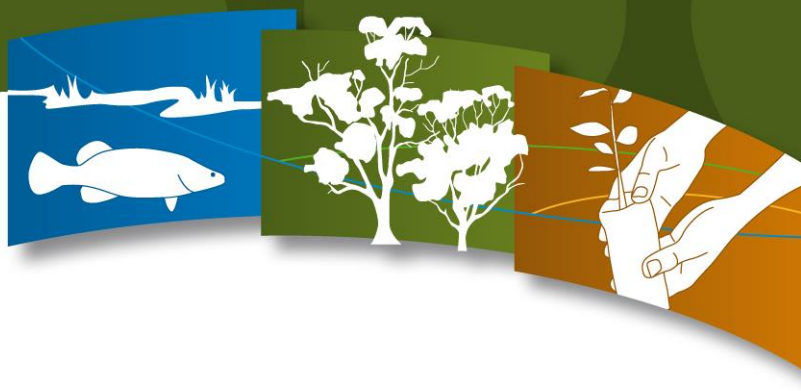
Connecting Rivers, Landscapes, People

Hird Swamp
Environmental Water Management Plan
Final

North Central Catchment Management Authority



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Connecting Rivers, Landscapes, People

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This is a working document, compiled from the best available information. It will be subject to revision in the future as new information becomes available.

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EXECUTIVE SUMMARY

This Environmental Water Management Plan investigates and documents existing knowledge about Hird Swamp. Its aim is to assist in the development of environmental watering proposals for the consideration of Environmental Water Holders. It is not a holistic management plan for the site, but is focused on specific environmental water management at Hird Swamp.

The following information is provided in the Plan to facilitate appropriate environmental water management at Hird Swamp into the future.

Hird Swamp is a 344 hectare deep freshwater marsh located within the Kerang Wetlands Ramsar site. The wetland is of international importance and listed under the Directory of Important Wetlands in Australia. It is classified as a Wildlife Reserve and is managed by Parks Victoria.

Hird Swamp provides habitat for a range of flora and fauna species listed under various international, national and Victorian state legislation, including species listed under the *Environment Protection and Biodiversity Conservation Act* 1999. Hird Swamp is known to support large numbers of waterbirds, and between 1980 and 2003 some of the highest abundances of waterbirds within the Kerang Wetlands Ramsar site were recorded here.

Hird Swamp is divided by Pyramid Creek, creating two distinct wetland habitats (referred to as Hird Swamp west and Hird Swamp east). Hird Swamp west is the larger of the two wetland sections at 271 hectares, and is characterised by Lignum Swampy Woodland EVC. Hird Swamp east is 73 hectares in size and contains Riverine Chenopod Woodland EVC.

There are a range of habitats through Hird Swamp, including open water, reed dominated areas and lignum habitats. All these contribute to Hird Swamp functioning as a highly valued and important wetland.

Background information and local technical input was used to determine an environmental water management goal and appropriate watering regime for Hird Swamp. These are summarised below:

Hird Swamp environmental water management goal

To provide an appropriate water regime that will maintain varying habitats through Hird Swamp (east and west) important for waterbird resting, nesting and feeding, in particular the provision of:

- Open-water habitat
- Lignum dominated woodland
- Reed habitat, with associated wetland flora which can withstand periods of dry.

Optimal watering regime

Provide two watering events every ten years.

Fill Hird Swamp west in spring of year one and allow water to siphon into Hird Swamp east. Top up west section of the wetland to maintain the wetland at full supply level with some variation during summer.

Top up Hird Swamp west in spring of year two and maintain maximum depth during summer (with some variation). Open outlet structure to Pyramid Creek in autumn to facilitate rapid drawdown of the wetland, inhibiting the proliferation of Cumbungi and *Phragmites.* In total, allow inundation of Hird Swamp west for 24 months.

Allow wetland to dry completely during year three, and allow wetland to remain completely dry during the following two years.

Provide second watering event in year six, targeting inundation of Hird Swamp west only. Manage watering regime as per the first cycle of wetting and drying.

A risk identification process was undertaken to investigate potential risks associated with environmental water delivery and associated site management at Hird Swamp. Detailed risk assessments will be undertaken prior to delivering environmental water to the site in any given season. This will be detailed in the environmental watering proposal for the site.

Knowledge gaps and recommendations are provided which will assist in improving knowledge about environmental water management and ecological outcomes achieved at Hird Swamp. Investment in these recommendations should be considered along with the provision of environmental water to the site.

Community consultation was also undertaken as part of developing this plan. Interviews with community members were focussed on collecting information in relation to the wetland, its values and the environmental watering regime recommendations. The community consultation component of developing the plan was essential in ensuring that the plan is meaningful and robust into the future.

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* Mark Tscharke (Parks Victoria)
* Shelley Heron (Kellogg Brown and Root)
* Emer Campbell (North Central CMA)
* Ross Stanton (Goulburn-Murray Water)

In addition, the assistance provided by Lyndall Rowley, Darren White, Tim Shanahan, Michelle Maher, Bree Bisset and Phil Slessar (North Central CMA) is greatly appreciated.

North Central CMA acknowledges the cross-collaboration with Goulburn Broken CMA, Mallee CMA and DSE in the development of the Environmental Water Management Plans.

ABBREVIATIONS

BE	Bulk Entitlement
Bonn	The Convention on the Conservation of Migratory Species of Wild Animals (also known as the Bonn Convention or CMS)
CAMBA	China-Australia Migratory Bird Agreement
CEWH	Commonwealth Environmental Water Holder
CMAs	Catchment Management Authorities
DEPI	Department of Environment and Primary Industries
DPI	Department of Primary Industries
DSE	Department of Sustainability and Environment
EVC	Ecological Vegetation Class
EWaMP	Environmental Water Management Plan
FSL	Full Supply Level
GL	Gigalitre (one billion litres)
G-MW	Goulburn-Murray Water
IWC	Index of Wetland Condition
JAMBA	Japan-Australia Migratory Bird Agreement
MDBA	Murray-Darling Basin Authority (formally Murray-Darling Basin Commission, MDBC)
ML	Megalitre (one million litres)
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
RRG	River Red Gum
TLM	The Living Murray Initiative
TSL	Targeted Supply Level
VEWH	Victorian Environmental Water Holder

1. INTRODUCTION

1.1. Background

Environmental water management in Victoria is entering a new phase as ongoing water recovery means significant volumes of water are being returned to the environment. This has provided new opportunities to protect, restore and reinstate high value aquatic ecosystems throughout northern Victoria. The spatial coverage of environmental watering has expanded considerably in recent years and this trend is likely to continue into the future.

Environmental watering in Victoria has historically been supported by management plans that document key information such as the watering requirements for a site, predicted ecological responses and any water delivery arrangements. State and Commonwealth environmental watering programs now have the potential to extend watering beyond those sites that have been traditionally watered in the past. It is important that there is a consistency in planning for environmental watering across both jurisdictions and therefore, new plans are required which will reflect this.

Environmental Watering Management Plans (the Plans) are currently being developed by Victorian Catchment Management Authorities for all current and future environmental watering sites throughout northern Victoria. It is intended that the Plans will provide a tool for consistent, transparent and informed management of environmental water across all sites.

1.2. Purpose

The purpose of the Plans is to investigate and document all existing knowledge about a site to facilitate the development of proposals for environmental watering for consideration by the State and/or Commonwealth Environmental Water Holders.

Critical information provided within the Plan for each site will include:

- management responsibilities
- environmental, social and economic values
- existing water delivery arrangements including recent delivery records and any identified issues
- environmental condition and threats
- environmental objectives
- any potential risks
- recommended water regimes to meet objectives under a range of climatic conditions
- delivery system constraints and any opportunities to improve delivery with infrastructure changes
- identification of any knowledge gaps and recommendations to resolve.

This document is the Environmental Water Management Plan for Hird Swamp in the North Central Catchment Management Authority (North Central CMA) region. The Plan is not a holistic management plan for the site, but rather is focused on specific environmental water management at the site.

1.3. Site location

The North Central CMA region is approximately three million hectares in size, bordered by the Murray River to the north, and the Central Highlands to the south (refer to Figure 1). The region includes the Campaspe, Loddon, Avoca and Avon-Richardson rivers and a number of significant wetland complexes, including Gunbower Forest, Kerang Wetlands, Avoca Marshes and the Boort Wetlands.

Hird Swamp is located in the northern part of the region, in the Torrumbarry Irrigation Area, and within the Kerang Wetlands Ramsar Site (refer to Figure 2). The wetland's natural water source is the Pyramid

Creek which divides the wetland into east and west parts as it flows from south to north. Kow Swamp (51,710ML capacity) is located upstream of Hird Swamp, and Johnsons Swamp (411 hectares) is located downstream on Pyramid Creek. Both Hird and Johnsons Swamps are intermittent wetlands and have significant value, particularly for waterbird habitat.

The dredging of Pyramid Creek in 1967 increased its capacity and resulted in the creek holding greater flows than natural. Hird Swamp now receives overbank flows less frequently than under natural conditions. As a result, there is a strong reliance on the provision of environmental water to Hird Swamp through the utilisation of Torrumbarry Irrigation Region infrastructure.

Figure 1: North Central CMA region

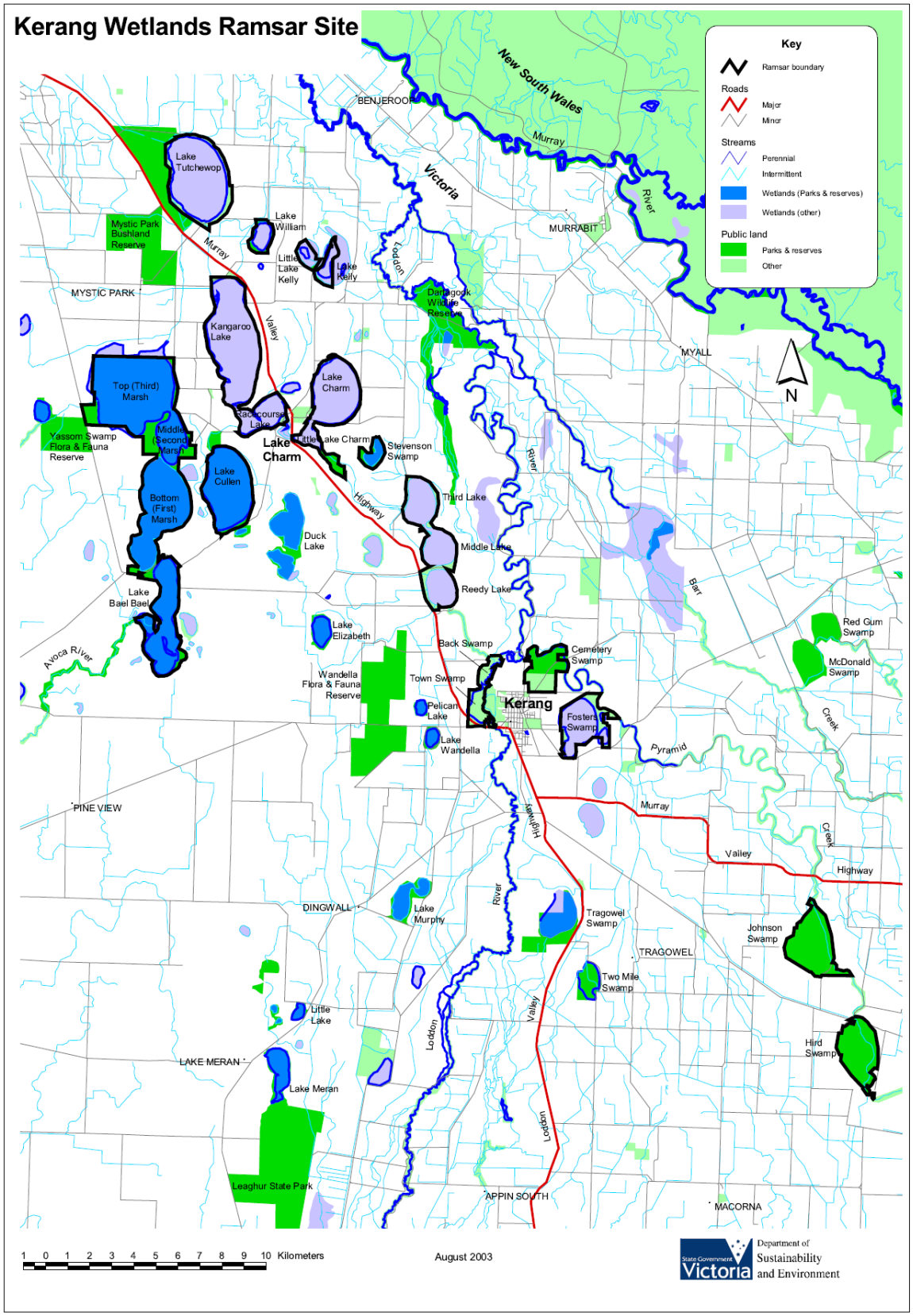


Figure 2: Kerang Wetlands Ramsar Site (DSE 2004)

1.4. Consultation

Specific consultation in the development of this plan was undertaken with a local technical group at a workshop held on 16 June 2011. Members represented at this workshop were: Mark Tscharke (Parks Victoria – Land Manager), Ross Stanton (Goulburn-Murray Water), Shelley Heron (KBR), Emer Campbell

(North Central CMA), Andrea Joyce, and Bridie Velik-Lord (North Central CMA). Representatives from regional DSE were unable to attend the workshop. Outcomes and key discussion points from the workshop are presented in Appendix 7.

Consultation was also undertaken with adjoining landholders and community members who have had a long association with the wetland and proven interest in maintaining its environmental value. Other stakeholders were directly engaged to provide technical and historic information including G-MW, Field & Game Association, bird observers and field naturalists. A summary of the information sourced from this process is provided in Appendix 10.

1.5. Information sources

Information used in the development of this Plan has been compiled from various sources including scientific reports, management plans, Geographic Information System layers, and stakeholder knowledge. A full list of information sources used can be found in the reference section of this Plan.

1.6. Limitations

The information sources used in the development of this Plan have some limitations. In particular, the management plans and reports relied upon vary in age and therefore the degree to which they reflect the current situation. Every effort has been made to use best available information in the development of this Plan, and it is acknowledged that there is an on-going intention to update the Plan as new information and knowledge become available.

2. SITE OVERVIEW

2.1. Catchment setting

Hird Swamp is located in the Kerang Wetlands Ramsar Site, south-east of the Kerang township (refer to Figure 3). The system of wetlands is on the western side of the Riverine Plain and includes approximately 9,419 hectares of permanent and temporary wetlands, including permanent freshwater lagoons, permanent open freshwater lakes, deep freshwater marshes, saline and hypersaline wetlands (DSE 2004a). Hird Swamp is considered a deep freshwater marsh with reeds, open water and lignum habitats (DSE 2011a).

Land use surrounding Hird Swamp is agricultural-based, with the area supporting irrigated agriculture enterprises (DSE 2004a). Hird Swamp is in the Pyramid Creek catchment and historically the wetland filled via high flows from the Pyramid Creek. With agricultural and commercial development in the area, the flooding nature and extent through this wetland system has been altered significantly (DSE 2004a).

Hird Swamp is split in two by the Pyramid Creek (Figure 4). The smaller, eastern section (Figure 5) is connected to the west (Figure 6) by a 375mm inverted siphon which runs under Pyramid Creek (SKM 2001). During very high flows in Pyramid Creek (greater than approximately 2,000ML/day), both the east and west sections receive water from Pyramid Creek overtopping its banks into the wetland (SKM 2001).

