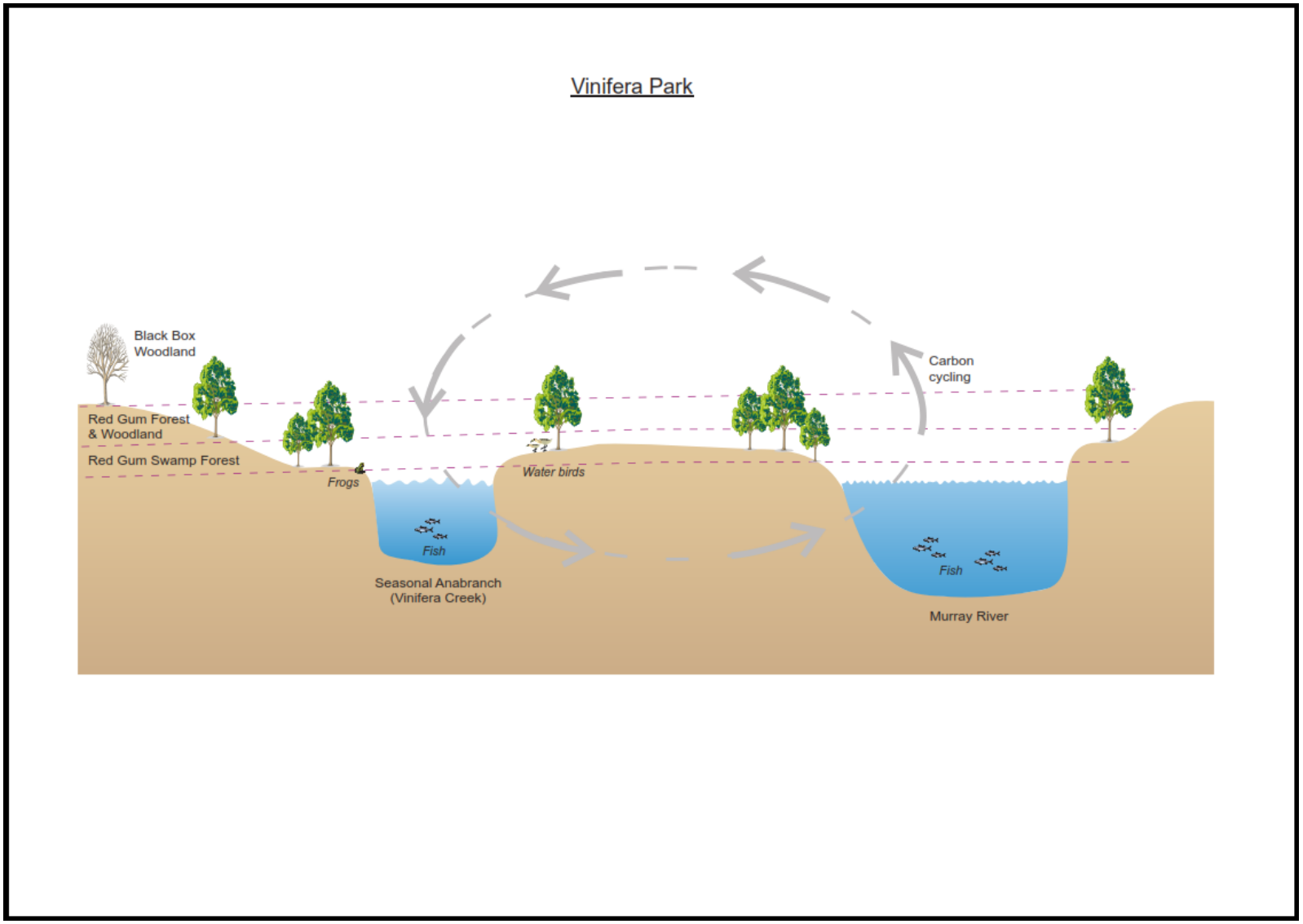


Figure 5 - Conceptual model of the Vinifera landscape

Table 3 - Vinifera Park Water Regime Classes and water dependant ecological values

Water Regime Class	Ecological values
Seasonal Wetland	River Red Gum Aquatic macrophytes Native fish Native frogs Habitat for waterbirds, including colonial nesting species
Red Gum Swamp Forest	Native fish Native frogs Habitat for waterbirds, including colonial nesting species Organic carbon
Red Gum Forest and Woodland	Native fish Native frogs Habitat for waterbirds, including colonial nesting species Carpet Python, Sugar Glider and Grey-crowned Babbler Organic carbon
Black Box Woodland	Habitat for waterbirds, including colonial nesting species Carpet Python, Sugar Glider and Grey-crowned Babbler Organic carbon

2.4 Land status and management

There are many agencies and individuals involved in managing the public and private land in the Nyah and Vinifera parks. Land management boundaries are shown in

(Nyah) and Figure 7 (Vinifera).

The Nyah and Vinifera parks have historically been managed by the Department of Environment, Land, Water and Planning and its predecessors as State Forest since the 1989 Land Conservation Council Final Recommendations (Land Conservation Council, 1989). Under recommendations from the Victorian Environmental Assessment Council River Red Gum Forests Investigation (VEAC 2008, p 67) the area has been declared a regional park with Parks Victoria as the land manager. This recommendation came into effect in July 2010. It is expected that in future, there will be co-management between the Wadi Wadi community, Parks Victoria and Department of Environment, Land, Water and Planning.

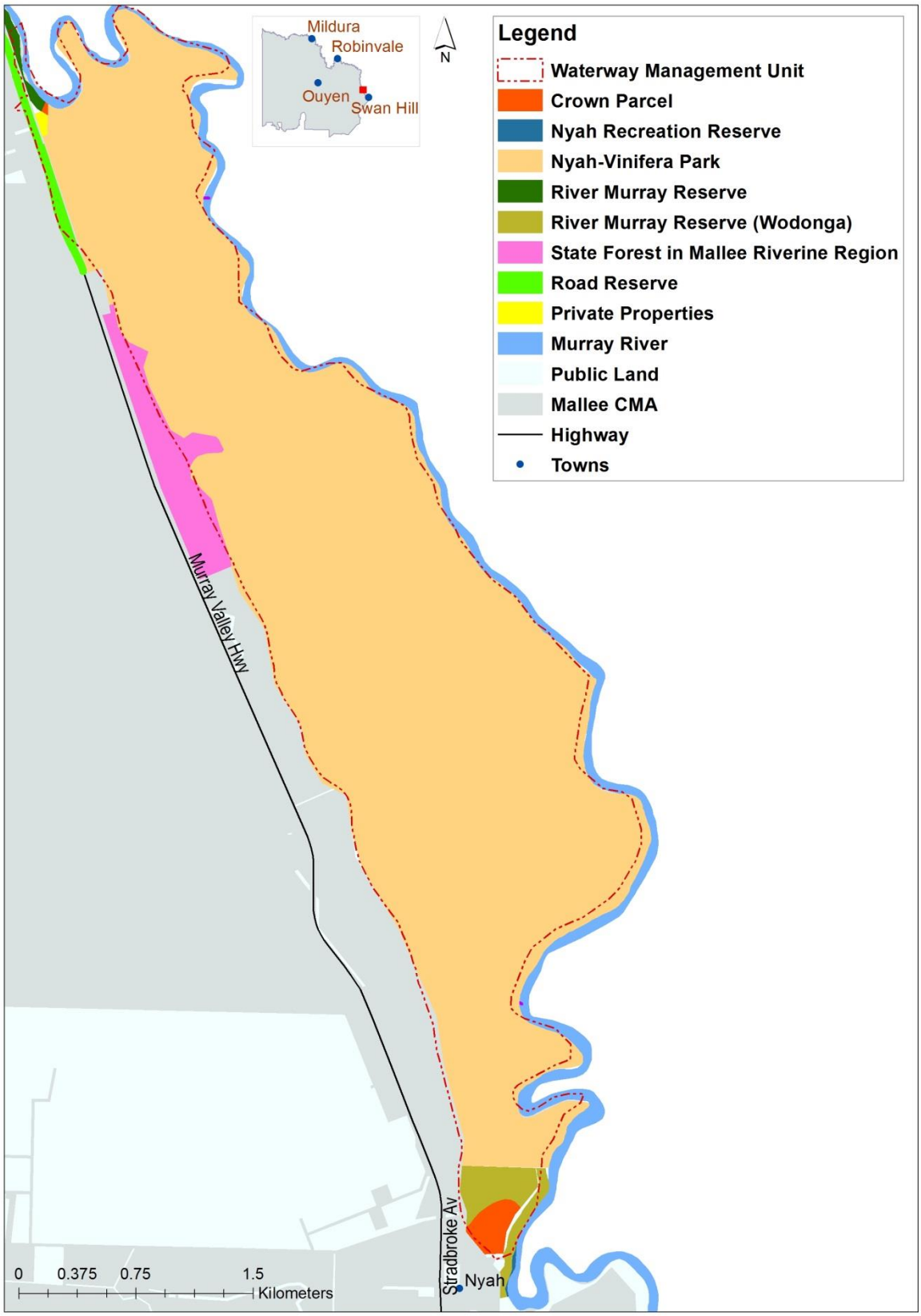


Figure 6 – Nyah Park Land Tenure

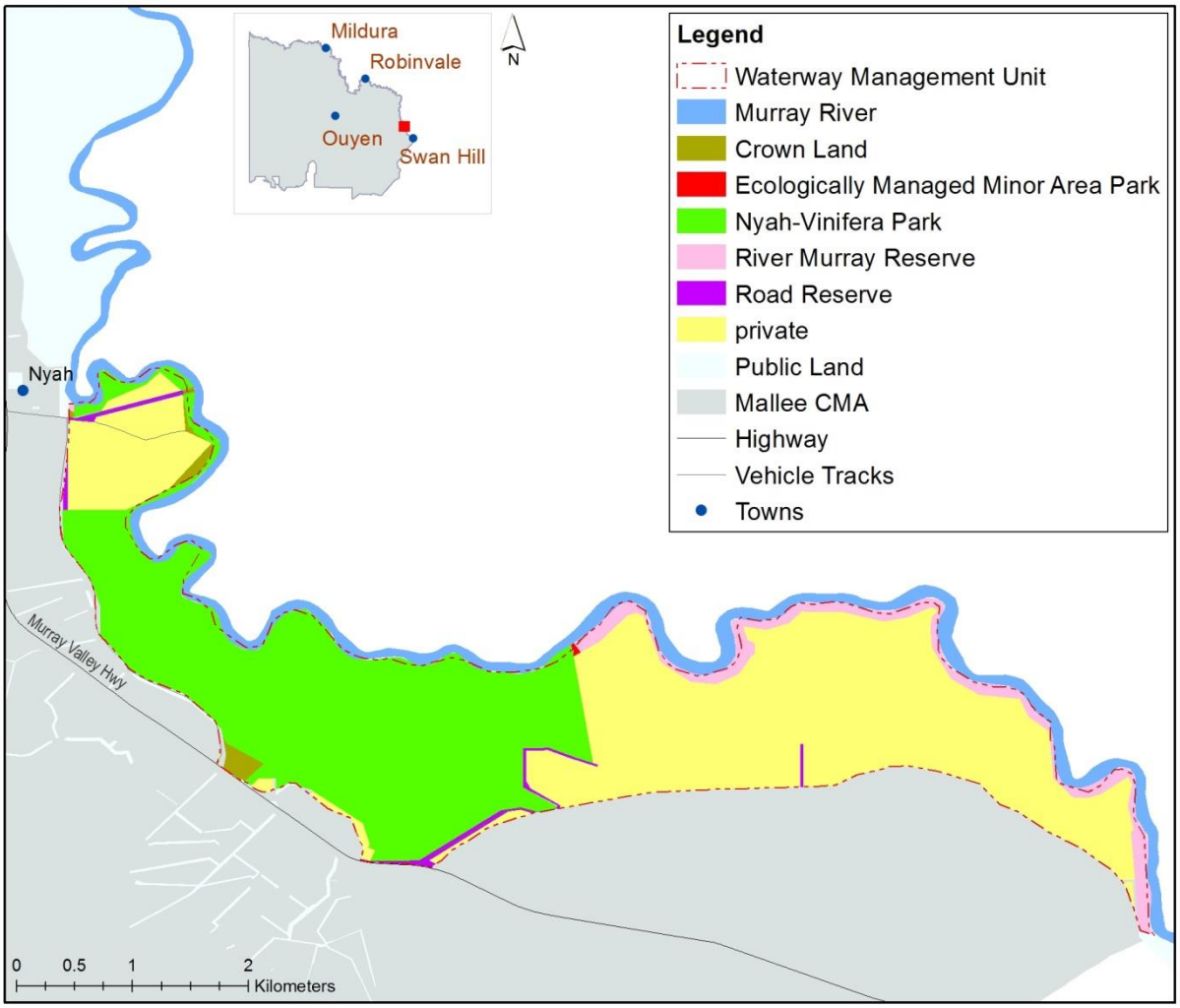


Figure 7 - Vinifera Park Land Tenure

Stakeholders associated with or interested in environmental water management outcomes for Nyah and Vinifera are listed in Table 4.

Table 4 - Stakeholders for Nyah and Vinifera

Group	Role
Parks Victoria	Land Manager. Parks Victoria is responsible for Conserving Victoria's Special Places with the aim to ensure that our valued parks, and the natural assets and cultural heritage they hold, can be enjoyed now and by future generations.
Mallee CMA	The Mallee CMA's responsibility is to ensure that natural resources in the region are managed in an integrated and ecologically sustainable way, including the regional environmental management.
Department of Environment, Land, Water and Planning	State level environmental water management planning, threatened species manager

Group	Role
Victorian Environmental Water Holder	Management of environmental water holdings since July 1 2011.
Mildura Rural City Council	Local Government. Mildura Rural City Council has a number of Water Management Programs to save water resources and improve the health of our waterways. They are responsible for disposing of storm water from Mildura into the southeast drainage basins and for recreational planning.
Aboriginal Stakeholders	Aboriginal Stakeholders. Provides assistance in planning and implementation of programs.
Local Landholders	Surrounding land users, provide assistance in planning and implementation of programs.
Friends of Nyah Forest	Local interest group
Mid Murray Field Naturalists	Flora and Fauna interest
Residents of Nyah, Vinifera, Wood Wood	Social and recreational use

2.6 Wetland characteristics

An overview of the main characteristics of the target areas in both the Nyah and Vinifera parks is outlined in Table 5 and Figure 8 and Figure 9.

Table 5 - Wetland characteristics of Nyah and Vinifera

Characteristics	Nyah	Vinifera
Mapping ID within area (numbers follow Corrick and Norman numbering system)	#7527147125 #7527153101 #7527149129 #7527158096 #7527159102 #7527184029 #7527195021	#7527179022 (Vinifera Creek Wetland) #7527169040 #7527189018 #7527191010 #75274180018
Wetland ID (current)	12583 12584	12507 12508 (Vinifera Creek) 12509 12512
Area (ha)	#7527147125 (1.77) #7527153101(4.05) #7527158096 (48.79) #7527159102 (13.96) **Total =68.57 ha**	#7527179022 (53.99) #7527169040 (3.73) #7527189018 (33.06) #7527191010 (2.14) #75274180018 (4.39) **Total = 97.31ha**
Bioregion	Murray Fans	

Characteristics	Nyah	Vinifera
Conservation status	Vulnerable, Depleted, Least Concern	
Land status	Regional Park	
Land manager	Parks Victoria	
Surrounding land use	Regional Park, broad acre dryland cropping, irrigated horticulture, rural townships	
Water supply	Natural inflows from Murray River 12,000ML/day at river gauge 409204	Natural inflows from Murray River 12,500ML/day at river gauge 409204
1788 wetland category	Deep Freshwater Marsh Shallow Freshwater Marsh	
1994 wetland category and sub-category	Deep marsh - open water shallow marsh – herb shallow marsh – lignum	Deep marsh - open water

Characteristics		Nyah	Vinifera
Current wetland categories	Aquatic system	Palustrine or lacustrine	Palustrine or lacustrine
	Salinity regime	Saline	Fresh
	Water regime	Periodically inundated- episodic	Periodically inundated- episodic Periodically inundated- seasonal or episodic (Vinifera Creek)

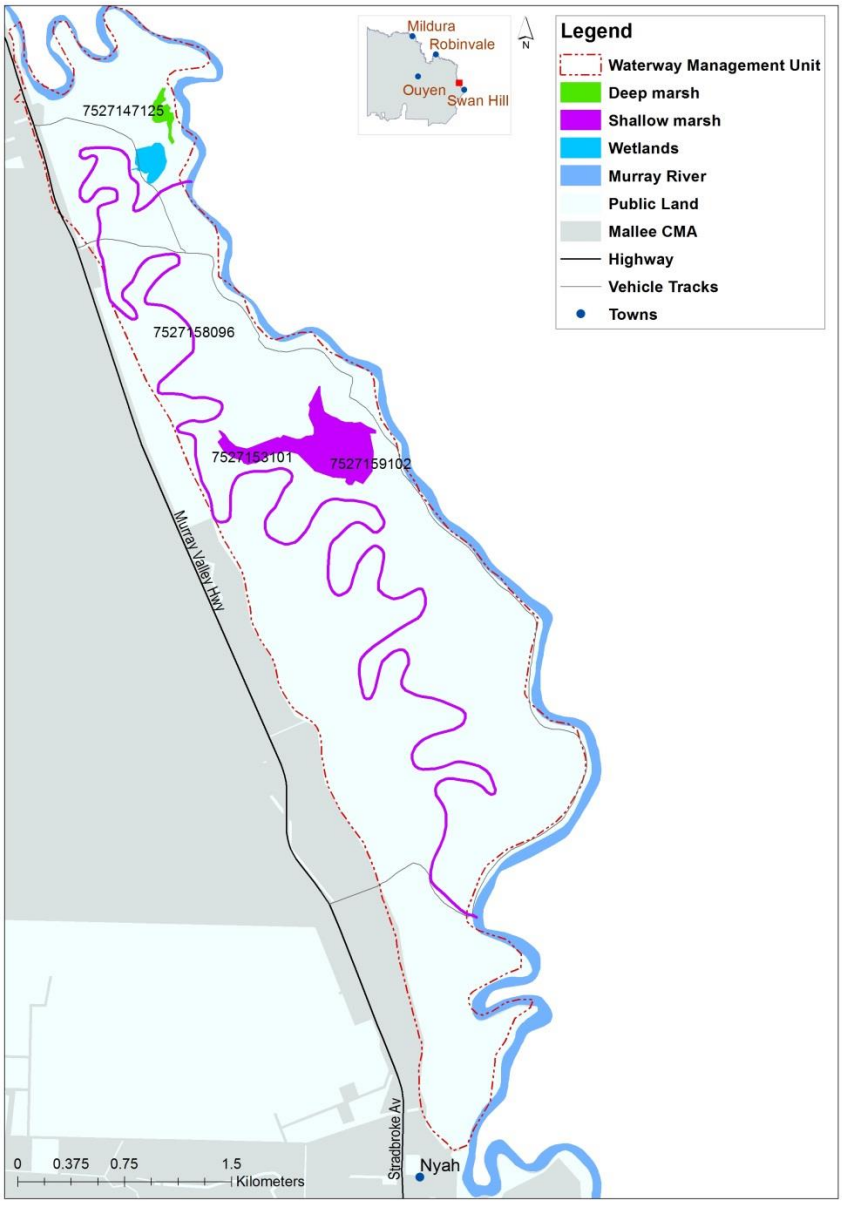


Figure 8 - Nyah Wetland Classification (Corrick and Norman)

