DEPARTMENT OF
PRIMARY INDUSTRIES

Kinnairds Swamp Environmental Management Plan

Final Report
2003

Victoria
The Place To Be

Department of Primary Industries

Department of Sustainability and Environment

Goulburn Broken Catchment Management Authority

Parks Victoria

Funded by the Department of Primary Industries, and the Shepparton Irrigation Region Implementation Committee of the Goulburn Broken Catchment Management Authority through the Shepparton Irrigation Region Catchment Strategy.

Environmental Management Program
Department of Primary Industries
Northern Irrigation Region
Private Bag 1
TATURA VIC 3616

Cover: Aerial view (looking south) of Kinnairds Swamp in flood during November 1993 prior to construction of Surface Water Management Scheme works (Photo: Paul O'Connor).

Acknowledgments

This environmental management plan represents the collective efforts of a range of people, whose assistance in the provision of background information, strategy formulation and review of draft documents have culminated in the development of a 'workable' supported strategy.

Special mention is made of:

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- Ernest Jones (Numurkah and District Development Committee Inc) for continued involvement in plan development and acting as the key consultative representative of the Numurkah and District Development Committee Inc.
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- Mani Manivasakan (SKM) for information and field inspection of the wetland.
- Anna Newham (Friends of Kinnairds Swamp group), Jenny Burkitt (former long-term local resident adjoining Kinnairds Swamp) and John Bourchier (adjoining resident) for sharing information gathered by many years of personal observations of the wetland.
- Constructive reviews of earlier drafts of this document were received from Paul O'Connor (NRE), Ken Sampson (GBCMA), Ross Plunkett (G-MW), Kevin Preece (G-MW) and members of the Kinnairds Swamp group (Anna Newham, Lola Twentyman and John Bourchier).

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Abbreviations

AAV	Aboriginal Affairs Victoria
ARI	Average Return Interval (i.e., the expected incidence of a particular flow event)
CAMBA	China-Australia Migratory Bird Agreement
DPI	Department of Primary Industries
EMG	Environmental Management Group (a unit within NRE)
GBCMA	Goulburn-Broken Catchment Management Authority
G-MW	Goulburn-Murray Water
ha	Hectare
JAMBA	Japan-Australia Migratory Bird Agreement
km	Kilometre
MDBC	Murray-Darling Basin Commission
ML	Megalitre (one million litres)
ML/d	Megalitre per day (measure of flow)
NRE	Department of Natural Resources & Environment
SKM	Sinclair Knight Mertz (consulting firm responsible for the arterial drain design)

Contents

Management Agreement

We the undersigned key stakeholder representatives acknowledge this document as being the operative management plan for the wetland and accept our responsibilities in partnership as recommended for its ecological sustainability.

……
Alex Sislov *for Chris Norman (CAS Manager)*
Team Leader
Environmental Management Program
DPI Catchment and Agricultural Services

……
Russell Pell
Chair
Implementation Committee
Goulburn-Broken Catchment Management Authority

……
Kevin Preece
Murray Valley Area Manager
Goulburn-Murray Water

……
Phillip Hoare
Manager
Asset Services Tatura
Goulburn-Murray Water

……
Gavin Cator
Chief Executive Officer
Moira Shire

……
John Dowling
Chair
Muckatah Community Surface Drainage Group

……
Allen Canobie
Chair
Kinnairds Wetland Committee

……
Steve Visser
Chair
Numurkah and District Development Committee Inc

……
Justin Sheed
River Health and Water Quality Manager
Goulburn Broken Catchment Management Authority

1. Summary

Kinnairds Wetland is a 93 ha part-public and part-privately owned terminal wetland complex near the township of Numurkah in Northern Victoria. The wetland is a Deep Freshwater Marsh in a prior stream depression (Muckatah Depression), characterised by a vegetation community of sparse mature River Red Gum over Common Spike-sedge, Water Milfoil and Moira Grass. The site is notable as a breeding ground for Royal Spoonbills, Little Pied Cormorants and Wedge-tailed Eagle, and as a feeding ground for migratory species.

The wetland has recently been modified and enhanced by earthworks associated with the Muckatah Surface Water Management Scheme. This scheme provides major regional drainage benefits for a considerable area of irrigated agriculture within the Muckatah catchment. The surface water management works have been designed to utilise the wetland as a retardation basin and filtering system whilst enhancing the wetland values. It also provides for the first time a means for water management control within the wetland basin. Prior to the works, agricultural development in the district had impacted on the wetland from inappropriate flooding regimes associated with poor drainage and unseasonal inflows.

This management plan presents the necessary geo-morphological, biological, utilisation history, management history and current stakeholders' requirements to support the management recommendations as detailed. Wetland values, especially as a Royal Spoonbill breeding site and Brolga and Latham's Snipe feeding site, public amenity and the flow retarding and nutrient assimilating attributes of the wetland, form the basis of this plan.

2. Introduction

2.1 Kinnairds Wetland

Kinnairds Wetland is a 93 ha part-public and part-privately owned wetland complex, situated approximately 2km north-east of the Numurkah township in northern Victoria (Figure 1). The site is listed within the Directory of Important Wetlands in Australia (ANCA 1993).

The wetland is a deep (~ 0.7m deep) freshwater marsh in a prior stream depression (Muckatah Depression) fed from a 600 km^2 catchment beginning near Yarrawonga on the north-western slopes of the Warby Ranges (G-MW 1999). It is a naturally formed terminal wetland system at the bottom of the Muckatah Catchment. Outfall from the wetland flows 1.5km south to the Broken Creek. Similarly, flooding flows from the Broken Creek historically flooded the wetland.

Prolonged seasonal inundation, following on from numerous attempts to crop and graze the site, has been responsible for forming the open character of the wetland. Common Spike-sedge (*Eleocharis acuta*) and Rush (*Juncus* sp.) dominate the wetland floor with a sparse overstorey of mature and some dead River Red Gum (*Eucalyptus camaldulensis*). Milfoils (*Myriophyllum* spp.) and Docks (*Rumex* spp.) are other species that are also seasonally found in abundance (Figure 2). The area surrounding the wetland is dominated by irrigated grazing land.

Kinnairds Wetland is also an important wetland for waterbirds such as Little Pied Cormorants (*Phalacrocorax melanoleuscos*), wading birds such as egrets and herons (*Ardea* spp.) and many species of duck. Notably, the area is a feeding site for the international migratory wader Latham's Snipe (*Gallinago hardwickii*) (O'Connor *pers. comm.* 2000), listed under the Japan and China Migratory Bird Agreements (JAMBA and CAMBA) and recognised nationally as Endangered (NRE 1999). The site is also used by Royal Spoonbills (*Platalea regia*) for breeding (Walsh 1997), a species classified as Vulnerable (NRE 1999), and a nesting pair of Wedge-tailed Eagle. Unfortunately, a pair of Brolga (Vulnerable status in Victoria; NRE 1999) that used to frequent the wetland have not been sighted since the 1950's (Newham *pers. comm.* 1999).

The wetland has had a history of increasing and prolonged flooding since the introduction of irrigated agriculture to the district. The wetland is now being recognised as an important asset for the community, with its ability to provide improved water quality and flow retardation for the catchment which will enable significant aesthetic and recreational values of the wetland and Broken Creek area to be appreciated. A Recreation Plan is also being developed via the Moira Shire Recreation Committee, and a set of Operational Guidelines are being developed by G-MW in conjunction with SKM, NRE and the Moira Shire (G-MW *in prep*.) to ensure that these objectives are consistent with the environmental requirements of the wetland.

2.2 Vision

This management plan aims to see the future Kinnairds Wetland as a biologically diverse functioning wetland system dominated by indigenous flora and fauna, enhancing their successful breeding opportunities and encouraging the utilisation from rare and threatened species, whilst providing suitable retardation and water purifying attributes for the Muckatah Surface Water Management Scheme and valued by the community for recreation, ecotourism and ecological benefits.

Figure 1: Location of Kinnairds Swamp

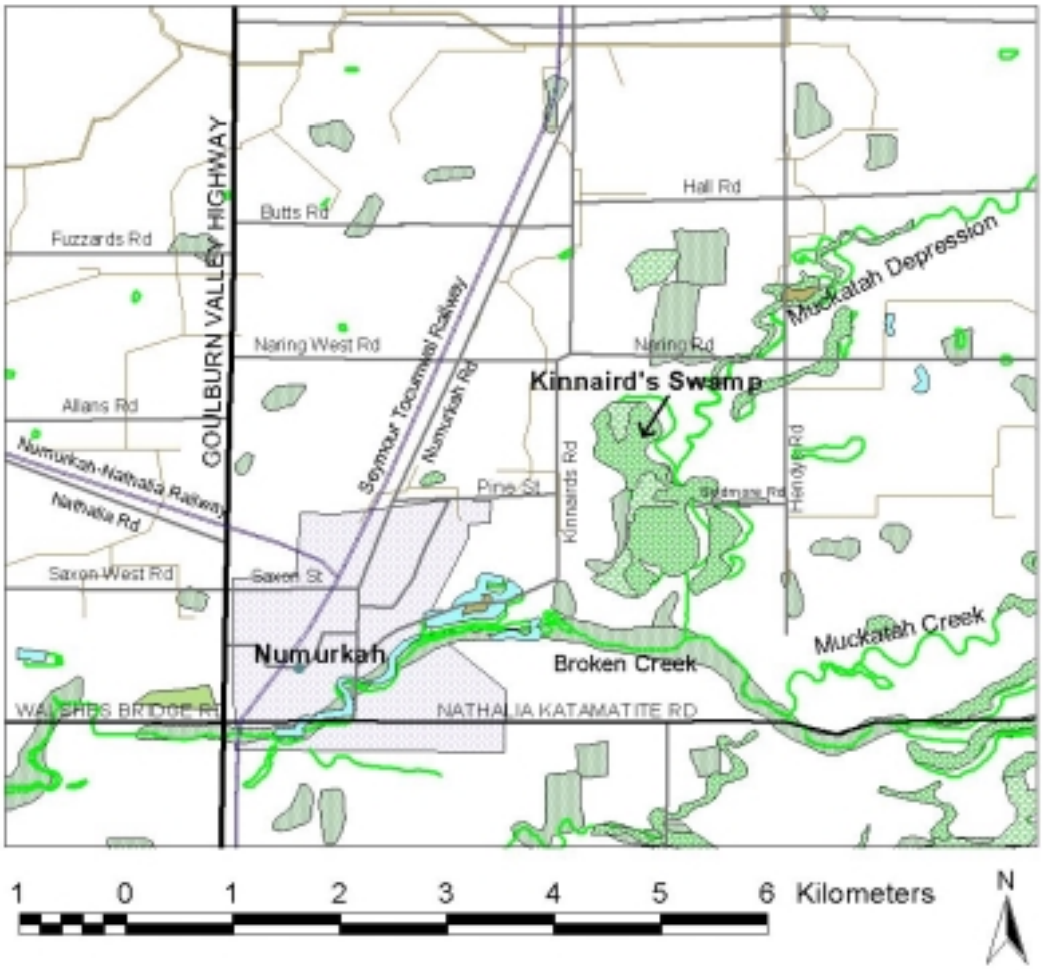


Figure 2. Shallow open wetland environment of Kinnairds Wetland, exhibiting extensive stand of Common Spike-sedge with a diversity of other vegetation, all providing habitat to a range of invertebrates, frogs, reptiles and birds (Photo: Melissa Walsh, EMG, November 1996).