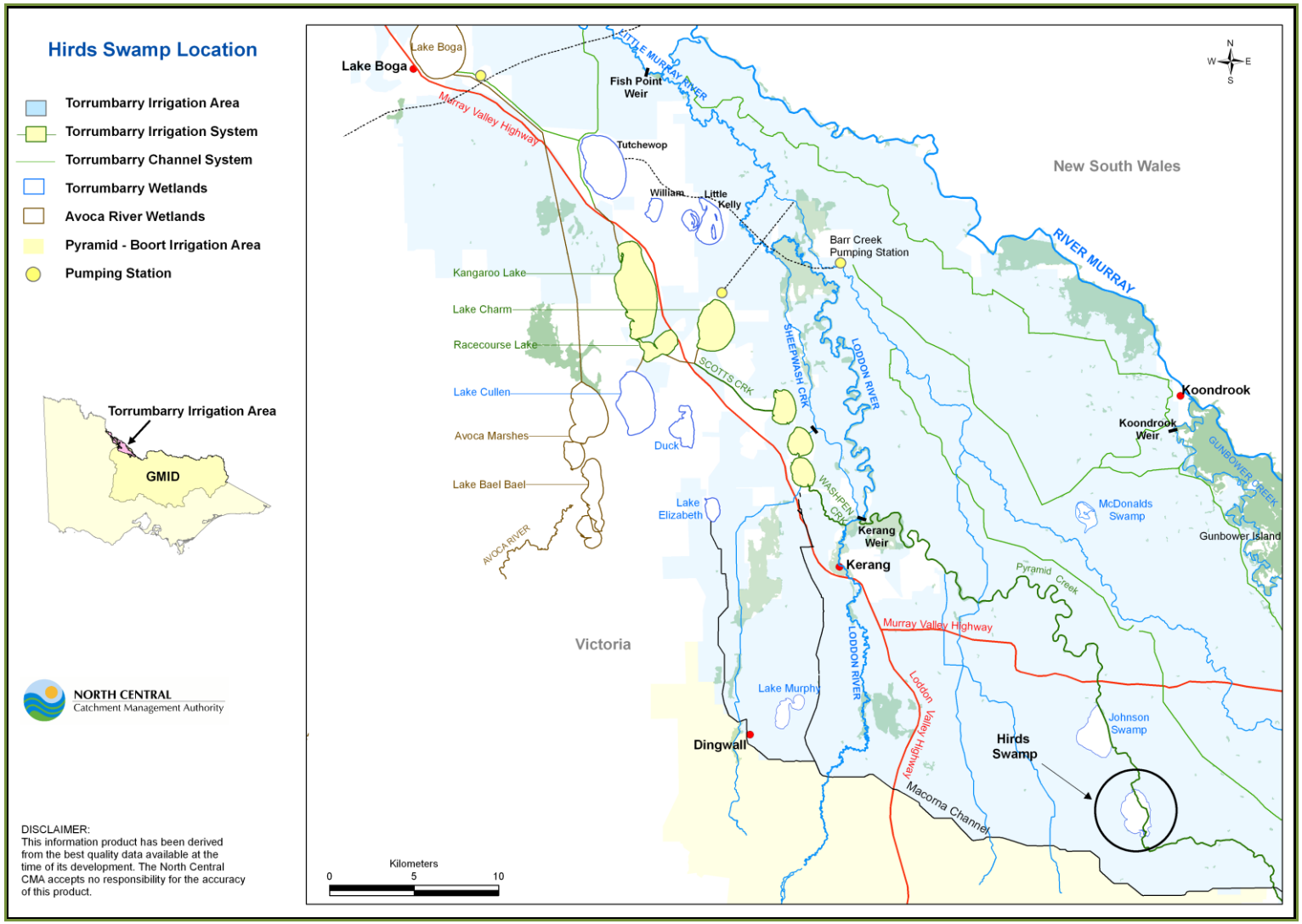


Figure 3: Hird Swamp location

Figure 4: Hird Swamp east (left), Pyramid Creek (centre) and Hird Swamp west (right). May 2011

Figure 5: Hird Swamp east. May 2011

Figure 6: Hird Swamp west. May 2011

2.2. Land status and management

Hird Swamp is classified as a Wildlife Reserve and is managed by Parks Victoria (DEWHA 2010). VEAC (2008) recommends that Hird Swamp remain as a Wildlife Area (State Game Reserve).

Management of the Torrumbarry irrigation system is undertaken by Goulburn-Murray Water as the local water corporation and North Central CMA is the regional environmental water manager. Table 1 describes key stakeholders with possible involvement in the management of Hird Swamp.

Table 1: Agencies and stakeholder groups with a responsibility or interest in the environmental water management of Hird Swamp

Agency / Stakeholder Group	Responsibility / Interest
Commonwealth Environmental Water Holder	Management of Commonwealth environmental water entitlements.
Department of Sustainability and Environment	Provision of financial, policy and strategic support for the management of public and private land (including wetlands). Management of hunting licensing on public land. Currently manage environmental water entitlements on behalf of the Minister for Environment. Management of recreational duck hunting on Hird Swamp. Liaison with hunters and community groups. Provision of technical and extension support for the sustainable management of agriculture surrounding Hird Swamp
Gannawarra Shire Council	Local council for area including Hird Swamp. Responsible for regulation of local development through planning schemes and on-ground works.
Goulburn-Murray Water	Rural water corporation responsible for the management of water-related services in the irrigation area of northern Victoria. Resource manager responsible for making seasonal allocations in the region. Operational coordination of water management and delivery in the Torrumbarry Irrigation Region.
Local community	Recreational users of Hird Swamp, including passive recreational pursuits (walking, bird watching), duck hunting.
Local landholders	Management of private land surrounding Hird Swamp.
Murray-Darling Basin Authority	Responsible for preparing, implementing and enforcing the Murray-Darling Basin Plan. Responsible for planning integrated management of water resources across the Murray-Darling Basin.
North Central CMA	Coordination and monitoring of natural resource management programs in north central Victoria. Local operational management of the Environmental Water Reserve to rivers and wetlands including Hird Swamp. Responsible for environmental water management within Hird Swamp (in consultation with the land manager).
Parks Victoria	Custodian and land manager of Hird Swamp.
Victorian Environmental Water Holder	Management of Victorian water holdings since 1 July 2011.
Wamba Wamba and Barapa Barapa Traditional Owners	Traditional owner groups of the Kerang Wetlands.

2.3. Wetland characteristics

Wetlands in Victoria are currently classified using a system developed by Corrick and Norman which includes information on water depth, water permanency and salinity (Corrick and Norman 1980 in DSE 2007) (refer to Appendix 1 for further information about the wetland categories). Wetlands through Victoria were mapped and classified between 1975 and 1994 and developed into spatial GIS layers. These layers represent the wetland characteristics at the time of mapping (referred to as Wetlands 1994 layer), as well as a categorisation of the wetland characteristics prior to European settlement (referred to as Wetlands 1788 layers) (DSE 2007b).

Under the Wetlands 1994 layer and SKM 2001, Hird Swamp is classified as a deep freshwater marsh dominated by reeds. This differs from the 1788 classification of Hird Swamp which considered it to be a shallow freshwater marsh. The difference in classifications can be attributed to the dredging of Pyramid Creek in 1967, which resulted in Hird Swamp receiving less frequent but longer inundation events. Deep freshwater marshes are characterised by an inundation depth of one to two metres, and being permanently inundated (Corrick and Norman 1980 in DSE 2007).

The Ramsar Convention provides a classification system for wetland types (The Ramsar Convention on Wetlands 1996). Within this system, Hird Swamp is classified as a permanent freshwater marsh/pool and

this classification is similar in characteristics to those of deep freshwater marshes (DSE 2004; DEWHA 2010). Table 2 describes the wetland characteristics of Hird Swamp.

Table 2: Summary of Hird Swamp characteristics

Characteristics	Description
Name	Hird Swamp
Mapping ID	7726 355320
Area	344 ha (west: 271ha; east: 73ha)
Bioregion	Victorian Riverina
Conservation status	Ramsar listed wetland; listed in the Directory of Important Wetlands in Australia; Bioregionally significant wetland
Land status	State Wildlife Reserve
Land manager	Parks Victoria
Surrounding land use	Grazing, irrigated agriculture
Water supply	To western section: Regulated flow from Torrumbarry 1/7/2 channel. Maximum outfall rate to the wetland is 50ML/day. To eastern section: 375mm siphon from western section To western and eastern section: Natural inundation from Pyramid Creek when flows exceed 2,000ML/day (SKM 2001).
1788 wetland category	Shallow freshwater marsh
1994 wetland category and sub-category	Deep freshwater marsh, reed-dominated
Ramsar category	Permanent freshwater marsh/pool
Wetland capacity	West: 1,236.1ML at 79.10m AHD (FSL)[1] East: ~ 350ML[2]
Wetland depth at capacity	~0.8m in western section[3]. Depth of eastern section is unknown.

2.4. Environmental water

Environmental water available for use at Hird Swamp can come from a number of sources, as detailed in Table 3 and expanded in Appendix 2.

Table 3: Environmental water that may be used at Hird Swamp

Water entitlement	Environmental water management agency
Victorian River Murray Flora and Fauna Entitlement	Department of Sustainability and Environment / Victorian Environmental Water Holder
River Murray Unregulated Flows	Department of Sustainability and Environment / Victorian Environmental Water Holder
Surplus / flood mitigation flows	Goulburn-Murray Water
Commonwealth Environmental Water Holdings	Commonwealth Environmental Water Holder

Water availability from all these water sources will vary from season to season, according to climatic conditions, volumes held in storage and carryover entitlements.

2.5. Legislative and policy framework

There are a range of international treaties, conventions and initiatives, as well as national and Victorian state Acts, policies and strategies that direct management of wetlands within Northern Victoria. Those which may have particular relevance to Hird Swamp and the management of its environmental and cultural values are listed below. For the functions and major elements of each refer to Appendix 3.

[1] Based on S. Archard pers. comm. in SKM (2001)
[2] S. Archard pers. comm. (2011)
[3] Based on S. Archard pers. comm. in SKM (2001)

International treaties, conventions and initiatives:

- Convention on Wetlands (Ramsar) 1971
- China Australia Migratory Birds Agreement (CAMBA) 1986
- Republic of Korea Australia Migratory Birds Agreement (ROKAMBA) 2002
- Japan Australia Migratory Birds Agreement (JAMBA) 1974
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) 1979

Commonwealth legislation and policy:

- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Part IIA)
- *Australian Heritage Commission Act 1975* (Register of the National Estate)
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- *Native Title Act 1993*
- *Water Act 2007*
- Wetlands Policy of the Commonwealth Government of Australia 1997
- A Framework for Determining Commonwealth Environmental Watering Actions 2009
- A Directory of Important Wetlands in Australia 1993 (first edition), 1996 (second edition) and 2001 (third edition)

Victorian legislation:

- *Aboriginal Heritage Act 2006*
- *Catchment and Land Protection Act 1994*
- *Water Act 1989*
- *Flora and Fauna Guarantee Act 1988* (FFG Act)
- *Wildlife Act 1975*
- State Environment Protection Policy (Waters of Victoria) 2003

Victorian policy, codes of practice, charters and strategies:

- North Central Regional Catchment Strategy (North Central CMA 2003)
- Northern Region Sustainable Water Strategy (DSE 2009b)
- Our Water Our Future (DSE 2004b)
- Victorian threatened flora and fauna species (advisory list).

2.6. Related plans and activities

As Hird Swamp forms part of the Kerang Wetlands Ramsar Site, a key document related to its management is the *Kerang Wetlands Ramsar Site Strategic Management Plan* (DSE 2004a).

A project is currently underway which will detail the baseline conditions of the Kerang Wetlands Ramsar Site, as required for all nominated Ramsar Sites and referred to as Ecological Character Descriptions (ECD). A first iteration of this process was undertaken by DSE in 2010 (DSE 2010). The framework for ECD development was modified after this document was completed, and a new ECD is currently being finalised according to the new framework. This is referred to as the *Draft Kerang Wetlands Ramsar Site Ecological Character Description* (DEWHA 2010).

In 2001 a project was undertaken to develop operational plans for wetlands in the Kerang Lakes Region. Within this project, the Wetland Water and Operational Management Plan for Hird Swamp (SKM 2001)

was developed.

In addition to these plans, Hird Swamp has received significant investment in vegetation management, particularly in relation to controlling the extent of Cumbungi (*Typha* spp.), Common Reed (*Phragmites australis*) and Spiny Rush (*Juncus acutus*). Associated investigations were commissioned by Parks Victoria to provide guidance on vegetation management in Hird Swamp (Dalby-Ball *et al.* 2000a; Dalby-Ball *et al.* 2000b). Extensive revegetation has also been undertaken at Hird Swamp, including the planting of vegetation bays with the view of providing a more diverse wetland environment and establishment of a seedbank for other parts of the wetland (DSE 2006).

The eastern side of Hird Swamp in particular has received complementary works including invasive plant and animal control (foxes and rabbits), fencing and bird monitoring (Heron Environmental Consulting 2006).

In the early 2000s, the channel supplying water to Hird Swamp was upgraded from 30ML/day to between 50 and 70ML/day (SKM 2001). In 2010, due to the delivery rate being restricted to 15ML/day, the delivery channel to the wetland was desilted and vegetation was strategically removed. This has increased the delivery rate back to within the designed capacity, and currently delivers at a rate of 50ML/day.

It is envisaged that with the recent environmental water delivery and natural flooding, both the west and east sides of Hird Swamp may benefit from actions outlined below:

- invasive plant management (including weeds germinating after flooding, and potentially *Typha* spp. and *Phragmites australis* if it encroaches on other ecological components of the wetland)
- invasive animal management (particularly relating to rabbits and foxes)
- revegetation.

3. WATER DEPENDENT VALUES

3.1. Environmental

3.1.1. Listings and significance

Hird Swamp is considered a wetland of international importance due to its inclusion in the Kerang Wetlands Site, and its listing under the Ramsar Convention (the Kerang Wetlands were listed on 15 December 1982 [Ramsar Secretariat, 2010]). Hird Swamp is also listed in the Directory of Important Wetlands in Australia (DIW) (Environment Australia 2001) within the Riverina Region (1 of 30 sites). Under the DIW, Hird Swamp is considered one of the *'…seasonal/intermittent freshwater ponds and marshes on inorganic soils; includes sloughs, potholes; seasonally flooded meadows, sedge marshes'* (classified as B10), and has been listed for the following reasons (Environment Australia 2001):

- it is a good example of a wetland type occurring within a biogeographic region in Australia
- it is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex
- it is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail.

Hird Swamp holds particular importance for its high flora and fauna values, the high habitat diversity in the wetland, its carrying capacity for waterbirds and the species diversity of these waterbirds (Lugg *et al.* 1989). Additionally the wetland provides a range of breeding habitat for waterbirds, the principle ones being the following vegetation communities (SKM 2001):

- Cumbungi (*Typha* spp.)
- River Club Rush (*Schoenoplectus validus*)
- Curly Pondweed (*Potamogeton crispus*)
- Tangled Lignum (*Muehlenbeckia cunninghamii*).