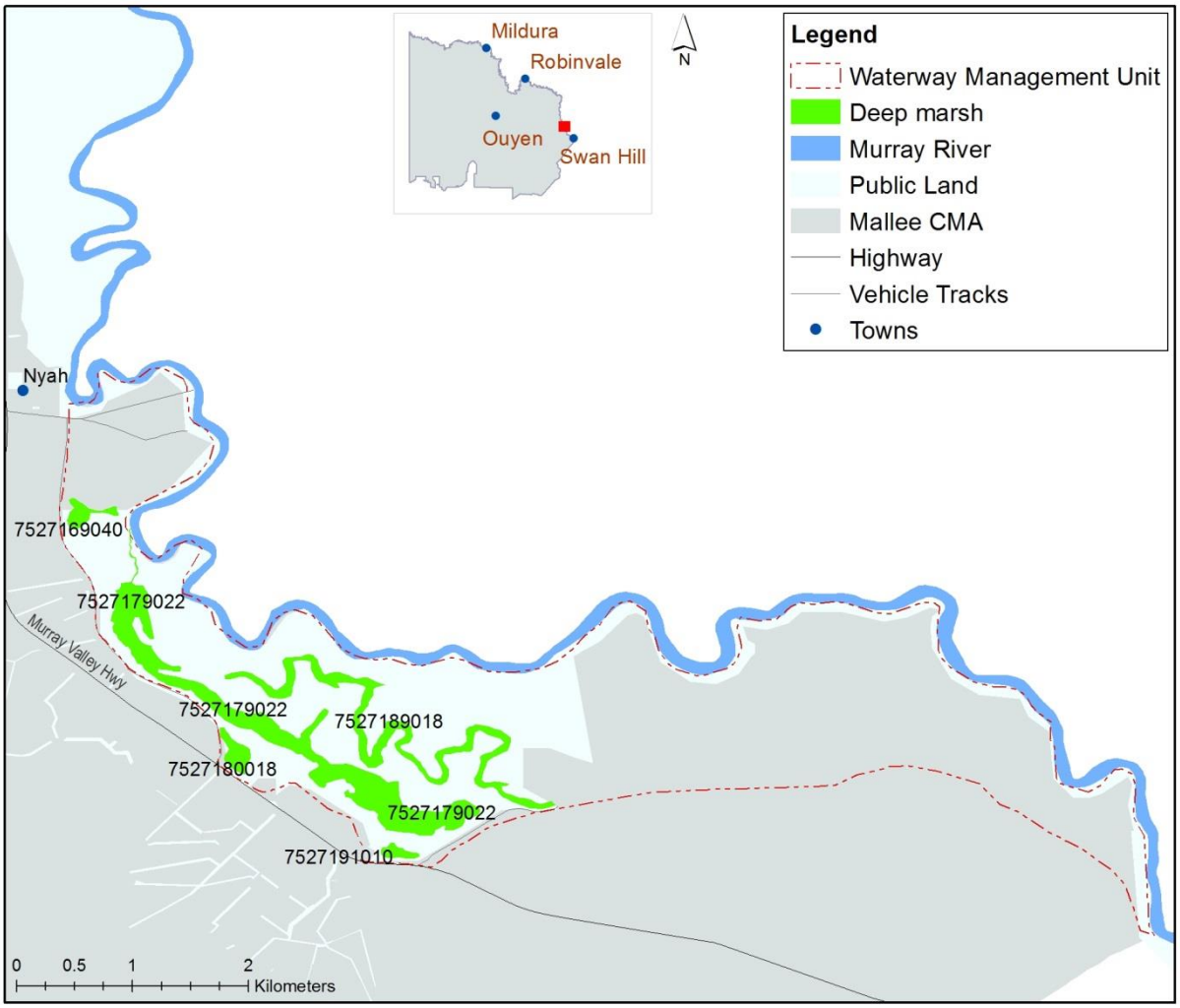


Figure 9 - Vinifera Wetland Classification (Corrick and Norman)

2.7 Management Scale

The whole of the Nyah and Vinifera Parks has a water requirement as a floodplain complex, but the focus for this plan is restricted to specific target areas within both Nyah and Vinifera Parks.

Nyah Park Target Area

The target area is based on the area that can be influenced by works proposed in the Nyah-Vinifera Sustainable Diversion Limit Business Case including track raising and regulators. These are fully detailed in section 8.2. These works will provide inundation of almost 500 hectares of inundation-dependant habitat with a water level of 63.2 m AHD (Ecological Associates 2014b). This includes the Parnee Malloo Creek, seasonal wetlands, Red Gum Swamp Forest and Red Gum Forest Woodlands (see Figure 10).

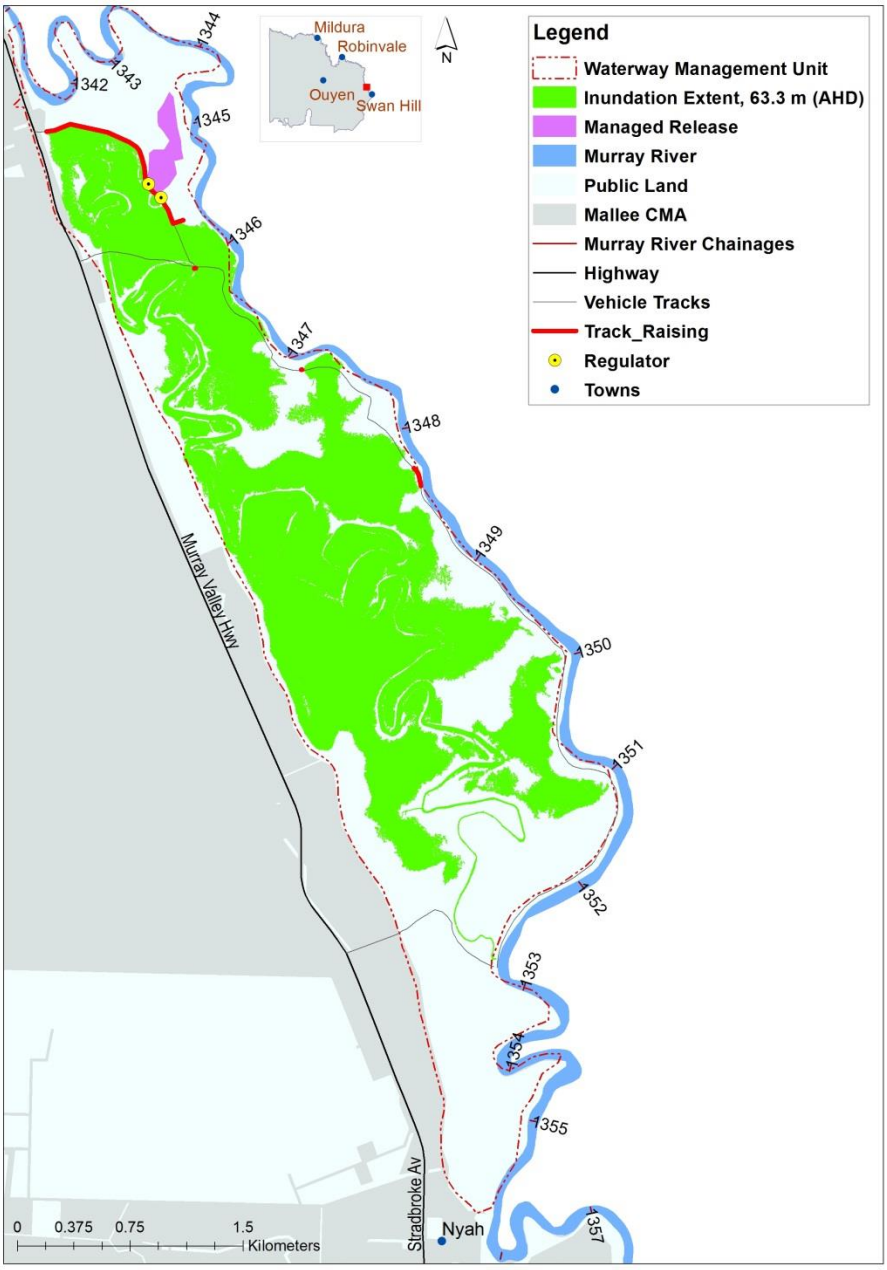


Figure 10 - Nyah target area (Inundation areas)

Vinifera Park Target Area

The target area is based on the area that can be influenced by the works proposed in the SDL Business case, which includes regulators, track raising, pipe culverts and overflow sills. These are fully detailed in section 8.2. This will provide inundation of almost 350 hectares of inundation-dependant habitat with a water level of 64.4 m AHD. This represents 55% of the total forest area and almost all of the flood dependent communities found within the forest (Ecological Associates 2014c). This includes the Vinifera Creek, seasonal wetlands, River Red Gum Swamp Forest, River Red Gum Forest Woodlands and Black Box Woodlands. See Figure 11.

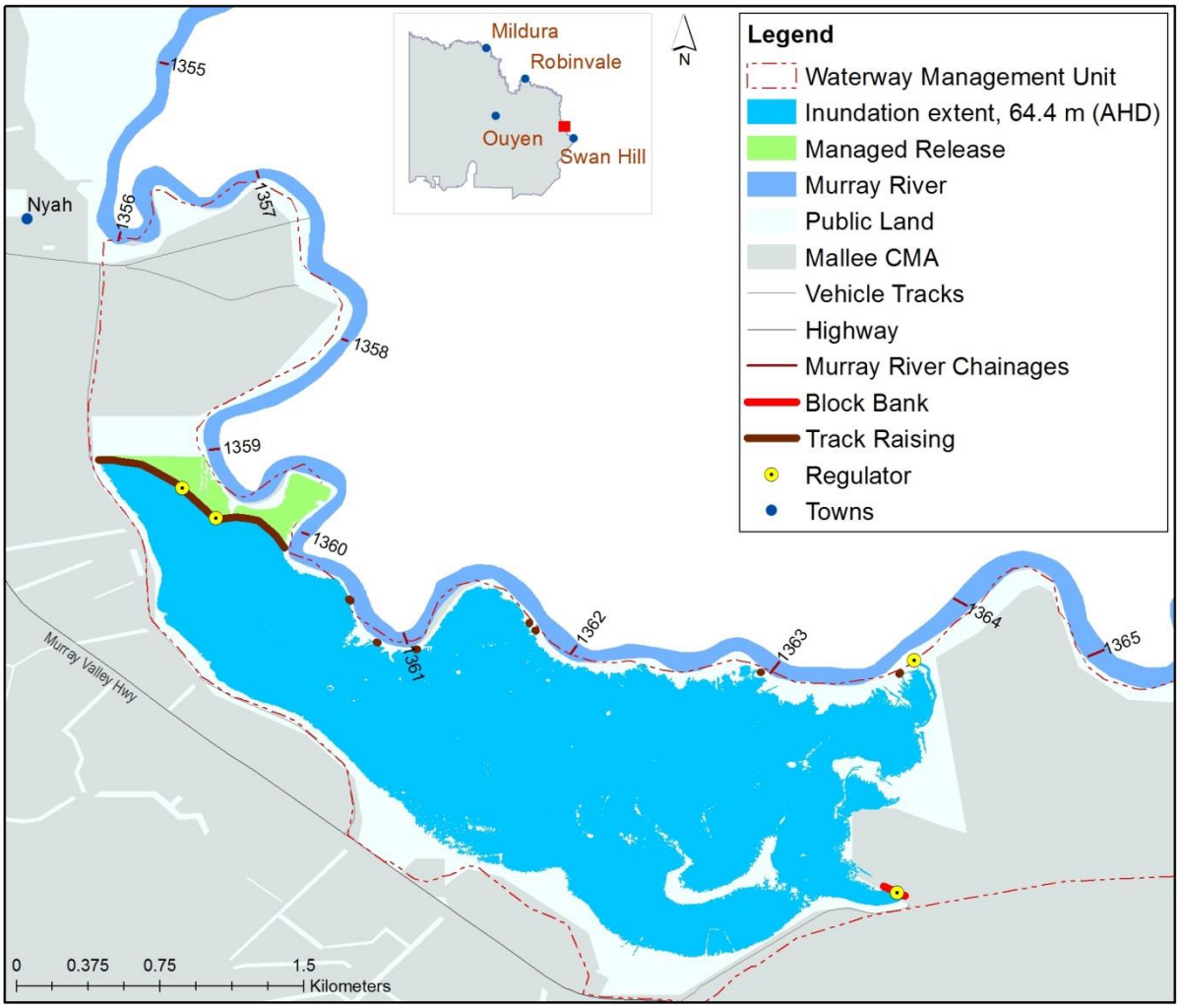


Figure 11 - Vinifera target area (Inundation areas)

2.8 Environmental Water Sources

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

The Victorian Minister for Environment, Climate Change and Water appoints Commissioners to Victoria's independent body for holding and managing environmental water – the Victorian Environmental Water Holder (VEWH). The VEWH is responsible for holding and managing Victoria's environmental water entitlements, and making decisions on their use.

Environmental Water for Nyah Vinifera may be sourced from the water entitlements and their agencies listed in Table 6 which is further explained in the Regional Context Document for Environmental Water Management Plans (Sunraysia Environmental 2014).

Table 6 - Summary of environmental water sources available to Nyah and Vinifera

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

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

2.9 Related Agreements, Policy, Plans and Activities

There are a range if international treaties, conventions and initiatives, as well as National and State Acts, policies and strategies that determine management of the target areas for each park. Those with particular relevance to the two parks and the management of their environmental values are listed in Table 7. For the functions and major elements of each refer to the Regional Context Document (North 2014).

Table 7 - Legislation, agreements, convention and listings relevant to the target areas within the Nyah-Vinifera WMU

Legislation, Agreement or Convention	Jurisdiction
China-Australia Migratory Bird Agreement (CAMBA)	International
Environment Protection and Biodiversity Conservation Act (EPBC)	National
Flora and Fauna Guarantee Act (FFG)	Vic State
Department of Environment, Land, Water and Planning advisory lists (DELWP)	Vic State

Nyah Vinifera is situated on the Victorian floodplain of the Murray River, which is subject to multiple investigations. These include Salinity Management Plans, environmental flow studies and Land Conservation Council reviews. An investigation into River Red Gum Health by the Victorian Environmental Assessment Council (VEAC) in 2008 resulted in Nyah and Vinifera being declared as Regional Parks in 2010.

The following plans and activities are relevant to the environmental management of Nyah and Vinifera.

Basin Plan - Sustainable Diversion Limit

The Basin Plan establishes the legal and policy framework for the use of environmental water in the Murray-Darling Basin. The Basin Plan includes a Sustainable Diversion Limit (SDL) on the amount of water that can be extracted for irrigation and other uses. The SDL is based on an assessment of the water that must be left in the system to maintain ecosystem health. An SDL adjustment mechanism has been established that will either allow equivalent environmental outcomes to be achieved with less water or increase the volume of water available for environmental use with neutral or improve socio-economic impact.

The proposed works at Nyah and Vinifera are two of several proposed by the Victorian Government as having the potential to contribute to the Basin Plan's SDL adjustment mechanism.

This view is based on the understanding that engineering works like flow control regulators, pipes and pumps can achieve similar environmental benefits to a natural flood, using a smaller volume of water to replenish greater areas. Works also allow for environmental watering in areas where system constraints prevent overbank flows and, due to the smaller volumes required, can be used to maintain critical refuge habitat during droughts.

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

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

Mallee Waterway Strategy

The Mallee Waterway Strategy applies a framework for targeting the delivery of management activities in the Mallee Region, including for Nyah and Vinifera Parks. These management activities include improving water quality, hydrology, aquatic habitat, riparian habitat and recording cultural heritage sites.

Preliminary salinity impact assessment for Mallee environmental water projects

SKM undertook a recent study on select Mallee environmental water projects which included Nyah and Vinifera (SKM 2013). This study was undertaken to identify if the proposed watering would have an impact on an area highlighted under the Basin Salinity Management Strategy (BSMS). The BSMS is implemented through a series of registers that track salinity credits and debits. Actions are identified as significant if they are assessed to change the average river salinity measurement at Morgan in South Australia by 0.1 EC or more within 30 years (Telfer, 2014).

According to SKM (2013) the largest component of the salinity impact from the proposed capital works at Nyah and Vinifera was associated with the displacement of groundwater due to diffuse recharge following inundation, but even these impacts remained insignificant.

3. Hydrology and System Operations

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

The target area within the Nyah and Vinifera Parks is located downstream of the river gauge at Swan Hill (409204).

3.1 Water Management and Delivery

3.1.1 Pre-regulation

Prior to river regulation in the reach of the Murray River past Nyah and Vinifera, the floodplain experienced inundation more frequently and lasted two to three times longer. For example, flow events of 20,000 ML/day occurred on average 130 times per 100 years compared with 80 times per 100 years post regulation, and the median duration pre regulation was 130 days compared to 45 days post regulation. High flow events of 30,000 ML/day still occur on average every eight to 10 years (Ecological Associates 2014b). The wetlands within the target area of Nyah and Vinifera require flows of between 5,000 and 27,000 ML/day to commence to flow (Green and Alexander, 2006). These thresholds would have been met by these more frequent events more than once a year and stayed inundated longer pre river regulation.

The seasonal distribution of flows in this section of the Murray River shows that, despite a reduction in discharge, the river retains the same annual pattern of higher flows in Winter and Spring with lower flows in Summer and Autumn (Figure 12).

Nyah Park

Water first enters Nyah Park at the downstream end of Parnee Malloo Creek. The upstream connection of the channel is connected soon after with through-flow occurring at river discharges approaching 12,500 ML/d. As river levels continue to rise above 17,500 ML/d, water spills from Parnee Malloo Creek to adjacent wetlands. Effluents along the river bank also introduce water to wetlands, the most important of which is Green Swamp which is flooded at river levels over 20,000 ML/d. Water spreads through the forest understorey as river levels rise and at river discharges exceeding 25,000 ML/d flood water approaches the higher ground along the river levee and terrestrial boundary of the floodplain (Ecological Associates 2014b).

Vinifera Park

Vinifera Creek is the collection of watercourses and wetlands in the Vinifera floodplain. Water enters the creek from the Murray River at flows of 12,500 ML/d. At higher flows minor effluents along the river bank also contribute water to the creek.

Water spills from Vinifera Creek to the general forest floor as river flows exceed 15,000 ML/d, filling the seasonal wetlands within the Park. Most of the forest is inundated at 17,500 ML/d which would have occurred in most years for a median duration of five months. Red gum forest and black box woodland on the terrestrial fringe of the floodplain is inundated when river levels exceed 20,000 ML/d.

Most of the forest drains freely as river levels fall. However, wetlands can retain water and can remain flooded between annual inflow events (Ecological Associates 2014c).

3.1.2 Post-regulation

In this part of the Murray River, the frequency, duration and magnitude of all but the largest floods have been reduced due to effects of major storages in the Murray River and its tributaries (Thoms *et al*, 2000).

At Nyah Park, the spread of water in the Parnee Malloo Creek is currently impeded by levees from redundant irrigation infrastructure and now provides access to the forest during inundation. Two earthen banks create a water storage in the creek that is filled by water pumped from the River Murray. This was originally used by the Nyah Golf Club and is now used as a fire water supply by two landholders.

Vinifera is a low-lying floodplain area that was reliably inundated in spring under natural (without regulation) flow conditions. Water commences entering Vinifera Creek at river flows of 12,500 ML/d, inundating low lying watercourses and wetlands on the floodplain. The creek commences spilling at flows above 15,000 ML/d and by 17,500 ML/d most of the forest is flooded. Red gum and black box on the terrestrial fringe of the forest is inundated when river levels exceed 25,000 ML/d.

Key changes to the hydrology of Nyah Park and Vinifera under current (regulated) conditions:

- Median monthly flow peaks have declined under current conditions, with the greatest impacts being in the high flow months from June to January (Figure 12);
- The frequency and duration of flow peaks greater than 10,000 ML/d has declined;
- Flows of 10,000 to 15,000 ML/d, which would have occurred almost 15 times every 10 years under natural conditions, last only five weeks rather than the five month median duration under natural conditions at Nyah Park, and have almost halved at Vinifera;
- At Vinifera, the frequency and duration of 17,500 ML/d has declined by approximately 30 percent (Ecological Associates 2014c).
- At Nyah Park, the duration of events which reach the upper extent of River Red Gum forest communities (25,000 ML/d) has almost halved from 75 days to 30. The frequency of these events has also declined significantly from 10 events every 10 years to only six (Ecological Associate 2014b).