2.3 Policy Support

The issues and directions for wetland management are outlined in a number of federal, basin, state, and catchment management strategies. The primary emphasis of the strategies are to protect natural systems from degrading processes and, where possible, restore the natural functioning of degraded systems to enhance indigenous biodiversity.

Key policy documents and management strategies of influence for this management plan include:

- 'The National Strategy for the Conservation of Australia's Biological Diversity' (CGoA 1996);
- 'Wetlands Policy of the Commonwealth of Australia' (CGoA 1997), including our international commitments via JAMBA and CAMBA Agreements;
- 'Floodplain Wetlands Management Strategy for the Murray-Darling Basin' (MDBC 1998);
- 'Victoria's Biodiversity Strategy – Directions in Management' (NRE 1997);
- 'The Goulburn-Broken Catchment Management Authority Catchment Strategy' (GBCMA 1998);
- 'Shepparton Irrigation Region Land and Water Salinity Management Plan' (GBCMA & NCCMA 1996);
- 'Muckatah Catchment Strategy' (G-MW 1999).

2.4 Land Status

The entire wetland was historically in private ownership between multiple landholders. However following subdivision of one main property in the late 1980s, the central component of the wetland basin and 'road' reserve was converted to public land and managed by the Shire (Bourchier *pers. comm.* 2000). More recent alterations to the public land boundary have occurred with the surface water management works managed by G-MW. Currently, the Shire of Moira and G-MW continue to manage the public reserve component of Kinnairds Wetland, with eight landholders (Hill, Reynolds, Bourchier, Newhams, Edwards, Hicks, Handfords, Skidmores) owning the predominantly private boundary of the wetland. A Flood and Drainage Easement in favour of G-MW exists over the private land occurring within the wetland basin delineated by the outer confining bank constructed as part of the Surface Water Management Scheme.

2.5 Community Consultation

Numerous individuals, special interest groups and agencies have, to varying degrees, interest in Kinnairds Wetland activities. Specific activities undertaken by the Shire of Moira and G-MW have well documented consultation processes to ensure coordinated and agreed outcomes are achieved (e.g., G-MW 1999). The formation of a Committee of Management, as constituted under Local Government Act, serves the means to ensure coordination of activities occur.

Similarly, a defined Consultation Strategy has been developed by EMG for this environmental management plan and includes consultation for both the background and development stages. This has been followed to capture past and current work issues, and now directs future environmental works and other related activities for Kinnairds Wetland.

Stakeholders in the wetland have been identified from previous and existing forums, with broader public consultation involved where required. Two levels of interest have been generalised for main comment and input into this plan; those of Broader Stakeholders such as the wider community and related interest groups, and Key Stakeholders that have a more direct management responsibility or interest in the site. A list of Key Stakeholders is provided in Table 1.

Table 1: Key Stakeholders for Kinnairds Wetland management consultation:

Name	Affiliation
Chris Norman (CAS Manager)	DPI
Phillip Hoare (Manager - Asset Services)	G-MW
Kevin Preece (MV Area Manager)	G-MW
Gavin Cator (CEO)	Moira Shire
John Dowling (Chair)	Muckatah Community Surface Drainage Group
Russell Pell (Chair)	SIR Implementation Committee
Allen Canobie (Chair)	Kinnairds Wetland Committee
Steve Visser (Chair)	Numurkah and District Development Committee Inc
Justin Sheed (Manager)	GBCMA
Anna & Mike Newham	Adjoining Land holder (Kinnairds Wetland Committee)
John Bourchier	"
Steve Hicks	"
Brian Reynolds	"
Murray Park Dairies	"
Rudy Notter	"
John Skidmore	"
Rod & Cheryl Hill	"

Numerous on-site inspections and planning at various levels of management have occurred to date, including the production of various drafts of this document that each represent selected stages of comments sought with subsequent refinement. The signed Management Agreement contained within the forward of this environmental management plan represents the collective acceptance of the direction and responsibilities as presented, and provides for the formal guiding of future management and works for the ecological maintenance of the valuable wetland.

3. Background

3.1 Wetland History:

Kinnairds Wetland is an increasingly valuable wetland within the catchment. This is particularly so considering that on a state scale over 37% of wetlands have been destroyed, mainly from drainage, with Deep Freshwater Marshland type wetlands (like Kinnairds Wetland) being amongst the most threatened following 70% loss. Also, approximately 85% of the catchment has been cleared of the original indigenous vegetation, with native flora and fauna diversity continuing to decrease.

Kinnairds Wetland was once an Open River Red Gum wetland abounding in indigenous flora and fauna and valued by the original Aboriginal custodians. Winter-spring seasonal rainfall and resultant run-off from the catchment would usually fill and spill the wetland on an annual basis.

However, subsequent clearing for agriculture upon European settlement in the mid to late 1800s has caused some profound changes to the wetland. Apart from the inadvertent introduction of deleterious pest plant and animals, direct clearing of the open woodland also altered the structure of the wetland and presumably also the diversity (Figure 3). Most profound has been the alteration of the flooding regime to the wetland.

Primarily since the introduction of irrigated agriculture to the region some 50 years ago, combined with levees and channel construction, the wetland has been experiencing prolonged flooding causing waterlogging and stress and death to the River Red Gum and alteration to the other wetland biodiversity and structure.

Until recently, surface runoff from the Muckatah Catchment (whether it be excess irrigation or rainfall) outfalled into Kinnairds Wetland. Due to the higher inflows and basin geomorphology of the wetland, most of the water would pond in the low regions to cause these areas to experience extended inundation compared with natural events. The flood duration was similar to a Type 4 wetland (Felton 1991), whereas the natural flood regime would have been a Type 3 environment (Table 2).

Table 2: Approximate flood requirement definitions of Type 3 (medium duration seasonal wetland) and Type 4 (prolonged duration seasonal open wetland) (after Felton 1991).

	Type 3 Wetland	Type 4 Wetland
Flooding frequency	Annual (most years)	Annual (most years)
Flooding period	Winter-spring	Winter-spring-summer
Flooding duration	4-6 months (120-180 days)	6-10 months (180-300 days)
Flooding depth	0.4-1.0 m	0.6-1.5 m
Drying frequency	Annual (most years)	3-5 years in 5
Dry period	Summer-autumn	Summer-autumn

The wetland has had a chequered history of landuse. Early European settlement of the area saw it partially cleared for use by grazing livestock and for cropping oats. The cycles of wet seasons and the additional runoff induced by irrigation progressively resulted in the wetland becoming wetter for longer durations. A variety of attempts to control or eliminate the flooding of the wetland were progressively made from the 1950s to the 1970s. Consequently a historic series of drains and banks can be found from the Broken Creek through to the upper reaches of the wetland. Despite these efforts, the wetland continued to flood and from the mid-1980s onwards attempts to crop the wetland basin had been abandoned. The drought of the mid-1980s assisted focus to shift to harvesting water from the basin, causing a new series of dams, banks and drains to be constructed.

Since January 1999, G-MW has initiated construction of the first stage of the Muckatah Surface Water Management Scheme (G-MW 1999). Private land adjoining the main body of the wetland has been acquired by G-MW to enable the construction of the vegetated floodway and nutrient removal wetland. Starting at the outfall end of the catchment and working upstream, Stage 1 was centred on Kinnairds Wetland and involved the construction of the primary floodway through the wetland to Broken Creek. The Muckatah Surface Water Management Scheme is to be implemented over a 10-year period (G-MW 1999) with Stage 1A reaching practical completion in April 2000.

The inclusion of wetland specific design features into this section of the scheme (refer to Section 3.6) will now permit a greater ability to manipulate water management within the wetland and thereby provide conditions more suitable for a range of indigenous flora and fauna.

3.2 Cultural Significance:

The wetland is likely to have had significance to Aboriginal people prior to European Settlement. Waterbodies throughout the Muckatah Depression, such as Kinnairds Wetland, and other prior stream depressions in such a semi-arid landscape dominated by Grey Box woodlands and open grassland, would have provided a valuable water and food gathering resource.

Some individual significant sites have been identified within the broader catchment by Aboriginal Affairs Victoria (AAV) in 1994 when the alignment of the Surface Water Management Scheme was surveyed. However these are all away from the scheme's alignment. A further inspection of the area for the modified floodway proposal was carried out prior to the construction of Stage 1, with no significant sites located (G-MW 1999).

3.3 Catchment Activities:

Irrigation was introduced to the broader Muckatah catchment in the 1950s, and now forms part of the Murray Valley Irrigation Region. Fifty percent of the Muckatah Catchment is now utilised for irrigation purposes (G-MW 1999).

Primary agricultural activities centre on irrigated pastures for dairy cattle, with some dryland grazing, horticulture and cropping enterprises (G-MW 1999). However, many of the wetlands in the Muckatah Catchment are currently waterlogged by irrigation induced runoff and are in a degraded state (G-MW 1999).

Figure 3: Aerial photograph of Kinnairds Wetland in April 1945 (earliest available image). Note most of the immediate catchment, including the wetland, has been cleared for agriculture. The former open woodland is retained only in the fenced roadside reserves and isolated patches within the wetland. Compare to recent aerial photograph of the wetland on the cover page of this document. (Photo: Lands Victoria, 17/04/45).

3.4 Flood Regime:

Kinnairds Wetland has experienced protracted flooding since the influencing catchment was cleared and irrigated agriculture was introduced. However, the issue of waterlogging was symptomatic of many areas within the catchment rather than restricted to Kinnairds Wetland. Rising watertables and increasing salinisation are also issues of concern within the region (GBCMA 1998).

The maintenance of high creek flows to supply irrigation water has also altered the flooding and drying regime of the wetland. The wetland is classified as a Deep Freshwater Marsh which experiences a seasonal flooding regime of more than 300 days inundation and dries 1-2 years out of 5 years (Felton 1991). Changes to the natural flood regime have affected the ecology of the wetland via altering vegetation diversity and structure, and value as habitat to wildlife (DCE 1992).

At present the wetland usually floods between the months of July through to January. When at full water levels Kinnairds Swamp swells to a size of 133 ha and has a maximum depth of around 0.7m (Felton *n.d.*). This depth occurs in the northern and central parts of the wetland.

With the development of the Muckatah Surface Water Management Scheme, natural flood regimes prior to irrigation will be able to be reinstated to the wetland. The works have been designed so as not to modify the natural surface of the wetland, although the confining banks will redefine the ponding depths. Higher than design flows will continue to flow and spread similar to natural conditions by overtopping the confining banks.