DSE (2010) analysed waterbird records from the Atlas of Victorian Wildlife between 1980 and 2003 and found that Hird Swamp supported 44 waterbirds species. Some of the highest abundances of waterbirds within the Kerang Ramsar site have also been recorded at Hird Swamp, including the following (DSE 2010):

- Straw-necked Ibis (*Threskiornis spinicollis*) – 11,000 recorded in 1993; 5,000 recorded in 1998.
- Australian White Ibis (*Threskiornis molucca*) – 6,000 recorded in 1993.
- Grey Teal (*Anas gracilis*) – 7,075 recorded in 2002.

In total, 57,186 waterbirds were recorded at Hird Swamp between 1980 and 2003 (DSE 2004a). This is the fourth highest number of waterbird records out of 16 wetlands monitored (DSE 2004a).

As well as being an important wetland component of the Kerang Wetlands Ramsar Site, it can also be considered on its own through its ability to provide the following ecosystem services (DSE 2010):

- supports depleted wetland types
- supports threatened vegetation communities
- supports a high diversity of waterbird species
- supports 1% of population of waterbird species
- supports high proportion of waterbird species under international agreements
- supports breeding waterbirds
- supports threatened species.

Figure 7: Hird Swamp before (top), and during (bottom) environmental watering event in 2010

Table 4 details the legislation, agreements, conventions and listings that are relevant to Hird Swamp. Key fauna recorded at Hird Swamp are protected by international, national and Victorian state legislation.

Table 4: Legislation, agreements, convention and listings relevant to the site, or species recorded at Hird Swamp

Legislation, Agreement or Convention	Jurisdiction	Listed
Ramsar Convention on Wetlands	International	✓
Japan Australia Migratory Birds Agreement (JAMBA)	International	✓
China Australia Migratory Birds Agreement (CAMBA)	International	✓
Korea Australia Migratory Birds Agreement (ROKAMBA)	International	×
Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)	International	×
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	National	✓
Flora and Fauna Guarantee Act 1988 (FFG Act)	State	✓
DEPI advisory lists	State	✓

3.1.2. Fauna

Hird Swamp provides habitat for a range of fauna species and communities. A number of these species are considered threatened under various legislation (as detailed above).

Hird Swamp is known to be a highly significant area for waterbird species, and much of its conservation significance stems from its ability to support large numbers of colonial nesting waterbirds such as Straw-necked Ibis (*Threskiornis spinicollis)*, Australian White Ibis (*Threskiornis molucca)*, Royal Spoonbill (*Platalea regia)* and Glossy Ibis (*Plegadis falcinellus)* which nest in platforms of reeds, nests on the ground and within trees, as well as other waterbirds such as Black Swan (*Cygnus atratus)*, Pacific Black Duck (*Anas superciliosa)*, Hardhead (*Aythya australis)* and Purple Swamphen (*Porphyrio porphyrio*) (SKM 2001). It is utilised by the EPBC listed Australian Painted Snipe which were recorded in 2003, 2004 and 2005 (DSE 2010). In addition to waterbird species, there is one amphibian listed under the EPBC Act (Growling Grass Frog [*Litoria raniformis]*) and one reptile listed under the FFG Act (Carpet Python [*Morelia spilota metcalfei]*).

Migratory species such as Caspian Tern (*Hydroprogne caspia*) utilise Hird Swamp, and their habitat requires protection under international migratory agreements.

Table 5 shows listed fauna species recorded at Hird Swamp.

Table 5: Listed fauna species recorded at the site (DSE 2011a)

Common name	Scientific name	Type	International agreements	EPBC status	FFG status	DEPI status
Carpet Python (non-water dependent)	*Morelia spilota metcalfei*	R	NL	NL	L	EN
Caspian Tern	*Hydroprogne caspia*	B	C, B	NL	L	NT
Australian Painted Snipe	*Rostratula benghalensis australis*	B	C	VU	L	CR
Baillon's Crake	*Porzana pusilla palustris*	B	NL	NL	L	VU
Little Egret	*Egretta garzetta nigripes*	B	NL	NL	L	EN
Australasian Bittern	*Botaurus poiciloptilus*	B	NL	NL	L	EN
Pied Cormorant	*Phalacrocorax varius*	B	NL	NL	NL	NT
Australasian Shoveler	*Anas rhynchotis*	B	NL	NL	NL	VU
Hardhead	*Aythya australis*	B	NL	NL	NL	VU
Brolga	*Grus rubicund*	B	NL	NL	L	VU
Musk Duck	*Biziura lobata*	B	NL	NL	NL	VU
Eastern Great Egret	*Ardea modesta*	B	B	NL	NL	VU
Royal Spoonbill	*Platalea regia*	B	NL	NL	NL	VU
Blue-billed Duck	*Oxyura australis*	B	NL	NL	L	EN
Freckled Duck	*Stictonetta naevosa*	B	NL	NL	L	EN
Glossy Ibis	*Plegadis falcinellus*	B	C, B	NL	NL	NT
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	B	C	NL	L	V
Little Bittern	*Ixobrychus minutus dubius*	B	NL	NL	L	EN
Growling Grass Frog	*Litoria raniformis*	A	NL	VU	L	EN
Whiskered Tern	*Chlidonias hybridus javanicus*	B	NL	NL		NT

Legend

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

International: CAMBA, JAMBA, ROKAMBA, Bonn, Not Listed

EPBC status: EXtinct, CRitically endangered, ENdangered, VUlnerable, Conservation Dependent, Not Listed

EPBC presence: Known to occur, Likely to occur, May occur, Not Listed

FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing

DSE status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known, Not Listed

3.1.3. Flora

Vegetation communities

Hird Swamp is located in the Victorian Riverina Bioregion, which occurs in northern Victoria between the highlands of the north-east, and the Mallee country in the west. The bioregion is bordered by the Goldfields, Central Victorian Uplands, Murray Mallee, Murray Fans and Northern Inland Slopes bioregions. It is an ancient riverine floodplain which is characterised mainly by river alluvium and fertile soils make the area suitable for irrigated agriculture. Due to this, over 94 per cent of the bioregion is privately owned (DPI 2009).

The vegetation monitoring undertaken at Hird Swamp in 2012 sampled the three dominant Ecological Vegetation Classes (EVCs) (Table 6).The deepest central section of the wetland supported Intermittent Swampy Woodland (EVC 813). Prolonged flooding has drowned the Eucalyptus camaldulensis (River Red Gum) trees that formed the canopy of this EVC. To the south of this is an area of Lignum Swamp (EVC 104) that was probably naturally treeless. Lignum Swampy Woodland (EVC 823) surrounded these EVCs on the shallower fringe of the wetland (Australian Ecosystems, 2012).

Table 6: Ecological vegetation classes recorded at the site

EVC no.	EVC name	Bioregional Conservation Status
		Victorian Riverina Bioregion
823	Lignum Swampy Woodland	Vulnerable
813	Intermittent Swampy Woodland	Depleted
104	Lignum Swamp	Vulnerable

The native vegetation components of Intermittent Swampy Woodland have been almost completely displaced. The large old River Red Gum which previously formed the canopy of this EVC are long dead, having drowned during periods of prolonged inundation. Live River Red Gums do occur within the former distribution of this EVC at the site, but they are growing in elevated areas along the track, where they probably germinated after changes to the areas flooding regime. Understorey species characteristic of this EVC are absent, having been replaced by species more tolerant of prolonged inundation which have formed associations with species composition similar to Tall Marsh or Floodway Pond Herbland.

A number of opportunistic native species are common in Lignum Swamp EVC, although they are not generally characteristic of Lignum Swamp such as Berry Saltbush (*Atriplex semibaccata*), Sprawling Saltbush (*Atriplex suberecta*) and Mealy Saltbush (*Atriplex pseudocampanulata*).

Lignum Swampy Woodland is characterised by a dense shrub layer of Tangled Lignum (*Muehlenbeckia florulenta*) with an overstorey of Black Box (*Eucalyptus largiflorens*). The ground layer consists of wetland species including Common Nardoo (*Marsilea drummondii*), Common Blown-grass (*Lachnagrostis filiformis s.l.*), and Tall Fireweed (*Senecio runcinifolius*) (Australian Ecosystems, 2012).

Flora species

A total of 82 species of vascular plants were recorded at Hird Swamp in a recent 2012 survey, 48 (59%) of which were indigenous (Australian Ecosystems, 2012)). Two rare or threatened plant species were recorded: the poorly known Dark Roly-poly (*Sclerolaena muricata var. semiglabra*) and the rare Mealy Saltbush (*Atriplex pseudocampanulata*) (Table 7).

Table 7: Significant flora species recorded at Hird Swamp

Common name	Scientific name	EPBC status	FFG status	DEPI status
Dark Roly-poly	*Sclerolaena muricata var. semiglabra*			PK
Mealy Saltbush	*Atriplex pseudocampanulata*			R

Source: Australian Ecosystems 2012

Conservation Status

EPBC status: EXtinct, CRitically endangered, ENdangered, VUlnerable, Conservation Dependent, Not Listed

EPBC presence: Known to occur, Likely to occur, May occur, Not Listed

FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing

DSE status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known, Not Listed

During the late 1990s, anecdotal information from Hird Swamp suggested that long periods of warm, shallow water resulted in the distributional increase of *Typha* spp. and *Phragmites australis* across the bed of the wetland (SKM 2001). Although these can be valuable habitat for waterbirds and other species, the altered water regime caused these species to dominate the bed of the wetland, restricting the abundance of other vegetation species and open-water habitat, promoting a monoculture through the wetland (Dalby-Ball *et al.* 2000b) and diminishing habitat diversity.

Other important species known to provide habitat at Hird Swamp include River Club Rush (*Schoenoplectus tabernaemontani*), Curly Pondweed (*Potamogeton crispus*) and Tangled Lignum (*Muehlenbeckia cunninghamii*) (SKM 2001).

3.1.4. Wetland depletion and rarity

Victoria's wetlands are currently mapped and are contained within a state wetland database, using an accepted statewide wetland classification system, developed by Andrew Corrick from the Arthur Rylah Institute (ARI). Mapping was undertaken from 1981 using 1:25,000 colour aerial photographs, along with field checking. This database is commonly known as the 1994 wetland layer (DNRE 2000b) and contains the following information (refer to Appendix 1):

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

At the same time, an attempt was made to categorise and map wetland areas occupied prior to European settlement. This was largely interpretive work and uses only the primary category, based on water regime, referred to as the 1788 wetland layer (DNRE 2000a).

It has been possible to determine the depletion of wetland types across the state using the primary category only, based on a comparison of wetland extent between the 1788 and 1994 wetland layers.

Comparison between the wetland layers has demonstrated the impact of European settlement and development on Victorian wetlands. This has been severe, with approximately one-third of the state's wetlands being lost since European settlement; many of those remaining are threatened by continuing degradation from salinity, drainage and agricultural practices (ANCA 1996). Across the state, the greatest losses of original wetland area have been in the freshwater meadow (43 per cent), shallow freshwater marsh (60 per cent) and deep freshwater marsh (70 per cent) categories (NRE 1997).

Deep freshwater marshes within the Kerang Wetlands Ramsar Site have reduced in number significantly since European settlement, with only 3.8% of these wetlands still remaining in the Site (DSE 2010). The ecosystem provided by the deep freshwater marsh characteristics through Hird Swamp should be maintained as the wetland contributes a large proportion of the wetland type within the region (16% within the Ramsar Wetlands Site) (refer to Table 8). Hird Swamp is considered a high value wetland in relation to waterbird carrying capacity, species diversity and breeding (Lugg *et al.* 1989).

Table 8: Current area of the site's classification in the region

classification	Region				
	North Central CMA Region	Goulburn-Murray Irrigation District	Victorian Riverina bioregion	Ramsar Wetlands Site	Victoria
Deep Freshwater Marsh (ha)	4,880	7,297	6,364	2,088	54,887
Hird Swamp (ha)	344	344	344	344	344
Hird Swamp as a percentage	7%	8%	5%	16%	0.6%

3.1.5. Ecosystem functions

Wetlands are considered ecologically important due to their role in maintaining biological diversity, promoting biochemical transformation and storage and decomposition of organic materials (DSE 2007). They also provide crucial habitats for flora, invertebrates, fish, birds, reptiles, amphibians and mammals, improve water quality through filtration, control floods, regulate carbon levels, cycle nutrients and provide significant cultural and recreational values (DSE 2007).

Hird Swamp is known to provide all the ecosystem functions outlined above. In addition, DEWHA (2010) describes supporting services provided by the Kerang Wetlands as:

- biodiversity – high diversity of waterbird species
- critical habitat – drought refuge and breeding habitat for waterbirds
- threatened species and communities – habitat for threatened species
- priority wetland species and ecosystems.

3.2. Social

3.2.1. Cultural heritage

The traditional owner groups of the Kerang Wetlands area are the Wamba Wamba and Barapa Barapa (DSE 2004a). The area is considered one of the most archaeologically important areas of Victoria with numerous middens, mounds, artifacts, scar trees and surface scatters documented with the Ramsar site (DEWHA 2010).

Hird Swamp and Pyramid Creek are in an area of cultural heritage sensitivity. There are areas in the southern and northern sections of the wetland containing mounds, and areas in the northern section containing scar trees and artifact scatters (DPI 2011).

3.2.2. Recreation

Hird Swamp is used extensively for various recreational activities. These include passive recreational pursuits such as bird watching and bushwalking. When holding water, Hird Swamp attracts a large number of duck hunters during hunting season (DEWHA 2010).

3.3. Economic

The economic value of a particular wetland to the regional economy can be quite difficult to measure. There are direct and indirect uses of wetlands which generate economic benefit on a local scale, regional and wider scale (ACF 2010). Direct uses of Hird Swamp include the income generated from recreational pursuits and tourism, while indirect uses include benefits such as groundwater recharge, nutrient treatment and carbon storage (DEWHA 2010).

4. HYDROLOGY AND SYSTEM OPERATIONS

The hydrology of a wetland will affect the chemical and physical aspects of that wetland (North Central CMA 2009). The chemical and physical aspects will in turn influence the flora and fauna communities that the wetland supports (DSE 2007). A wetland's hydrology is determined by surface and groundwater inflows and outflows in addition to precipitation and evapotranspiration (Mitsch and Gosselink, 2000 in DSE 2007a). Duration, frequency and seasonality (timing) are the main components of the hydrological regime for wetlands and rivers. Appendix 5 details the recent watering history of Hird Swamp.

4.1. Water management and delivery

4.1.1. Pre-regulation

Pre-regulation, Hird Swamp was considered a shallow freshwater marsh, with a depth of less than half a metre. Both the west and eastern sides of the wetland would have naturally had a more frequent wetting and drying cycle than current. This is due to Pyramid Creek, in its natural state prior to dredging, overtopping at a lower volume than it does now. Therefore, Hird Swamp would have received flood waters on a more regular basis, and due to the shallow depth in the wetland, would have had a shorter inundation period than it does now. It may also have had a longer duration of flooding on occasion when Pyramid Creek overtopped prior to the wetland drying completely. However, this hydrology was altered when Pyramid Creek was modified and water was regulated through Kow Swamp.