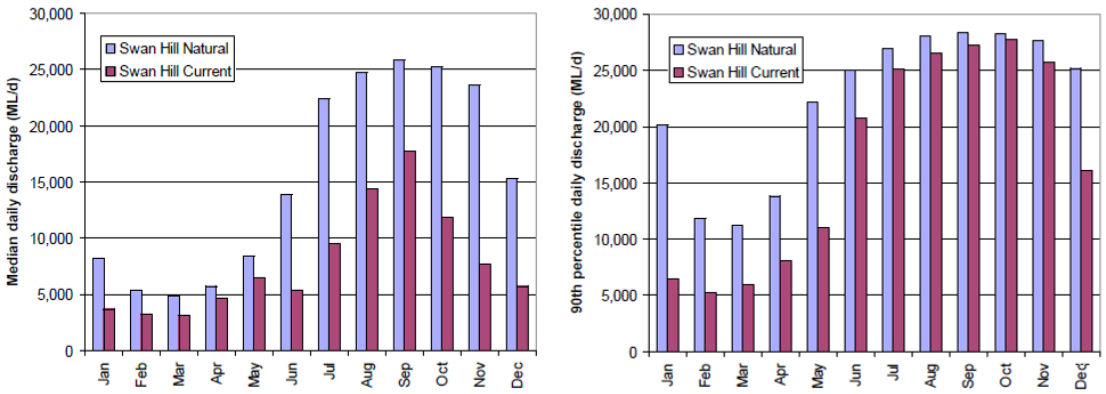


Figure 12 - Distribution of median flows and 90th percentile flows for each month in the River Murray through Nyah to Robinvale section for natural and current (benchmark) conditions. Source: derived from MDBC MSM-Bigmod 109-year data (Ecological Associates 2006)

3.1.3 Environmental watering

Environmental watering began in Nyah Park in 2005 as emergency River Red Gum watering. The water for these events was from various sources as outlined in Table 8. The initial purpose of the emergency watering program was to address the decline in River Red Gum health due to the the prolonged dry conditions associated with the Millennium Drought. The watering filled two wetlands and flooded the adjacent riparian zone and was effective in improving the health of trees lining the creeks and wetlands in the target area. It had the added benefit of providing some drought refuge for waterbirds. Anecdotal evidence indicated a positive response by the River Red Gums to the watering through increased foliage vigour.

Once the trees began to respond positively to the environmental watering and dry conditions abated, the purpose of the environmental watering changed from emergency response to long term sustainability of the system.

Table 8 - A summary of recent environmental watering events in Nyah Park

Water year	Time of inflow	Inflow source	Source volume (ML)	Total volume (ML)	Area (ha) Inundated
2004/05	Autumn	Environmental water	153	153	35
2005/06	Spring	Environmental water	560	1241	110
		Environmental water	681		
	Autumn	Environmental water	500	500	110
2009/10	Autumn	Environmental water	2125.8	2125.8	165.36
2010/11	Spring	Environmental Water	161.52	161.52	
2010/11	Spring, Summer and Autumn	Natural flows	-	-	1867
2014/15	Autumn and Winter	Environmental water	1266	1266	145
2015/16	Spring	Environmental water	750	789.5	
2016/17	Spring	Natural flows	-	-	1159

2017/18	Spring	Environmental Water	1877.13	1877.13	244

Currently environmental water can be pumped into Nyah Park from the Murray River into the creeks and held on the floodplain, covering an area of 244 ha. This requires the use of diesel pumps and temporary earth block banks to maintain the water on the floodplain and prevent the water flowing back into the river at low points (Figure 13). The extent of inundation can be increased by further infrastructure described in Section 8.2 below.

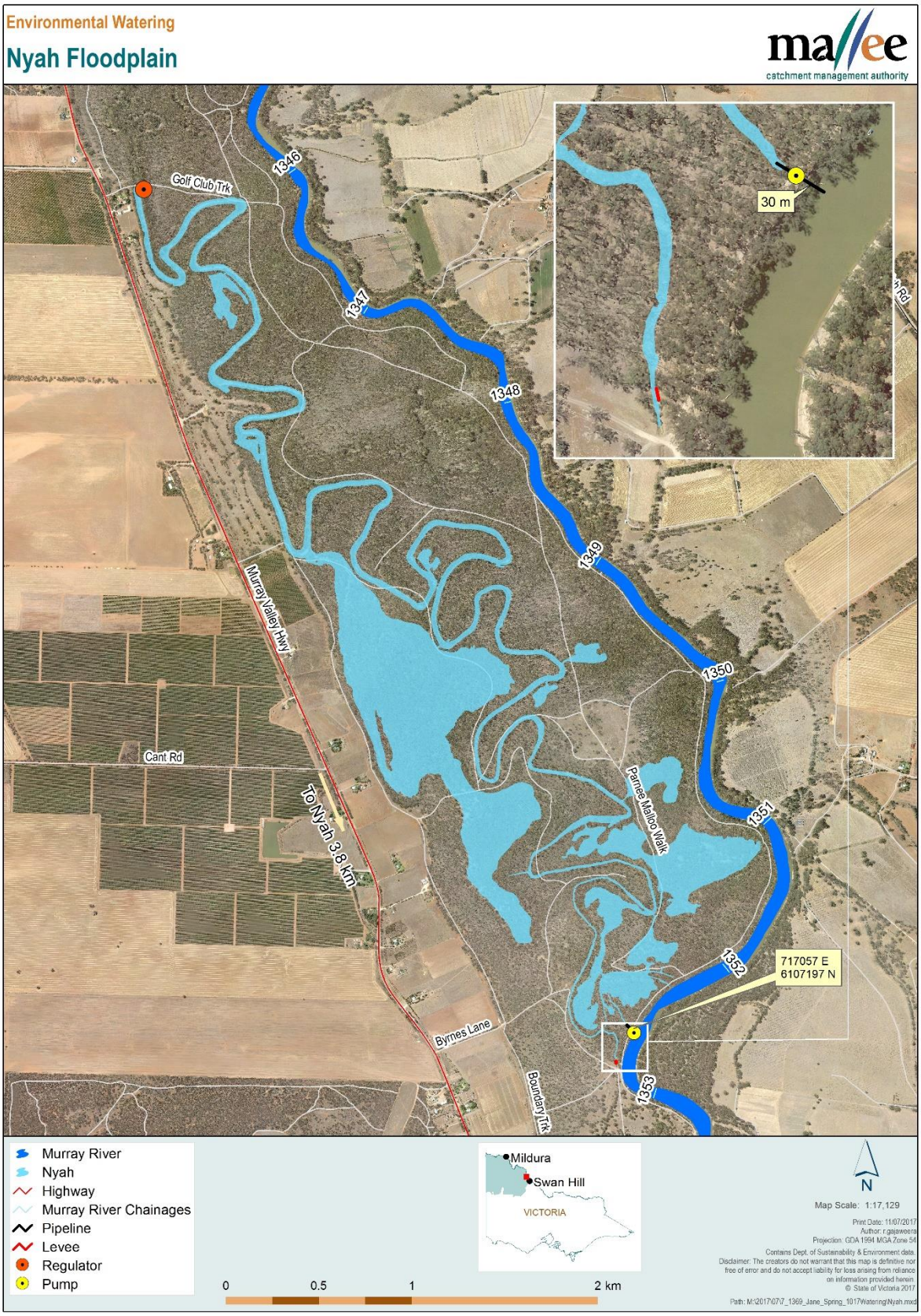


Figure 13 - Current inundation extent of Nyah Park

Vinifera did not receive environmental water during the emergency response period as the condition of the River Red Gums was of less concern.

Environmental watering began in 2015 to support the long term sustainability of the wetland, Table 9.

Table 9 - A summary of recent environmental watering events in Vinifera Park

Water year	Time of inflow	Inflow source	Source volume (ML)	Total volume (ML)	Area (ha) Inundated
2010/11	Spring, Summer and Autumn	Natural flows	-	-	
2014/15	Autumn and Winter	Environmental water	500	500	65
2015/16	Spring	Environmental water	399.851	399.851	
2016/17	Spring	Natural flows	-	-	-
2017/18	Spring	Environmental Water	925.135	925.135	78

Currently environmental water can be pumped into Vinifera Park from the Murray River into the creeks and held on the floodplain, covering an area of 78 ha. This requires the use of diesel pumps, culvert blockages and temporary earth block banks to maintain the water on the floodplain and prevent the water flowing back into the river at low points (Figure 134). The extent of inundation can be increased by further infrastructure described in Section 8.2 below.

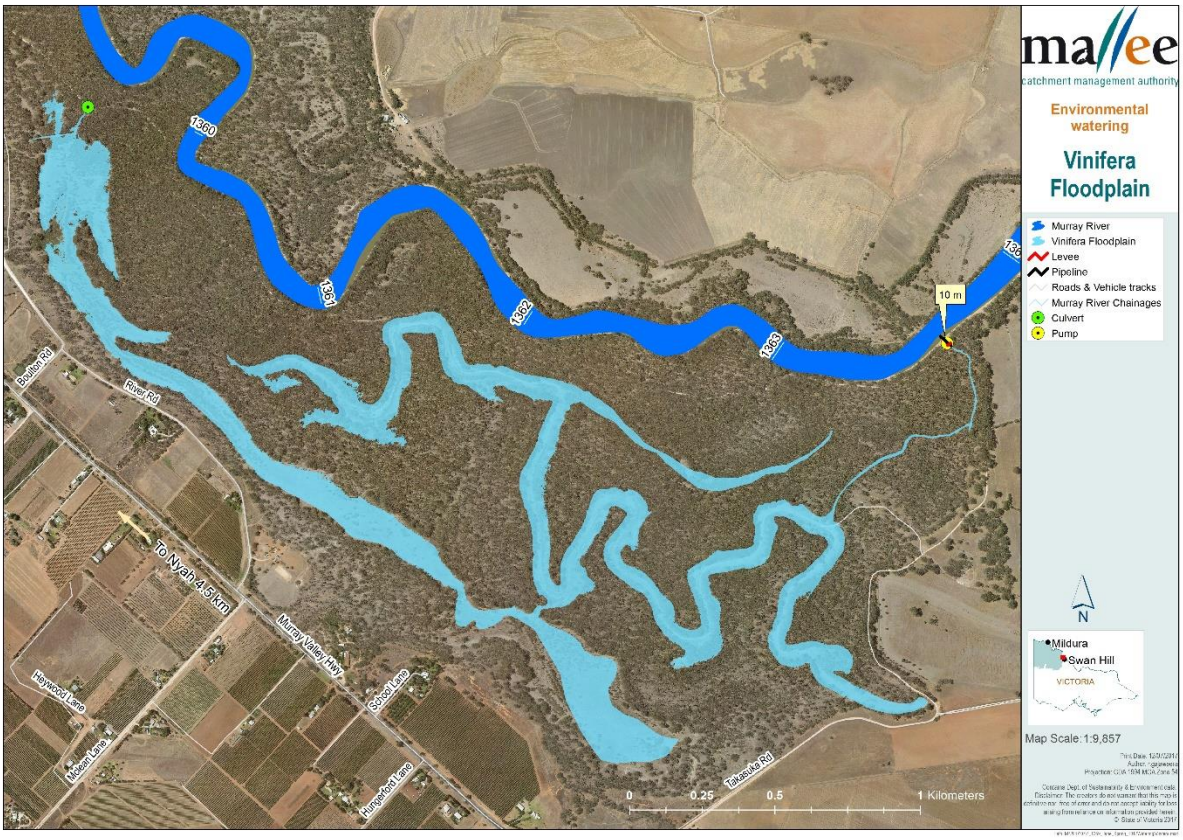


Figure 144 - Current inundation extent of Vinifera Park

4. Water Dependent Values

4.1 Environmental Values

Wetlands and waterways on the floodplain are a vital component of the landscape supporting a vast array of flora and fauna which may vary greatly with the type of wetland/waterway system. The habitat provided by vegetation communities around wetlands is essential for maintaining populations of water dependent fauna species. Other ecological functions provided by floodplain complexes include water filtration, slowing surface water flow to reduce soil erosion, flood mitigation and reducing nutrient input into waterways. Protecting the ecological functioning of wetlands ensures these vital services are maintained.

4.1.1 Listings and significance

Fauna

Nyah Park

Nyah-Vinifera consists of a series of wetlands, creeks and River Red Gum forests that provide habitat for a large range of fauna. This includes water dependent species which will benefit from the wetlands in the target area receiving water on a more regular basis (MCMA 2010).

Several fauna species common in this bioregion are at or near the downstream limit of their range in this area, including Sugar Glider (*Petaurus breviceps*) and Black Wallaby (*Wallabia bicolor*). The forests support breeding by colonial nesting waterbirds and provide habitat for woodland fauna that require dense and productive understorey (Ecological Associates 2014a).

The nationally Vulnerable (EPBC Act) Regent Parrot (*Polytelis anthopeplus monarchoides*) nest at Nyah. These birds feed in nearby mallee woodland and depend on large, healthy River Red Gum near the River Murray to provide nesting hollows (Ecological Associates 2014a).

The Endangered (FFG) Broad Shelled Turtle was found in Parnee Malloo creek, Nyah forest, in Spring 2017 by the Arthur Rylan Institute. The environmental watering program has supported permanent, deep water habitat and prey (small fish and shrimp) suitable for the freshwater turtle.

Nyah Park supports an important population of Grey-crowned Babbler (*Pomatostomus temporalis*). These birds depend on large, rough-barked trees in a forest community with a complex understorey of grasses, shrubs and timber. Flooding maintains the productivity of the ecosystem, including the insect fauna on which grey-crowned babbler depend (Ecological Associates 2014a).

Nyah Forest has a diverse microchiropteran bat fauna with ten species reported from the site. One of the species, Yellow-bellied Sheathtailed Bat (*Saccolaimus flaviventris*), is listed under the Victorian FFG Act. The bats are largely insectivorous and depend on high levels of forest productivity to provide prey. They roost in the crevices and hollows of *Eucalyptus camaldulensis* and *E. largiflorens* trees (Ecological Associates 2014a).

Nyah Park supports threatened reptiles such as the Inland Carpet Python (*Morelia spilota metcalfei*) and Lace Monitor (*Varanus varius*). High levels of forest productivity are required to provide the birds, possums, gliders and other small vertebrate prey on which these predators depend. Refuge habitat is provided by tree hollows and logs on the forest floor (Ecological Associates 2014a).

The floodplain includes wetlands in floodplain depressions adjacent to Parnee Malloo Creek. Under a natural flow regime, these wetlands would have been flooded almost annually and frequently remained flooded throughout the year. Persistent annual flooding would have excluded trees and supported a community of marshland plants including Spiny Mudgrass. Growling Grass

Frog (*Litoria raniformis*), Murray-Darling Rainbowfish (*Melanotaenia fluviatilis*) and other aquatic species that depend on permanent aquatic habitat would have expanded from these refuges into the forest understorey during spring floods (Ecological Associates 2014a).

Nyah Park has a diverse avifauna with over 140 bird species reported from the site and the local vicinity many of which have conservation significance in Victoria or under the federal EPBC Act 1999.

Wetlands provide habitat for dabbling, diving and filter feeding ducks while fish provide prey for waterbirds such as White-bellied Sea-eagle (*Haliaeetus leucogaster*). Large wading birds such as egrets, herons and spoonbill will prey on macroinvertebrates, frogs and small fish and will make use of large woody debris and emergent macrophytes for cover.

Semi-permanent wetlands, such as Green Swamp in Nyah Park, that are surrounded by frequently flooded red gum forest provide breeding habitat for colonial nesting waterbirds.

Of special interest and responsibility are the species listed in legislation previously recorded at Nyah Park (Table 1010)[2]. Many of these species are strictly water-dependent while others may rely on flood events or other characters of the water ecosystem for foraging or to trigger biological events such as breeding. A full list of all fauna previously recorded within the area is provided in Appendix 1.

Table 10 - Listed fauna recorded at the Nyah Park site (Mallee CMA 2010, ARI 2013, Brown, Bryant and Horrocks 2013 in Ecological Associates 2014a)

Scientific Name	Common Name	EPBC	FFG	DELWP	Ecological Associates 2014a	ARI 2013	MCMA 2010
MAMMALS							
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat		L	DD	✓		
BIRDS							
Polytelis anthopeplus monarchoides	Regent Parrot*	VU	L	VU			✓
Lophochroa leadbeateri	Major Mitchell's Cockatoo		L	VU	✓		
Haliaeetus leucogaster	White-bellied Sea-eagle	Mi	L	VU	✓		
Pomatostomus temporalis	Grey-crowned Babbler*		L	EN		✓	

[2] NB records from databases have not been included.

Scientific Name	Common Name	EPBC	FFG	DELWP	Ecological Associates 2014a	ARI 2013	MCMA 2010
Ardea modesta	Eastern Great Egret	Mi	L	VU			✓
Nycticorax caledonicus	Nankeen Night Heron			NT	✓	✓	✓
Anas rhynchotis	Australasian Shoveler			VU			✓
Aythya australis	Hardhead			VU			✓
Biziura lobata	Musk Duck			VU	✓		✓
Platalea regia	Royal Spoonbill			NT			✓
	REPTILES						
Morelia spilota metcalfei	Carpet Python*		L	EN	✓		✓
Chelodina longicollis	Common Long-necked Turtle			DD	✓		
Chelodina expansa	Broad Shelled Turtle		L	EN			
Pogona barbata	Eastern Bearded Dragon			VU	✓		
Varanus varius	Lace Monitor			EN	✓		
FROGS							
Litoria raniformis	Growling Grass Frog	VU	L	EN			✓
INVERTEBRATES							
Notopala sublineata	River Snail		L	CR			✓

Legend
EPBC status: Vulnerable, Migratory
FFG status: Listed as threatened

DELWP status: CRitically endangered, ENdangered, Vulnerable, Near Threatened, Data Deficient,

*Species are included as water dependent due to habitat requirements

These species are considered water dependent (or at least dependent on habitat that is water dependent) because they forage or nest in or over water, or require flooding to trigger breeding and fledging. The list includes the Regent Parrot which is indirectly dependent on water as they require riparian trees for nesting habitat.

The floodplain includes wetlands along Vinifera Creek. Under a natural flow regime, these wetlands would have been flooded almost annually and frequently remained flooded throughout the year. Persistent annual flooding would have excluded trees and supported a community of marshland plants including Spiny Mudgrass. frogs, small fish and other aquatic species that depend on permanent aquatic habitat would have expanded from these refuges into the forest understorey during floods (Ecological Associates 2014a).

Wetlands provide habitat for dabbling, diving and filter feeding ducks while fish provide prey for waterbirds such as White-bellied Sea-eagle. Large wading birds such as egrets, herons and spoonbill will prey on macroinvertebrates, frogs and small fish and will make use of large woody debris and emergent macrophytes for cover (Ecological Associates 2014a).

Seasonally flooded wetlands, that are surrounded by frequently flooded red gum forest provide breeding habitat for colonial nesting waterbirds. Vinifera is known as a breeding area the colonial nesting waterbirds cormorant and Australasian Darter (A*nhinga novaehollandiae*) (Ecological Associates 2006) and may also support breeding by Royal Spoonbill (*Platalea regia*) and Nankeen Night-heron (*Nycticorax caledonicus*) (Ecological Associates 2014a).

While not reported from Vinifera Park, the floodplain potentially provides habitat for Regent Parrot (EPBC vulnerable, DEPI vulnerable, FFG) which feeds in the mallee and depends on tree hollows provided on the floodplain.

Vinifera Forest has a diverse microchiropteran bat fauna with eleven species reported from the site (Table 9). The bats are largely insectivorous and depend on high levels of forest productivity to provide prey. They roost in the crevices and hollows *of Eucalyptus camaldulensis* and *E. largiflorens* trees (Ecological Associates 2014a).

The forest provides a variety of complex habitats in understorey vegetation, litter, woody debris, shrubby vegetation tree bark, crevices and hollows. Flooding maintains the structure of these habitat components and high levels of productivity which provide food for reptiles and amphibians in the form of vegetation, invertebrates and small birds and mammals (Ecological Associates 2014a).

Vinifera is a low-lying floodplain area that is reliably inundated in spring by elevated river flows. Under a restored water regime, the wetland and flooded forest areas would provide reliable refuge and breeding habitat for aquatic fauna and waterbirds.

Of special interest and responsibility are the species listed in legislation previously recorded at Vinifera Park (Table 9)[3]. Many of these species are strictly water dependent others may rely on flood events or other characters of the water ecosystem for foraging or to trigger biological events such as breeding. A full list of all fauna previously recorded within the WMU is provided in Appendix 1.