3.5 Groundwater

The soils of the Muckatah Catchment around Kinnairds Wetland have bedrock that consists of Permian mudstone of marine origin. Above this lies sand, clay and loams that have been deposited by prior streams carrying sediment from the highlands. These soils are Muckatah Clay Loam, Mywee Clay, Boosey Loam and Naninganingalook Loam (Bowler & Macumber 1973). They tend to form an impermeable clay base to the wetland, although between flood events, these soils exhibit deep cracking that improves their infiltration capacity (Bowler & Macumber 1973).

The impermeable clay substrate to the wetland may prevent groundwater seeping up into the wetland (Kelly 1994). However saline inflows, concentrated via evaporative losses, can occur and flora and fauna living close or on the bottom can be killed by a stagnant saline layer (McGuchin 1990). Stagnant layers often persist in wetlands longer than they do in creeks and rivers due to limited mixing with fresh water.

The introduction of irrigation to the Muckatah Catchment approximately 50 years ago gave no consideration to the drainage (G-MW 1999). As a result, and in conjunction with widespread tree clearance, water tables are known to have risen in the last 30 years from around 20 m to the current level of approximately 2-3m below ground surface (G-MW 1999; Figure 4).

The effects of saline groundwater increase as the watertable rises closer to the surface. Once in the region of 2-3m within the ground's surface, salts can affect vegetation by the capillary action of their roots (Duff & Garland 1988, Norman *et al.* 1995). Frequency of flora and fauna taxon that are salt sensitive will decrease while populations of salt tolerant species will increase. For example, salt tolerant species such as Spiny Rush (*Juncus acutus*), Couch (*Cynodon dactylon*) and Water Buttons (*Cotula coropifolia*) become dominant and out-compete salt sensitive species (Kelly 1994).

However, the Muckatah Surface Water Management Scheme is designed to relieve the onset of accessions to the watertables of the Muckatah Catchment by providing catchment drainage for irrigation induced runoff. Further suppression of rising watertables is being implemented in conjunction with the Muckatah Catchment Management Strategy (G-MW 1999) with landholders being assisted and encouraged to undertake Whole Farm Planning to improve their irrigation efficiency, Ground Water Pumping options and catchment wide revegetation projects.

3.6 Surface Water Management Scheme:

Work on the Muckatah Primary Surface Water Scheme has begun with Kinnairds Wetland being used as a retardation basin (G-MW 1999). A set of low-level confining banks has been constructed around the margins of the wetland to retard the 1 in 2 year flow events. The purpose of using the wetland as a retardation basin is to aid in filtering sediments and nutrients, and to minimise the discharge rate into Broken Creek during the 1 in 2 year design events (reducing the outfalls into Broken Creek from 225 ML/d to the more natural outfall conditions of 150 ML/d; G-MW 1999).

The scheme is expected to spill into the wetland when the amount of water tops the 107.4m AHD lower confining bank. This will ensure that Kinnairds Wetland can fill and flood naturally. The design of the vegetated floodway around the margins of the wetland has incorporated numerous features to benefit water quality and to manage the quantity and rate of outfall entering the Broken Creek while providing for the appropriate wetting regime for the main body of the wetland (Figure 5).

The main body of the wetland is dissected by a levee that prevents the dispersal of water over the area of the wetland basin. It is recommended that this levee be breached in a number of locations to allow for passage of these flows and provide for flood retardation and ecological benefits.

Kinnairds Wetland in flood (G-MW 2003)

Figure 4: Watertable contours of the Shepparton Region (August 1998). Note the relatively high watertables in the vacinity of the Kinnairds Wetland and up stream catchment.

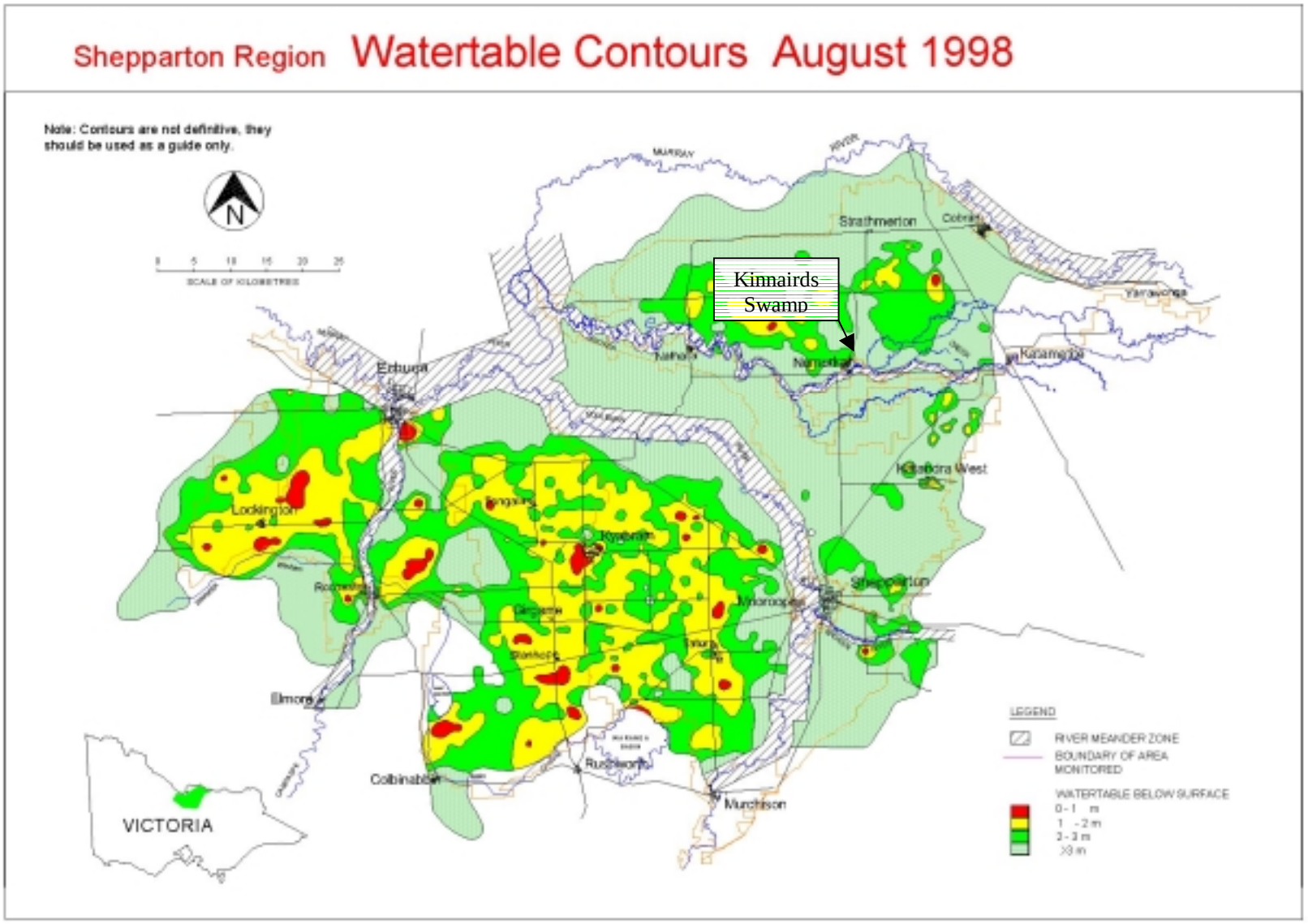


Figure 5: Meandering flow path of the Muckatah Surface Water Management Scheme as it passes through Kinnairds Wetland. The design of this section of drain incorporates constructed wetlands, siltation sumps and more natural aesthetics (Photo: G-MW 1999; view looking south-west).

These features include:

a) Silt trap/drainage water diversion sump which extends for approximately 1 km upstream of Kinnairds Wetland;
b) Additional low flow diversion from sumps within the floodway;
c) Vegetated floodway with top-soiled batters graded at 1:20 to encourage a broader area of suitable zones for macrophyte growth and feeding areas for waterbirds;
d) Meandering floodway path through the constructed wetland for natural hydraulic functioning (i.e., zones of differential flow, which in turn encourages biotic diversity) and 'natural' aesthetics;
e) Areas of variable flooding depth to encourage natural aquatic plant re-establishment along with zones planted out with specific wetland plant species to act as water-borne nutrient filter strips and as wildlife habitat;
f) Primary overflow sills set to 110 ML/d (107.4m) in which floodway flows are expected to exceed in most years to provide a seasonal flood regime for Kinnairds Wetland;
g) Secondary overflow sills set to 225 ML/d which drainage flows are expected to exceed more than 50% of years and hence provide the 1 in 2 year flooding regime to the broader Kinnairds floodplain;
h) Regulating structure on the downstream end of the floodway within the constructed wetland to provide for the manipulation of water height within the wetland by the degree of restriction of out flows;
i) An outlet from Kinnairds Wetland to the constructed wetland which will ensure that drawdown of the swamp occurs after 28 days from filling (also ensures that the rate of discharge to the Broken Creek mimics the estimated natural rate of 150 ML/d instead of the 225 ML/d that will occur as a result of the upstream surface water management works in a 1 in 2 year Annual Return Interval.

Under current licence arrangements, G-MW have the ability to cease diversions from the drain upstream of Kinnairds Wetland should conditions necessitate this. It may be considered appropriate in the future to include a condition upon use which ensures the supply and delivery of an EWA.

3.7 Water Quality:

Irrigation runoff has recently been seen as one of the major contributing source of nutrients to waterways within the Shepparton Region (GWQWG 1996). However, the water quality entering Broken Creek from the Muckatah Depression is expected to be greatly improved due to the filtration of sediments and nutrients by several wetlands (vegetated floodways, on-line and off-line wetlands and constructed wetlands). Also, the volume of water entering Broken Creek from the Muckatah Depression is expected to reduce from improved irrigation practices of minimising off-farm drainage and diversions of water from the drain.

For example, the 12 ha vegetated floodway in the east of Kinnairds Wetland (average 80m wide and approximately 1500m long) will create a relatively slow water velocity that will assist to physically remove some of the finer suspended sediments from the passing water.

It is important to filter out suspended sediments because elements such as Phosphorus (a major nutrient implicated in causing deleterious Blue-Green Algal blooms) attaches to the sediment particles (DLWC 1998). Furthermore, sedimentation and turbidity alone can cause a range of additional deleterious biophysical impacts on aquatic ecology and riverine hydrology (DLWC 1998).

3.8 Flora:

Terrestrial grasses, often common pasture species form cleared surrounding land, give way to a mix of native and exotic grasses and indigenous floodplain species as the terrain falls away within the basin of Kinnairds Wetland (Appendix 1).

The most common vegetation species found in Kinnairds Wetland are Common Spike-sedge (*Eleocharis acuta*), Rushes (*Juncus* spp.), Water Milfoils (*Myriophyllum* spp.), Docks (*Rumex* spp.), Pacific Azolla (*Azolla filiculoides*) and River Red Gum (*Eucalyptus camaldulensis*). This exists primarily as scattered open woodland over and often interspersed by relatively large plains dominated by the semi-aquatic herbs and forbs.