4.1.2. Post-regulation

Pyramid Creek was dredged in 1967 and this removed both Hird Swamp and Johnsons Swamp from all but major flood events (DEWHA 2010). This dredging has had a significant impact on the structure and function of Hird Swamp, as it altered the frequency of natural inundation from Pyramid Creek (SKM 2001). The altered water regime at Hird Swamp has resulted in changes to the growth and distribution of *Typha* spp. and *Phragmites* making them so abundant and widespread that they begun encroaching on other wetland habitats such as open water areas (SKM 2001).

During the 1990s, Hird Swamp dried completely only three times, and these drying events only lasted between one and two months (SKM 2001).

Until the late 1980s, Hird Swamp was filled by pumping from Pyramid Creek (DEWHA 2010). The wetland can now be filled using the Torrumbarry Irrigation Region 1/7/2 channel which has a maximum delivery rate of 50ML/day. This rate of delivery can however, only be maintained with regular desilting and/or vegetation management in the channel. This G-MW channel outfalls to a delivery channel which then runs east to the wetland reserve itself, entering the wetland at the southern end of the western section (Figure 8). Once water reaches the northern end of the western side of Hird Swamp, the siphon under Pyramid Creek can be operated to fill the eastern section of Hird Swamp. In order to effectively operate the siphon, the western section of Hird Swamp needs to be at least 70% full. When the wetland reaches this level, water will flow through the siphon without active management.

The two sections of Hird Swamp are currently characterised by different vegetation communities. This vegetation composition highlights the more frequent and lengthy inundation in the western side (dominated by lignum swamp), than the eastern side (a chenopod woodland). The western side of the wetland has historically (both pre and post-regulation) received more frequent inundation which has been maintained for longer duration. The maintenance of low levels of water through the western section of the wetland in particular has provided the ideal habitat for *Typha* and *Phragmites* to grow, and these species have become the dominant vegetation component through the wetland (SKM 2001). The open water areas of the wetland have decreased with these species encroaching on the open water habitat, lowering the habitat diversity (SKM 2001). Significant investment has been provided to manage the *Typha* spp. and *Phragmites* spp. growth through Hird Swamp due to this recognition.

Vegetation bays were constructed during the 1990s. These were constructed and planted out with the view of providing a more diverse wetland environment and establishment of a seedbank for other parts

of the wetland (DSE 2006).

In 1998 a fire was deliberately lit in Hird Swamp west (without land manager permission), destroying vegetation, logs and dead timber across the bed of the wetland (SKM 2001). There remains some standing dead timber through the bed of the wetland, however it is believed that some trees were lost in this event. The fire would have also had an effect on shrubs and reeds in the wetland, decreasing their abundance and recruitment.

There is an outlet structure at the northern end of the western side of Hird Swamp which allows water to empty back out to Pyramid Creek. The top of this outlet structure has been set at 79.10m AHD and dictates the full supply level of the western part of the wetland (Figure 9) (SKM 2001).

North Central CMA (2011) note that salinity problems within the irrigation region emerged in the early 1900s, and while salinity is a natural feature of the landscape, clearing of deep rooted native plants has increased the effects of salinity on natural assets within the region such as wetlands.

While the watertable depth varies greatly across the region, analyses undertaken in 2006 showed the area surrounding Hird Swamp as having a watertable depth of less than two meters below the surface (North Central CMA 2011).

There is a risk to Hird Swamp posed by this groundwater, particularly during wetter times. This is based on the finding that the bed of Hird Swamp can be at a lower elevation than the local groundwater table (as was found by SKM (2001)). When this occurs, saline groundwater may flow toward the wetland if there is no hydrostatic pressure on the base of the wetland (i.e. when the wetland is dry) (SKM 2001). This saline intrusion can occur either by horizontal seepage or by vertical transfer, however the latter mechanism is less common (SKM 2001). While there are currently no obvious signs of saline groundwater intrusion to the wetland, regular monitoring of groundwater bores should be undertaken to ensure that this issue does occur.

Figure 8: Delivery channel entering Hird Swamp reserve, prior to desilting works being undertaken (October 2010).

Figure 9: Outlet structure from Hird Swamp west to Pyramid Creek (April 2011).

5. CONDITION AND THREATS

5.1. Current condition

An Index of Wetland Condition (IWC) assessment was undertaken at Hird Swamp (west) in October 2009 when it had been completely dry for the previous three years and April 2013. The IWC defines wetland condition as the state of the biological, physical, and chemical components of the wetland ecosystem and their interactions (refer to Appendix 6) (DSE 2007a).

The method undertaken under the IWC involves measuring five subindices based on the catchment of the wetland and its fundamental characteristics of physical form, hydrology, water properties, soil and biota.

Table 9 shows the IWC scores for Hird Swamp in 2009 and IWC Biota assessment in 2012. It highlights that in 2009 the wetland was in a moderate condition overall, but with a Very Poor score for Biota due to its low vegetation diversity, poor vegetation health and high weediness. This was primarily due to the dry phase of the wetland, and drought conditions experienced at the time of sampling. It is recommended that a subsequent IWC assessment be undertaken during spring while the wetland holds water, which will show a baseline condition of the wetland after a natural flood event. In 2012

Table 9: Index of Wetland Condition scores recorded for Hird Swamp (west) (October 2009 and April 2012)

IWC Sub-Index	Score	Condition Category	EVC Assessment (2012)	Result	Condition Category
Wetland catchment	12.00 / 20	Moderate	Intermittent Swampy Woodland	6.0	
Physical form	18.00 / 20	Excellent	Lignum Swamp	14.4	
Hydrology	10.00 / 20	Moderate	Lignum Swampy Woodland Z1	16.2	
Water properties	20.00 / 20	Excellent	Lignum Swampy Woodland Z2	6.5	
Soils	19.75 / 20	Excellent			
Biota	4.72 / 20	Very Poor			
Overall IWC Score	**6.00 / 10**	**Moderate**	**Wetland condition biota score**	**7.25**	**Moderate**

5.2. Water dependent threats

General threats to the wetlands analysed through the Plan process have been informed by the Aquatic Value Identification and Risk Assessment (AVIRA) process developed by DSE (DSE 2009a). The threat categories are outlined below and these have been used to identify specific threats and their likelihood of impacting Hird Swamp (Table 10).

Altered water regime (specifically relating to a changed water regime):

The hydrology of a wetland is an important component to consider for the overall ecological functioning of a site. Hydrology drives the development of wetland soils and the biotic communities (DSE 2009a).

Activities with the potential to cause a change in water regime are those that (AVIRA):

- change the flow regime of the water source of the wetland
- interfere with the natural connectivity of flow to and from the wetland
- involve disposal of water into the wetland or extraction of water from the wetland
- change wetland depth and, therefore, alter the duration of inundation by changing the rate of evaporation (DSE 2005c in DSE 2009a).

Altered physical form (specifically relating to reduced wetland area and altered wetland form):

Physical form of a wetland is related to the wetland area and wetland bathymetry (DSE 2005c). AVIRA notes the key threats to physical form as being (DSE 2009a):

- reduction in wetland area (through drainage or infilling)
- alteration in wetland form – depth, shape, bathymetry (through excavation, landforming or sedimentation).

AVIRA also notes that the realisation of the threats listed above can modify the availability of wetland for biota through changes in water depth and its resultant impact on duration and inundation area (DSE 2005c, DSE 2006b in DSE 2009a).

Poor water quality (specifically relating to degraded water quality):

Degrading water quality in this instance is particularly focused on landuse activities which impact the water in, or entering the wetland. Within the wetland itself, examples of landuse activities which can degrade the water quality include livestock grazing, feral animals and aquaculture (DSE 2009a). Catchment land practices with potential to degrade wetland water quality include clearing of vegetation, land uses such as agriculture or urbanisation, fire, poor irrigation practices and point source discharges (DSE 2009a). Both these aspects may be manifested by changes in several physical and chemical water properties (e.g. nutrient enrichment, salinisation and turbidity) (DSE 2005c in DSE 2009a).

Degraded habitats (soil disturbance in particular):

The soils of wetland habitats are vital component for the wetland to function as a whole. It provides the physical substrate which aquatic vegetation requires to establish, and provides habitat for benthic invertebrates and microorganisms (DSE 2009a). The threatening processes which can impact wetland soils include pugging by livestock and feral animals, human trampling, driving of vehicles in the wetland and carp disturbance (DSE 2009a), resulting in soil disturbance which can reduce water storing capacity of soil, have negative impacts on some invertebrates and increase turbidity during wetland filling events (DSE 2008e in DSE 2009a).

Exotic flora and fauna (including terrestrial and aquatic species):

The presence of exotic flora (i.e. species introduced from outside Australia) in the terrestrial and aquatic zones of wetlands causes harm when the extent of the exotic species replaces the native EVC components. When this occurs, there can be a threat to biodiversity and primary production of the wetland, increasing the land and water degradation and impacting the native flora and fauna species of the site (DSE 2009a).

Exotic fauna species can also pose a threat to the biodiversity of wetlands, along with its primary production potential (DSE 2009a). This occurs when the exotic species disturb the functioning of the native vegetation and/or displace native fauna species.

Reduced connectivity (reduced wetland connectivity)

Wetland connectivity is most likely to occur where there are a series of habitat areas arranged in close proximity through the landscape, for example the Kerang wetland complex and the Boort wetland complex (DSE 2009a). DEWHA and DAFF (2008) in DSE (2009a) define connectivity as 'the location and spatial distribution of natural areas in the landscape to provide species and populations with access to resources (food, breeding sites and shelter), increase habitat availability and facilitate population processes (dispersal, migration, expansion and contraction) and enable ecological processes (evolution, water, fire and nutrients)'.

When hydrologic connectivity is reduced through a landscape, there is less opportunity for aquatic species to move from one place to another in the search for food, habitat and population processes.

Table 10: Possible threats and likelihood of detrimental impacts occurring at Hird Swamp (as compared to pre-regulation condition)

Threat	Likelihood of detrimental impact	Comment
Altered water regime	High	Due to the regulation of the system and dredging of Pyramid Creek, Hird Swamp receives modified flows as compared to natural. SKM (2001) note that a key threat to the long-term health of Hird Swamp is the altered water regime.
Altered physical form	Medium	Physical form has changed significantly from historical, however is unlikely to alter significantly from current physical form.
Poor water quality	Medium	Only water source readily available is irrigation supply, and therefore considered relatively good quality. However, there can be a threat of saline groundwater intrusion into the base of Hird Swamp when watertable levels are within one to two metres of the surface.
Degraded habitats	High	Particularly relating to impacts of non-target vegetation growth on wetland structure and function.
Exotic flora and fauna	Medium	Particularly relating to predation by exotic fauna on native species recruitment (e.g. fox predation on birds).
Reduced connectivity	Medium	Connectivity has reduced as compared to natural conditions, however there are still opportunities for fauna species in particular to move through the landscape. The two sections of the wetland are hydrologically disconnected aside from an artificial siphon under the Pyramid Creek.

5.3. Condition trajectory

The main concern for the condition trajectory of Hird Swamp currently relates to the very low vegetation diversity, vegetation health and its high level of weediness (refer to Section 5.1).

Despite this finding, the condition of Hird Swamp has improved in the past decade due to appropriate environmental water management, and the provision of complementary management actions. The land manger and environmental water manager worked closely through this time to come up with the most appropriate watering regime and complementary works schedule to maximise the ecological outcomes of the wetland (including timing of delivery, inundation duration and invasive vegetation management).

The prolific vegetation growth of *Phragmites australis* and *Typha* spp. through Hird Swamp west has required significant management in the past. While the environmental water regime proposed aims to maximise ecological outcomes for the wetland, there may be instances into the future that growth of *Phragmites australis* and *Typha* spp. needs to be managed. The preference is to avoid detrimental growth of these species by aligning environmental water management with the recommended regime (as will be discussed in the following sections). However, mechanical or herbicide control (not burning) may be required if the communities are considered to dominate too much of the wetland (SKM 2001).

The fact that Hird Swamp is disconnected from the Pyramid Creek in all but high flows/flood events means that its ecological condition needs to be managed through the on-going provision of environmental water.

6. MANAGEMENT OBJECTIVES

6.1. Management goal

The environmental water management goal for Hird Swamp has been based on information produced in SKM (2001), and refined by the regional technical workshop participants. Workshop notes from this meeting are provided in Appendix 7.

Hird Swamp environmental water management goal

To provide an appropriate water regime that will maintain varying habitats through Hird Swamp (east and west) important for waterbird resting, nesting and feeding, in particular the provision of:

- Open-water habitat
- Lignum dominated woodland
- Reed habitat, with associated wetland flora which can withstand periods of dry.

6.2. Ecological and hydrological objectives

6.2.1. Ecological objectives

Ecological objectives represent the desired ecological outcomes of the site. In line with the draft policy Victorian Strategy for Healthy Rivers, Estuaries and Wetlands (VSHREW), the ecological objectives are based on the key values of the site (as outlined in Section 3) (e.g. Campbell *et al.* 2005). The ecological objectives are expressed as the target condition or functionality for each key value. The ecological objectives involve establishing one of the following trajectories of each key value, which is related to the present condition or functionality of the value (informed by Marquis-Kyle and Walker 1994; Campbell *et al.* 2005).

Protect – retain the biodiversity and/or the ecosystems at the existing stages of succession.

Improve – improve the condition of existing ecosystems by either returning an area of land to an approximation of the natural condition or to a known state.

Maintain – maintain the biodiversity and/or ecosystems while allowing natural processes of regeneration, disturbance and succession to occur.

Reinstate – reintroduce natural values that can no longer be found in an area.

Reduce - reduce the abundance and cover of undesirable exotic species that impact upon native values.

The ecological objectives developed for Hird Swamp are based on the values that the wetland provides, particularly in relation to its waterbird carrying capacity, ability to support EPBC listed species, species diversity and ability to support breeding events. The ecological objectives for the site have been developed for Hird Swamp west and Hird Swamp east to recognise the different characteristics the two sections provide to the wetland as a whole. The ecological components are described in Table 11 and Table 12, and have been reviewed by the regional technical workshop participants.

Table 11: Ecological objectives for Hird Swamp west

Ecological objective (Hird Swamp West)	Justification (value based)
Restore wetland macrophyte plant community during watering events, and ensure successful reproduction through viable seeds and propagules for subsequent watering events.	▪ Provision of habitat (including nesting areas on islands and on ground, in reeds, lignum and rushes for waterbird species) and food source for waterbird species.[1] ▪ Provision of vegetation seed source for on-going recruitment.
Maintain open water habitats at current extent through wetland.	▪ Provision of habitat diversity for waterbird species for feeding on aquatic macrophytes, frogs, crustaceans, insects etc.[1]
Reduce current extent and density of *Phragmites australis* and *Typha* sp., ensuring it does not encroach on other ecological values.	▪ Provision of habitat for waterbirds to rest, nest and feed, while ensuring it does not dominate the whole wetland area and decrease habitat diversity.
[1] Source: Kingsford 1997	

Table 12: Ecological objectives for Hird Swamp east

Ecological objective (Hird Swamp East)	Justification (value based)
Restore wetland macrophyte plant community during watering events, and ensure successful reproduction through viable seeds and propagules for subsequent watering events.	▪ Provision of habitat (including nesting areas on islands and on ground, in reeds, lignum and rushes for waterbird species) and food source for waterbird species.[1] ▪ Provision of vegetation seed source for on-going recruitment.
Maintain biota typical of lignum and chenopod woodland.	▪ Provision of ecological habitat through ensuring floristic diversity through the wetland, aligned with a natural flooding regime.