[3] NB records from databases have not been included.

Table 91 - Listed fauna recorded at the Vinifera Park site (Mallee CMA 2010, ARI 2013, Brown, Bryant and Horrocks 2013 in Ecological Associates 2014a)

Scientific Name	Common Name	EPBC	FFG	DSE	Ecological Associates 2014a	ARI 2013	MCMA 2010
MAMMAL							
Scotorepens greyii	Little Broad-nosed Bat			NT	✓	✓	
BIRD							
Ardea modesta (=alba)	Eastern Great Egret	Mi	L	VU			✓
Polytelis anthopeplus	Regent Parrot*	VU	L	VU			✓
Cacatua leadbeateri	Major Mitchell's Cockatoo*		L	VU	✓		
Nycticorax caledonicus	Nankeen Night Heron			NT	✓		✓
Anas rhynchotis	Australasian Shoveler			VU		✓	✓
Aythya australis	Hardhead			VU		✓	✓
Biziura lobata	Musk Duck			VU			✓
Platalea regia	Royal Spoonbill			NT			✓
REPTILE							
Morelia spilota metcalfei	Carpet Python*		L	EN			✓
FROG							
Litoria raniformis	Growling Grass Frog	VU	L	EN			✓
INVERTEBRATE							
Notopala sublineata	River Snail		L	CR			✓

Legend
EPBC status: Vulnerable, Migratory
FFG status: Listed as threatened
DELWP status: CRitically endangered, ENdangered, Vulnerable, Near Threatened, Data Deficient,

*Species are included as water dependent due to habitat requirements

*Species are included as water dependent due to habitat requirements

These species are considered water dependent (or at least dependent on habitat that is water dependent) because they forage or nest in or over water, or require flooding to trigger breeding and fledging. The list includes the Regent Parrot which is indirectly dependent on water as they require riparian trees for nesting habitat.

Fish and Crayfish

The same ten native fish species and one crayfish species (Nyah Park only) are encountered regularly in the River Murray near Nyah Park and near Vinifera Park and could be expected to at least occasionally occur within floodplain wetlands. Wetlands and flooded forest provide habitat for a range of small fish that benefit from submerged aquatic vegetation, woody debris and plant, biofilm and invertebrate food sources (Ecological Associates 2014a).

The following table (Table 102) identifies the native fish expected to occur at both Nyah Park and Vinifera Park (Ecological Associates 2014a).

Table 102 - Native fish expected to occur at Nyah Park and Vinifera Park

Scientific Name	Common Name	Conservation Status		
		EPBC	FFG	DELWP
FISH				
Bidyanus bidyanus	Silver Perch		L	V
Craterocephalus stercusmuscarum fulvus	Fly-specked Hardyhead			
Hypseleotris klunzingeri	Carp Gudgeon			
Maccullochella peelii peelii	Murray Cod	V	L	V
Macquaria ambigua	Golden Perch		I	NT
Melanotaenia fluviatilis	Murray-Darling Rainbowfish		L	V
Nematalosa erebi	Bony Herring			
Phylipnodon grandiceps	Flathead Gudgeon			
Retropinna semoni	Australian Smelt			
Tandanus tandanus	Freshwater Catfish		L	E
CRAYFISH				
Euastacus armatus*	River Murray Crayfish		L	NT

Legend
***Nyah Park only**
EPBC status: VUlnerable,
FFG status: Listed as threatened, Ineligible for listing
DELWP status: ENdangered, Vulnerable, Near Threatened

Nyah Park

Seasonal fast-flowing habitat in Parnee Malloo Creek will provide habitat for large-bodied channel specialists, specifically Murray Cod, Golden Perch and Silver Perch. The restoration of wetland habitat would potentially support resident populations include Murray-Darling Rainbowfish, Carp Gudgeon, Flathead Gudgeon, Australian Smelt and River Murray Crayfish which would promote the ecological objectives of water management at this Park.

Vinifera Park

The large channel-specialist fish species of Murray Cod, Silver Perch and Golden Perch are unlikely to use the floodplain to a significant degree. The restoration of wetland habitat would potentially support resident populations of Murray-Darling Rainbowfish, Carp Gudgeon, Flathead Gudgeon and Australian Smelt which would support the ecological objectives for this site.

Frogs

One of the key ecological objectives of the project is to restore resident populations of frogs at Nyah and Vinifera Parks. Like most flood dependent species, frogs respond to the timing, duration and frequency of flooding, with the timing of inundation being the most significant factor. Close proximity to permanent waterbodies and drought refuges is also important for frogs. Aquatic vegetation complexity is important for many species, particularly at tadpole stage, and can drive occupancy patterns and recruitment success (Tarr & Babbitt 2002, cited in Rogers & Ralph 2011).

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

Inundation of wetlands will provide terrestrial frogs with abundant aquatic invertebrates and flying insects, a substrate for eggs and shelter from predators.

Nyah Park supports six frog species (Table 113).

Table 113 - Frogs recorded at Nyah Park

Scientific Name	Common Name	EPBC	FFG	DSE	Ecological Associates 2014a	ARI 2013	MCMA 2010
Litoria raniformis	Growling Grass Frog	VU	L	EN			✓
Litoria peronii	Peron's Tree Frog				✓	✓	
Crinia parinsignifera	Plains Froglet				✓	✓	
Crinia signifera	Common Froglet				✓		
Limnodynastes dumerilii	Southern Bullfrog				✓	✓	
Limnodynastes tasmaniensis	Spotted Marsh Frog				✓	✓	

Vinifera Park supports four frog species (Table 124).

Table 124 - Frogs recorded at Vinifera Park

Scientific Name	Common Name	EPBC	FFG	DSE	Ecological Associates 2014a	ARI 2013	MCMA 2010
Litoria raniformis	Growling Grass Frog	VU	L	EN			✓
Litoria peronii	Peron's Tree Frog				✓	✓	
Limnodynastes dumerilii	Southern Bullfrog				✓	✓	
Limnodynastes tasmaniensis	Spotted Marsh Frog				✓	✓	

The wetlands are a refuge habitat for frogs such as Southern Bullfrog and Spotted Marsh Frog. Reliable flooding in the wetlands maintains the population, which expands to flooded red gum understorey during floods.

Waterbirds

Nyah

Semi-permanent wetlands, such as Green Swamp in Nyah Park, that are surrounded by frequently flooded red gum forest provide breeding habitat for colonial nesting waterbirds.

Vinifera

Vinifera is known as a breeding area the colonial nesting waterbirds cormorant and Australasian Darter (Ecological Associates 2006) and may also support breeding by Royal Spoonbill and Nankeen Heron.

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

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

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

Vegetation communities

Information on the Ecological Vegetation Classes (EVCs) present at Nyah and Vinifera was compiled from field surveys undertaken by Australian Ecosystems (2012) and GHD (2013). The Nyah and Vinifera Parks are within the Murray Fans Bioregion, and the conservation status of the thirteen EVCs identified during field surveys are outlined in Table 135.

The EVCs present within the Nyah and Vinifera Parks are shown in Figure 155 (Nyah) and Figure 166 (Vinifera).

Table 135 - Conservation status of EVCs present at Nyah-Vinifera (Australian Ecosystems 2012, Mallee CMA 2015)

EVC no.	EVC name	Conservation Status	Area (Ha) based on DELWP modelled mapping
103	Riverine Chenopod Woodland	Endangered	No data
308	Aquatic Sedgeland	Endangered*	No data
295	Riverine Grassy Woodland	Vulnerable	3.1
819	Spike-sedge Wetland	Vulnerable	15.1
106	Grassy Riverine Forest	Depleted	11.5
810	Floodway Pond Herbland	Depleted	6.7
811	Grassy Riverine Forest/Floodway Pond Herbland Complex	Depleted	0
812	Grassy Riverine Forest/Riverine Swamp Forest Complex	Depleted	178.5
814	Riverine Swamp Forest	Depleted	126.4
816	Sedgy Riverine Forest	Depleted	44.6
817	Sedgy Riverine Forest/ Riverine Swamp Forest Complex	Depleted	79.6
945	Floodway Pond Herbland/Riverine Swamp Forest Complex	Depleted	No data
821	Tall Marsh	Least Concern	No data

*EVC that is not recognised within the Murray Fans Bioregion, indicating that the conservation status is likely to be Endangered (Australian Ecosystems 2012).

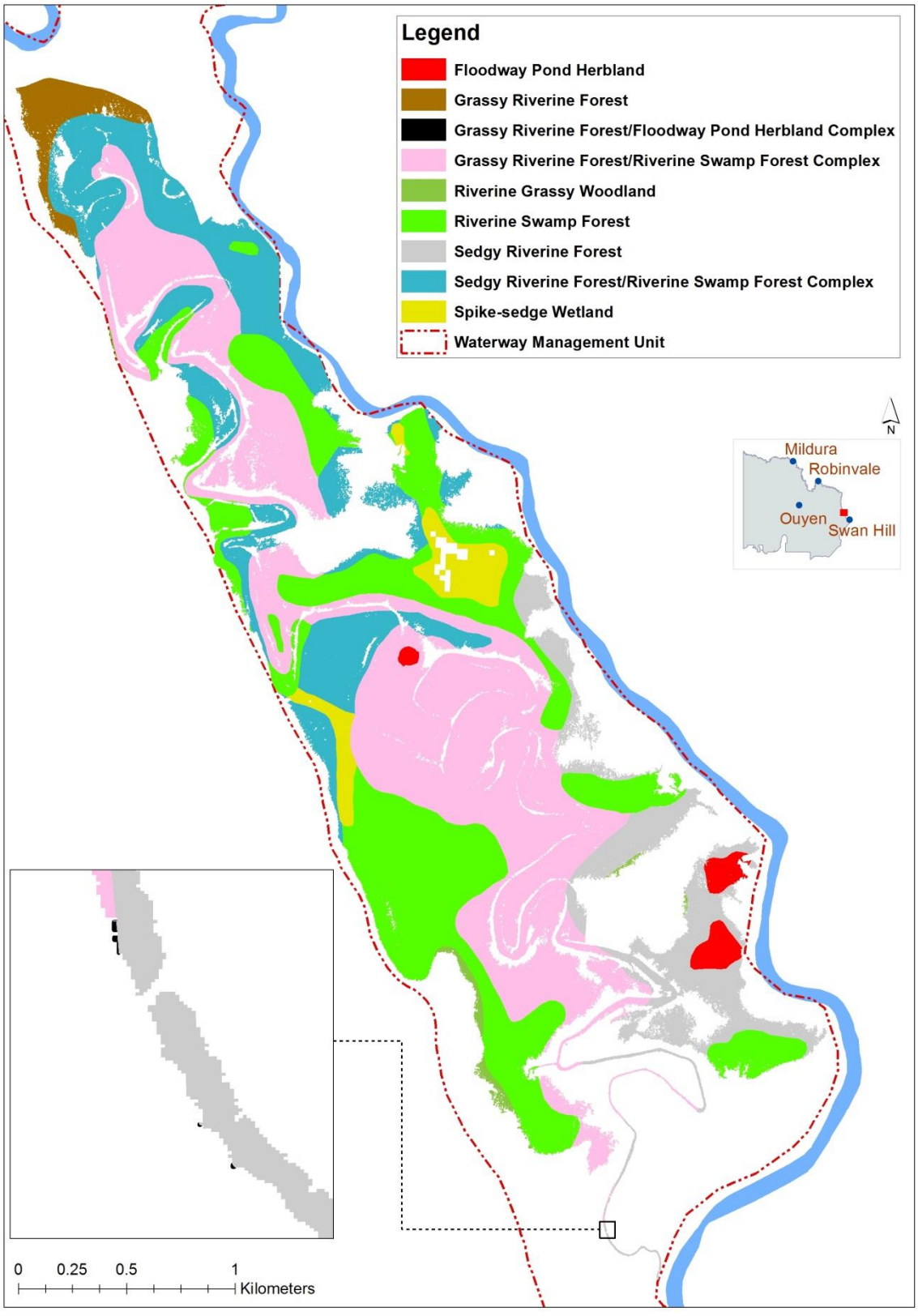


Figure 155 - Ecological Vegetation Classes (EVCs) present within Nyah Park

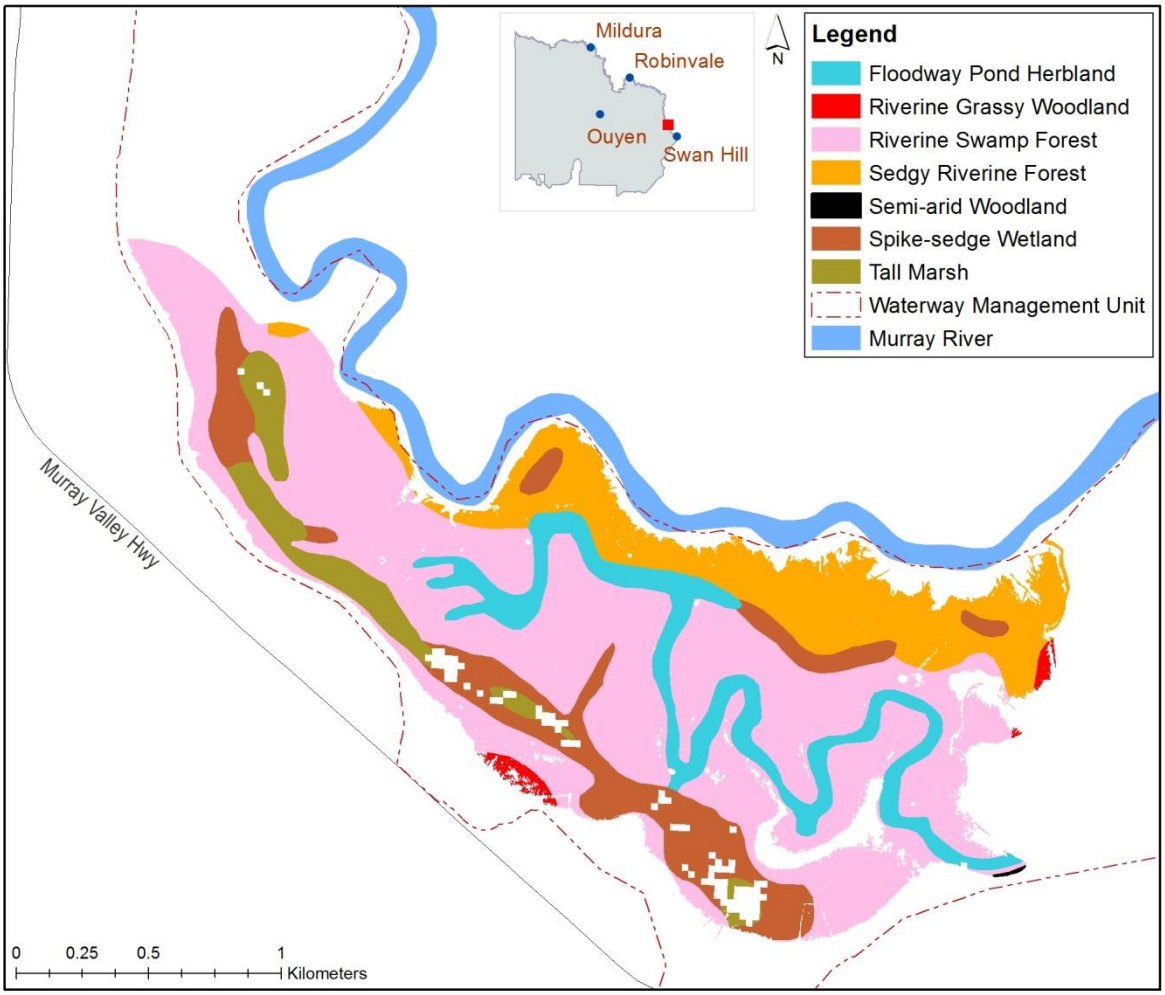


Figure 166 - Ecological Vegetation Classes (EVCs) present within Vinifera Park

Flora

A full list of flora recorded at the Nyah-Vinifera WMU can be found in Appendix 1. Threatened flora species have been recorded during surveys within the WMU: six VROTs listed species have been recorded at Nyah Park (see Table 146) and 12 VROTs listed species have been recorded at Vinifera Park (one of these species is also listed under the FFG Act) (see 7).

The majority of the listed species (Table 157) occur in EVC's dominated by Lignum, Black Box and River Red Gum and management will be directed towards these species, whose water requirements are well known.

Table 146 - Listed flora species recorded at Nyah Park (Australian Ecosystems 2014b)

Scientific name	Common name	Conservation status		
		EPBC	FFG	DELWP
Cardamine moirensis	Riverina Bitter-cress			R
Cuscuta australis	Australian Dodder			R
Dianella porracea	Riverine Flax-lily			V
Glossostigma drummondii	Desert Mud-mat			PK
Senecio campylocarous	Floodplain Fireweed			PK
Senecio cunninghamii* var. *cunninghamii	Branching Groundsel			R

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

Table 157 - Listed water dependent flora species recorded at Vinifera Park (Australian Ecosystems 2014b)

Scientific name	Common name	Conservation status		
		EPBC	FFG	DELWP
Asperula gemella	Twin-leaf Bedstraw			R
Cardamine moirensis	Riverina Bitter-cress			R
Cuscuta australis	Australian Dodder			R
Cynodon dactylon* var. *dactylon	Native Couch			V
Cyperus pygmaeus	Dwarf Flat-sedge			V
Glossostigma drummondii	Desert Mud-mat			PK
Nymphoides crenata	Wavy Marshwort		L	V
Ranunculus pumilio* var. *politus	Ferny Small-flower Buttercup			PK

Scientific name	Common name	Conservation status		
		EPBC	FFG	DELWP
Ranunculus undosus	Swamp Buttercup			V
Rorippa eustylis	Dwarf Bittercress			V
Rutidosis helichrysoides	Grey Wrinklewort			E
Senecio cunninghamii* var. *cunninghamii	Branching Groundsel			R

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

4.1.2 Wetland depletion and rarity

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

Nyah and Vinifera Parks contain eleven wetlands. Seven have been classified using the Corrick-Norman wetland classification system as deep freshwater marsh and four as shallow freshwater marsh (Table 168). There has been very little decrease in the area of these two wetland types in the Murray Fans Bioregion, however both types of wetlands have decreased in area quite substantially in Victoria and in the Mallee CMA region since 1788, with deep freshwater marsh and shallow freshwater marsh being the second and third most depleted categories respectively in the Mallee CMA region (Mallee CMA, Mallee Wetland Strategy, 2006). This makes them significant in terms of representativeness.

Table 168 - Changes in area of the wetlands by Corrick classification

Category	No of Wetlands in target area	Total area (ha)	Decrease in wetland area from 1788 to 1994		
			% Change in area in Victoria	% Change in area in Mallee CMA	% Change in Murray Fans
Deep freshwater marsh	7	147.87	70	45	6
Shallow freshwater marsh	4	22.4	60	6	10

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

4.1.3 Ecosystem functions

Wetlands and waterways on the floodplain are a vital component of the landscape which support a vast array of flora and fauna which may vary greatly with the type of wetland/waterway system. The habitat provided by vegetation communities around wetlands is essential for maintaining populations of water dependent fauna species. Other ecological functions provided by floodplain complexes include water filtration, slowing surface water flow to reduce soil erosion, flood mitigation and reducing nutrient input into waterways. Protecting the ecological functioning of wetlands ensures these vital services are maintained.

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

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

The target area within this WMU contains a floodplain wetland complex of eleven wetlands which are categorised as deep freshwater marsh or shallow freshwater marsh. Altered water regimes in the target area due to river regulation and dry conditions have seen a decrease in the frequency of inundation in these floodplain wetlands and therefore a decrease in the ability for these wetlands to perform these valuable ecosystem functions.

4.2 Social

4.2.1 Cultural Value

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

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

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

In the south of the region, waterways were focal points for the region's Traditional Owners, with many lakes being the site for large gatherings of several social clan groups that afforded trade and cultural exchanges.

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

4.2.2 Cultural Heritage

The floodplain of the Murray River has significant cultural heritage values for the local indigenous communities. It is well recognised as a traditional meeting place providing water, food and materials for medicines, shelter, clothing and tools. The area contains numerous scar trees, middens, mounds, burial sites, surface scatters and other artefacts.