Individual species of significance around Kinnairds Wetland include the vulnerable species Yellow Tongue Daisy (*Brachyscome chrysoglossa*), and some rare species that are found nowhere else in Victoria such as Spiny-fruit Saltbush (*Atriplex spinibractea)* and Coolibah Grass (*Panicum queenslandicum*).

Other rare species found in the nearby areas of natural grassland include Spurred Spear-grass (*Austrostipa gibbosa*), Dwarf Bluebush (*Maireana humillima*) and Smooth Minuria (*Minuria integerrima*). White Cypress-pine (*Callitris glaucophylla*), a species with depleted numbers throughout Victoria, is also present in the surrounding higher rises of the catchment.

However, much of the wetland margin that occurs within private ownership has a history of cultivation and grazing. Such disturbances have caused a corresponding decrease in indigenous species diversity within those areas. Therefore, the region that occurs within the public land boundary generally contains the higher values as characterised by its indigenous floristic diversity.

Of concern for the wetland is some notable weed species within the catchment. Increases in the range of the highly invasive exotic aquatic forb Saggitaria (*Saggitaria graminae*) throughout the region poses a threat to the biodiversity of Kinnairds Wetland. This species is difficult to control, though appropriate efforts should be attempted throughout the catchment as a priority.

Furthermore, the presence of Willows within the catchment and immediate floodplain of Kinnairds Wetland presents additional threats to encroachment within the wetland. Of particular concern has been the deliberate planting of the species within some adjoining freehold areas of the Kinnairds Swamp floodplain, especially as increasing potential exists for free-seeding varieties (Ladson *et al.* 1997). Immediate control of known problem varieties is required (Ladson *et al.* 1997).

3.9 Fauna:

Kinnairds Swamp offers habitat for a diverse range of reptiles, frogs, mammals and birds (Appendix 2). The wetland is home to reptiles such as the Eastern Brown Snake (*Pseudonaja textilis*), Tiger Snake (*Notechis scutatus*) and the Tree Goanna (*Varanus varius*) (Walsh 1997). The two species of snake may have once been very common in the late-1800s (Leslie 1995), though along with the Tree Goanna are now an uncommon sight (Newham per. comm. 1999). Similarly, the Warty Bell Frog or Growling Grass Frog (*Litoria raniformis*) which has been recorded in the wetland, is a species that is becoming uncommon throughout much of its range (White 1995).

As with the remainder of the northern plains, Brown Hares (*Lepus capensis*) and Foxes (*Vulpes vulpes*) are two common exotic mammals that frequent the area. Hares can cause a severe impact from selective browsing for some flora, and foxes within the wetland could impact on the breeding success of many ground-nesting birds through direct predation.

Other mammals occurring at Kinnairds Wetland include the Common Ringtail (*Pseudocheirus peregrinus*) and Brushtail (*Trichosurus vulpecula*) possums. Availability of nest sites (tree hollows) may be a factor limiting abundance of the Common Ringtail Possum and Common Brushtail Possum (Strahan 1995). There are also accounts of Water-rats (*Hydromys chrysogaster*) living in the wetland area (Walsh 1997). Although Water-rats may have dense populations in some irrigated areas, particularly in drainage wetlands, wetland reduction and flood mitigation has removed much of the Water-rats habitat (Strahan 1995) and hence wetlands such as Kinnairds Wetland are an increasingly important habitat.

A single Eel-tail Catfish (*Tandanus tandanus*) was recently recorded from the wetland (Newham *pers. comm.* 2000). This notable species was previously common within the catchment, though is now becoming very uncommon (Pollard *et al.* 1996, Trickey *pers. comm.* 1999).

Approximately 50 bird species have been recorded from Kinnairds Wetland, although as with the other faunal groups, the number is expected to be greater had detailed specific assessment been undertaken over broader time. The species include many common water birds such as herons, pelicans, spoonbills, ibis and ducks as well as common terrestrial birds such as honeyeaters, magpies, parrots and pigeons. Eurasian Coot (*Fulica atra*), Black Swan (*Cygnus atratus*), Pacific Black Duck (*Anas superciliosa*), and Grey Teal (*Anas gibberifrons*) are common species that have been known to breed in the wetland (Newham *pers. comm.* 1999).

A pair of Brolga (*Grus rubicundus*) was once present until the 1950s, though has not been sighted at the wetland since (Newham *pers. comm.* 1999). The pair came and went about the same time each year indicating that they were there to feed or breed in the wetland.

A pair of Wedge-tailed Eagle (*Aquila audax*) regularly nests in a mature River Red Gum within the wetland. The tree is also an important colonial breeding site for Little Pied Cormorants (*Phalocrocorax melanoleucos*), and Royal Spoonbills (*Platalea regia*) which have a status as being a Vulnerable species in Victoria (NRE 1999). The three species regularly nest in the same individual tree within the main southern body of the wetland. As nesting site selection is based on key criteria such as tree size, shape, orientation, etc (Briggs *et al.* 1997), then particular single trees of suite of trees can be of particular conservation importance. Therefore special protection of the current colonial-nesting tree in Kinnairds Wetland is required.

Royal Spoonbills usually breed during the months of October and November, although it is not uncommon to find birds nesting within the district in December/early January (R. Weber *pers. comm.* 1999). They require a significant and protracted flood event to induce breeding, though unfortunately such triggers have commonly been disturbed by alterations to wetland flood regimes throughout much of their range. Royal Spoonbills nest above water in fringing River Red Gums or on reeds such as Giant Rush (*Juncus ingens*) (Leslie 1995, Thornton & Briggs 1994, Briggs *et al.* 1997).

During the recent flood event of 1992, the wetland also played host for a period to approximately 1500 Pink-eared Ducks (*Malachorhynchus membranaceus*) (O'Connor *pers. comm.* 2000). This species is commonly a waterbird of the interior, which further signifies the importance of the wetland in providing drought refuge at the national scale.

At the international level, the Muckatah Depression including the Kinnairds Wetland also plays an important role in providing habitat for international migratory species such as Latham's Snipe (*Gallinga hardwickii*). Snipe have been observed around the margins of the wetland and in its upper reaches during several flood events (O'Connor *pers. comm.* 2000).

3.10 Tree Health:

The health of the predominantly River Red Gum trees at Kinnairds Wetland has been greatly affected by the prolonged flooding that has occurred from increased upstream irrigation and subsequent runoff to the wetland. An embankment constructed at the downstream margins of the wetland by a private landholder in an attempt to exclude backup flooding from the Broken Creek historically facilitated the ponding of water in Kinnairds Wetland. Some mature River Red Gum have died as a result.

However other areas have undergone a reduction in flooding, and thick regeneration of Red Gum has occurred following the large flood events of 1956, 1974/75 and 1992/93. These trees form at least three distinct age classes within the wetland, and their health remains in an apparent good state. Unfortunately some thickets remain in large very dense clusters which threatens biodiversity and water quality. Biodiversity is threatened through direct shading of understorey and groundcover species, and water quality impacts can imparted directly via toxic leachate from the Eucalypt debris or indirectly via suppressing growth of beneficial species that have known benefits for improving water quality.

Although arguably a natural phenomenon, ecological control measures appear to have been reduced and hence deliberate thinning of many (not all) stands should be employed. Physical cutting (with minimal soil disturbance), plus potential employment of flood and fire (refer to Section 3.12), should be undertaken.

On a historical scale, no commercial timber gathering has occurred in the wetland. The only harvesting that has occurred has been for the provision of fence posts (Burkitt *pers. comm.* 1999), and presumably some firewood.

As noted in Section 3.9, special management is required for the continued health of the mature River Red Gum in the centre of Kinnairds Wetland that serves as an important colonial bird nesting tree. The main management action required to do this is to ensure that the site is not waterlogged by extended inundation periods (ie those exceeding a year or more without the punctuation of a sufficient dry period to begin to crack surrounding clays) or ensuring that the site does not experience drought stress (i.e., will depend on the tree and seasons, though three to four years without flooding is expected to promote drought stress).

Also, especially considering the recent construction of the first stage of the surface water management scheme, the wetland is now likely to experience drier than usual conditions for a number of years when the wetland has to some extent adapted to a prolonged flooding conditions. Additional stress may result without weaning the system to drier conditions. Use of make-up water supply (environmental water allocation) or appropriate manipulation of sill levels to provide a flood regime that weans the system more gradually, or conversely to break induced-droughts, may be required (see Section 3.14).

3.11 Grazing:

The lack of suitable continuous fencing was a determining factor in influencing grazing cattle or sheep within the wetland. As a result there was generally no cattle licences issued on the public land, although a history of grazing has occurred on some of the private land neighbouring the wetland. Most of the adjoining land is managed with seasonal pasture for beef cattle, though one large property on the western and northern margins has been managed with perennial pasture for dairy cattle which has a significant influence on runoff to the wetland.

3.12 Fire:

There have been no significant fires throughout the wetland and no burning-off periods for at least 60 years (Burkitt *pers. comm.* 1999). Aboriginal burning may have occurred prior to European settlement in the district, though in general the vegetation structure and diversity currently seen is unlikely to be due to fire. Instead, the main factors that appear to have shaped the vegetation diversity and structure within the wetland is likely to have been the flooding, grazing and cultivation regimes, especially within the last 60-80 years.