6.2.2. Hydrological objectives

Hydrological objectives describe the components of the water regime required to achieve the ecological objectives at this site. The hydrological objectives are derived from an understanding of the local hydrology, using a 'landscape logic' for the site (Figure 10). The landscape logic identifies the relationship between vegetation communities, ecological objectives, position in the landscape and hydrological objectives (i.e. flow requirements).

In recognition of the differing ecological characteristics of Hird Swamp west and east, hydrological objectives have been developed for each section of the wetland.

Environmental water delivery to Hird Swamp should occur between August and October, coinciding with a late-winter, early-spring fill (SKM 2001). This will ensure the greatest depth of inundation through the wetland base is maintained through summer, limiting the potential for prolific growth of *Phragmites australis* and *Typha* spp. Regular top ups should be provided to Hird Swamp west throughout summer to maintain water depth (with variation). It has been found that when water depth remains greater than two meters, the roots and rhizomes of *Typha* spp. become starved of oxygen, lose vigour and may eventually die off (Roberts *et al.* 1999 in Dalby-Ball *et al.* 2000b).

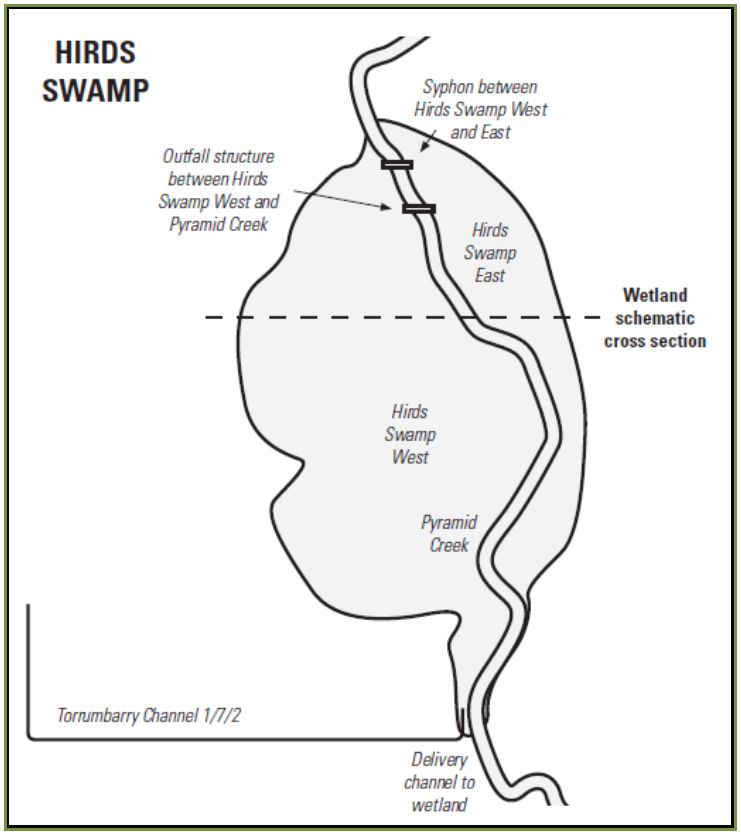
The timing of water delivery during spring will ensure that the ecological processes involved in wetland functioning and provision of waterbird habitat, will develop during the first spring of water delivery. Target water depth should be maintained until summer of the following year (with some variation in levels) then in autumn, natural drawdown should begin to occur. At this time, the outlet structure to Pyramid Creek should be opened to facilitate a rapid drawdown of water through Hird Swamp west, limiting the beneficial conditions for *Phragmites* growth (pers. comm. local technical workshop participants, June 2011). Complete drying should occur early in the following summer.

The environmental water delivery should occur through the channel system into Hird Swamp (west). When water has penetrated through to the northern end of the wetland, water should be provided to Hird Swamp (east) through the siphon every second filling event.

There is currently no capacity to deliver water to the eastern section of Hird Swamp independently of the western section. During dry times when environmental water is scarce, the provision of water to Hird Swamp east may need to occur in isolation of the western section. If this is recommended, appropriate infrastructure will be required.

During the drought in northern Victoria, regional groundwater levels have dropped significantly (North Central CMA 2011). However, it is acknowledged that groundwater has been an issue for the management of Hird Swamp in the past, and may be an issue when groundwater areas recharge in the future. Therefore, if groundwater levels surrounding the wetland are within one metre of the wetland surface and salinity is in the order of 30,000 EC, environmental water should be provided to Hird Swamp in order to avoid saline groundwater intrusion into the wetland (SKM 2001).

Table 13 and Table 14 details the hydrological objectives for Hird Swamp west and Hird Swamp east.



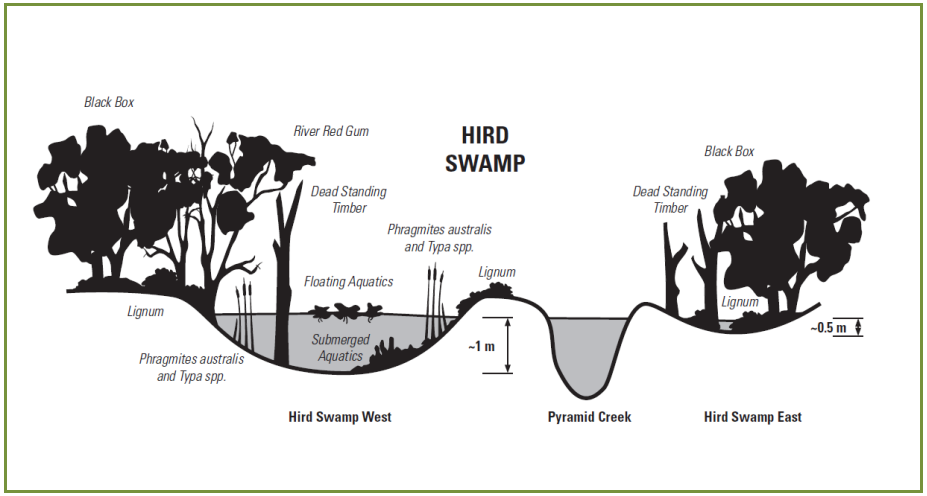


Figure 10: Schematic representation of the ecological components of Hird Swamp

Table 13: Hydrological objectives for Hird Swamp west

Ecological objective	Water management area	Hydrological objectives						
		Recommended frequency of events (number per 10 years)[1]	Duration of flooding (months)	Preferred timing of inflows	Target supply level (mAHD)[2]	Volume to fill to target supply level (ML)[2]	Volume to maintain at TSL (ML)	Total volume per event (ML)
Restore wetland macrophyte plant community during watering events, and ensure successful reproduction through viable seeds and propagules for subsequent watering events.	Bed	A watering frequency of two events per ten year period is proposed to ensure optimal drying and wetting of the seed store.	Duration of flooding to target recruitment of this component is 24 to 30 months. This will ensure two annual cycles are completed prior to drying.	Spring	79.10	~1,236 plus losses	~2,000	~3,500
Maintain open water habitats at current extent through wetland.	Bed	A watering frequency of two events to permanent inundation per ten year period is proposed to ensure open water habitat is provided.	Duration of flooding of between 12 months and permanent inundation is recommended.	Spring	79.10 (and maintain depth through summer)	~1,236 plus losses	~2,000	~3,500
Reduce current extent and density of *Phragmites australis* and *Typha* sp., ensuring it does not encroach on other ecological values.	Bed	Annual inundation will provide ideal conditions for these species. Therefore, two events per ten years is recommended to limit their spread through the wetland, but allow for existing stands to flourish.	Duration of greater than 12 months (with depth fluctuating) should limit the spread of these species through the wetland, while providing water to the existing stands.	Spring	79.10 (and maintain depth through summer)	~1,236 plus losses	~2,000	~3,500

[1] The frequency of watering events only relates to wetland watering from dry, and does not show top-up events.

[2] Based on S. Archard pers. comm. November 2000 in SKM (2001). Refer to Appendix 8.

Table 14: Hydrological objectives for Hird Swamp east

Ecological objective	Water management area	Hydrological objectives						
		Recommended frequency of events (number per 10 years)	Duration of flooding (months)	Preferred timing of inflows	Target supply level (ML / mAHD)[1]	Volume to fill to target supply level[1] (ML)[1]	Volume to maintain at TSL (ML)	Total volume per event (ML)
Restore wetland macrophyte plant community during watering events, and ensure successful reproduction through viable seeds and propagules for subsequent watering events.	Bed	A watering frequency of one to two events per ten year period is proposed to ensure optimal drying and wetting of the seed store.	Duration of flooding to target recruitment of this component is 12 to 24 months. This will ensure at least one annual cycle is completed prior to drying.	Spring (note: top up from the western section may be required)	350 / -	~350 + losses	-	~350 + losses
Maintain biota typical of lignum and chenopod woodland.	Bed and riparian zone	One to two events every ten year period is proposed to promote vigorous of lignum.[2]	Between three and seven months to achieve best growth. Continuous flooding should be avoided.[2]	Spring	350 / -	~350 + losses	-	~350 + losses

Note: Watering regimes proposed are based on delivery through Hird Swamp west. If an independent water supply is provided to Hird Swamp east, these regimes should be reviewed.

[1] Based on S. Archard pers. comm. March 2011.

[2] Based on information provided in Roberts and Marston (2011) and Rogers and Ralph (2011).

6.2.3. 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.

The management of environmental water at Hird Swamp needs to be undertaken in conjunction with associated complementary works such as strategic spraying of vegetation which is encroaching on the open water habitat through the wetland. If the complementary works are not undertaken, the wetland will not benefit from the provision of environmental water.

Minimum watering regime
Provide two watering events every ten years.

Fill Hird Swamp west in spring of year one and allow water to syphon into Hird Swamp east. Top up west section of the wetland to maintain the wetland at full supply level with some variation during summer.

Top up Hird Swamp west in spring of year two and maintain depth during summer. Open outlet structure to Pyramid Creek in autumn to facilitate rapid drawdown of the wetland, inhibiting the proliferation of Cumbungi and *Phragmites.* In total, allow inundation of Hird Swamp west for 18 months.

Allow wetland to dry completely during year three, and allow wetland to remain completely dry during the following three year.

Provide second watering event in year seven, targeting inundation of Hird Swamp west only. Maintain water depth during summer, and facilitate the rapid drawdown of water by opening the outlet structure to Pyramid Creek during autumn. Allow wetland to dry completely during year eight, and remain dry for the next two seasons.

Optimal watering regime

Provide two watering events every ten years.

Fill Hird Swamp west in spring of year one and allow water to syphon into Hird Swamp east. Top up west section of the wetland to maintain the wetland at full supply level with some variation during summer.

Top up Hird Swamp west in spring of year two and maintain maximum depth during summer (with some variation). Open outlet structure to Pyramid Creek in autumn to facilitate rapid drawdown of the wetland, inhibiting the proliferation of Cumbungi and *Phragmites.* In total, allow inundation of Hird Swamp west for 24 months.

Allow wetland to dry completely during year three, and allow wetland to remain completely dry during the following two years.

Provide second watering event in year six, targeting inundation of Hird Swamp west only. Manage watering regime as per the first cycle of wetting and drying.

Maximum watering regime
Provide two watering events every ten years.

Fill Hird Swamp west in spring of year one and allow water to siphon into Hird Swamp east. Top up west section of the wetland to maintain the wetland at full supply level with some variation during summer.

Top up Hird Swamp west in spring of year two and maintain depth during summer. Top up in spring of year three and maintain depth during summer. Open outlet structure to Pyramid Creek in autumn to facilitate rapid drawdown of the wetland, inhibiting the proliferation of Cumbungi and *Phragmites*. In total, allow inundation of Hird Swamp west for not more than 30 months.

Allow wetland to dry completely during year four, and allow wetland to remain completely dry during the following two years.

Provide second watering event in year six, targeting inundation of Hird Swamp west only. Manage watering regime as per the first cycle of wetting and drying.

6.3. Seasonally adaptive approach

Victoria has adopted an adaptive and integrated management approach to environmental management. A key component of this approach for environmental watering is the 'seasonally adaptive' approach, developed through the Northern Region Sustainable Water Strategy (DSE 2009b) and incorporated into the Victorian Strategy for Healthy Rivers, Estuaries and Wetlands.

The seasonally adaptive approach identifies the priorities for environmental watering, works and complementary measures, depending on the amount of water available in a given year. It is a flexible way to deal with short-term climatic variability and helps to guide annual priorities and manage droughts. The approach is outlined in Table 15.

The seasonally adaptive approach has been used to guide the watering regime under various climatic scenarios. In drier periods, restricted water resource availability will potentially limit the number of ecological objectives which can realistically be provided through environmental water management. However, these ecological objectives can be achieved in wetter periods as water resource availability increases.

This seasonally adaptive approach will be used for management of Hird Swamp particularly in relation to the distinctiveness of the two sections of the wetland. In average to wet scenarios where all aspects of the relevant flow regimes should be provided to sites, both west and eastern sections of Hird Swamp can be provided with environmental water.

ANCA (1996) note that Hird Swamp west is a highly valued wetland due to its ability to provide a drought refuge function. Under drought and dry scenarios, there is opportunity to manage Hird Swamp west with water independently of Hird Swamp east. However, there is currently no infrastructure to provide water to Hird Swamp east independently of Hird Swamp west. Therefore, the ability to use this section of the wetland as a drought refuge in the long-term will be dependent on establishing an independent water supply to that eastern section of the wetland.

Under average and wet scenarios, Hird Swamp as a whole can be managed with environmental water to provide all aspects of the flow regime, including the required top ups. This will improve the ecological health and resilience of Hird Swamp.

Table 15: The seasonally adaptive approach to river and wetland management (DSE, 2009b)

	Drought	Dry	Average	Wet to very wet
Long-term ecological objectives	Long-term objectives to move towards ecologically healthy rivers - set through regional river health strategies and sustainable water strategies and reviewed through the 15-year resource review			
Short-term ecological objectives	• Priority sites have avoided irreversible losses and have capacity for recovery	• Priority river reaches and wetlands have maintained their basic functions	• The ecological health of priority river reaches and wetlands has been maintained or improved	• The health and resilience of priority river reaches and wetlands has been improved
Annual management objectives	• Avoid critical loss • Maintain key refuges • Avoid catastrophic events	• Maintain river functioning with reduced reproductive capacity • Maintain key functions of high priority wetlands • Manage within dry-spell tolerances	• Improve ecological health and resilience	• Maximise recruitment opportunities for key river and wetland species • Minimise impacts of flooding on human communities • Restore key floodplain linkages
Environmental water reserve	• Water critical refuges • Undertake emergency watering to avoid catastrophic events • Provide carryover (for critical environmental needs the following year) • If necessary, use the market to sell or purchase water	• In priority river reaches provide summer and winter baseflows • Water high priority wetlands • Provide river flushes where required to break critical dry spells • Provide carryover (for critical environmental needs the following year) • If necessary, use the market to sell or purchase water	• Provide all aspects of the flow regime • Provide sufficient flows to promote breeding and recovery • Provide carryover to accrue water for large watering events • If necessary, use the market to sell or purchase water	• Provide overbank flows • Provide flows needed to promote breeding and recovery • If necessary, use the market to sell or purchase water
River and wetland catchment activities	• Protect refuges (including stock exclusion) • Increase awareness of the importance of refuges • Enhanced monitoring of high risk areas and contingency plans in place • Investigate feasibility of translocations • Environmental emergency management plans in place • Protect high priority river reaches and wetlands through fencing; pest, plant and animal management; and water quality improvement works • Implement post-bushfire river recovery plans	• Protect refuges • Protect high priority river reaches and wetlands through fencing, revegetation, pest plant and animal management, water quality improvement and in-stream habitat works • Environmental emergency management plans in place • Improve connectivity • Implement post-bushfire river recovery plans	• Protect and restore high priority river reaches and wetlands through fencing, revegetation, pest plant and animal management, water quality improvement and in-stream habitat works • Monitor and survey river and wetland condition • Improve connectivity between rivers and floodplain wetlands	• Protect and restore high priority river reaches and wetlands through fencing, revegetation, pest plant and animal management, water quality improvement and in-stream habitat works • Monitor and survey river and wetland condition • Improve connectivity between rivers and floodplain wetlands • Emergency flood management plans in place • Implementation of post-flood river restoration programs

7. POTENTIAL RISKS OF AND MITIGATION MEASURES FOR ENVIRONMENTAL WATERING

A risk identification process has been undertaken to investigate the risks associated with environmental water delivery and site management at Hird Swamp and is presented in Table 16.