There is no Registered Aboriginal Party (RAP) appointed for the area. There are no RAP applicants for the area. Wamba Wamba Barapa Barapa and Wadi Wadi Peoples Native Title Group (WWBBWW) is the Aboriginal group relevant to the Nyah-Vinifera Park and the Murray River Reserve activity area (Bell et al. 2014).

A search of the Victorian Aboriginal Heritage Register (VAHR) (Bell et al 2014) in relation to any archaeological investigations previously undertaken within the vicinity of the activity areas, indicate that a number of investigations have been carried out in the region including both regional and more site specific studies. The majority of Nyah Forest has been surveyed for Aboriginal archaeological sites although this has not continued into Vinifera Forest. The most extensive and intensive studies were those carried out by the Victoria Archaeological Survey as part of their summer field school programs.

Nyah and Vinifera forests are important cultural sites for the local indigenous people and there are numerous burial sites, middens, and scarred trees throughout the park (Department of Planning and Community Development website: Maps of Areas of Cultural Heritage Significance in Victoria). The area is subject to a Native Title Claim by the Wamba Wamba, Barapa Barapa and Wadi Wadi people which takes in parcels of land from Nyah to Boundary Bend. Earthen ovens and middens are listed on the Register of the National Estate and some cultural sites have been documented and records are held by Aboriginal Affairs Victoria. As is the case for most of the Murray River floodplain and beyond, it is recognised that waterways and floodplains are highly significant for the indigenous culture but the true extent of the number and types of sites present is still unknown.

The Wadi Wadi people have a strong connection to the area and make use of the natural resources within the forest for bush medicine, basket weaving and other cultural activities. The opportunity of co-management of the park by Parks Victoria and the Indigenous community opens up the possibility for the younger members of the community to gain valuable knowledge, skills, training and employment.

European heritage reflects the pioneering history of the area. These forests have had many uses since European settlement including grazing, rice growing, charcoal burning, forestry and local firewood collection. The area is popular for bird watching and water related activities such as camping, fishing and picnics.

The Friends of Vinifera and Nyah Forests became incorporated in 1996 to promote and enhance the cultural and environmental values of the forests and to encourage community participation under their management (Mallee CMA 2006). Friends of Nyah Vinifera and Friends of the Earth (FoE) are community stakeholder groups with an interest in activity within the area (Bell et al 2014).

4.2.3 Recreation

The region is popular for camping, fishing, boating, four wheel driving, trail bike riding, horse riding and walking and these uses will continue in the park. Vinifera forest was popular for duck hunting when the creek is running but this activity will not continue in the Nyah Vinifera Park.

The Nyah District Pony Club is currently licensed to use 13 hectares of Vinifera forest for equestrian activities and this activity will be allowed to continue (VEAC, 2008).

4.3 Economic

The Nyah-Vinifera Park has been used for grazing and fire wood collection in the past. However due to community opposition no coupe has been cut and domestic firewood has been sourced from elsewhere. Cattle grazing (agistment) was removed from Vinifera State Forest after it was changed to Vinifera River Reserve with the 1989 Land Conservation Council Final Recommendations (Land Conservation Council, 1989). Cattle agistment in the Nyah Park was halted in 1998 after attempts to protect cultural sites were not effective in preventing damage to the Aboriginal cultural sites. Domestic firewood collection and grazing are not permitted uses in the recommended park. There is an apiary site in each of Nyah and Vinifera Parks that will be continued (VEAC, 2008).

4.4 Significance

The environmental, social and economic values of the Nyah and Vinifera Parks outlined in preceding sections indicate that this site is significant to the local communities and is important in maintaining the functioning of the river system and the sustainability of the riparian and floodplain ecosystems.

The riparian and floodplain communities of Nyah and Vinifera are important to the functioning and sustainability of the River Murray system and as such should be protected.

The wetlands within the Nyah and Vinifera Parks are classified as regionally important wetlands and Parne-Malloo Creek and Green Swamp within the Nyah Park are included in the Register of National Estate (MCMA 2012). Furthermore, Nyah Park is at the western extent of the central River Red Gum forests, in the Murray Fans bioregion. It is an example of a an ecological community where the semi-arid Mallee landscape connects to the Murray River and its floodplain. The Park provides a corridor for fauna to move between the riverine and floodplain environments.

The area is rich in biodiversity, essential as habitat to native species and a refuge for listed flora and fauna species. The social and cultural values are important to local communities of the area. The values contained within Nyah and Vinifera and specifically the target area for this plan makes this area a priority for protection and enhancement through environmental water management. Of particular significance are the River Red Gum communities which line the temporary wetlands and creeks throughout the target area. These iconic trees form the basis for the functioning ecological system and are the primary focus of this plan.

5. Ecological Condition and Threats

5.1 Past condition

Nyah-Vinifera Index of Wetland Condition Assessment: 2009

The condition of two of the eleven wetlands within the Nyah Vinifera WMU was assessed in 2009 using the Index of Wetland Condition (IWC) method (see Appendix 3 for details on IWC method and the results of the assessment). The IWC defines wetland condition as the state of the biological, physical, and chemical components of the wetland ecosystem and their interactions. The overall IWC score for both wetlands assessed in this WMU in December 2009 was 6 out of 10, which is considered to be a moderate level of condition (**Error! Reference source not found.**).

The hydrology and biota sub-indices were considered to be in very poor and poor condition respectively. Hydrology was considered to be very poor due to a lack of water reaching the wetlands in more than a decade due to river regulation, dry conditions and being beyond the extent of recent environmental water events. These altered conditions were in turn reflected in the poor biota score which indicated a lack of diversity and abundance of the species expected to be present in the EVC for the wetland.

Management intervention had already begun in the Nyah Vinifera WMU with environmental watering events between 2005 and 2016 as outlined in Section 2.8. Photographic (see Figure 177) and anecdotal evidence indicated an increase in River Red Gum canopy health following these watering events. If this intervention is not continued the benefits from these watering events such as River Red Gum recovery may not be sustained and the floodplain will continue to become drier, resulting in reduced productivity, less carbon flux, and reduced ecosystem functionality. Due to river regulation, flooding alone may not be enough to sustain these communities.

Figure 177 - River Red Gum communities at Nyah Park, pre and post environmental watering.

5.1 Current condition and trajectory

Nyah and Vinifera are relatively intact, however the condition of wetlands within the area of focus will continue to decline without regular and well planned environmental watering targeting appropriate objectives.

The loss of seasonal wetland habitat from Vinifera Park reflects a reduction in the duration of spring flow peaks. River Red Gums have colonised former wetlands as high river levels now only inundate

wetlands briefly. The shorter duration of floods means that aquatic marshland vegetation is no longer supported and the understorey has become dominated by seasonal floodplain herbs and grasses (Cook 2012). The associated decline of wetland habitat has meant that the floodplain only provides opportunistic habitat for aquatic fauna when water is available. Further encroachment by trees has excluded waterbirds that depend on open water.

The altered water regime is considered the major threat for the target area and is the primary factor behind the development of this environmental water management plan.

5.3 Water related threats

Threats to the water dependent values at the sites are the result of such factors as human intervention and climate variability. Some of the threats which may have an impact on the Nyah and Vinifera include:

- Changed water regime;
- Loss or reduction of wetland connectivity;
- Water quality; and
- Introduction/increase of exotic flora and fauna.

River Regulation

The regulation of the Murray River has seen the water regime through the Nyah Vinifera WMU altered. Flow events of the appropriate magnitude required to promote flows into creeks and wetlands of the floodplain occur less frequently and when they do, they are of a shorter duration than preferred. This combined with dry conditions over the last decade affects the vigor of the vegetation and places trees under stress, affecting the productivity and functioning of the floodplain ecosystem.

The wetlands present in the target area of the WMU are classified as deep freshwater marsh and shallow freshwater marsh (Table 5). Both types of wetlands have decreased in area in Victoria and the Mallee CMA region since 1788 with deep freshwater marsh and shallow freshwater marsh being the second and third most depleted categories respectively in the Mallee CMA region (Mallee Wetland Strategy). Reduction in wetland area and loss of wetland connectivity threaten the vegetation communities surrounding the wetlands and therefore the fauna communities which inhabit the target area are also threatened.

Irrigation Impacts

Nyah

The Nyah Irrigation District Drain No. 1 discharges water directly in the Parnee Malloo Creek. Monitoring of drainage water showed that saline water (1532 EC) was entering the Creek, which evaporated within the first 3 km of the creek bed. Regular flooding (every four out of five years) stopped the salt from accumulating however, the drain blocked with cumbungi and caused localised salinity and waterlogging effects.

A lack of defined drains along the Northern Extension to the Nyah Irrigation District (about 25 irrigators) allows drainage water to pond along the boundary of the Nyah forest and freehold. This caused water logging and excess surface salinity that encourages the growth of pest plants to the area, e.g. sea barley grass and spiny rush.

Vinifera

Along with floodwater and rainfall wetland #7527179022 receives irrigation drainage water from eight open drains that vary in length (from 100 m to 500 m), 20 ha of which remain permanently inundated. The permanent inundation is likely to have reduced the species diversity but thought to have provided good drought relief for waterbirds. There has been no significant drainage going into this area for almost 10 years due to conversion to more efficient irrigation methods in the area, e.g. flood to drip irrigation (EWMP 2012; EA 2006).

The drains are prone to blocking with excessive cumbungi growth causing local waterlogging and soil salinity build-up. The waterlogging caused by the blocked drains results in growth of pest plants and decline in health of River Red Gums.

Historically irrigation and other drainage water have been a consideration for water quality issues. Drains from adjoining freehold land enter along the western boundary of the southern end of Nyah forest. Changed irrigation practices (flood to drip) in surrounding horticultural land and dry conditions have drastically reduced the run off into the target area (MCMA 2012).

Pest Plants

Agricultural and other weeds are an ongoing threat and management issue along the Murray River floodplain. These may pose a threat when water is applied. Of concern to local communities is the increase in occurrence of *Exocarpos strictus* (Pale-fruit ballart), a root parasite, that has proliferated through the forest over the past 14 years. Sinclair (2004) recommended the restoration of winter floods as a means of increasing River Red Gum health and incidentally achieving limited reduction in the vigour of *Exocarpus strictus.*

6. Management Objective

Ecological objectives were revised in 2014 by Ecological Associates for the purpose of preparing a business case for the sites under the Basin Plan SDL Offset project. The two sites share the same management goal and almost the same ecological objectives, given their close proximity to each other.

6.1 Management Goal

The environmental water management goal for Nyah and Vinifera over the next 5-10 years is:

"to restore the key species, habitat components and functions of the Nyah and Vinifera Parks ecosystem by providing the hydrological environments required by indigenous plant and animal species and communities".

6.2 Ecological Objectives

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

Ecological Objectives for Nyah and Vinifera were reviewed during the development of Business Cases for the SDL Adjustment Projects (Ecological Associates 2014a). The revised ecological objectives for the Nyah and Vinifera Parks are:

1. Restore the structure of wetland plant communities
2. Restore resident populations of frogs and small fish
3. Providing seasonal feeding and reproductive opportunities for riverine fish species
4. Provide reliable breeding habitat for waterbirds, including colonial nesting species
5. Restoring floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler
6. Contribute to the carbon requirements of the River Murray channel ecosystem

Attainment of the ecological objectives is anticipated to have wider benefits for the target area and is expected to result in:

- Protect an important community of woodland bat species
- Restore colonial nesting waterbird breeding habitat
- Restore wetland and forest structural diversity and productivity
- Maintain the western-most extent of the central Murray floodplain river red gum forest
- Provide habitat for mallee vertebrate fauna that depend on floodplain habitat for prey, shelter and breeding including carpet python, regent parrot and major mitchell parrot
- Restore the productivity and structure of floodplain forest, increasing the viability of vertebrate fauna populations including carpet python, grey-crowned babbler and sugar glider
- Supply organic matter to the River Murray channel ecosystem (Ecological Associates 2014, p192)

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

6.3 Hydrological Objectives

Hydrological objectives describe the components of the water regime required to achieve the ecological objectives at this site. Ecological Associates (2014b) identified water regime classes as a way of grouping EVCs with common water requirements. Watering each of these water regime classes will contribute to the achievement ecological objectives as summarised in Table 9 and Table 20. The hydrological requirements of the water regime classes that will address the ecological objectives are presented in Table 1 (Nyah) and Table 2 (Vinifera).

Table 19 - Water Regime Classes and ecological objectives for Nyah Park

Water Regime Class	EVC/location	Area	Ecological Objectives
Seasonal Anabranch	Parnee Malloo Creek mapped by Murray Wetlands Working Group "Wetlands54"	58	Provide seasonal feeding and reproductive opportunities for riverine fish species Restore the structure of wetland plant communities
Seasonal Wetland	819 Spike-sedge Wetlands 810 Floodway Pond Herbland	45	Restore resident populations of frogs and small fish Provide seasonal feeding and reproductive opportunities for riverine fish species Restore the structure of wetland plant communities Provide reliable breeding habitat for waterbirds, including colonial nesting species
Red Gum Swamp Forest	814 Riverine Swamp Forest	168	Provide reliable breeding habitat for waterbirds, including colonial nesting species Restore floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler Contribute to the carbon requirements of the River Murray channel ecosystem
Red Gum Forest and Woodland	106 Grassy Riverine Forest 811 Grassy Riverine Forest / Floodway Pond Herbland Complex 812 Grassy Riverine Forest / Riverine Swamp Forest Complex 816 Sedgy Riverine Forest 817 Sedgy Riverine Forest / Riverine Swamp Forest Complex	576	Provide reliable breeding habitat for waterbirds, including colonial nesting species Restore floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler Contribute to the carbon requirements of the River Murray channel ecosystem

Table 20 - Water Regime Classes and ecological objectives for Vinifera Park

Water Regime Class	EVCs	Area	Ecological Objectives
Seasonal Wetland	819 Spike-sedge Wetlands 821 Tall Marsh 810 Floodway Pond Herbland	98	Restore the structure of wetland plant communities Restore resident populations of frogs and small fish Providing seasonal feeding and reproductive opportunities for riverine fish species Provide reliable breeding habitat for waterbirds, including colonial nesting species
Red Gum Swamp Forest	814 Riverine Swamp Forest	277	Restore the structure of wetland plant communities Restore resident populations of frogs and small fish Provide reliable breeding habitat for waterbirds, including colonial nesting species Contribute to the carbon requirements of the River Murray channel ecosystem
Red Gum Forest and Woodland	106 Grassy Riverine Forest 811 Grassy Riverine Forest/ Floodway Pond Herbland Complex 816 Sedgy Riverine Forest	161	Restore the structure of wetland plant communities Restore resident populations of frogs and small fish Provide reliable breeding habitat for waterbirds, including colonial nesting species Contribute to the carbon requirements of the River Murray channel ecosystem
Black Box Woodland	295 Riverine Grassy Woodland 103 Riverine Chenopod Woodland	94	Provide reliable breeding habitat for waterbirds, including colonial nesting species Contribute to the carbon requirements of the River Murray channel ecosystem Restoring floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler

Table 21 - Hydrological objectives for Nyah

Water regime Class	Ecological Objective	Mean frequency of evens (Number per 10 years)			Tolerable interval between events (years)		Duration of Ponding (months)			Preferred timing of inflows
		Min	Opt	Max	Min	Max	Min	Opt	Max	
Seasonal Anabranch	1,3	10	10	10	0	0	NA	NA	NA	Spring/early Summer
Seasonal Wetland	1, 2, 3, 4	8	9	9	1	1	9	10	12	Spring/Summer Wetland depth to be less than 50% of retention level in May 5 years in 10
Red Gum Swamp Forest	4,5,6	7	9	10	1	3	5	6	7	Spring/Summer
Red Gum Forest and Woodland	4,5,6	7	8	9	1	3	1	1.5	3	Spring/Summer

1. Restore the structure of wetland plant communities
2. Restore resident populations of frogs and small fish
3. Providing seasonal feeding and reproductive opportunities for riverine fish species
4. Provide reliable breeding habitat for waterbirds, including colonial nesting species
5. Restoring floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler
6. Contribute to the carbon requirements of the River Murray channel ecosystem

Table 22 - Hydrological objectives for Vinifera

Water regime Class	Ecological Objective	Mean frequency of evens (Number per 10 years)			Tolerable interval between events (years)		Duration of Ponding (months)			Preferred timing of inflows
		Min	Opt	Max	Min	Max	Min	Opt	Max	
Seasonal Wetland	1, 2, 3, 4	8	9	9	1	1	6	7-8	9	Spring/Summer
Red Gum Swamp Forest	1, 2, 4, 6	7	9	10	1	1	5	6	7	Spring/Summer
Red Gum Forest and Woodland	1, 2, 4, 6	7	9	10	1	1	2	4	6	Spring/Summer
Black Box Woodland	4, 5, 6	6	8	9	2	2	1	1.5	2	Spring/Summer

1. Restore the structure of wetland plant communities
2. Restore resident populations of frogs and small fish
3. Providing seasonal feeding and reproductive opportunities for riverine fish species
4. Provide reliable breeding habitat for waterbirds, including colonial nesting species
5. Restoring floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler
6. Contribute to the carbon requirements of the River Murray channel ecosystem

6.4 Watering regime

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

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

Table 173 - Target water regime in response to climatic conditions

	Dry/drought	Median	Wet
Nyah	Seasonal Anabranch Seasonal Wetland	Seasonal Anabranch Seasonal Wetland Red Gum Swamp Forest	Seasonal Anabranch Seasonal Wetland Red Gum Swamp Forest Red Gum Forest and Woodland
Vinifera	Seasonal Wetland	Seasonal Wetland Red Gum Swamp Forest	Seasonal Wetland Red Gum Swamp Forest Red Gum Forest and Woodland Black Box Woodland

7. MANAGING RISKS TO ACHIEVE OBJECTIVES

A detailed risk assessment was undertaken as part of the SDL Business Case Offset Project (Newell et al 2014). This included risks during construction and operation of the proposed infrastructure. Risks were classified as very high, high, moderate, or low dependent on the likelihood and consequence of them occurring. The complete risk assessment is in Appendix 4. Items that relate to the proposed water regime and deemed very high risk are summarised in Table 184.

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

Table 184 - Risks associated with hydrological objectives for Nyah and Vinifera

Threat	Likelihood	Consequence	Risk – H, M, L (likelihood x consequence)	Management Measure	Residual Risk
Enhancing carp recruitment conditions	Certain	Severe	V high	Promote native fish to balance impacts of increased carp. Drying sequence should aim to maximise impacts to carp and minimise impacts on native (if this is possible). Research required. PV Management Plan.	Moderate
Changed flow regime favouring high risk weed species	Certain	Severe	V high	Time water manipulations to drown seedlings, minimise growth and germination, seed set etc; promote native species. Problem species and severity not fully known - monitor and manage adaptively.	Low
Removal of habitat for recently established threatened species which resulted/adapted from historic regulation practices	Likely	Severe	High	Operating plans/rules/strategies Monitoring/reporting to adaptively manage Confirming flow regime requirements through modelling – target species. Clearly define ecological outcomes (seasonal plans, long term objectives etc)	Low
Germination of river red gum in watercourses	Certain	Moderate	High	Operational strategies to drown seedlings Operations to vary water levels each season, each year Hydraulic model to determine where strand lines will be and how extensive issue might occur Timing and duration (avoid seed drop time) Last resort remove them.	Low

Threat	Likelihood	Consequence	Risk – H, M, L (likelihood x consequence)	Management Measure	Residual Risk
Episodic reduction in hydrodynamic diversity	Likely	Severe	High	Design & operation Operating strategy Monitor flow dependent fauna – adaptive management Manage expectations in stakeholder groups.	Moderate
Blackwater events result from waterings	Likely	Severe	High	Plan flooding with regard to quality of incoming water including Darling water Monitor antecedent floodplain conditions (organic matter loads) Take account seasonal conditions (e.g. blackwater, algae). Have rules in place to manage risks. Manage through-flow to help manage risk. Monitor risk factors (DO, temp) and manage flooding event to minimise risk. Disposing of blackwater – can manage outflow rates to wait for dilution flow. Water can be disposed within the site (pump to higher wetlands) Flood frequency – prevent high organic load build. Manage community expectations.	Moderate

Threat	Likelihood	Consequence	Risk – H, M, L (likelihood x consequence)	Management Measure	Residual Risk
Low DO levels	Likely	Severe	High	Plan flooding with regard to quality of incoming water including Darling water Monitor antecedent floodplain conditions (organic matter loads) Take account seasonal conditions (e.g. blackwater, algae). Have rules in place to manage risks. Manage through-flow to help manage risk. Monitor risk factors (DO, temp) and manage flooding event to minimise risk. Disposing of blackwater – can manage outflow rates to wait for dilution flow. Water can be disposed within the site (pump to higher wetlands) Flood frequency – prevent high organic load build. Manage community expectations.	Low
Inability to discharge poor quality water	Likely	Severe	High	Dilution flows Good relationships Local disposal	Low
Increase in native and non-native pest mammals (kangaroos, rabbits, pig)	Likely	Severe	High	Monitor and “control” Implement existing management strategy. Support partner agencies to seek complementary funding	Low
Loss of artefacts via Inundation	Possible	Severe	High	Ongoing inspection and management O&M Ongoing stakeholder liaison (early and often)	Low

8. Environmental Water Delivery Infrastructure

8.1 Constraints

The current constraints to achieving the ecological objectives at Nyah and Vinifera Parks are the current River Murray operations reducing the frequency and duration of inundation and redundant irrigation infrastructure creating blockages in the creek lines.