3.13 Community Involvement/Recreation:

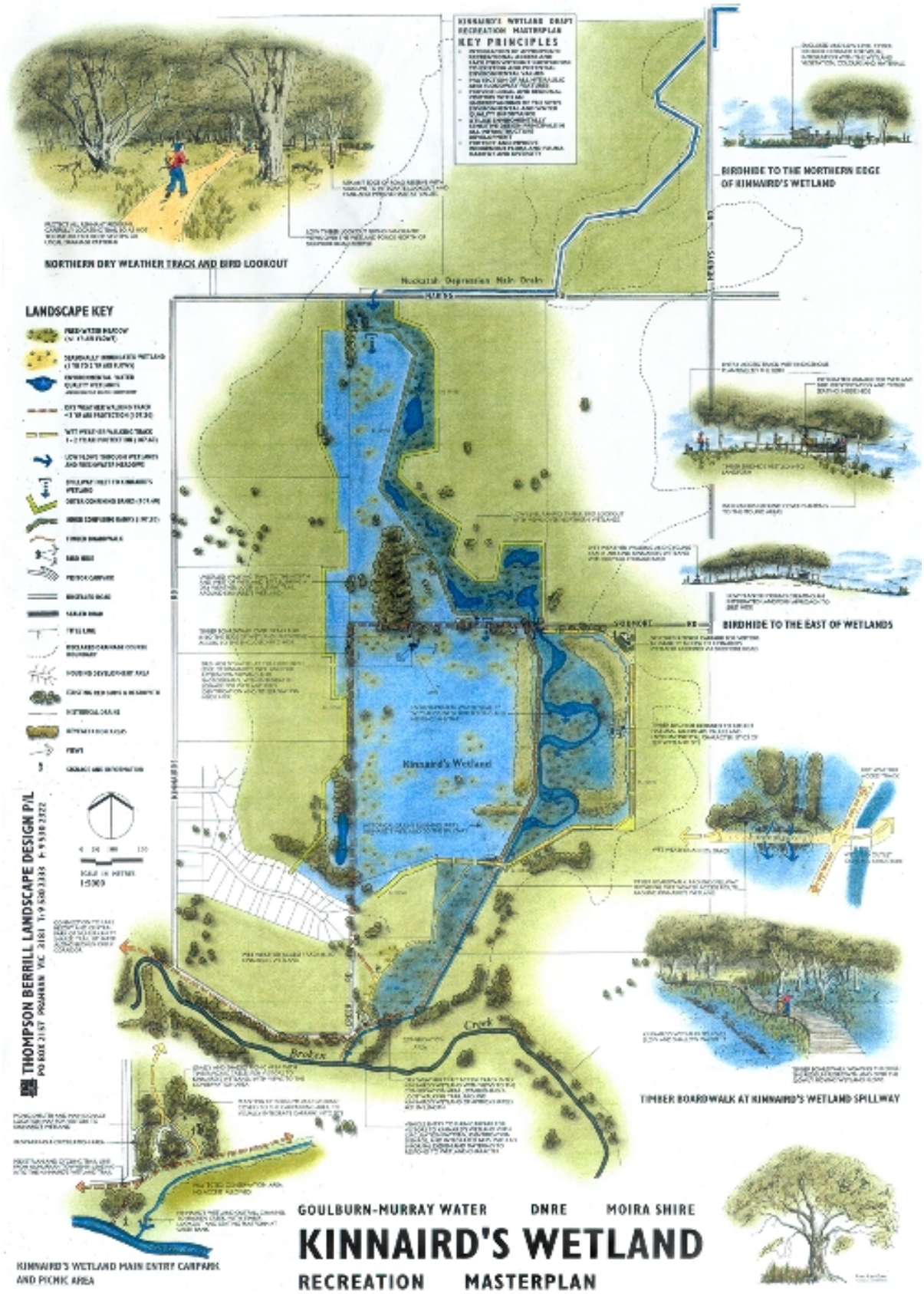
The wetland has had a history of use by locals, mainly for hunting. The regular seasonal flooding of the wetland and its proximity to the Wunghnu wetlands (Black and Purdy's Swamps), and being adjacent to the Broken Creek, meant that Kinnairds Wetland was a very productive wetland to hunt waterfowl and other game. However, since an increase in housing developments and the recent climatic and engineering works causing a drier wetland, duck shooting by a small group of local hunters has not been as common as in the past (Burkitt *pers. comm.* 1999). Fox shoots have also occurred within the wetland, sometimes involving up to 30-40 local farmers (Burkitt *pers. comm.* 1999).

The Kinnairds Wetland Recreation Masterplan (2000) outlines passive recreation potential of the site. The on ground aspects of the recreation plan have been mapped out (Figure 6). The proposed plan provides for two main points of access with a network of all-weather and seasonal walking tracks with a number of bird hides and interconnecting boardwalks. The main car park is proposed at the southern (Broken Creek) access end of the wetland, while a disabled and bus access vehicle park is proposed on the eastern boundary (off Skidmore Road).

Kinnairds Wetland is not commonly used by trail bikes mainly because many of the access points to the wetland are through private land and prove too difficult to get to (Newham *pers. comm.* 1999). However, the recent acquisition of public land within the centre of the wetland and along various access routes, plus the proposed development for improved public access, may now result in trial bikes and other off road vehicle usage becoming more prevalent. Such pursuits would be unwelcomed within the reserve due to potential damage to the wetland environment through soil disturbance, compaction, direct physical damage, weed invasion, increased fire risk, and greater disturbance to fauna. The activities also conflict with the main aims of encouraging passive recreation and wildlife utilisation of the wetland.

Provision for cycling access to the wetland area is being considered as part of the development of the Recreation Plan in conjunction with the development of a network of pedestrian access along the Broken Creek frontage to and from Numurkah. This type of activity is unlikely to cause as much damage or disturbance to the reserve environment, and provides for greater further opportunities for public appreciation, understanding and support for Kinnairds Wetland's natural values and management.

Figure 6: Draft Recreation Plan for Kinnairds Wetland (G-MW 1999). Note passive recreation pursuits enhanced by boardwalks, bird-hides and circuit path to promote interest and education while having minimal impact on the environment.



3.14 Environmental Water Allocations:

The design of the Surface Water Management Scheme constructed within the Kinnairds Wetland basin will allow for a return towards natural flooding regimes for the wetland. The scheme will allow for the unnaturally protracted flooding regime of the past to be reduced, while seasonal inflows will be able to enter the wetland. Wise manipulation of the regulating structure at the tail of the wetland will permit flooding flows to be managed as required. However there exists a requirement for access to a make-up water supply (Environmental Water Allocation) for Kinnairds Wetland, especially in the early construction stages of the Muckatah Surface Water Management Scheme, to minimise potentially damaging drought stress to Red Gums and other wetland flora and fauna arising from the rapid alteration of the wetland from the Type 4 regime to that of a Type 3 (as discussed in Section 3.1). Currently no such allocation exists for the wetland, though this issue is currently being progressed through other forums. Also, it is likely that proportionately fewer inflows will enter Kinnairds Wetland until the entire Surface Water Management Scheme is implemented through the depression. Recognition of the expected dry interim conditions provides further support for the need of direct manipulation of natural inflows via temporary adjustments to sill levels, plus possible EWA supply.

The volume of EWA required for the wetland would ideally be sufficient to fill the entire natural wetland area to the natural 0.5 - 0.9m depth with flow through supply and maintained for approximately 6 months with some natural variability in seasonal and annual supply (i.e., to mimic natural conditions). However this can not be realistically achieved given a range of existing constraints, hence appropriate management of a core part of the wetland complex should instead be strived for.

Two core areas that require special management are the main body of Kinnairds Wetland surrounding the colonial nesting tree and the floodway containing the constructed wetlands. A constructed lower confining bank that defines the primary floodway from the surrounding terraced floodplain now separates these areas. The bank provides the opportunity for one section of the wetland to flood more effectively with limited inflows. The floodway includes areas of extensive low level floodplain naturally grading up to surrounding high ground, catering for a broad range of habitats and biotic niches. This region is expected to flood to some extent in most years. Conversely, the now terraced floodplain containing the colonial nesting tree will be inundated on average every second year following floodway inflows breaching the lower confining bank. Depending on the timing of flood initiation and its duration and depth, colonial nesting may be triggered to occur in the nesting tree. In either flood event, nesting of other species is likely to occur in other sites as a result of flooding.

The opportunities for management will primarily rest with some manipulation of the regulator to ensure an appropriate Type 3 flood regime is supplied, with particular 'tweaking' to cater for significant breeding attempts of waterbirds or other biota. This is most easily performed for the floodway section of the wetland without significant compromise to the flood retardation capacity of the wetland within the Surface Water Management Scheme.

Furthermore, G-MW can potentially increase flows into Kinnairds Wetland by placing restrictions on diversions from the Surface Water Management Scheme by upstream landowners (refer Section 3.6).

However, in years where inflows are insufficient to provide for a suitable Type 3 flood regime, especially where breeding attempts have been triggered are under threat of abandonment following premature inundation draw-down, then use of an EWA will be required to extend flooding. Other uses of an EWA include the breaking of scheme-induced droughts, topping up of constructed wetland permanent pools (especially required for protection against desiccation of stocked indigenous fish as discussed in Section 3.15), and the weaning of the wetland towards the drier flood regime that will be experienced as a result of the surface water scheme implementation (as discussed in Section 3.6 and 3.10).

The merits of providing EWA to the nesting tree site have been discussed under Tree Health in Section 3.10, with the significance of the nesting tree discussed in Section 3.10.

Additionally, as Kinnairds Wetland is increasingly becoming a valuable remaining wetland within the district (due to continued degradation of other wetlands and reduced opportunities for flora and fauna to feed and breed elsewhere), then access to a share of a broader Environmental Water Allocation may also be required in the future (e.g., as part of a potential Shepparton Irrigation Region Wetland Environmental Water Allocation). Use of such an allocation could be beneficial to ensure successful completion of breeding attempts by notable numbers of waterbirds or for notable species such as Spoonbills.

An ability to deliver specific allocations of water could most efficiently be sourced from nearby irrigation supply channels that exist to the west and east of the wetland. This would necessitate construction of a small channel to the wetland from the existing irrigation supply channels. The western route would link into the outfall at Kinnairds Road to outfall into the broader Kinnairds Wetland. The preferred route lies to the east along Hendys Road (MV No. 4) and could be modified to outfall at Skidmore or Naring Road into the constructed wetlands of inner Kinnairds Wetland. The delivery of an Environmental Water Allocation and the suitability of either route is however dependant on acquisition of the identified land parcels.

The western supply channel would be used for supply to the main body of Kinnairds Wetland containing the colonial bird nesting tree, whereas the eastern channel would supply to floodway and constructed wetlands. The ability to supply the two main sections of the wetland means that limited EWA can be used for best use of enhancing flood events as they occur. Small events that flood only the constructed wetland component would therefore necessitate direct supply as required via the eastern route. Larger events that overtop the lower confining bank to inundate the colonial nesting tree and floodplain have by default already adequately flooded the constructed wetland component of the wetland and hence supply of EWA via only the western route may be required.

However, the western channel currently possesses strong growth of the highly invasive exotic aquatic weed Saggitaria (*Saggitaria graminae*). This species is difficult to control, and hence ideally should be eradicated from the drain before using the drain water in Kinnairds Wetland. Unfortunately the species is beginning to occur in a number a sites throughout the catchment, and may inevitably make its own way into Kinnairds Wetland regardless.

A further issue with regard to supply of EWA or other water management for prolonging inundation in the broader terraced floodplain of Kinnairds Wetland (i.e., that component that contains the colonial nesting tree) is that it may significantly reduce the flood retarding capacity of the Muckatah Surface Water Scheme. Therefore, other than attempting to break scheme-induce droughts to save vegetation or nesting waterbirds, it may not obtain endorsement by some sectors of the community. However, the floodway component of Kinnairds Wetland could continue to offer some form of retarding capacity as it functions independently at inflow levels below the lower confining bank. Further retardation is provided even with this bank being breached, as management of the terraced floodplain need not be at full capacity.

One option may be to factor current catchment conditions with Bureau of Meteorology seasonal and longer-range forecasts to inject some form of risk statistics of retardation being required into management consideration. Community acceptance of a small increase in flood risk would also be required.

An important opportunity considered crucial to ensuring optimal water management, is the purchase of land parcels, currently under floodway easement, comprising the greater wetland. This would minimise localised flooding impacts on adjacent landholders and allow for complete ecological management of the whole wetland in alignment with G-MW's water quality and retardation charter.

3.14.1 Regulating Structure Management

An operational agreement governing the operation of the regulating structure for implementation of the watering regime recommendations of the Management Plan should be developed. These guidelines should provide for flexibility in management to cater for any number of the potential scenarios which may arise. The agreement is directly linked to the Management Plan and all signatories to the plan are expected to observe the 'agreements' obligations.