These risks are considered as potential only, and may not eventuate during environmental water delivery and management at Hird Swamp. In addition, a detailed risk assessment process will be developed prior to delivering environmental water in any given season and provided in the site watering proposal.

Table 16: Possible risks and mitigation measures associated with environmental water delivery to Hird Swamp

Risk	Description	Potential Impacts								Potential mitigation measures
		Environmental (Water regime does not support breeding and feeding requirements or vegetation establishment and growth)					Social		Economic	
		Fish	Birds	Amphibians	Invertebrate	Native aquatic flora	Reduced public access and use	Degradation of cultural heritage sites	Flooding of adjacent land	
Required watering regime not met	Flood duration too long or short		✓	✓		✓				• Determine environmental water requirements based on seasonal conditions and to support potential bird breeding events • Monitor flood duration to inform environmental water delivery • Monitor the ecological response of the wetland to flooding • Add or drawdown water where appropriate or practical
	Flood timing too late or early		✓	✓		✓	✓			• Undertake a water mass-balance based on seasonal conditions before placing water order • Consult with water authority throughout season. Consider purchasing delivery shares of casual use if need be. • Monitor flood timing to inform environmental water delivery • Monitor the ecological response of the wetland to flooding
	Flooding depth too shallow or deep		✓			✓	✓	✓	✓	• Determine environmental water requirements based on seasonal conditions and to support potential bird breeding events • Monitor flood depth to inform environmental water delivery • Liaise with adjoining landowners prior to and during the delivery of environmental water to discuss and resolve potential or current flooding issues • Add or drawdown water where appropriate or practical
	Flood frequency too often or too infrequent	✓	✓	✓	✓	✓	✓			• Prioritise water requirements of wetlands in seasonal watering proposals according to their required water regimes and inundation history • Monitor the condition of the wetland • Monitor the ecological response of the wetland to flooding

Continued

Risk	Description	Potential Impacts								Potential mitigation measures
		Environmental (Water regime does not support breeding and feeding requirements or vegetation establishment and growth)					Social		Economic	
		Fish	Birds	Amphibians	Invertebrate	Native aquatic flora	Reduced public access and use	Degradation of cultural heritage sites	Flooding of adjacent land	
Poor water quality	Low dissolved oxygen	✓	✓							• Monitor dissolved oxygen levels and the ecological response of the wetland to flooding • Add or drawdown water where appropriate or practical
	High turbidity	✓				✓				• Monitor turbidity levels and the ecological response of the wetland to flooding • Add or drawdown water where appropriate or practical
	High water temperature	✓				✓				• Monitor water temperature and the ecological response of the wetland to flooding • Add or drawdown water where appropriate or practical
	Increased salinity levels	✓		✓	✓	✓				• Monitor salinity levels and the ecological response of the wetland to flooding • Add or drawdown water where appropriate or practical
	Increased nutrient levels	✓	✓	✓	✓	✓	✓			• Monitor nutrient and Blue Green Algae levels, and the ecological response of the wetland to flooding • Place public warning signs at the wetland if BGA levels are a public health risk • Add or drawdown water where appropriate or practical
Invasive aquatic plants and animals	Introduction of invasive aquatic fauna	✓		✓	✓	✓				• Monitor the ecological response of the wetland to flooding • Implement an appropriate drying regime
	Growth and establishment of aquatic invasive plants	✓	✓	✓	✓	✓				• Monitor the abundance of native and invasive aquatic plants • Control invasive plants in connected waterways • Spray or mechanically remove invasive plants • Implement an appropriate drying regime

8. ENVIRONMENTAL WATER DELIVERY INFRASTRUCTURE

8.1. Constraints

The delivery channel to Hird Swamp, downstream of the G-MW supply point requires regular maintenance in the form of desilting and vegetation management. The channel was cleared at the end of 2010, and will require regular maintenance to continually achieve desired delivery rate of 50ML/day. This work should be considered as a component of environmental water.

Currently there is an inability to provide environmental water to the eastern side of Hird Swamp independently of watering the western section. When minimal environmental water is available for use, Hird Swamp west and east could be managed independently to provide drought refuge. In order to do this, there needs to be an independent supply of water to manage Hird Swamp east.

As Hird Swamp is known to support waterbird breeding events, there may also be a need to support these events with additional environmental water (beyond the initial filling phase). As it is difficult to manage water levels in Hird Swamp east using the syphon (Parks Victoria [M. Tscharke] pers. comm. 2011), there would be benefits of having an independent water supply to this section of the wetland. The possibility of providing a water supply to Hird Swamp east should be investigated (including the opportunity to pump directly from Pyramid Creek).

8.2. Irrigation modernisation

The Northern Victorian Renewal Project (NVIRP) is a program which aims to upgrade existing irrigation infrastructure in the Goulburn-Murray Irrigation District to achieve water savings. The connections for Hird Swamp are currently being considered, and may impact on delivery infrastructure into the future.

8.3. Infrastructure recommendations

Infrastructure is required to enable environmental water delivery to the eastern side of Hird Swamp independently of Hird Swamp west. This will be particularly important in dry climates where there is not sufficient water to deliver to Hird Swamp west and east, and when waterbird breeding events in Hird Swamp east need to be supported with environmental water.

The current infrastructure used to supply water to Hird Swamp west is considered adequate for environmental water deliveries. The current infrastructure linking Hird Swamp west and east is considered sufficient to manage the ecological objective relating to lignum and chenopod woodland. Options for an independent water supply (including pumping options) should be investigated for Hird Swamp west, particularly to support waterbird breeding events.

9. KNOWLEDGE GAPS AND RECOMMENDATIONS

There are currently a number of knowledge gaps in relation to environmental water management at Hird Swamp. While most of these do not impact the ability to provide water to the wetland and generate ecological benefit, addressing these knowledge gaps would significantly improve the accuracy of environmental water bids, and provide long-term ecological understanding of the site.

Specifically, the following activities are recommended to be undertaken along with long term investment of environmental water to Hird Swamp:

- complete detailed a detailed flora survey (including aquatic vegetation)
- review existing wetland capacity table and undertake survey of wetland bed (to be undertaken once site has dried)
- complete additional IWC assessment for wet phase of wetland (west and east)
- develop a long and short-term monitoring program to be used in conjunction with environmental watering proposals and delivery plans including the following:
    - identify ecological indicators for monitoring long-term ecological condition and change
- undertake baseline GPS mapping of the current extent of *Phragmites* sp. through the wetland, and undertake regular monitoring to inform environmental water management and the requirement for complementary works
- develop a map of dominant wetland plant communities overlayed with counters of the wetland – this may then be used to set a baseline from which to track the expansion of species through the wetland
- continue to investigate appropriate options for providing an independent mechanism for water supply to Hird Swamp east
- management of Hird Swamp into the future needs a concerted effort managing environmental water according to the recommended watering regime, as well as regular spraying of encroaching vegetation (every two to three years), otherwise the values of the wetland will be lost.

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APPENDIX 1: CORRICK AND NORMAN CLASSIFICATION OF WETLAND CATEGORIES

Source: DSE 2007b

Category	Sub-category	Depth (m)	Duration of inundation
Flooded river flats These include many areas of agricultural land that become temporarily inundated after heavy rains or floods. Water may be retained in local depressions for just a few days or for several months.		< 2	
Freshwater meadow These include shallow (up to 0.3 m) and temporary (less than four months duration) surface water, although soils are generally waterlogged throughout winter.	1 Herb-dominated 2 Sedge-dominated 3 Red gum- dominated 4 Lignum dominated	< 0.3	< 4 months/year
Shallow freshwater marsh Wetlands that are usually dry by mid-summer and fill again with the onset of winter rains. Soils are waterlogged throughout the year and surface water up to 0.5 m deep may be present for as long as eight months.	1 Herb-dominated 2 Sedge-dominated 3 Cane grass dominated 4 Lignum dominated 5 Red gum-dominated	< 0.5	< 8 months/year
Deep freshwater marsh Wetlands that generally remain inundated to a depth of 1 – 2 m throughout the year.	1 Shrub-dominated 2 Reed-dominated 3 Sedge-dominated 4 Rush-dominated 5 Open water 6 Cane grass dominated 7 Lignum-dominated 8 Red gum-dominated	< 2	permanent
Permanent open freshwater Wetlands that are usually more than 1 m deep. They can be natural or artificial. Wetlands are described to be permanent if they retain water for longer than 12 months, however they can have periods of drying.	1 Shallow 2 Deep 3 Impoundment	<2 >2	permanent
Semi-permanent saline These wetlands may be inundated to a depth of 2 m for as long as eight months each year. Saline wetlands are those in which salinity exceeds 3,000 mg/L throughout the whole year.	1 Salt pan 2 Salt meadow 3 Salt flat 4 Sea rush-dominated 5 Hypersaline lake	< 2	< 8 months/year
Permanent saline These wetlands include coastal wetlands and part of intertidal zones. Saline wetlands are those in which salinity exceeds 3,000 mg/L throughout the whole year.	Shallow Deep Intertidal flats	< 2 > 2	permanent
Sewage oxidation basin These include artificial wetlands used for sewage treatment.	Sewage oxidation basin		
Salt evaporation basin These include artificial wetlands used salt concentration.	Salt evaporation basin		

APPENDIX 2: ENVIRONMENTAL WATER SOURCES

Commonwealth Environmental Water Holder (CEWH)

Under *Water for the Future* the Commonwealth Government committed $3.1 billion to purchase water in the Murray-Darling Basin over 10 years. The Commonwealth Environmental Water Holder will manage their environmental water.

The Commonwealth Water Act 2007 identified that "the Commonwealth Environmental Water Holder must perform its functions for the purpose of protecting or restoring environmental assets so as to give effect to relevant international agreements". Wetlands listed as of International Importance (Ramsar) are considered priority environmental assets for use of the commonwealth environmental water (DEWHA 2008).

Victorian Environmental Water Holder (VEWH)

The VEWH (when established in June 2011) will be responsible for holding and managing Victorian environmental water entitlements and allocations and deciding upon their best use throughout the State. The environmental entitlements held by the VEHW that could potentially be made available to this site include:

- Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order (incl. Amendments Orders and Notices 2005, 2006, 2007 and 2009); and
- Environmental Entitlement (River Murray Environmental Water Reserve) 2010.

In 1987 an annual allocation of 27,600 ML of high security water was committed to flora and fauna conservation in Victorian Murray wetlands. In 1999, this became a defined entitlement for the environment called the Victorian River Murray Flora and Fauna Bulk Entitlement.

The Northern Victoria Irrigation Renewal Project (NVIRP) water savings are predicted to provide up to 75 GL as a statutory environmental entitlement, which will be used to help improve the health of priority stressed rivers and wetlands in northern Victoria (DSE, 2008). The entitlement will have properties which enable the water to be used at multiple locations as the water travels downstream (provided losses and water quality issues are accounted for); meaning that the water can be called out of storage at desired times to meet specific environmental needs.

River Murray Unregulated Flows (RMUF)

Unregulated flows in the River Murray system are defined as water that cannot be captured in Lake Victoria and is, or will be, in excess of the required flow to South Australia. If there is a likelihood of unregulated flow event in the River Murray system, the Authority provides this advice to jurisdictions The Upper States then advise the Authority on altered diversion rates and environmental releases within their existing rights to unregulated flows.

Based on the information received from Jurisdictions, the Authority reassesses the event and, if necessary, limits Upper States' access to ensure that the unregulated flow event is not over committed. The Authority then issues formal unregulated flow advice to jurisdictions including any limits to States access.

Depending on the volume of water remaining, the Authority advises EWG and the Water Liaison Working Group (WLWG) on the availability and volume of RMUF. Whilst there is a range of measures that can be undertaken by Upper States as part of their 'prior rights' during unregulated flows, RMUF events are prioritised solely for the environment.

APPENDIX 3: LEGISLATIVE FRAMEWORK

International agreements and conventions

Ramsar Convention on Wetlands (Ramsar)

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

Bilateral migratory bird agreements

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

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

These agreements require that the parties protect migratory birds by:

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

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

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

Commonwealth legislation

Environment Protection and Biodiversity Conservation Act 1999 (EPBC)

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

Water Act 2007 (Commonwealth Water Act)

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

Aboriginal and Torres Straight Islander Heritage Protection Act 1984

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

State legislation and listings

Flora and Fauna Guarantee Act 1988 (FFG)

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

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

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

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

Environmental Effects Act 1978

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

Planning and Environment Act 1987

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

Water Act 1989 (Victorian Water Act)

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

Aboriginal Heritage Act 2006

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

Other relevant legislation

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

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

APPENDIX 4: ECOLOGICAL VEGETATION CLASSES

Figure 11 shows the Ecological Vegetation Classes mapped at Hird Swamp.

Lignum Swampy Woodland (EVC 823) is shown in green; Riverine Chenopod Woodland (EVC 103) is shown in pink hash; Semi-arid Woodland (EVC 97) is shown in light green hash.