The proposed infrastructure is designed to increase the frequency and duration of inundation within current river Murray operations.

8.2 Infrastructure recommendations

Nyah Park

The infrastructure proposed in the Nyah Floodplain SDL Business Case (Ecological Associates 2014b) are four regulators, three on the downstream end of Parnee Malloo Creek and one on the upstream end. To contain water within the forest it is necessary to raise 1,648 m of low level track to form a levee at the downstream end of the forest.

Decommissioning of former irrigation infrastructure including two blockages and an overflow bypass on Parnee Mallee Creek will also be undertaken. Details of these works are provided in Table 5.

These works will be able to provide water to 488 ha of inundation dependant habitat, which is 53% of the total forest area and almost all of the water dependant communities at the site (Ecological Associates 2014b).

The works will replicate Murray River flows of 25,000 ML/d and inundate up to 63.2 m AHD. The works will allow natural river flows in and In the absence of suitable river flows, temporary pumping will be used to provide water from the Murray River to the floodplain.

Table 25 - Nyah Infrastructure works (Jacobs, 2014, in Ecological Associates 2014b)

Structure	Description
Main track raising and overflow sills	A section of the main track at the northern end of the floodplain will be raised in order to retain water to 63.2 m AHD. The track raising will incorporate regulators N1a, N1b, N2 and 3 overflow sills. Existing track alignment to be raised over a length of 1,308 m and will include 300 mm freeboard and 150 mm crest allowance. Overflow sills 1 and 3 will each be 100 m long; overflow sill 2 will be 65 m long.
N1a and N1b	Enables water to be held up to 63.2 m AHD and released as required. Two regulators, each consisting of 3 box culverts, each with single sluice gates and access provision.
N2	The main regulator and outlet point for the floodplain, N2 will be used to hold water to 63.2 m AHD and control return flows. Regulator consists of 8 box culverts, all with split leaf gates and access provision.

Structure	Description
Drop Structure	Situated downstream of N2, the drop structure is necessary to protect banks against erosion upon release of impounded water. The structure will establish a tailwater at the regulator sufficient to prevent sweep out of the hydraulic jump and provide a plunge pool for downstream fish passage. Consists of sheet piles and rock beaching.
N5	Replacement structure for an existing pipe culvert of correct size but unreliable quality, at the southern end of the Parnee Malloo Creek. This structure will prevent impounded water draining back to the River Murray. 1,200 mm diameter reinforced concrete pipe with manually actuated penstock gate and access provision.
Raised track sections and overflow sills (4, 5, 6, 7, 8)	Small sections of additional track raising and overflow sill works, to contain water on the floodplain and provide inflow and outflow path for natural flood events. Approximately 340 m of track raising is proposed at five locations, incorporating overflow sills at each.
N4	Decommissioning of redundant irrigation infrastructure including blockages in the creek and a bypass pipeline.

Vinifera Park

The infrastructure proposed in the Vinifera Floodplain SDL Business Case (Ecological Associates 2014c) are two box regulators (V1 and V2) and a stop bank (levee) with overflow sills near the northern (downstream) end of the floodplain. Details of these works are provided in Table 6.

The regulators will be located in a stop bank (levee) to allow through-flow in the creek and to retain water at a level of up to 64.4 m AHD, replicating a 20,000 ML/d flow event through natural river flows or pumping. The works will inundate up to 350 ha.

Table 26 - Vinifera Infrastructure works (Jacobs, 2014, in Ecological Associates 2014c)

Works	Description
V1 – Regulator	New ten bay regulator to retain water within Vinifera Creek allowing release of gravity controlled water to the very north-western tip of the Vinifera floodplain. 10 box culverts, four with dual leaf combination gates and 6 with single leaf gates.
V2 – Regulator	New four bay regulator allowing the release of water into the bend directly adjacent to the River Murray in the northern section of the Vinifera floodplain. Four box culverts with split leaf combination gates
Main Levee	1087 m long raised track, to a maximum height of 1700 mm, incorporating 2 x 70 m long overflow sills.
Drop structure	Rock structure to minimise erosion risk associated with the return of the impounded water to the River Murray.
V3 – Pipe culvert	New pipe culvert regulator on Vinifera creek to pass both local drainage and overland flows in large events. 1,200 mm diameter concrete pipe with penstock gate.
V4 – Pipe culvert	New pipe culvert to allow inflows from the River Murray and prevent backflow to the River Murray when retaining water on the floodplain during a watering event. 1,200 mm diameter concrete pipe with penstock gate.
Raised track sections and overflow sills	Seven overflow sill works, to contain water on the floodplain. The location of overflow sills to align with existing roads where possible, to reduce environmental and cultural heritage impacts. Raise short sections (< 200 m in total) of the natural river levee at some sites.

Table 197 - Estimates of watering possibilities in Nyah Vinifera WMU

	Area able to be inundated (ha)			Volume (ML)		
	Nyah	Vinifera	**Total**	Nyah	Vinifera	**Total**
Current arrangements	165.36	36.81	**202.17**	2,125	179	**2,304**
With proposed infrastructure	488	350	**838**	2,797	2,743	**5,540**

9. Demonstrating Outcomes

9.1 Monitoring priorities at the site

Ecological Associates (2014a) established ecological targets to measure progress towards ecological objectives. The targets compare a baseline to the state of the site after the proposed water regimes have been applied. A baseline will need to be established for each parameter at both sites. It is not expected that outcomes will be achieved until several years after the water regime has been in place.

In some cases existing monitoring programs can be used or adapted to monitor the achievement of ecological objectives including TLM monitoring for fish and waterbirds (Henderson, *et al.* 2013) and MDBA tree health monitoring (Cunningham, et al. 2011). A method to evaluate the export of carbon to the floodplain needs to be developed.

The monitoring requirements to demonstrate progress towards ecological objectives for both Nyah and Vinifera are the same.

Table 208 Ecological objective outcome monitoring recommendations

Ecological Objective	Target	Monitoring Recommendation
Restoring the vegetation structure of wetland plant communities	The projected red gum canopy cover in seasonal wetlands decreases by 50% from 2015 levels by 2030 The projected aquatic macrophyte plant cover in December in seasonal wetlands exceeds 50% by 2030.	Cunningham (2011) tree health monitoring Nicol and Weedon (2006) approach to monitoring littoral and aquatic vegetation
Re-establishing resident populations of frogs and vegetation-dependent fish	At least four native fish species are present in seasonal wetlands every spring between 2025 and 2035. At least three frog species are present in seasonal wetlands every spring between 2025 and 2035	**Fish** TLM monitoring (Henderson, et al. 2013) **Frogs** Song meters Active search - nocturnal
Providing seasonal feeding and reproductive opportunities for channel-dependent fish species	No target set in Ecological Associates 2014	**Fish** TLM monitoring (Henderson, et al. 2013)

Ecological Objective	Target	Monitoring Recommendation
Providing reliable breeding habitat for waterbirds, including colonial nesting species	Any species of waterfowl, crake, rail, waterhen or coot breeds every year between 2025 and 2035 at Vinifera Park. Cormorants and / or nankeen night heron breed at Nyah Park on at least six occasions between 2025 and 2035	Waterbird surveys – conducted pre, during and post inundation as water levels change GIS mapping to monitor water levels – i.e. waterbird habitat availability.
Restoring floodplain productivity to maintain resident populations of vertebrate fauna including carpet python, sugar glider and grey-crowned babbler	All red gum and black box stands within the project area achieve a health score of moderate or better under Cunningham (2011) tree health monitoring for all years between 2025 and 2035. Total bat abundance increases by 25% from 2015 levels by 2030	**Habitat** Cunningham (2011) tree health monitoring **Bats –** Harp traps, Anabat **Carpet Python** – Nocturnal spotlight transects **Sugar Glider** – Nocturnal spotlight transects **Grey-crowned Babbler** – 20min/2ha bird census and call playback
Contributing to the organic carbon requirements of the River Murray channel ecosystem	The average annual carbon load (dissolved and particulate) to the River Murray for the period 2025 to 2035 is double 2015 to 2020 levels.	Dissolved and particulate organic matter concentrations in water draining from floodplain

10. CONSULTATION

This Plan was developed in collaboration with key stakeholders namely Parks Victoria, the Department of Environment, Land, Water and Planning, Lower Murray Water and local interest groups.

Table 219 - Consultation Process for development of Nyah and Vinifera Environmental Water Management Plan

Meeting date	Stakeholders	Details
May 2014	Parks Victoria	Initial discussion to introduce concept of plan and discuss the issue of feral pigs in the area.
May 2016	Parks Victoria	Presentation of plan.
June 2016	Department of Environment Land Water and Planning	Presentation of plan.
May 2014 & June 2016	Lower Murray Water	Discussion on drainage disposal to the wetlands creating habitat for feral pigs and management actions going forward. Presentation of plan.
June 2016	Murray Lower Darling Rivers Indigenous Nations	Presentation of plan.
June 2016	Mid-Murray Field Naturalists	Presentation of plan.
May 2016	Community – Swan Hill College	Presentation of plan.

11. Knowledge Gaps and Recommendations

This plan is based on the best information at the time of writing. In some cases this information is scarce or outdated. Further investigation and information collection will continue and the results of this further work will continue to build a better picture of the site and add rigor to future planning. Some areas where further knowledge would be beneficial are outlined in Table 3030.

Table 30 - Knowledge gaps and recommendations for the target area

Knowledge and data gaps	Action recommended	Priority
Role of wetland on fish breeding and population	Monitoring of fish population	2
Accurate depth and volumes for the wetland	Install depth gauges and bathymetric survey	2
Nesting habits of birds at the site	Data collection and monitoring	2
Bat, Carpet Python, Sugar Glider and Grey-crowned Babbler populations and response to environmental watering	Data collection and monitoring	2
Impacts of climate variability	Data collection and monitoring	3
Monitoring method for carbon export to the Murray River	Method and data collection	1

12. References

ANCA (1996) *A Directory of Important Wetlands in Australia Second Edition.* Australian Nature Conservation Agency, Canberra, ACT

Bell, J., Edwards, A., Grinter, B. (2014) *Sustainable Delivery Limits Project Nyah-Vinifera Park, River Red Gums National Park Due Diligence Assessment.* Prepared by Jo Bell Heritage Services for Mallee Catchment Management Authority

Bureau of Meteorology (2015) Accessed 14 September 2015. http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=076044

Cook, D. *Preliminary investigation of the floodplain vegetation of Nyah-Vinifera Forest.* Patterson Lakes, Victoria: Australian Ecosystems report prepared for Wadi Wadi Community and Friends of the Earth, 2012

Cunningham, S.C., P. Griffioen, M. White, and R. MacNally. *Mapping the condition of river red gum (Eucalyptus camaldulensis Dehnh.) and black box (Eucalyptus largiflorens F. Muell.) stands in The Living Murray Icon Sites. Stand condition report 2010.* Canberra: Murray-Darling Basin Authority, 2011

DEWHA (2008). *Commonwealth Environmental Water Holder 2008-09 Business Plan*, Department of Environment, Water, Heritage and the Arts, Canberra, ACT

DEWNR (2012). Riverine Recovery Monitoring and Evaluation Program – Conceptual understanding of the ecological response to water level manipulation. Department of Environment, Water and Natural Resources (DEWNR), Adelaide, South Australia

DSE (2005) *Index of Wetland Condition. Conceptual framework and selection of measures.* Department of Environment and Primary Industries, East Melbourne, Victoria

DSE (2006). Wetlands, Biodiversity and Salt; Frogs. Department of Sustainability and Environment, East Melbourne, Victoria

Ecological Associates (2006) *Investigation of Water Management Options for the Murray River – Nyah to Robinvale: Final Report,* Ecological Associates for *Mallee Catchment Management Authority Mildura , Victoria*

Ecological Associates (2014a). SDL Rationale and Outcomes. Ecological Associates report AL040-1-D prepared for Mallee Catchment Management Authority, Irymple

Ecological Associates (2014b). Phase 2 Assessment Supply Measure Business Case: Nyah Floodplain Management Project. prepared for Mallee Catchment Management Authority, Irymple

Ecological Associates (2014c). Phase 2 Assessment Supply Measure Business Case: Vinifera Floodplain Management Project. Prepared for Mallee Catchment Management Authority, Irymple

GHD (2015) *Murray River Frontage Action Plan- 2015 Monitoring* (Prepared by GHD for Mallee Catchment Management Authority, 2015)

Green, D and Alexander, P (2006), *River Murray Wetland Database: NSW, Victoria. Wetland Commence to flow levels, June 2006* NSW Wetland Working Group Albury, NSW

Henderson, M., et al. The Living Murray Condition Monitoring Report at Lindsay, Mulcra and Wallpolla Islands 2012-2013: Part A - Main Report. Irymple, Victoria: Murray-Darling Freshwater Research Centre Report 17/2013 prepared for Mallee Catchment Management Authority, 2013

Jacobs 2014. Hydrodynamic modelling of SDL sites - Nyah preliminary modelling report. Irymple, Victoria: Jacobs report prepared for Mallee Catchment Management Authority.

Jacobs 2014a. SDL Adjustment Supply Measures Advanced Concept Design Report – Nyah Park. Report for the Mallee CMA.

Land Conservation Council (1989) *Mallee Area Review Final Recommendations* Land Conservation Council, Melbourne Victoria

McKane, B (1992) *Environmental Report: Nyah – South Australian Border Salinity Management Plan*. Department of Conservation and Environment Mildura, Victoria

MCMA (2003) *Murray River Frontage Action Plan – Nyah to Robinvale* Mallee Catchment Management Authority Mildura, Victoria

MCMA (2006) *Mallee River Health Strategy* Mallee Catchment Management Authority Mildura, Victoria

MCMA (2006A) *Mallee Wetland Strategy* Mallee Catchment Management Authority Mildura, Victoria

MCMA (2012) Nyah and Vinifera Parks Wetlands Environmental Management Plan (Irrigation Impact)

MCMA (2010) *Nyah Vinifera Floodplain Management Unit Environmental Water Management Plan*. Mallee Catchment Management Authority Mildura, Victoria

MCMA (2014) *Mallee Waterway Strategy 2014-22* Mallee Catchment Management Authority Mildura, Victoria

Newall, P.R., Lloyd, L.N., Barton, A. and Cooling, M. 2014. SDL offsets projects – risks investigation, assessment and management strategy. Lloyd Environmental report to Mallee CMA. Lloyd Environmental Pty Ltd, Syndal, Victoria

North, L., (2014). Regional Context Document for Environmental Water Management Plans. Final Report prepared for the Mallee Catchment Management Authority by Sunraysia Environmental

Sinclair SJ (2004) *River Red Gum decline in the Nyah-Piangil Area: Is the semi-parasitic Pale-fruit Ballart involved?* Report to Mallee CMA. Arthur Rylah Institute for Environmental Research. Heidelberg, Victoria

SKM (2013) Preliminary Salinity Impact Assessment for Mallee Environmental Water Projects: Wallpolla Floodplain; Buloke Swamp;Hattah Lakes; Belsar & Yungera; BurraCreek; Nyah Forrest, Vinifera. For Mallee Catchment Management Authority Mildura, Victoria

Sunraysia Environmental (2014). *Regional Context Document for Environmental Water Management Plans: Mallee CMA Region,* Sunraysia Environmental for Mallee Catchment Management Authority Mildura, Victoria

Thomas, MC, Suter, P., Roberts, J., Koehn, J., Jones, G., Hillman, T. and Close, A. (2000). *Report of the River Murray Scientific Panel on Environmental Flows: River Murray – Dartmouth to Wellington and the Lower Darling River*, River Murray Scientific Panel on Environmental Flows, Murray Darling Basin Commission, Canberra ACT

VEAC (2008) *River Red Gum Investigation* Victorian Environmental Assessment Council East Melbourne, Victoria

Websites

Department of Environment and Primary Industries, Bioregions: http://www.DEPI.vic.gov.au/conservation-and-environment/victorias-bioregions#bioregion (Nov 2011)

www.depi.vic.gov.au/...and.../**biodiversity**/**biodiversity**-**interactive**-**map**

13. Abbreviations and Acronyms

CAMBA	China-Australia Migratory Bird Agreement
CMA	Catchment Management Authority
DELWP	Department of Environment, Land, Water and Planning
DEPI	Department of Environment and Primary Industries (now DEWLP)
DSE	Department of Sustainability and Environment (now DELWP)
EVC	Ecological Vegetation Class
EPBC	Environment Protection and Biodiversity Conservation Act
EWMP	Environmental Water Management Plan
EWH	Environmental Water Holder
EWR	Environmental Water Reserve
FFG	Flora and Fauna Guarantee Act
FSL	Full Supply Level
WMU	Floodplain Management Unit
IWC	Index of Wetland Condition
JAMBA	Japan-Australia Migratory Bird Agreement
MCMA	Mallee Catchment Management Authority
MDBA	Murray-Darling Basin Authority (formally Murray-Darling Basin Commission, MDBC)
Ramsar	Global treaty adopted in the Iranian city of Ramsar in 1971 that focuses on the conservation of internationally important wetlands
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
RRG	River Red Gum
SDL	Sustainable Diversion Limit
TLM	The Living Murray Initiative
TSL	Targeted Supply Level
VEWH	Victorian Environmental Water Holder
VWMS	Victorian Waterway management Strategy
WMU	Waterway Management Unit