3.15 Wetland Seeding:

The need for specific introduction of species into Kinnairds Wetland to 'seed' (inoculate) the wetland is generally not of high priority. The re-creation of the natural flooding regime to the wetland, which currently contains a good representation of indigenous wetland species combined with the wetland's close proximity to Broken and Boosey Creeks, means that a diverse flora and fauna community should develop of its own accord over time.

However to assist in the rate of establishment, especially for plants where earthworks have caused disturbance and weed species will potentially establish and out-compete indigenous plant species, then some strategic planting should be undertaken. Of high priority is the planting of the constructed wetland, where a suitable range of emergent and submerged species are currently being established. The use of indigenous species should have additional benefits for the remainder of Kinnairds Wetland and its ecologically influenced areas (e.g., downstream wetlands).

Faunal species that could be assisted in establishing within the wetland include small indigenous fish species such as Flat-headed Gudgeon (*Philypnodon grandiceps*), Western Carp Gudgeon (*Hypseleotris klunzingeri*), Crimson-spotted Rainbow-fish (*Melanotaenia fluviatilis*) Australian Smelt (*Retropinna semoni*) and Eel-tailed Catfish (*Tandanus tandanus*). It is unlikely that inflows from the degraded and often ephemeral Muckatah Depression will yield such species, and colonisation from flood events arising from the Broken Creek may be relatively rare (especially as such species are now often uncommon or restricted in their current distribution). Without their re-introduction into the permanent water bodies of Kinnairds Wetland, then it remains likely that the only fish fauna to colonise the wetland will be Common Carp (*Cyprinus carpio*), Mosquito Fish (*Gambusia holbrooki*) and Oriental Weatherloach (*Misgurnus anguillicaudatus*).

3.16 Monitoring and Indicator Species:

The Environmental Management Group of DPI is undertaking current on-going monitoring at Kinnairds Wetland as part of Project T072. This program was established in accordance with the Statewide Salinity Monitoring Strategy, with the local aim of monitoring the effectiveness of SIRLWSMP activities with regard to environmental issues. At Kinnairds Wetland, the program is recording basic water quality parameters (temperature, conductivity, turbidity, dissolved oxygen, pH) and invertebrate species (identified to the taxonomic resolution of Order) at three locations all within the northern region of the wetland. This program began in 1995, with monitoring being undertaken seasonally (Cody *pers. comm.* 1999).

G-MW has recently established a series of continuous monitoring stations to monitor water quality and flow from the Muckatah Depression into Broken Creek. This program automatically records the parameters of salinity, flow, temperature, and turbidity, with fortnightly monitoring of key nutrients. Such monitoring sites have been located upstream and downstream of Kinnairds Wetland (at the outfall to Broken Creek in Stage 1A and at Naring Hall Road in Stage 1B).

A short-term investigation by NRE in 1996 and 1997 was conducted of the vegetation and fauna species of Kinnairds Wetland (Walsh 1997; Appendix 1 & 2). This project located the endangered Variable Spike-sedge (*Eleocharis minuta*) occurring within the wetland. This small species closely resembles the more common Small Spike-sedge (*E. pusilla*) which has also been recorded at the wetland. Future works involving soil disturbance will have to determine the location of the two species and avoid areas of Variable Spike-sedge as it remains unclear as to this species ability to recolonise disturbed sites that the Small Spike-sedge is otherwise capable of.

No further biological monitoring other than that currently being undertaken is scheduled, however implementation of the G-MW Operational Guidelines (G-MW in prep.) or the Recreation Plan may highlight areas that require monitoring.

Results from the Mandatory Environmental Monitoring program will continue to increase in value for the management of Kinnairds Wetland, both from a historical perspective and for future management. Simple monitoring of flood distribution within the wetland will assist in refining modifications to the sill levels, if required, to establish the required wetting regimes. Prediction of water quality trends, arising as direct or in-direct actions of management, will enable refined predictive abilities for future management. Combined with G-MW water quality and flow monitoring, current-time management will benefit as it can be directed by such results. Similarly, some form of on-going vegetation and fauna monitoring would be useful. In time, wetland water regimes should be refined towards encouraging notable species (e.g., Brolga, Spoonbill, Snipe, etc) to effectively utilise the wetland.

4. Recommendations

Management recommendations for Kinnairds Wetland are presented on the basis of priority. A description of required management action and the agency or groups responsible for implementing each action are included.

PRIORITY	MANAGEMENT RECOMMENDATIONS
High	Actions of high priority should be implemented as soon as possible but within the first year of the life of this plan. These management actions may or may not require the most resources and commitment.
Medium	Actions of medium priority should also be implemented as soon as possible, but focus should be turned to these actions after high priority actions have been addressed.
Low	Actions of low priority should be considered after high and medium priority actions have been addressed.
On-going	Ongoing action to be implemented over the life of the plan. Unless otherwise specified, ongoing actions are to be considered the same priority as high priority actions.
As needed	Management issues or opportunities that may need to be addressed on an infrequent occasion or when a situation or opportunity develops. To be determined by the appropriate management authority in consultation with other stakeholders.

4.1 Flood regime:

Action		Responsibility	Actioned By	($) Cost Estimate	Priority
4.1.1	Earthworks to accommodate recommendation 4.1.2 o n G-MW owned land.	G-MW	G-MW **Complete**		High
4.1.2	Attempt to gradually wean the wetland ecosystem back to a winter-spring flood regime from the former extended flood regime prior to the Surface Water Management Scheme works. Where possible, aim to initiate flooding in August with draw-down by late December unless a fauna breeding attempt is uncompleted. This type of flood regime is expected to automatically occur from 'normal' rainfall within the design intent of the Surface Water Management Scheme and hence places less reliance on supplying an Environmental Water Allocation (which has yet to be established). However, the flood regime may need to be weaned from a flood initiating in late Autumn to conclude in December over a 5-year timeframe (delaying flooding by one month per year if possible). This period represents the lower evaporative losses for the current core flooding period, whilst allowing natural summer and autumn drying. The broad flooding regime of 1 year in 2 return period, with approximate 4-6 months duration (i.e., Type 3 wetland regime), may be managed via appropriate operation of the regulator at the drainage end of Kinnairds Swamp to create appropriate short-term larger-flooding events or to extend various flood events. Variations to the flood event can be targeted to promote desired growth of indigenous macrophyte beds and, if required, to discourage possible over-abundant Red Gum regeneration that would otherwise threaten the open structural amenity of the wetland via submergence for 2 or more months (Dexter 1978). [*NB: Rainfall is a natural event and hence flood manipulation will depend on seasonal conditions. Also, G-MW has an obligation to its customers and the downstream community to use Kinnairds Swamp as a retarding basin, hence 'un-natural' manipulation of water levels, especially where 'air-space' is compromised, needs to take this into account]*.	G-MW on advice from DPI	G-MW	$2,000	High/ On-going

4.1.3	Strive for a continual flow through the wetland system in years when conditions allow (i.e., as the surface water management scheme should automatically allow for). However, pond water within the floodway when inflows begin to decline until Type 3 regime achieved, especially in dry years. *[NB: as long as this does not interfere with the designed performance of the Surface Water Management Scheme]*.	G-MW on advice from DPI	G-MW	$1,000	On-going
4.1.4	Provide suitable natural flood regimes, spurred by high flow events, by appropriately manipulating the regulator control structure to achieve maximum flood depth around the months of August to October and durations of up to 6 months on the broader floodplain. Ensure desired flora and fauna values and water quality not be compromised (e.g., avoid encouraging exotic species or increasing salinity). Ideally permit some passing flows through the regulator to provide lotic (flowing) conditions in parts of the wetland and downstream, and ensure water level variability is achieved over time, although variability in any given major event should not be extreme (i.e., don't 'pull the plug' entirely when initiating the draw-down phase of the flood regime). Slow rates of draw-down are recommended. *[NB: as long as this does not interfere with the designed performance of the Surface Water Management Scheme]*.	G-MW on advice from DPI	G-MW	$1,000	On-going
4.1.5	Ensure drying is achieved for the floodplain in most years, and avoid where possible regular ponding of isolated water pools with high vegetation cover during summer to minimise nuisance mosquito numbers (especially due to the close proximity of Numurkah township to the wetland). [*NB: generally mosquitoes tend not to have successful prolific breeding in natural, ecologically balanced, wetland systems, as is the management aim for Kinnairds Wetland*].	G-MW on advice from DPI	G-MW	$1,000	On-going
4.1.6	The maintenance of a permanent central pool for preservation of the Crimson-spotted Rainbowfish and Flat Headed Gudgeon	G-MW on advice from DPI	G-MW	$0	On-going
4.1.7	Establish breaches in levee bank stipulated in section 3.6	G-MW & Shire	G-MW	$1000	High

4.2 Environmental Water Allocations

Action		Responsibility	Actioned By	Cost ($) Estimate	Priority
4.2.1	Seek to formalise an Environmental Water Allocation (EWA) for wetlands within the Shepparton Irrigation Region as a collective group, of which Kinnairds Wetland could share. The allocation should offer high security water for use specifically in meeting environmental objectives of the wetlands.	DPI	NRE / GBCMA	Variable	High
4.2.2	Negotiate the purchase of land parcels under floodway easement comprising the greater wetland to ensure flexibility in ecological management and security of EWA use.	G-MW, DPI/DSE & GBCMA	G-MW	Not determined	High
4.2.3	Construct delivery channel to wetland from supply channel on Hendy's Road (eastern supply route) to provide an ability to supply water to the wetland from irrigation water supply sources. The design of the delivery channel should be the maximum capacity possible within the constraints of current infrastructure to enable appropriate water delivery rate and efficiency at times or providing the EWA, as well as minimising periods of supply channel use conflict with other diverters.	G-MW	G-MW DPI	$30,000	Depends on Action 4.2.1
4.2.4	Appropriately manipulate water within Kinnairds Wetland during breeding attempts by notable species (e.g., Spoonbills) and/or to punctuate droughts (i.e., lack of natural flooding in the main wetland) that have occurred for up to 4 years. Use of an EWA or re-adjustment of sills may especially be required in the initial years following the Muckatah Surface Water Management Scheme implementation to provide a more gradual transition of the wetland's flood regime from the recent Type 4 to the expected Type 3 regime. Also, delays to completing the scheme through the catchment may cause less water to reach Kinnairds Swamp than has occurred prior to the works. This, combined with increased irrigation water re-use and extraction from the Muckatah Depression may additionally facilitate a reduction in inflows reaching Kinnairds Wetland.	G-MW on advice from DPI	G-MW / DPI	Unknown	Medium