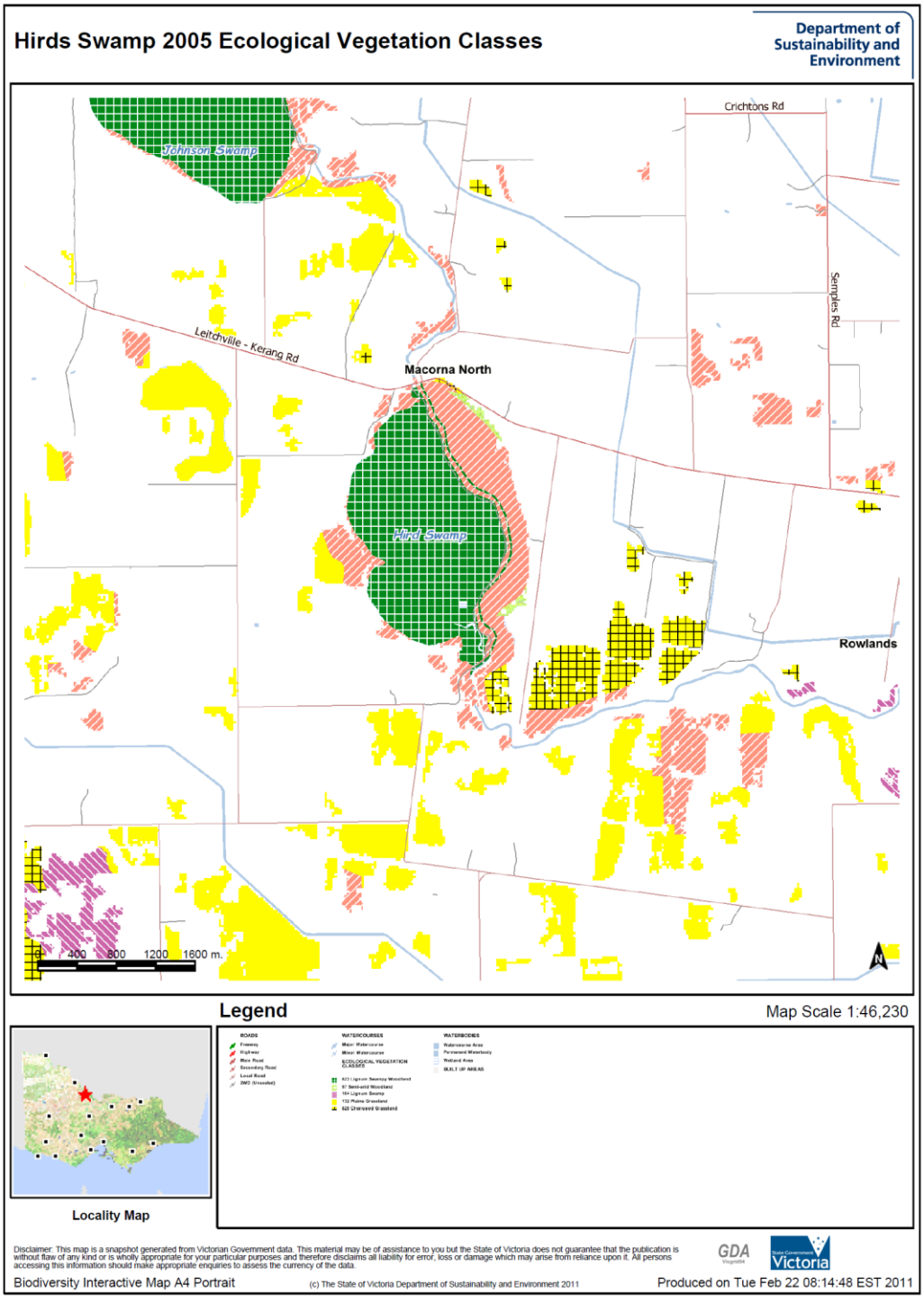

Figure 11: EVCs recorded at Hird Swamp, and their location

Department of Sustainability and Environment

EVC/Bioregion Benchmark for Vegetation Quality Assessment

Victorian Riverina bioregion

EVC 823: Lignum Swampy Woodland

Description:
Understorey dominated by Lignum, typically of robust character and relatively dense (at least in patches), in association with a low Eucalypt and/or Acacia woodland to 15 m tall. The ground layer includes a component of obligate wetland flora that is able to persist even if dormant over dry periods.

Large trees:

Species	DBH(cm)	#/ha
Eucalyptus largiflorens	50 cm	15/ha
Eucalyptus camaldulensis	70 cm	

Tree Canopy Cover:

% cover	Character Species	Common Name
20%	*Eucalyptus largiflorens*	Black Box
	Eucalyptus camaldulensis	River Red Gum

Understorey:

Life form	#Spp	%Cover	LF code
Immature Canopy Tree		5%	IT
Understorey Tree or Large Shrub	1	5%	T
Medium Shrub	2	30%	MS
Small Shrub	1	5%	SS
Large Herb	2	1%	MH
Medium Herb*	8	10%	MH
Small or Prostrate Herb*	4	10%	SH
Medium to Small Tufted Graminoid*	2	5%	MTG
Large Non-tufted Graminoid	1	5%	LNG
Medium to Tiny Non-tufted Graminoid*	3	15%	MNG
Soil Crust	na	10%	S/C
* Largely seasonal life form			
Total understorey projective foliage cover		**80%**	

LF Code	Species typical of at least part of EVC range	Common Name
T	*Acacia stenophylla*	River Coobah
MS	*Muehlenbeckia florulenta*	Tangled Lignum
MS	*Chenopodium nitrariaceum*	Nitre Goosefoot
MS	*Muehlenbeckia florulenta*	Tangled Lignum
SS	*Atriplex lindleyi*	Flat-top Saltbush
SS	*Sclerolaena muricata*	Five-spined Bassia
LH	*Rumex* spp.	Dock
MH	*Marsilea drummondii*	Common Nardoo
MH	*Brachyscome ciliaris*	Variable Daisy
MH	*Euchiton sphaericus*	Annual Cudweed
MH	*Ranunculus* spp.	Buttercup
LNG	*Eragrostis australasica*	Cane Grass
MTG	*Setaria jubiflora*	Warrego Summer-grass
MTG	*Austrodanthonia duttoniana*	Brown-back Wallaby-grass
MTG	*Sporobolus mitchellii*	Short Rat-tail Grass
MTG	*Eragrostis setifolia*	Bristly Love-grass
MNG	*Eragrostis infecunda*	Southern Cane grass
MNG	*Eleocharis acuta*	Common Spike-sedge
MNG	*Eleocharis pusilla*	Small Spike-sedge
SC	*Asperula gemella*	Twin-leaf Bedstraw

EVC 823: Lignum Swampy Woodland - Victorian Riverina bioregion

Recruitment:
Continuous

Organic Litter:
5% cover

Logs:
10m/0.1 ha.

Weediness:

LF Code	Typical Weed Species	Common Name	Invasive	Impact
SH	*Phyla canescens*	Lippia	high	high

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EVC/Bioregion Benchmark for Vegetation Quality Assessment

Victorian Riverina bioregion

EVC 103: Riverine Chenopod Woodland

Description:
Eucalypt woodland to 15 m tall with a diverse shrubby and grassy understorey occurring on most elevated riverine terraces. Confined to heavy clay soils on higher level terraces within or on the margins of riverine floodplains (or former floodplains), naturally subject to only extremely infrequent incidental shallow flooding from major events if at all flooded.

Large trees:

Species	DBH(cm)	#/ha
Eucalyptus spp.	50 cm	5/ha

Tree Canopy Cover:

%cover	Character Species	Common Name
10%	*Eucalyptus largiflorens*	Black Box

Understorey:

Life form	#Spp	%Cover	LF code
Immature Canopy Tree		5%	IT
Understorey Tree or Large Shrub	1	5%	T
Medium Shrub	3	30%	MS
Small Shrub	5	25%	SS
Prostrate Shrub	1	1%	PS
Medium Herb	5	5%	MH
Small or Prostrate Herb*	5	10%	SH
Medium to Small Tufted Graminoid	2	5%	MTG
Soil Crust	na	10%	S/C

* Largely seasonal life form

Total understorey projective foliage cover **65%**

LF Code	Species typical of at least part of EVC range	Common Name
T	*Acacia stenophylla*	River Coobah
MS	*Atriplex nummularia*	Old-man Saltbush
MS	*Chenopodium nitrariaceum*	Nitre Goosefoot
MS	*Eremophila divaricata* ssp. *divaricata*	Spreading Emu-bush
SS	*Sclerolaena tricuspis*	Streaked Copperburr
SS	*Enchylaena tomentosa* var. *tomentosa*	Ruby Saltbush
SS	*Atriplex lindleyi*	Flat-top Saltbush
SS	*Rhagodia spinescens*	Hedge Saltbush
PS	*Sclerochlamys brachyptera*	Short-wing Saltbush
MH	*Einadia nutans* ssp. *nutans*	Nodding Saltbush
MH	*Calocephalus sonderi*	Pale Beauty-heads
MH	*Senecio glossanthus*	Slender Groundsel
MH	*Brachyscome lineariloba*	Hard-head Daisy
SH	*Disphyma crassifolium* ssp. *clavellatum*	Rounded Noon-flower
SH	*Maireana pentagona*	Hairy Bluebush

Recruitment:
Continuous

Organic Litter:
5% cover

Logs:
5 m/0.1 ha.

Weediness:

LF Code	Typical Weed Species	Common Name	Invasive	Impact
T	*Olea europaea* subsp. *europaea*	Olive	low	high
MS	*Lycium ferocissimum*	Boxthorn	low	high
LH	*Sisymbrium erysimoides*	Smooth Mustard	high	high
LH	*Critesion* spp.	Barley-grass	high	low
LH	*Gazania linearis*	Gazania	high	high
LH	*Opuntia* spp.	Prickly Pear	low	high
LH	*Sisymbrium irio*	London Mustard	high	high
LH	*Psilocaulon granulicaule*	Noon-flower	high	high
MH	*Limonium sinuatum*	Notch-leaf Sea-lavender	high	high
MH	*Limonium lobatum*	Winged Sea-lavender	high	high
MH	*Trifolium arvense* var. *arvense*	Hare's-foot Clover	high	low
MH	*Mesembryanthemum nodiflora*	Ice-plant	high	high
MH	*Carrichtera annua*	Ward's Weed	high	high
MH	*Marrubium vulgare*	Horehound	high	high
MH	*Carpobrotus aequilaterus*	Angled Pigface	low	high
MH	*Silene apetala* var. *apetala*	Sand Catchfly	high	low
MH	*Medicago* spp.	Medic	high	low
MH	*Oxalis pes-caprae*	Soursob	high	high
MH	*Silene gallica*	French Catchfly	high	low
MH	*Silene nocturna*	Mediterranean Catchfly	high	low
SH	*Mesembryanthemum crystallinum*	Common Ice-plant	high	high
MTG	*Vulpia bromoides*	Squirrel-tail Fescue	high	high
MTG	*Lolium rigidum*	Wimmera Rye-grass	high	low
MTG	*Asphodelus fistulosus*	Onion Weed	high	high
MNG	*Bromus rubens*	Red Brome	high	high
MNG	*Vulpia myuros*	Rat's-tail Fescue	high	low
MNG	*Bromus* spp.	Brome	high	high
MNG	*Schismus barbatus*	Arabian Grass	high	low
SC	*Asparagus asparagoides*	Bridal Creeper	high	high

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EVC/Bioregion Benchmark for Vegetation Quality Assessment

Victorian Riverina bioregion

EVC 97: Semi-arid Woodland

Description:
Non-eucalypt woodland or open forest to 12 m tall, of low rainfall areas. Occurs in a range of somewhat elevated positions not subject to flooding or inundation. The surface soils are typically light textured loamy sands or sandy loams.

Large trees:

Species	DBH(cm)	#/ha
Allocasuarina spp.	40 cm	20 / ha
Callitris spp.	40 cm	
Myoporum platycarpum	35 cm	

Tree Canopy Cover:

% cover	Character Species	Common Name
20%	*Allocasuarina luehmannii*	Buloke
	Callitris gracilis ssp. *murrayensis*	Slender Cypress-pine
	Myoporum platycarpum	Sugarwood

Understorey:

Life form	#Spp	%Cover	LF code
Immature Canopy Tree		5%	IT
Medium Shrub	5	15%	MS
Small Shrub	5	20%	SS
Large Herb*	2	5%	LH
Medium Herb*	7	5%	MH
Small or Prostrate Herb*	2	5%	SH
Medium to Small Tufted Graminoid	2	10%	MTG
Medium to Tiny Non-tufted Graminoid	1	1%	MNG
Bryophytes/Lichens	na	10%	BL
Soil Crust	na	20%	S/C

* Largely seasonal life form

Total understorey projective foliage cover **75%**

LF Code	Species typical of at least part of EVC range	Common Name
MS	*Alectryon oleifolius* ssp. *canescens*	Cattle Bush
MS	*Acacia oswaldii*	Umbrella Wattle
MS	*Hakea tephrosperma*	Hooked Needlewood
MS	*Hakea leucoptera* ssp. *leucoptera*	Silver Needlewood
SS	*Enchylaena tomentosa* var. *tomentosa*	Ruby Saltbush
SS	*Sclerolaena diacantha*	Grey Copperburr
SS	*Olearia pimeleoides*	Pimelea Daisy-bush
SS	*Rhagodia spinescens*	Hedge Saltbush
MH	*Einadia nutans* ssp. *nutans*	Nodding Saltbush
MH	*Vittadinia dissecta* s.l.	Dissected New Holland Daisy
MH	*Calandrinia eremaea*	Small Purslane
MH	*Crassula colorata*	Dense Crassula
SH	*Actinobole uliginosum*	Flannel Cudweed
MTG	*Austrodanthonia caespitosa*	Common Wallaby-grass
MTG	*Austrostipa* spp.	Spear-grass
MNG	*Austrostipa elegantissima*	Feather Spear-grass

Victoria The Place To Be

EVC 97: Semi-arid Woodland - Victorian Riverina bioregion

Recruitment:
Continuous

Organic Litter:
20% cover

Logs:
20 m/0.1 ha.

Weediness:

LF Code	Typical Weed Species	Common Name	Invasive	Impact
LH	*Brassica tournefortii*	Mediterranean Turnip	high	high
LH	*Reichardia tingitana*	Reichardia	high	low
MH	*Silene* spp.	Catchfly	high	high
SH	*Medicago minima*	Little Medic	high	high
MTG	*Schismus barbatus*	Arabian Grass	high	high
MTG	*Pentaschistis airoides* ssp. *airoides*	False Hair-grass	high	high
MNG	*Bromus rubens*	Red Brome	high	high
MNG	*Vulpia myuros*	Rat's-tail Fescue	high	high
MNG	*Critesion murinum* subsp. *glaucum*	Blue Barley-grass	high	high
SC	*Asparagus asparagoides*	Bridal Creeper	high	high

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APPENDIX 5: RECENT WATERING HISTORY

Wetland		1990-1991	1991-1992	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003
Hird Swamp	Status[1]	D	W-D	D/U	W/U	D	W	D	W	D	D	D	W	W
	Water source[2]	-	E	-	F	-	E	-	E	-	-	-	E	E
	Volume delivered (if available)	-	U	-	U	-	U	-	U	-	-	-	2025	4,259
	Comment													

Wetland		2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013
Hird Swamp	Status[1]	W	W	D	W	D	D	D	W	W	W-D
	Water source[2]	E	E	-		-	-	-	E/F	-	-
	Volume delivered (if available)	3,445	3,008	-	2,077	-	-	-	1,713 + flooding	-	-
	Comment	Water delivered as part of the implementation of the Hird Swamp Recovery Plan. *Typha* and *Phragmites* were sprayed in previous season.	Water delivered to Hird Swamp west and east as part of the implementation of the Hird Swamp Recovery Plan. Environmental water delivered in association with restoration works.						Environmental water was delivered to the wetland in late-spring. Widespread flooding through the catchment resulted in overtopping of Pyramid Creek into Hird Swamp east and west.		

[1] Water present / dry wetland
[2] Environmental water allocation / Torrumbarry irrigation system / Flood mitigation/Flood flow / Unknown / Channel outfall / Unknown / na
Source: Joyce and Turner in DSE (2010); Stanton, R., G-MW; DSE (2003); DSE (2004c); DSE (2005).

APPENDIX 6: INDEX OF WETLAND CONDITION METHOD

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
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

APPENDIX 7: WORKSHOP OUTCOMES

Key discussion points from the local technical group workshop held on 16 June 2011 are provided below. Members of the local technical group present at the workshop were Mark Tscharke (Parks Victoria), Shelley Heron (Kellogg Brown and Root), Emer Campbell (North Central Catchment Management Authority) and Ross Stanton (Goulburn-Murray Water).