Appendix 1 – Flora and Fauna Species List

Flora and Fauna Species List

Flora Species List

Scientific Name	Common Name	Classification	Source of information			
			2010 EWMP (both sites)	AE 2012 (both sites)	2013 GHD survey	
					Nyah	Vinifera
Native Species						
Acacia hakeoides	Hakea Wattle	P	Y			
Acacia ligulata	Small Cooba	P	Y			
Acacia loderi	Nealie	v, P	Y			
Acacia melvillei	Yarran	v, P	Y			
Acacia oswaldii	Umbrella Wattle		Y			
Acacia spp.	Wattle		Y			
Acacia stenophylla	Eumong	P	Y			
Alternanthera prostrata s.l.	Lesser Joyweed		Y	Y	Y (*A. denticulata*)	Y
Amphibromus nervosus	Common Swamp Wallaby-grass		Y			
Amyema miquelii	Box Mistletoe		Y			
Asteraceae spp.	Composite	P	Y			
Atriplex acutibractea subsp. *karoniensis*	Pointed Saltbush	r	Y			
Atriplex leptocarpa	Slender-fruit Saltbush		Y		Y	Y
Atriplex semibaccata	Berry Saltbush		Y	Y	Y	Y
Atriplex suberecta	Sprawling Saltbush		Y	Y		
Austrostipa elegantissima	Feather Spear-grass		Y			
Austrostipa scabra subsp. *prostrata*	Rough Spear-grass		Y	Y		
Austrostipa spp.	Spear Grass		Y			
Azolla filiculoides	Pacific Azolla		Y			Y
Azolla spp.	Azolla		Y			
Beyeria opaca	Dark Turpentine-bush		Y			
Billardiera cymosa s.l.	Sweet Apple-berry		Y			
Bolboschoenus medianus	Marsh Club-sedge		Y	Y		Y
Brachychiton populneus subsp. *populneus*	Kurrajong		Y			
Brachyscome basaltica var. *gracilis*	Woodland Swamp-daisy	P	Y	Y	Y	
Brachyscome ciliaris	Variable Daisy	P	Y			
Brachyscome lineariloba	Hard-head Daisy	P	Y			
Calandrinia eremaea	Small Purslane		Y			
Callistemon rugulosus	Scarlet Bottlebrush		Y			
Callitris gracilis subsp. *murrayensis*	Slender Cypress-pine		Y			
Calotis scapigera	Tufted Burr-daisy		Y			
Cardamine moirensis	Riverina Bitter-cress	r	Y	Y	Y	
Carex appressa	Tall Sedge		Y			
Carex tereticaulis	Poong'ort		Y			
Carpobrotus modestus	Inland Pigface		Y			
Cassytha melantha	Coarse Dodder-laurel		Y			
Centipeda cunninghamii	Common Sneezeweed	P	Y	Y	Y	Y
Centipeda minima s.l.	Spreading Sneezeweed	P	Y			
Centipeda minima subsp. *minima* s.s.	Spreading Sneezeweed	P	Y			
Chenopodium curvispicatum	Cottony Saltbush		Y			
Chenopodium desertorum	Frosted Goosefoot		Y			
Chenopodium desertorum subsp. *microphyllum*	Small-leaf Goosefoot		Y			
Chenopodium nitrariaceum	Nitre Goosefoot		Y			
Chloris prostrata	Windmill Grass		Y	Y (*C. truncata*)		
Clematis microphylla s.l.	Small-leaved Clematis		Y			
Convolvulus remotus	Grassy Bindweed			Y		
Crassula colorata	Dense Crassula		Y			
Crassula helmsii	Swamp Crassula		Y			Y
Crassula sieberiana s.l.	Sieber Crassula		Y			
Cressa australis	Rosinweed			Y		
Cuscuta australis	Australian Dodder	k		Y	Y	
Cynodon dactylon	Couch		Y			
Cynodon dactylon var. *pulchellus*	Native Couch	v	Y		Y	
Cyperus difformis	Variable Flat-sedge			Y		
Cyperus exaltatus	Tall Flat-sedge		Y	Y	Y	

Scientific Name	Common Name	Classification	Source of information			
			2010 EWMP (both sites)	AE 2012 (both sites)	2013 GHD survey	
					Nyah	Vinifera
Cyperus gymnocaulos	Spiny Flat-sedge		Y			
Cyperus pygmaeus	Dwarf Flat-sedge	v	Y			
Damasonium minus	Star Fruit		Y			
Daucus glochidiatus	Australian Carrot		Y			
Dianella porracea	Riverine Flax-lily	v			Y	
Dianella prostrata s.l.	Black-anther Flax-lily		Y			
Dianella sp. aff. *prostrata (North-west Victoria)*	Stiff Flax-lily		Y			
Dichondra repens	Kidney-weed		Y			
Dodonaea prostrata	Sticky Hop-bush		Y			
Dodonaea prostrata subsp. *angustissima*	Slender Hop-bush		Y			
Dysphania pumilio	Clammy Goosefoot		Y	Y	Y	
Eclipta platyglossa	Yellow Twin-heads		Y	Y		Y
Einadia nutans subsp. *nutans*	Nodding Saltbush		Y	Y	Y	
Elatine gratioloides	Waterwort		Y			Y
Eleocharis acuta	Common Spike-sedge		Y	Y	Y	Y
Eleocharis pusilla	Small Spike-sedge		Y			
Eleocharis sphacelata	Tall Spike-sedge		Y			
Enchylaena prostrata var. *prostrata*	Ruby Saltbush		Y	Y	Y (*E. tomentosa*)	Y
Enteropogon acicularis	Spider Grass		Y			
Ephemerum cristatum	Earth Moss		Y			
Epilobium billardierianum subsp. *cinereum*	Grey Willow-herb		Y			
Eragrostis infecunda	Southern Cane Grass			Y		
Eragrostis spp.	Love Grass		Y			
Eucalyptus calycogona	Red Mallee		Y			
Eucalyptus camaldulensis	River Red-gum		Y	Y	Y	Y
Eucalyptus dumosa	Dumosa Mallee		Y			
Eucalyptus gracilis	Yorrell		Y			
Eucalyptus largiflorens	Black Box		Y		Y	
Eucalyptus leptophylla	Slender-leaf Mallee		Y			
Eucalyptus oleosa subsp. *oleosa*	Oil Mallee		Y			
Eucalyptus socialis subsp. *socialis*	Grey Mallee		Y			
Euchiton sphaericus	Annual Cudweed		Y			
Euphorbia drummondii	Flat Spurge				Y	Y
Euphorbia drummondii	Flat Spurge		Y	Y		
Exocarpos aphyllus	Leafless Ballart		Y	Y		
Exocarpos sparteus	Broom Ballart				Y	
Exocarpos strictus	Pale-fruit Ballart		Y		Y	
Gemmabryum pachythecum	Acorn-fruited Thread-moss		Y			
Geranium retrorsum s.s.	Grassland Crane's-bill		Y			
Glinus lotoides	Hairy Carpet-weed		Y	Y	Y	
Glinus oppositifolius	Slender Carpet-weed				Y	
Glossostigma drummondii	Desert Mud-mat	k				
Glycyrrhiza acanthocarpa	Southern Liquorice		Y			
Gnaphalium polycaulon	Indian Cudweed	P				Y
Grevillea huegelii	Comb Grevillea		Y			
Haloragis aspera	Rough Raspwort		Y			
Helichrysum leucopsideum	Satin Everlasting	P	Y			
Helichrysum luteoalbum	Jersey Cudweed	P	Y	Y		
Juncus amabilis	Hollow Rush			Y		
Juncus aridicola	Tussock Rush					Y
Juncus bufonius	Toad Rush		Y	Y		
Juncus flavidus	Gold Rush		Y			
Juncus holoschoenus	Joint-leaf Rush		Y			
Juncus ingens	Giant Rush		Y			
Juncus subsecundus	Finger Rush		Y			
Lachnagrostis filiformis	Common Blown-grass		Y	Y	Y	Y
Lachnagrostis filiformis var. 1	Common Blown-grass		Y			
Landoltia punctata	Thin Duckweed		Y			

Scientific Name	Common Name	Classification	Source of information			
			2010 EWMP (both sites)	AE 2012 (both sites)	2013 GHD survey	
					Nyah	Vinifera
Limosella australis	Austral Mudwort		Y			Y
Limosella curdieana	Large Mudwort		Y			
Lobelia concolor	Poison Pratia		Y		Y	Y
Lomandra effusa	Scented Mat-rush		Y			
Ludwigia peploides subsp. *montevidensis*	Clove-strip		Y	Y	Y	Y
Lythrum hyssopifolia	Small Loosestrife		Y	Y	Y	
Maireana brevifolia	Short-leaf Bluebush		Y			
Maireana decalvans	Black Cotton-bush		Y	Y		
Marsilea costulifera	Narrow-leaf Nardoo		Y			
Marsilea drummondii	Common Nardoo		Y		Y	Y
Mentha australis	River Mint		Y			
Minuria leptophylla	Minnie Daisy	P	Y			
Morgania glabra spp. agg.	Blue Rod		Y			
Muellerina eucalyptoides	Creeping Mistletoe		Y			
Myoporum montanum	Waterbush	r	Y			
Myoporum platycarpum	Sugarwood		Y			
Myosurus australis	Mousetail				Y	
Myriophyllum spp.	Water-milfoil		Y			
Nymphoides crenata	Wavy Marshwort	v, L	Y			
Olearia muelleri	Mueller Daisy-bush	P	Y			
Olearia pimeleoides	Pimelea Daisy-bush	P	Y			
Ottelia ovalifolia subsp. *ovalifolia*	Swamp Lily		Y			
Oxalis perennans	Grassland Wood-sorrel		Y	Y	Y	
Panicum effusum	Hairy Panic		Y			
Panicum spp.	Panic		Y			
Paspalidium jubiflorum	Warrego Summer-grass		Y	Y	Y	
Pelargonium australe	Austral Stork's-bill		Y			
Persicaria lapathifolia	Pale Knotweed		Y			Y
Persicaria prostrata	Creeping Knotweed		Y	Y	Y	Y
Phascum robustum var. *crassinervium*	Ball Moss		Y			
Phragmites australis	Common Reed		Y			
Picris angustifolia	Native Picris	P	Y			
Picris spp.	Picris	P	Y			
Picris squarrosa	Squat Picris	P	Y			
Pimelea microcephala subsp. *microcephala*	Mallee Rice-flower		Y		Y	
Pittosporum angustifolium	Weeping Pittosporum		Y			
Polygonum plebeium	Small Knotweed		Y	Y	Y	
Potamogeton pectinatus	Fennel Pondweed		Y			
Potamogeton tricarinatus s.l.	Floating Pondweed		Y			
Pseudoraphis spinescens	Spiny Mud-grass		Y			
Ptilotus seminudus	Rabbit Tails		Y			
Ranunculus inundatus	River Buttercup		Y			
Ranunculus pumilio	Ferny Small-flower Buttercup		Y			
Ranunculus pumilio var. *pumilio*	Ferny Small-flower Buttercup		Y		Y	
Ranunculus spp.	Buttercup		Y			
Ranunculus undosus	Swamp Buttercup	v	Y			
Rhagodia spinescens	Hedge Saltbush		Y	Y	Y	Y
Rumex crystallinus s.l.	Glistening Dock		Y	Y		
Rumex prostrata	Slender Dock		Y		Y (*R. brownii*)	Y
Rumex tenax	Narrow-leaf Dock			Y	Y	Y
Rytidosperma caespitosa	Common Wallaby-grass		Y			
Rytidosperma setacea	Bristly Wallaby-grass		Y			
Rytidosperma setacea var. *setacea*	Bristly Wallaby-grass		Y			
Rytidosperma setaceum var. *setaceum*	Bristly Wallaby-grass			Y		
Rytidosperma spp.	Wallaby Grass		Y			
Salsola tragus subsp. *tragus*	Prickly Saltwort			Y		
Santalum murrayanum	Bitter Quandong		Y			
Sarcozona praecox	Sarcozona	r			Y	

Scientific Name	Common Name	Classification	Source of information			
			2010 EWMP (both sites)	AE 2012 (both sites)	2013 GHD survey	
					Nyah	Vinifera
Sclerolaena diacantha	Grey Copperburr		Y			
Sclerolaena muricata	Black Roly-poly		Y			
Sclerolaena muricata var. *villosa*	Grey Roly-poly			Y	Y	
Sclerolaena tricuspis	Streaked Copperburr			Y		
Senecio cunninghamii var. *cunninghamii*	Branching Groundsel	r, P	Y	Y		Y
Senecio quadridentatus	Cotton Fireweed	P	Y	Y	Y	Y
Senecio runcinifolius	Tall Fireweed	P	Y	Y		Y
Senna form taxon 'coriacea'	Broad-leaf Desert Cassia		Y			
Senna form taxon 'filifolia'	Fine-leaf Desert Cassia		Y			
Senna form taxon 'zygophylla'	Narrow-leaf Desert Cassia		Y			
Sida corrugata	Variable Sida				Y	
Spergularia sp. 3	Salt Sea-spurrey		Y	Y		
Sphaeromorphaea australis	Spreading Nut-heads	P	Y			
Sporobolus caroli	Yakka Grass	r		Y		
Stellaria angustifolia	Swamp Starwort		Y			
Stellaria prostrata	Matted Starwort		Y		Y (*S. caespitosa*)	
Stelligera endecaspinis	Star Bluebush			Y		
Templetonia sulcata	Flat Templetonia		Y			
Tetragonia eremaea s.l.	Desert Spinach		Y			
Triglochin multifructa	Northern Water-ribbons		Y	Y		
Triglochin procera s.l.	Water Ribbons		Y			Y
Triglochin procera s.s.	Common Water-ribbons		Y			
Triodia scariosa	Porcupine Grass		Y			
Typha domingensis	Narrow-leaf Cumbungi		Y		Y	
Typha orientalis	Broad-leaf Cumbungi		Y			
Typha spp.	Bulrush		Y			
Vittadinia cuneata	Fuzzy New Holland Daisy	P	Y	Y	Y	Y
Vittadinia dissecta s.l.	Dissected New Holland Daisy	P	Y		Y	
Vittadinia gracilis	Woolly New Holland Daisy	P	Y			
Vittadinia spp.	New Holland Daisy	P	Y			
Wahlenbergia fluminalis	River Bluebell		Y	Y	Y	Y
Westringia rigida	Stiff Westringia		Y			
Xerochrysum bracteatum	Golden Everlasting	P	Y			
Zygophyllum apiculatum	Pointed Twin-leaf		Y		Y	
Zygophyllum aurantiacum subsp. *aurantiacum*	Shrubby Twin-leaf		Y			
Introduced Species						
Acacia saligna	Golden Wreath Wattle		Y			
Acetosella vulgaris	Sheep Sorrel		Y			
Asparagus asparagoides	Bridal Creeper	R, WoNS	Y			
Asparagus officinalis	Asparagus		Y	Y	Y	Y
Aster subulatus	Aster-weed		Y	Y	Y	Y
Atriplex prostrata	Hastate Orache		Y	Y		
Avena fatua	Wild Oat		Y			
Avena spp.	Oat		Y			
Brassica tournefortii	Mediterranean Turnip		Y		Y	Y
Bromus catharticus	Prairie Grass		Y			
Bromus diandrus	Great Brome		Y		Y	Y
Bromus lanceolatus	Mediterranean Brome		Y			
Bromus rubens	Red Brome		Y			
Carduus tenuiflorus	Winged Slender-thistle	R, WoNS			Y	
Centaurea melitensis	Malta Thistle		Y		Y	
Chenopodium album	Fat Hen		Y			
Chloris gayana	Rhodes Grass		Y			
Chloris virgata	Feather Windmill Grass		Y			
Chondrilla juncea	Skeleton Weed		Y			
Cichorium intybus	Chicory		Y			
Cirsium vulgare	Spear Thistle	R, WoNS	Y	Y	Y	Y
Conyza bonariensis	Flaxleaf Fleabane		Y	Y	Y	Y

Scientific Name	Common Name	Classification	Source of information			
			2010 EWMP (both sites)	AE 2012 (both sites)	2013 GHD survey	
					Nyah	Vinifera
Cotula coronopifolia	Water Buttons		Y			
Cotyledon orbiculata	Pig's Ear		Y			
Cynodon dactylon var. *dactylon*	Couch		Y			
Cyperus eragrostis	Drain Flat-sedge		Y			Y
Dittrichia graveolens	Stinkwort	R	Y			
Echium plantagineum	Paterson's Curse	R			Y	
Ehrharta longiflora	Annual Veldt-grass		Y			
Fumaria bastardii	Bastard's Fumitory				Y	Y
Fumaria capreolata	White Fumitory		Y			
Gomphocarpus fruticosus subsp. *fruticosus*	Swan Plant		Y			
Heliotropium supinum	Creeping Heliotrope		Y	Y	Y	Y
Helminthotheca echioides	Ox-tongue		Y			Y
Hordeum marinum	Sea Barley-grass		Y			
Hordeum murinum s.l.	Barley-grass		Y			
Hypochaeris glabra	Smooth Cat's-ear		Y			
Hypochaeris radicata	Flatweed		Y			
Lactuca saligna	Willow-leaf Lettuce		Y			
Lactuca serriola	Prickly Lettuce		Y	Y	Y	Y
Leontodon taraxacoides subsp. *taraxacoides*	Hairy Hawkbit		Y			
Lepidium africanum	Common Peppercress		Y		Y	Y
Lolium rigidum	Wimmera Rye-grass		Y			Y
Lycium ferocissimum	African Box-thorn	C, WoNS	Y			
Lysimachia arvensis	Pimpernel		Y		Y	
Marrubium vulgare	Horehound	R	Y		Y	
Medicago minima	Little Medic		Y			
Medicago polymorpha	Burr Medic		Y	Y		Y
Melilotus indicus	Sweet Melilot				Y	
Opuntia spp.	Prickly Pear	C, WoNS	Y			
Paspalum dilatatum	Paspalum		Y			
Paspalum distichum	Water Couch		Y	Y		Y
Petrorhagia dubia	Velvety Pink				Y	
Phyla canescens	Fog-fruit		Y	Y	Y	Y
Plantago lanceolata	Ribwort		Y	Y		Y
Polygonum aviculare s.s.	Hogweed		Y	Y		Y
Polypogon monspeliensis	Annual Beard-grass		Y			
Ranunculus muricatus	Sharp Buttercup		Y			
Ranunculus sceleratus subsp. *sceleratus*	Celery Buttercup		Y	Y		
Reichardia tingitana	False Sow-thistle		Y			
Reseda luteola	Weld		Y			
Rhaponticum repens	Creeping Knapweed		Y			
Rorippa palustris	Marsh Yellow-cress		Y	Y		
Rostraria cristata	Annual Cat's-tail		Y			
Rumex crispus	Curled Dock		Y			
Salvia verbenaca	Wild Sage		Y			
Schismus barbatus	Arabian Grass		Y			
Scorzonera laciniata	Scorzonera		Y			
Sida rhombifolia	Paddy's Lucerne		Y			
Silene apetala var. *apetala*	Mallee Catchfly		Y			
Solanum nigrum sensu Willis (1972)	Black Nightshade		Y	Y	Y	
Sonchus asper s.l.	Rough Sow-thistle		Y	Y	Y	
Sonchus asper subsp. *glaucescens*	Blue Sow-thistle		Y			
Sonchus oleraceus	Common Sow-thistle		Y	Y	Y	
Sorghum halepense	Johnson Grass		Y			
Stellaria media	Chickweed		Y			
Trifolium fragiferum var. *fragiferum*	Strawberry Clover		Y			
Trifolium glomeratum	Cluster Clover		Y			
Trifolium spp.	Clover		Y			
Trifolium campestre var. *campestre*	Hop Clover				Y	

Scientific Name	Common Name	Classification	Source of information			
			2010 EWMP (both sites)	AE 2012 (both sites)	2013 GHD survey	
					Nyah	Vinifera
Vicia sativa	Common Vetch				Y	
Vulpia bromoides	Squirrel-tail Fescue		Y	Y	Y	
Xanthium spinosum	Bathurst Burr	R	Y			
Xanthium strumarium spp. agg.	Noogoora Burr species aggregate	C	Y			

Key:

r Listed as rare under VROTs list
k Listed as poorly known under VROTs list
P Listed as protected under FFG Act
C Listed as Regionally Controlled under CaLP Act within the Mallee CMA
R Listed as Restricted under the CaLP Act within the Mallee CMA
WoNS Weed of National Significance