4.2.5	Seek to supply environmental water allocations to the wetland at times when lower demand from private irrigators exist in the channel network. [*This should generally not be a problem as during dry periods the wetland should only require periodic topping to negate evaporative losses when attempting to maintain a more stable water level for breeding waterbirds. During wet years, when wetland flood regimes may require augmentation between surface water scheme overflows to prolong flooding events or increase depths, demand on the main supply channel from other irrigators are unlikely to be high*].	GBCMA	DPI - G-MW to deliver	App. $4,500	Medium
4.2.6	G-MW to operate regulating structures to the wetland in accordance with this management plan. NRE should initially oversee management and offer direct advice on adaptive management, though ultimately aim to have the plan wholly implemented by the G-MW with appropriate monitoring for adaptive management undertaken by agencies and interested though committed community groups.	G-MW on advice from DPI	G-MW	As accounted in 4.1 ($5,000)	On-going
4.2.7	Develop operational agreement between the managing authorities governing management of the regulating structure.	G-MW & DPI	DPI	$200	As soon as possible

4.3 Grazing Management:

Action		**Responsibility**	**Actioned By**	**Cost ($) Estimate**	**Priority**
4.3.1	Targeted grazing of agisted stock in the wetland reserve may be considered as a management tool for specific removal of problem weed species, Red Gum regeneration control, or occasional fuel reduction measure. Crash grazing with relatively higher numbers of animals for a short period of time is preferred in most such management instances. Use of temporary fencing (e.g., star-pickets and ring-lock for sheep, or hot-wire or tape for cattle) to confine stock within required area. Do not allow grazing of constructed wetland areas, and no grazing to be permitted during periods when substrate is soft from significant rain or inundation.	G-MW & Shire with advice from DPI (annual)	G-MW, Shire & Adjoining Landholders	$0	As needed

4.4 Pest Plants & Animals:

Action		Responsibility	Actioned By	Cost ($) Estimate	Priority
4.4.1	Encourage an integrated and a coordinated fox control program for at least one kilometre surrounding Kinnairds Wetland and at least immediately prior and during the waterbird breeding season (including chick raising period). Encourage FGA and other interested community members to undertake fox drives prior to anticipated nesting at the wetland, and away from the immediate wetland during nesting. [*NB: incentives to landholders to participate in a baiting program may have to be explored, such as cheaper baits or assistance in placing and monitoring bait take up, as foxes tend to cause less direct impact on enterprises based on cattle than if they had been based on sheep. However, it would be preferable to refresh landholders' knowledge of other problems caused by foxes that could impact on them directly (e.g., vectors implicated in the spread of Blackberries and Prairie Ground Cherry on their properties, or mange to their domestic dogs, etc.) rather than offer financial or physical assistance incentives. This should all occur before enforcement of the landholders' legally enforceable vermin control responsibilities that, although exist, are rarely enforced elsewhere and hence would likely to breed resentment to the management objectives by the landholders*].	Shire on advice from DPI, GBCMA & explore opportunities with Conservation Management Network	Shire	$0	Low
4.4.2	Control populations of non-indigenous vegetation, attempting eradication where possible from within the wetland and upstream sites. Notable species will include willow varieties and invasive aquatic species such as Sagittaria.	All Shire, DPI, G-MW, landholders	All Shire, DPI, G-MW, landholders	Unknown (high)	On-going

4.4.3	Continued legal hunting for ducks and quail within the public land components of Kinnairds Wetland should be discontinued due to conflicting with the purpose of the proposed constructed wetland and passive recreation values of viewing undisturbed wetland wildlife. Note: Controlled hunting of waterfowl on the constructed wetland to protect establishing wetland plants may still be required	G-MW and adjoining landholders (annual)	G-MW and adjoining landholders	$0	On-going
4.4.4	Encourage fox, cat and hare control programs throughout the wetland and neighbouring district, especially prior to waterbird breeding season (spring and early summer). Include other secondary exotic species as appropriate (e.g., European Starlings, Indian Mynas, Common Carp, etc). Coordinated fox control is to be actively managed between Moira Shire, G-MW, and adjoining landholders via targeted baiting program and encouragement of appropriately organised fox drives. Hare control can also be undertaken during fox drives. Feral cat control is to be undertaken by the Shire via deployment of suitable cage traps. However, appropriately organised fox and hare drives could continue to be permitted, provided that Shire approval is obtained and warning signs are erected at all public entry points of the activity occurring, as the outcome of this activity supports the principles of promoting indigenous wildlife to the wetland.	Shire on advice from DPI (annual)	FGA (Cobram) and adjoining landholders Baiting programs supported by DPI & Shire	$0	As needed

4.5 Other Management Issues:

Action		Responsibility	Actioned By	Cost ($) Estimate	Priority
4.5.1	Maintain all dead trees and fallen timber in situ within the wetland to continue to provide habitat (e.g., no firewood collection). Areas low in major fallen debris (e.g., wetland floor) should have woody debris re-established. A suitable assortment of large and smaller fallen timber can be located such that it provides a variety of both submerged and emergent values to a range of species.	G-MW, Shire and adjoining landholders	G-MW, Shire and adjoining landholders	$3,000	On-going

4.5.2	Assist and encourage adjoining landholders to consider placing an appropriate covenant on their properties, especially those areas that form part of the wetland basin and surrounds (e.g., Trust for Nature or Section 173).	DPI	DPI	$1,000	Low
4.5.3	Establish, maintain and monitor waterfowl nest box program in Kinnairds Wetland. Discourage use of nest boxes by exotic species with active control.	Shire in conjunction with appropriate conservation group	Shire in conjunction with appropriate conservation group	$1,000	As needed
4.5.4	Red Gum regeneration control should be undertaken through a combination of targeted flood regime (ensuring low wetland regions are permitted to adequately dry during summer/autumn period, and flooded to a depth exceeding seedling height where possible for at least two months), fire regime (control burning of thick regeneration sites every 3-5 years or as required), and possibly targeted cattle grazing.	Shire, G-MW and GBCMA on advice from DPI	Shire & G-MW	Accounted for above (= $2,000)	High
4.5.5	Ensuring specific protection measures are undertaken for key breeding sites, especially the Spoonbill/Cormorant/Eagle nesting tree.	All Shire, G-MW and adjoining landholders on advice from NRE	All Shire, G-MW and adjoining landholders	-	As needed
4.5.6	Discourage (by active means or otherwise) human and exotic predator entry to areas on the wetland that have notable and/or easily disturbed species during breeding attempts.	Shire, GMW and adjoining landholders on advice from DPI	Shire, GMW and adjoining landholders	-	On-going
4.5.7	Undertake strategic planting of indigenous aquatic plant species in the constructed wetland (emerged and submerged).	G-MW	G-MW **Complete**	Variable	As soon as possible

4.5.8	Undertake intermittent ecological burns within small areas of the wetland to promote habitat structural diversity, encourage indigenous biodiversity, and provide an improved selection of breeding and feeding areas for wetland fauna. Fire can be useful to kill young Red Gums, and hence provide an ability to control large areas of unwanted thick regeneration where natural open wetland communities exist. Tussock Grass growth and distribution can be diversified with occasional firing, and can be useful in avoiding extensive thick monoculture growth of the species. Unless future specific management aims dictate, fire regimes should be introduced as a mosaic of varying return intervals and areas. Mosaic burns also hedge against seasonal variations in species response to firing, and recognises our current incomplete understanding of ecological processes associated with fire regimes (including the consequences of not firing).	Shire, G-MW and adjoining landholders on advice from DPI	Shire, G-MW and adjoining landholders on advice from DPI	$5,000	As needed
4.5.9	Establish and maintain adequate firebreaks where required to reduce incidence of wildfire spread to and from the reserve. Use of natural or existing fire breaks (e.g., water bodies, roads, etc) are to be used in preference to burning, slashing, or ploughing (in that order) or new ground.	Shire and G-MW on advice from DPI (annual)	Shire and G-MW	$0 - $10,000	On-going

4.6 Monitoring:

Action		**Responsibility**	**Actioned By**	**Cost ($) Estimate**	**Priority**
4.6.1	Establish at least one Watertable Bore, preferable two or more, in the wetland and monitor watertable levels and salinity concentrations over time. Other bores could be located outside the wetland to assist in determining the relationship of groundwater with wetland flooding.	G-MW	G-MW in conjunction with Land care	$5,000	Medium

4.6.2	Monitor growth and spread of the major wetland understorey species. Notable concerns should centre on restricting the spread or domination of invasive weeds, and where possible encourage establishment, growth and seed set in indigenous species. Seek to encourage a diversity of indigenous wetland vegetation where practically possible, and aim to create a suitable mosaic within the plant community structure.	Shire, G-MW, and adjoining land holders on advice from DPI	DPI	$5,000 - $10,000	Medium
4.6.3	Utilise appropriate indicator or flagship species in monitoring and implementation of adaptive management of the wetland. Such species should include: • Red Gum health (especially the colonial bird nesting tree); • Sagittaria - attempt eradication if present; • Presence of other vegetation species establishment - attempt expansion of desirable indigenous species and contraction of exotic species; • Frog species successfully breeding (tadpole metamorphosis); • Presence of waterbird breeding - attempt diversity and productivity; • Spoonbill breeding (fledged chicks). • Snipe utilisation of wetland.	Shire, G-MW, and adjoining land holders on advice from DPI	DPI	Variable	Medium
4.6.4	Continue monitoring water quality, flow, and fauna and fauna usage of the wetland. Include specific surveys to record notable weed species to ensure early targeted control strategies are undertaken.	G-MW, DPI & Friends of Kinnairds	G-MW, DPI		On-going

4.7 Recreation Plan:

Action		Responsibility	Actioned By	Cost ($) Estimate	Priority
4.7.1	Support the development of passive recreation within the Kinnairds Wetland reserve, including improved restricted visitor access and facilities as is currently proposed in the Recreation Plan.	GBCMA, Shire, G-MW, and Recreation Committee adjoining land holders	GBCMA, Shire, G-MW, and Rec Com.		
4.7.2	All recreational vehicles other than cyclists and management vehicles (i.e., horses, motorbikes, 4WDs, etc) to be prohibited from entering the reserve to protect the passive recreation aim and minimise potential damage to the environment from off road use (such as direct physical damage to plants, introduction or spread of weeds, disturbance of wildlife, etc).	Shire and G-MW	Shire , G-MW and adjoining landholders	$2,000	On-going
4.7.3	Continue adequate provision for management vehicle or emergency vehicle (e.g., Fire) access.	Shire and G-MW	Shire and G-MW	$0	On-going
4.7.4	Visitor management, including information interpretation and enforcement of regulations, must be actively undertaken so as to derive the highest benefit from the Recreation Plan, and to maintain the natural values of the wetland and reserve. Litter/rubbish management is expected to be an on-going activity associated with encouraging people to Kinnairds Wetland.	Shire and G-MW	Shire and G-MW	$5000	On-going

4.8 Steering Committee:

Action		Responsibility	Actioned By	Cost ($) Estimate	Priority
4.8.1	Establish a local steering committee/key contacts that can respond to specific issues associated with Kinnairds Wetland as the need arises. Primary management advice should rest between NRE, G-MW and Shire of Moira, with further wider input invited from GBCMA, adjoining landholders and others were appropriate.	All	Rec. Com & Shire	$2,000	On-going
4.8.2	Establish a regional steering committee (with NRE, G-MW, GBCMA and community representatives) to oversee annual water management activities and allocations to a range of SIR wetlands, which includes Kinnairds Wetland. This committee would be responsible for subjectively reviewing water requirements of the wetlands within its charter, and make considered and coordinated recommendations to the relevant management authorities (G-MW, Shires, NRE and Parks Victoria for various public wetlands).	DPI	DPI and GBCMA	$2,000	On-going

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5.1 Personal Communication

Bourchier, John. Adjoining resident of Kinnairds Swamp, Numurkah.