Hird Swamp overview:

- Hird Swamp is considered to be a beautiful, highly productive wetland for waterbirds, but has some difficult management issues – particularly related to the proliferation of Phragmites and Typha
- Some investigation/planning were done in the early 2000s – primarily done to address threats to wetland condition posed by encroachment by invasive vegetation species (prolific growth)
- East and west are basic ally two distinct wetlands now (by the way they've been developed), however listed as one site
- Having separate objectives means that there will be flexibility in managing the wetland as one site, or managing them separately (e.g. in drought years)
- Historically the wetland was maintained full with water, then with environmental water management it changed to 1 in 2, 1 in 3 year cycle – Typha and Phragmites spread through wetland
- Tried to get it back to a more diverse wetland through spending lots of money
- Now its starting to go back to how it was with the encroachment of Typha and Phragmites
- Historic management also had some politics involved whereby the provision of environmental water to Hird and Johnson Swamp was interchanged so that there was one wet and one dry in any given year – this did not always promote the best outcome for the wetlands

Hird Swamp recommendation:

- There is a recommendation that the wetland should never be allowed to 'dry out' slowly, rather than water should be dropped quickly from the wetland to avoid warm, low water conditions that may stimulate encroachment of Typha and Phragmites. Phragmites is considered much more difficult to manage than Typha
- In reality this is somewhat difficult to do. Water has been dumped out of the wetland back into the system a couple of times in the past, but need to make sure that the water quality is ok to do this as the water goes back into Pyramid Creek
- From these events, it seems that dumping the water out in one go is better than letting it do a natural dry out (filling in spring and letting it dry out naturally over summer is considered the worst management as the Phrgmites and Typha are 'running' and do their most vigorous growth through this time – by keeping the wetland held high, it seems that their growth is slowed).
- Other options for management would be spraying however this needs a concerted and on-going effort
- Need monitoring to inform, and adaptively manage the wetland watering regime
- Don't want to have the same outcome at Hird Swamp as has happened at Johnson Swamp – with lack of mosaic of habitats due to impact of Phragmites and Typha
- Need to ensure there is open water through the wetland as this is an important ecological component of the wetland
- Water management at the site needs to be complemented by other activities – the threat posed by these species encroaching on other values cannot be managed with environmental water alone.

- Need more information from experts on the management of Typha and Phragmites at this wetland to assist in guiding management
- Primary influencing factors for the management of environmental water is the management of Typha and Phragmites (slowing down the encroachment) by filling, topping up and then rapidly drying
- If we manage for these species, will there be any detrimental impact on other target species/communities (e.g. submerged aquatics) that we need to be mindful of? The feeling of the group was that there wouldn't be detrimental impacts as there will be some fluctuation in levels
- There are no longer big live trees through the wetland bed as the fire took most of them out – therefore, holding water in the wetland for two years would not detrimentally impact any other existing values. The constructed islands have some young trees planted on them, however these would unlikely be impacted (due to the elevation of these islands)
- Need to keep the wetland wet for a couple of years to allow other species to go through their cycles before drying again
- The ideal watering regime would likely be around keeping the wetland full (with some variation) for two years which would mean there would likely need a couple of water top ups through summer (this may be difficult in some cases with the volume of water required and the operational management). This has been done in the past, with the wetland using about 4,500ML including the top up water for one season
- The management of this wetland into the future would likely be against all the wetland management 'rules' e.g. there will not be the natural drawdown of water promoting the littoral zone. However this type of active management is considered to be what this wetland needs
- There is a recommendation to regularly undertake spraying at this wetland (e.g. every two to three years). This may cost about $10,000 plus labour to manage.
- The wetland needs a committed program of water management and other activities e.g. spraying to make the wetland function, otherwise it will be lost
- Recommended watering regime developed by group is shown below:

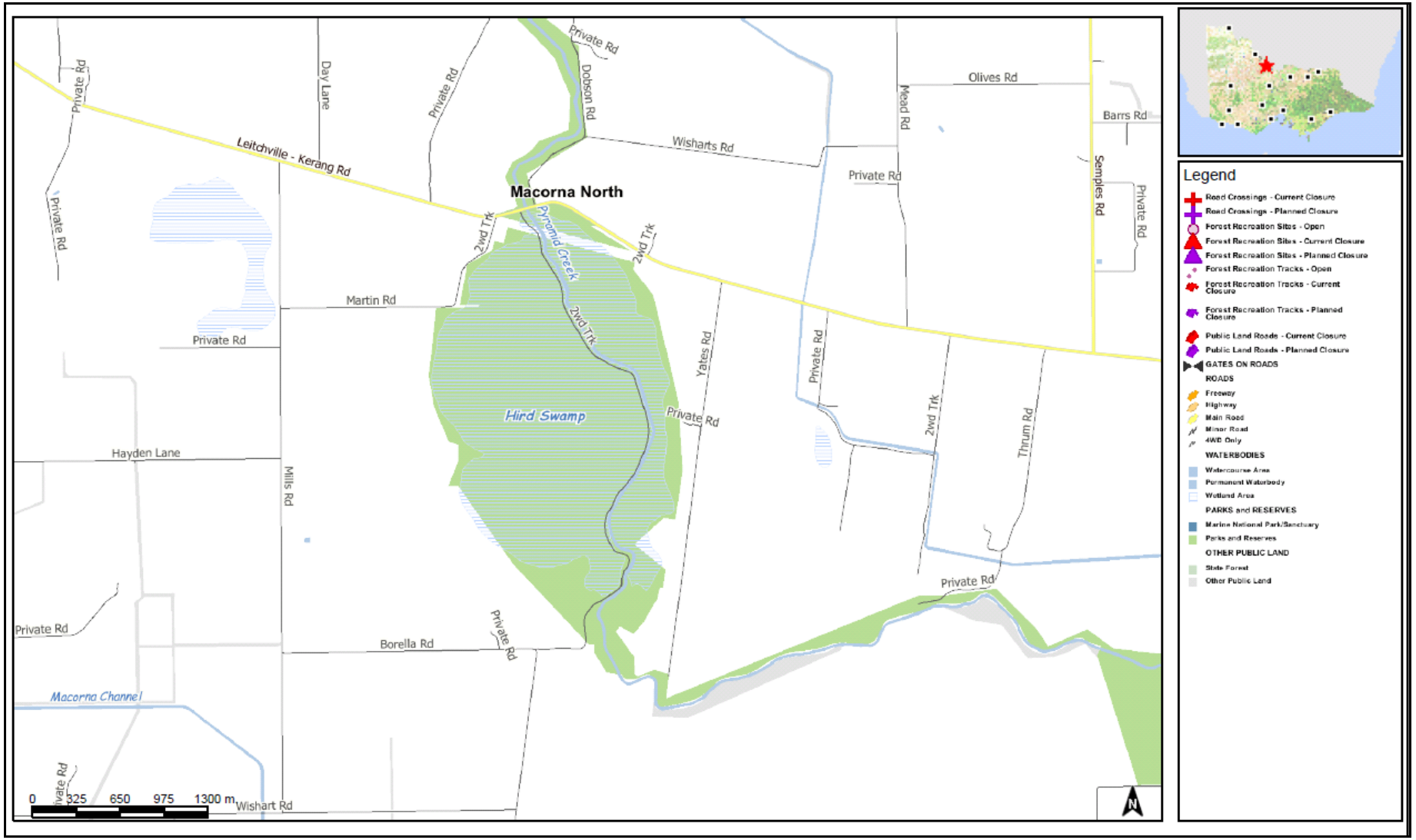
Year	Optimal watering regime
One	Fill Hird Swamp west in spring, and allow water to flow into Hird Swamp east via the siphon. Top up Hird Swamp west to maintain wetland at full supply level (with some variation).
Two	Top up Hird Swamp west in spring and maintain depth through summer. Open outlet structure to Pyramid Creek in autumn and allow wetland to rapid drawdown (~18 months of inundation).
Three	Allow wetland to dry completely.
Four	Allow wetland to remain dry.
Five	Allow wetland to remain dry.
Six	Fill Hird Swamp west in spring and top up to maintain wetland at full supply level (with some variation).
Seven	Top up wetland in spring and maintain through summer. Open outlet structure to Pyramid Creek in autumn and allow wetland to rapid drawdown (~18 months of inundation).
Eight	Allow wetland to dry completely.
Nine	Allow wetland to remain dry.
Ten	Allow wetland to remain dry.

APPENDIX 8: CONTOUR PLAN AND CAPACITY TABLE

Source: S. Archard pers. comm. November 2000 in SKM (2001).

Storage Level (m AHD)	Storage Volume (ML)
78.30	4.2
78.40	31.9
78.50	108.8
78.60	230.8
78.70	390.4
78.80	580.0
78.90	789.7
79.00	1,010.0
79.10	1,236.1
Note: Capacity table relates to Hird Swamp west only.	

APPENDIX 9: HIRD SWAMP PHOTOPOINT MONITORING



Hird Swamp Photopoints

	Photopoint 1	Photopoint 2	Photopoint 3	Photopoint 4	Photopoint 5	Photopoint 6
	EASTING NORTHING DESCRIPTION:	EASTING NORTHING DESCRIPTION: (at outlet to Pyramid Creek)	EASTING NORTHING DESCRIPTION:	EASTING NORTHING DESCRIPTION:	EASTING NORTHING DESCRIPTION: (junction between deliver channel and swamp @ south end)	EASTING NORTHING DESCRIPTION: (junction between deliver channel and swamp @ south end)
2013-14						
	N/A				N/A	
						

NORTH CENTRAL
Catchment Management Authority
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APPENDIX 10: TARGETED COMMUNITY CONSULTATION – SUMMARY REPORT

Method

Community Consultation for the Hird Swamp Environmental Water Management Plan (EWMP) has been undertaken via telephone interviews during the week of the 8th April 2013. To finalise the EWMP local knowledge and input was required. The interviews were focussed on collecting information from the community in relation to the wetland, its values and the draft environmental watering regime recommendations. The information collected has been summarised below and will be used to update, revise and complete the plan. The community consultation component of developing the plan is essential in ensuring that the plan is meaningful and robust into the future.

Community representatives interviewed

Adrian Dee, Betty Watterson, Charlie Gillingham, Dianne Bowles, Mark Daley, Stan Archard and Stuart Simms

1. Wetland information (general)

- Intermittent wetland, introduction of Torrumbarry turned it into a permanent wetland and in 1967 the water was cut off due to dredging of the Pyramid Creek. Now the wetland is being watered for environmental purposes.
- Trees have died within the wetland during it permanent regime.
- Natural watering regime would have been annual with the wetland being dry the following winter. Providing top-ups in summer is considered unnatural.
- An issue is that there is no flexibility for natural watering events.
- While the recent flood was bad on our property it showed what a wetland was all about. Overall the flood did us enormous good. We had an amazing crop and Clover and Rye Grass gro where we had never had feed on before.
- Hird Swamp is feed by the Pyramid Creek system.
- Kow Swamp and the Pyramid Creek receive water from the Bendigo Creek and water that sheds off the Patho Plains area, then into Taylors Creek.
- The Pyramid Creek and associate wetlands were mostly shallow systems and were a haven for waterbirds (pre dredging)
- The dredging of the Pyramid Creek allows floodwater to get away more quickly and reduces the length of inundation of the associated swamps.
- Locals, agency staff and other local Field & Game members were successful pressuring government to construct a bound bank along the Pyramid Creek so the Hird and Johnson swamps could hold water and they also managed to get a specific environmental water allocation of 2,600 ML for Hird and Johnson.

- Naturally Box Creek-Pyramid Creek were ephemeral streams that flowed for many months each year but stopped in the dry season of late summer and autumn
- High flows down the Pyramid Creek would lift the water levels up in the creek, flooding Hird Swamp.
- Hird Swamp water levels didn't seem to fluctuate much prior to dredging (68/69) as there were many wet years where water continually flowed high in the creek and entered the swamp systems.
- After the Pyramid Creek was dredged the section under Milnes Bridge remained shallow and coloured fish (carp) could be seen under the bridge and the carp caused the Redfin disappeared
- The dredging of the Pyramid Creek allows floodwater to get away more quickly and reduces the length of inundation of the associated swamps (Hird and Johnsons swamps).
- The late Des Thomas (OMA) and Ken Hooper fought hard to protect Hird & Johnsons Swamp after the dredging of the Pyramid Creek.
- Des, Ken and other local Field & Game members were successful pressuring government to construct a bound bank along the Pyramid Creek so the Johnsons & Hirds Swamp could hold water and they also managed to get a specific environmental water allocation of 2,600 ML for Hird and Johnsons

2. Wetland values

Environmental

- More birdlife have visited here than at Kakadu.
- When the wetland is kept fill, massive Ibis breeding events occur. It is one of the biggest rookeries. Egrets and Brolgas also frequently visit the wetland.
- Drying upsets the birds, Ducks will fly anywhere.
- A lot of foxes are in the area and I haven't seen a Carpet Python since the 2004/05 fires.
- The most common emerging water plants within the Pyramid Creek system, prior to dredging, were Club Rush and Cumbungi and they provided great habitat for nesting waterbirds.
- The islands and vegetation bays that were constructed in Hird Swamp were planted up with trees and have been very successful
- There is a need to increase pest plant and animal works at Hird Swamp.
- Fire could be an ongoing threat to Hird Swamp
- The most common emerging water plants within the Pyramid Creek system, prior to dredging, were Club Rush and Cumbungi and they provided great habitat for nesting waterbirds.
- Redfin (a few Tench) became the dominant fish species in the Pyramid Creek and perhaps in some of the deeper sections of the adjoining wetlands like Hird Swamp.
- Few native fish were caught in the Pyramid Creek as the Redfin and later European Carp wiped them out.

Cultural Heritage

- There are areas of cultural significance within the wetland (e.g. Scar Trees)

Recreation

- Local farmers use to dump scrap metal. Three semi-load trailers of metal have been taken out of Hird and Red Gum swamps.
- Great wetland for bird watching, tours often stop at this wetland.
- Camping, 4WD and duck hunting activities.

3. Draft environmental watering regime

- The Pyramid Creek and associated wetlands originally contained Black Box trees and therefore were only likely to flood periodically (i.e. not River Red Gum).
- Due to the good quality water that is provided to the wetland and ability for it to drain means it won't have a salt problem.
- Watering more frequently than what is being recommended may impact on the water table and surrounding land.
- Can't put the wetland back to its natural state because the creek is at a much lower level.
- The siphon is not big enough to get water into the east side, Cumbungi and Phragmites escalate the issue.
- The wetland should have been filled in the 2012/13 season. Water has been going down the Pyramid Creek for no real environmental value.
- The Cumbungi and Reeds within the wetland suck a lot of water out.
- Water should be put in the wetland every year but not maintained. The wetland holds water for months and rapidly draws down after filling.
- In years when there is lots of water around the wetland should be watered, understand that when water is scarce that watering wetlands has to be prioritised.
- All well and good filling the wetland and setting environmental objectives, however Carp are causing major environmental damage to all wetlands in the region. Investment is required for fish traps.
- The optimal watering regime is too dry, it is a seasonal wetland.
- Watering event in 2011 led to birds breeding, however no top up flows were providing leading to birds abandoning their nests.
- The wetland should have been filled this season (2012/13).