Fauna Species List

Scientific Name	Common Name	Classification	Type	Source of information						
Native Species				2010 EWMP (both sites)	2013 GHD survey		ARI 2013 Survey		2014 Ecological SDL	
					Nyah	Vinifera	Nyah	Vinifera	Nyah	Vinifera
Acanthiza chrysorrhoa	Yellow-rumped Thornbill		B		Y		Y			
Acanthiza reguloides	Buff-rumped Thornbill		B		Y		Y			
Acanthiza uropygialis	Chestnut-rumped Thornbill		B	Y			Y			
Accipiter fasciatus	Brown Goshawk		B	Y	Y		y			
Accipiter (Paraspizias) cirrocephalus	Collared Sparrowhawk		B		Y		y			
Accipiter novaehollandiae	Grey Goshawk		B	Y						
Acrocephalus stentoreus	Clamorous Reed Warbler		B	Y						
Alisterus scapularis	Australian King-Parrot		B	Y						
Anas gracilis	Grey Teal		B	Y		Y				
Anas rhynchotis	Australasian Shoveler	v	B			Y				
Anas superciliosa	Pacific Black Duck		B	Y		Y				
Anhinga melanogaster	Darter		B			Y				
Anthochaera carunculata	Red Wattlebird		B	Y						
Aquila audax	Wedge-tailed Eagle		B	Y						
Ardea modesta	Eastern Great Egret		B	Y						
Ardea pacifica	White-necked Heron		B	Y						
Artamus cyanopterus	Dusky Woodswallow		B	Y						
Artamus personatus	Masked Woodswallow		B		Y		Y			
Artamus superciliosus	White-browed Woodswallow		B		Y		Y			
Aythya australis	Hardhead		B	Y						
Biziura lobata	Musk Duck		B	Y						
Cacatua galerita	Sulphur-crested Cockatoo		B		Y		y			
Lophochroa leadbeateri	Major Mitchell's Cockatoo	v, L	B						Y	Y
Cacatua sanguinea	Little Corella		B		Y					
Chalinolobus gouldi	Gould's Wattled Bat		M		Y	Y	y	y	Y	Y
Chalinolobus morio	Chocolate Wattled Bat		M		Y	Y	y	y	Y	Y
Chelodina longicollis	Common Long-necked Turtle	dd	R						Y	
Chenonetta jubata	Australian Wood Duck		B	Y		Y				
Christinus marmoratus	Marbled Gecko		R	Y					Y	
Chrysococcyx basalis	Horsfield's Bronze-Cuckoo		B	Y						
Cincloramphus mathewsi	Rufous Songlark		B	Y						
Climacteris picumnus	Brown Treecreeper		B				Y			
Colluricincla harmonica	Grey Shrike-thrush		B		Y	Y	Y			
Coracina novaehollandiae	Black-faced Cuckoo-shrike		B	Y	Y	Y	Y	Y		
Corcorax melanorhamphos	White-winged Chough		B	Y	Y	Y	Y	Y		
Corvus coronoides	Australian Raven		B	Y	Y	Y	Y	Y		
Corvus mellori	Little Raven		B	Y				Y		
Cracticus nigrogularis	Pied Butcherbird		B	Y	Y	Y	Y	Y		
Crinia parasignifera	Plains Froglet		R		Y				Y	
Crinia signifera	Common froglet		R						Y	
Cryptoblepharus carnabyi	Carnaby's Wall Skink		R	Y	Y	Y	Y		Y	Y
Cygnus atratus	Black Swan		B	Y						
Daphoenositta chrysoptera	Varied Sittella		B		Y		Y			
Dacelo novaeguineae	Laughing Kookaburra		B	Y	Y	Y				y
Delma inomata	Olive Legless Lizard		R			Y		Y		Y
Dicaeum hirundinaceum	Mistletoebird		B	Y						
Egretta novaehollandiae	White-faced Heron		B	Y		Y				
Elseyornis melanops	Black-fronted Dotterel		B	Y						
Entomyzon cyanotis	Blue-faced Honeyeater		B	Y		Y		Y		

Scientific Name	Common Name	Classification	Type	Source of information						
Native Species				2010 EWMP (both sites)	2013 GHD survey		ARI 2013 Survey		2014 Ecological SDL	
					Nyah	Vinifera	Nyah	Vinifera	Nyah	Vinifera
Eolophus roseicapilla	Galah		B	Y	Y	Y	y	y		
Falco berigora	Brown Falcon		B	Y						
Falco cenchroides	Nankeen Kestrel		B	Y	Y		y			
Fulica atra	Eurasian Coot		B	Y						
Gallinula tenebrosa	Dusky Moorhen		B	Y						
Gallinula ventralis	Black-tailed Native-hen		B	Y						
Gerygone fusca	Western Gerygone		B		Y		Y			
Geopelia striata	Peaceful Dove		B	Y	Y	Y				
Grallina cyanoleuca	Magpie-lark		B	Y	Y	Y	Y	Y		
Gymnorhina tibicen	Australian Magpie		B	Y	Y	Y	Y	Y		
Haliaeetus (Pontoaetus) leucogaster	White-bellied Sea-eagle	v, L	B						Y	
Haliastur sphenurus	Whistling Kite		B	Y		Y				
Hirundo neoxena	Welcome Swallow		B	Y						
Hirundo nigricans	Tree Martin		B	Y	Y					
Hydromus chrysogaster	Water Rat		M						Y	
Lalage (Lalage) sueurii	White-winged Triller		B		Y		Y			
Lampropholis guichenoti	Garden Skink		R		Y	Y	Y	Y	Y	Y
Lerista punctatovittata	Spotted Burrowing Skink		R	Y						
Lichenostomus penicillatus	White-plumed Honeyeater		B	Y	Y	Y	Y	Y		
Lichenostomus virescens	Singing Honeyeater		B	Y						
Limnodynastes dumerilii	Southern Bullfrog		A	Y	Y	Y	Y	Y	Y	Y
Limnodynastes tasmaniensis	Spotted Marsh Frog		A	Y	Y	Y	Y	Y	Y	Y
Litoria peronii	Peron's Tree Frog		A	Y	Y			Y	Y	Y
Litoria raniformis	Growling Grass Frog		A	Y						
Macropus giganteus	Eastern Grey Kangaroo		M			Y	Y	Y	Y	Y
Malacorhynchus membranaceus	Pink-eared Duck		B	Y						
Malurus cyaneus	Superb Fairy-wren		B	Y	Y		Y			
Manorina melanocephala	Noisy Miner		B	Y	Y	Y	Y	Y		
Menetia greyii	Grey's Skink		R						Y	
Merops ornatus	Rainbow Bee-eater		B	Y		Y				
Microcarbo melanoleucos	Little Pied Cormorant		B	Y						
Morelia spilota metcalfei	Carpet Python	e, L	R	Y					Y	
Morethia boulengeri	Boulenger's Skink		R	Y	Y	Y	Y	Y	Y	Y
Mormopterus sp. 2	Eastern Freetail Bat		M		Y	Y	y	y	Y	Y
Mormopterus sp. 4	Southern Freetail Bat		M		Y	Y	y	y	Y	Y
Myiagra inquieta	Restless Flycatcher		B			Y		Y		
Ninox novaeseelandiae	Southern Boobook		B		Y	Y	Y	Y		
Northiella haematogaster	Blue Bonnet		B	Y						
Notopala sublineata	River Snail		I	Y						
Nycticorax caledonicus	Nankeen Night Heron	nt	B	Y					Y	Y
Nymphicus hollandicus	Cockatiel		B	Y						
Ocyphaps lophotes	Crested Pigeon		B	Y		Y		y		
Pachycephala rufiventris	Rufous Whistler		B	Y	Y	Y	Y			
Pardalotus striatus	Striated Pardalote		B	Y	Y	Y	Y	Y		
Pelecanus conspicillatus	Australian Pelican		B	Y	Y	Y	y			
Petrochelidon nigricans	Tree Martin		B				Y			
Petroica goodenovii	Red-capped Robin		B	Y	Y		Y			
Phalacrocorax carbo	Great Cormorant		B	Y		Y				
Phalacrocorax melanoleucos	Little Pied Cormorant		B			Y				
Phalacrocorax sulcirostris	Little Black Cormorant		B	Y		Y				
Phaps chalcoptera	Common Bronzewing		B	Y	Y	Y	y			
Philemon citreogularis	Little Friarbird		B	Y	Y	Y	Y	Y		
Platalea flavipes	Yellow-billed Spoonbill		B	Y		Y				
Platalea regia	Royal Spoonbill		B	Y						
Platycercus elegans elegans	Crimson Rosella		B	Y						

Scientific Name	Common Name	Classification	Type	Source of information						
Native Species				2010 EWMP (both sites)	2013 GHD survey		ARI 2013 Survey		2014 Ecological SDL	
					Nyah	Vinifera	Nyah	Vinifera	Nyah	Vinifera
Platycercus elegans flaveolus	Yellow Rosella		B	Y	Y	Y	y	y		
Platycercus eximius	Eastern Rosella		B	Y				y		
Podargus strigoides	Tawny Frogmouth		B		Y	Y	Y	Y		
Poliocephalus poliocephalus	Hoary-headed Grebe		B			Y				
Polytelis anthopeplus	Regent Parrot	v, L, VU	B	Y						
Pomatostomus temporalis	Grey-crowned Babbler		B	Y						
Porzana tabuensis	Spotless Crake		B	Y						
Psephotus haematonotus	Red-rumped Parrot		B	Y	Y	Y	y	y		
Pseudonaja textilis	Eastern Brown Snake		R			Y		Y	Y	Y
Rhipidura albiscarpa	Grey Fantail		B	Y						
Rhipidura leucophrys	Willie Wagtail		B	Y	Y	Y	Y	Y		
Saccolaimus flaviventris	Yellow-bellied Sheathtailed Bat	dd, L	M		Y		y		Y	
Scotorepens balstoni	Inland broad-nosed Bat		M			Y		y		Y
Scotorepens greyii	Little Broad-nosed Bat	NT	M			Y		y		Y
Simoselaps australis	Coral Snake		R	Y						
Smicrornis brevirostris	Weebill		B	Y	Y	Y	Y	Y		
Tachybaptus novaehollandiae	Australasian Grebe		B			Y				
Tachyglosssus aculeatus	Short-beaked Echidna		M						Y	
Tadarida australis	White-striped Freetail Bat		M		Y	Y	y	y		Y
Taeniopygia guttata	Zebra Finch		B	Y						
Threskiornis molucca	Australian White Ibis		B	Y		Y				
Threskiornis spinicollis	Straw-necked Ibis		B	Y						
Todiramphus sanctus	Sacred Kingfisher		B	Y	Y	Y			y	y
Trichosurus vulpecula	Common Brushtail Possum		M		Y	Y	Y	Y	Y	Y
Turnix varia	Painted Button-quail		B	Y						
Tyto alba	Barn Owl						Y	Y		
Tyto javanica	Eastern Barn Owl		B		Y	Y				
Varanus varius	Lace Monitor		R						Y	
Vespadelus darlingtoni	Large Forest Bat		M		Y	Y	y	y	Y	Y
Vespadelus regulus	Southern Forest Bat		M		Y	Y	y	y	Y	Y
Vespadelus vulturnus	Little Forest Bat		M		Y	Y	y	y	Y	Y
Wallabia bicolor	Black Wallaby		M	Y		Y	Y	Y	Y	Y
Zosterops lateralis	Silvereye		B	Y	Y		Y			
Introduced Species										
Anas platyrhynchos	Northern Mallard		B	Y						
Lepus europaeus	European Hare							Y		
Oryctolagus cuniculus	European Rabbit		M		Y		Y			
Passer domesticus	House Sparrow		B	Y						
Sturnus vulgaris	Common Starling		B	Y						
Turdus merula	Common Blackbird		B	Y						
Vulpes vulpes	Red Fox		M	Y		Y	Y	Y		

Appendix 2 - Recent watering history

The table below summarises the recent environmental watering history in the target area. Environmental watering has only occurred in the Nyah section of the WMU.

This appendix will be updated seasonally.

Water year	Time of inflow	Inflow source	Source volume (ML)	Total volume (ML)	Cost of delivery ($)	Area (ha) Inundated	Comments
2004/05	Autumn	Donated water	153	153	$30 -45/Ml*	35	
2005/06	Spring	EWR	560	1241		110	
		RMUF	681				
	Autumn	EWR	500	500		110	
2009/10	Autumn	EWR	2125.8	2125.8		165.36	

*the cost of delivery is dependent on factors such as fuel prices, river heights, site access, type of pump required, volume to be pumped etc

Pumping at Nyah, April 2010

Nyah Forest photo point #3 April 8 2010

Appendix 3 - Index of Wetland Condition Assessment

Background

The condition of the Nyah Vinifera WMU was assessed in 2009 using the Index of Wetland Condition (IWC) method. The IWC defines wetland condition as the state of the biological, physical, and chemical components of the wetland ecosystem and their interactions. The condition of two of the eleven wetlands within the target area of the Nyah Vinifera WMU (see map below) was assessed in December 2009.

The IWC has five sub-indices based on the catchment of the wetland and its fundamental characteristics: physical form, hydrology, water properties, soils and biota. Each sub-index is given a score between 0 and 20 based on the assessment of a number of measures. The overall IWC score is not a simple summation of the sub-index scores. A formula is used that weights each sub-index according to the contribution it makes to the overall condition of the wetland. The wetland hydrology sub-index for example contributes more to the overall score than the soils sub-index.

Methods

Sub-indices

The table below shows what is measured for each of the six sub-indices and how each sub-index is scored. The sections below describe this in greater detail. Further information can be found on the IWC website (www.dse.vic.gov.au/iwc).

IWC sub-indices and measures

Sub-index	What is measured	How it is scored
Wetland catchment	The intensity of the land use within 250 metres of the wetland	The more intensive the landuse the lower the score
	The width of the native vegetation surrounding the wetland and whether it is a continuous zone or fragmented	The wider the zone and more continuous the zone, the higher the score
Physical form	Whether the size of the wetland has been reduced from its estimated pre-European settlement size	A reduction in area results in a lowering of the score
	The percentage of the wetland bed which has been excavated or filled	The greater the percentage of wetland bed modified, the lower the score
Hydrology	Whether the wetland's water regime (i.e. the timing, frequency of filling and duration of flooding) has been changed by human activities	The more severe the impacts on the water regime, the lower the score
Water properties	Whether activities and impacts such as grazing and fertilizer run-off that would lead to an input of nutrients to the wetland are present	The more activities present, the lower the score
	Whether the wetland has become more saline or in the case of a naturally salty wetland, whether it has become more fresh	An increase in salinity for a fresh wetland lowers the score or a decrease in salinity of a naturally salty wetland lowers the score

Sub-index	What is measured	How it is scored
Soils	The percentage and severity of wetland soil disturbance from human, feral animals or stock activities	The more soil disturbance and the more severe it is, the lower the score
Biota	The diversity, health and weediness of the native wetland vegetation	The lower the diversity and poorer health of native wetland vegetation, the lower the score
		The increased degree of weediness in the native wetland vegetation, the lower the score

Scoring method

Each subindex is given a score between 0 and 20 based on the assessment of a number of measures as outline above. Weightings are then applied to the scores as tabulated below. The maximum possible total score for a wetland is 38.4. For ease of reporting, all scores are normalised to an integer score out of 10 (i.e. divide the total score by 38.4, multiply by 10 and round to the nearest whole number).

IWC sub-index	Weight
Biota	0.73
Wetland catchment	0.26
Water properties	0.47
Hydrology	0.31
Physical form	0.08
Soils	0.07

Five wetland condition categories have been assigned to the sub-index scores and total IWC scores as tabulated over page. The five category approach is consistent with the number of categories used in other condition indices such as the Index of Stream Condition. Biota sub-index score categories were determined by expert opinion and differ to those of the other sub-indices.

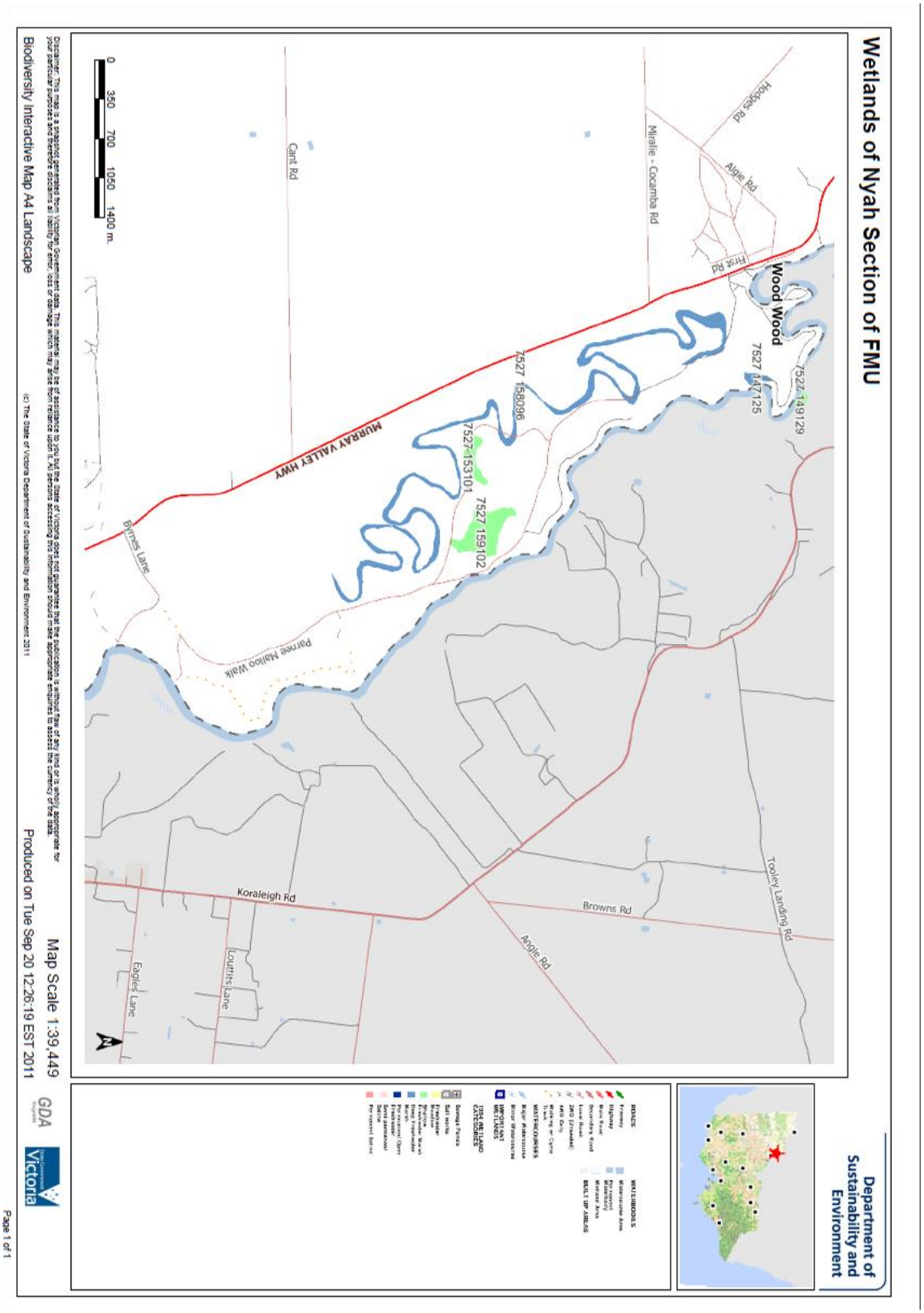
Non-biota sub-index score range	Biota sub-index score range	Total score range	Wetland condition category
0-4	0-8	0-2	Very poor
5-8	9-13	3-4	Poor
9-12	14-16	5-6	Moderate
13-16	17-18	7-8	Good
16-20	19-20	9-10	Excellent
N/A	N/A	N/A	Insufficient data

Results

The overall IWC score for both wetlands assessed in this WMU in December 2009 was six out of 10, which is considered to be moderate (see table below)

IWC sub-index and overall score for two wetlands in the target area

IWC sub-index	Wetland #7527147125		Wetland #7527153101	
	Score /20	Category	Score /20	Category
Wetland catchment	18	Excellent	18	Excellent
Physical form	20	Excellent	20	Excellent
Hydrology	0	Very poor	0	Very poor
Water properties	17	Excellent	17	Excellent
Soils	19.8	Excellent	19.8	Excellent
Biota	11.4	Poor	8.4	Poor
Overall IWC score	**6 / 10**	**Moderate**	**6 / 10**	**Moderate**


Wetlands of Nyah Section of FMU
Department of Sustainability and Environment
Wood Wood
7527 147125
7527 149129
7527 158096
7527 153101
7527 159102
MURRAY VALLEY HWY
Cant Rd
Miralie - Cocamba Rd
Hodges Rd
Algie Rd
Frisk Rd
Byrnes Lane
Parnee Mallee Walk
Koraleigh Rd
Browns Rd
Tooley Landing Rd
Angle Rd
Louttits Lane
Eagles Lane
0 350 700 1050 1400 m.
Biodiversity Interactive Map A4 Landscape
Map Scale 1:39,449
Produced on Tue Sep 20 12:26:19 EST 2011
GDA
Victoria
Page 1 of 1