Burkitt, Jenny. Former local resident neighbouring Kinnairds Swamp.

Cody, Todd. Environmental Assessment Officer, Environmental Management Group, Department of Natural Resources & Environment, Tatura.

Newham, Anna. Adjoining resident and convener of Friends of Kinnairds Swamp, Numurkah.

O'Connor, Paul. Environmental Assessment Coordinator, Environmental Management Group, Department of Natural Resources & Environment, Tatura.

Trickey, David. Senior Fisheries and Wildlife Officer, Department of Natural Resources & Environment, Tatura.

Walsh, Melissa. Public Land Management Coordinator, Environmental Management Group, Department of Natural Resources & Environment, Tatura.

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Appendix 1: Flora species recorded in Kinnairds Swamp (& district), Numurkah

Categories of rare or threatened plants in Victoria:

- x Species presumed extinct in Victoria, i.e. not post-1950 records from Victoria.
- r Plants which are considered rare in Victoria but which are not considered otherwise threatened.
- v Vulnerable in Victoria i.e. rare, but not presently endangered.
- d Plants that are not rare in Victoria in the wild state, yet are considered threatened as their regeneration is considered problematic and populations are continuing to decrease.
- k Species poorly known and are suspected, but not definitely known, to belong to any of the following categories (i.e. x, e, v, r)
- E Endangered species in serious risk of disappearing from the wild state within one or two decades.
- e Endangered in Victoria i.e. rare and at risk from disappearing from the wild state
- * Alien species

Kinnairds Flora

F48112 (within Kinnairds Swamp)
Number of Spp: 53 Longitude: +145°27 16 Latitude: -36°05 39 Date: 17 Oct 1992

	Scientific Name	Common Name
*	*Aira cupaniana*	Small Hair-grass
	Amphibromus macrorhinus	Long-nosed Swamp Wallaby-grass
*	*Arctotheca calendula*	Cape Weed
	Arthropodium minus	Small Vanilla-lily
	Arthropodium strictum s.l.	Chocolate Lily
	Austrodanthonia caespitosa	Common Wallaby-grass
	Austrodanthonia duttoniana	Brown-back Wallaby-grass
	Austrodanthonia eriantha	Hill Wallaby-grass
r	*Austrostipa gibbosa*	Spurred Spear-grass
	Austrostipa scabra ssp. *Falcata*	Rough Spear-grass
	Austrostipa scabra	Rough Spear-grass
*	*Avena barbata*	Bearded Oat
*	*Briza minor*	Lesser Quaking-grass
*	*Bromus hordeaceus* ssp. *hordeaceus*	Soft Brome
	Bulbine bulbosa	Bulbine Lily
	Burchardia umbellata	Milkmaids
	Calotis anthemoides	Cut-leaf Burr-daisy
*	*Centaurium* spp.	Centaury
*	*Cicendia quadrangularis*	Square Cicendia
	Convolvulus remotus	Grassy Bindweed
*	*Cotula bipinnata*	Ferny Cotula
	Crassula spp.	Crassula
	Dichopogon sp. aff. *strictus*	
	Drosera glanduligera	Scarlet Sundew
	Drosera peltata ssp. *peltata*	Pale Sundew
	Drosera peltata	Tall Sundew
	Enteropogon acicularis	Spider Grass
	Goodenia pinnatifida	Cut-leaf Goodenia
*	*Hypochoeris glabra*	Smooth Cat s-ear
	Hypoxis spp.	Hypoxis
*	*Juncus capitatus*	Capitate Rush
	Juncus radula	Hoary Rush
*	*Leontodon taraxacoides*	Hairy Hawkbit
	Leptorhynchos squamatus	Scaly Buttons
*	*Lolium perenne*	Perennial Rye-grass
*	*Lolium rigidum*	Wimmera Rye-grass
	Lythrum hyssopifolia	Small Loosestrife
	Maireana spp.	Bluebush
*	*Medicago* spp.	

	Oxalis perennans	Grassland Wood-sorrel
*	*Parentucellia latifolia* ssp. *latifolia*	Common Bartsia
*	*Paspalum* spp.	
	Plantago gaudichaudii	Narrow Plantain
	Ptilotus exaltatus	Mulla Mulla
	Pycnosorus globosus	Drumsticks
*	*Romulea rosea*	Onion Grass
	Sida corrugata	Variable Sida
	Swainsona procumbens	Broughton Pea
*	*Trifolium angustifolium* var. *angustifolium*	Narrow-leaf Clover
*	*Trifolium arvense* var. *arvense*	Hares-foot Clover
*	*Trifolium campestre* var. *campestre*	Hop Clover
*	*Trifolium glomeratum*	Cluster Clover
*	*Vulpia bromoides*	Squirrel-tail Fescue

U32142 (within Kinnairds Swamp)
Number of Spp: 102 Longitude: +145°27'02 Latitude: -36°05'32 Date: 30 Nov 1996 Vegetation: NATGRASSLN

	Scientific Name	Common Name
	Acacia acinacea s.l.	Gold-dust Wattle
	Acacia pycnantha	Golden Wattle
	Alternanthera denticulata s.l.	Lesser Joyweed
	Aristida behriana	Brush Wire-grass
	Arthropodium fimbriatum	Nodding Chocolate-lily
	Arthropodium minus	Small Vanilla-lily
	Asperula conferta	Common Woodruff
	Atriplex semibaccata	Berry Saltbush
	Austrodanthonia bipartita s.l.	Leafy Wallaby-grass
	Austrodanthonia caespitosa	Common Wallaby-grass
	Austrodanthonia duttoniana	Brown-back Wallaby-grass
	Austrodanthonia setacea	Bristly Wallaby-grass
r	*Austrostipa gibbosa*	Spurred Spear-grass
	Austrostipa scabra ssp. *falcata*	Rough Spear-grass
	Boerhavia dominii	Tah-vine
v	*Brachyscome chrysoglossa*	Yellow-tongue Daisy
	Brachyscome ciliaris	Variable Daisy
	Bulbine bulbosa	Bulbine Lily
	Bursaria spinosa	Sweet Bursaria
d	*Callitris glaucophylla*	White Cypress-pine
	Calocephalus citreus	Lemon Beauty-heads
	Calotis anthemoides	Cut-leaf Burr-daisy
	Carex inversa	Common Sedge
	Carex tereticaulis	Rush Sedge
	Cassinia arcuata	Drooping Cassinia
	*Chamaesyce dru*mmondii	Flat Spurge
	Chloris truncata	Windmill Grass
	Chrysocephalum apiculatum s.l.	Common Everlasting
	Convolvulus erubescens	Pink Bindweed
	Crassula decumbens var. *decumbens*	Spreading Crassula
	Crassula peduncularis	Purple Crassula
	Crassula sieberiana	Sieber Crassula
	Cyperus exaltatus	Tall Flat-sedge
	Dianella longifolia	Pale Flax-lily
	Dianella revoluta s.l.	Black-anther Flax-lily
	Drosera glanduligera	Scarlet Sundew
	Drosera peltata ssp. *peltata*	Pale Sundew
	Eclipta platyglossa	Yellow Twin-heads
	Einadia nutans ssp. *nutans*	Nodding Saltbush
	Elatine gratioloides	Waterwort
	Eleocharis acuta	Common Spike-sedge
	Eleocharis pusilla	Small Spike-sedge

	Elymus scaber	Common Wheat-grass
	Enchylaena tomentosa var. *tomentosa*	Ruby Saltbush
	Enteropogon acicularis	Spider Grass
	Eryngium ovinum	Blue Devil
	Eucalyptus camaldulensis	River Red-gum
	Eucalyptus melliodora	Yellow Box
	Eucalyptus microcarpa	Grey Box
	Eutaxia microphylla s.s.	Common Eutaxia
	Glycine tabacina s.l.	Variable Glycine
	Gnaphalium indutum	Tiny Cudweed
	Goodenia fascicularis	Silky Goodenia
	Goodenia gracilis	Slender Goodenia
	Goodenia pinnatifida	Cut-leaf Goodenia
	Haloragis aspera	Rough Raspwort
	Homopholis proluta	Rigid Panic
	Hypoxis vaginata	Yellow Star
	Isoetopsis graminifolia	Grass Cushion
	Isolepis hookeriana	Grassy Club-sedge
	Isolepis hookeriana	Grassy Club-sedge
	*Isolepis platycar*pa	Broad-fruit Club-sedge
	*Ixiolaena lep*tolepis	Narrow Plover-daisy
	Juncus holoschoenus	Joint-leaf Rush
	Leptorhynchos squamatus	Scaly Buttons
	Limosella curdieana	Large Mudwort
	Linum marginale	Native Flax
	Lomandra effusa	Scented Mat-rush
	Maireana decalvans	Black Cotton-bush
	Maireana enchylaenoides	Wingless Bluebush
r	*Maireana humillima*	Dwarf Bluebush
	Marsilea costulifera	Narrow-leaf Nardoo
	Marsilea drummondii	Common Nardoo
	Mentha satureoides	Creeping mint
	Microseris scapigera spp. agg.	Yam-daisy
r	*Minuria integerrima*	Smooth Minuria
	Myriocephalus rhizocephalus	Woolly-heads
	Myriophyllum crispatum	Upright Water-milfoil
	Myriophyllum glomeratum	Clustered Water-milfoil
	Myriophyllum gracile var. *lineare*	Slender Water-milfoil
	Oxalis perennans	Grassland Wood-sorrel
	Pimelea curviflora s.s.	Curved Rice-flower
	Pittosporum phylliraeoides	Weeping Pittosporum
	Pratia concolor	Poison Pratia
	Ptilotus exaltatus	Mulla Mulla
	Pycnosorus globosus	Drumsticks
	Rhodanthe corymbiflora	Paper Sunray
	Rumex brownii	Slender Dock
	Rumex crystallinus s.l.	Glistening Dock
	Rumex tenax	Narrow-leaf Dock
	Schoenus apogon	Common Bog-sedge
	Sida corrugata	Variable Sida
	Solanum esuriale	Quena
	Swainsona procumbens	Broughton Pea
	Teucrium racemosum s.l.	Grey Germander
	Triptilodiscus pygmaeus	Common Sunray
	Trithuria submersa	Trithuria
	Utricularia dichotoma s.l.	Purple Bladderwort
	Vittadinia cuneata	Fuzzy New Holland Daisy
	Vittadinia gracilis	Woolly New Holland Daisy
	Wahlenbergia gracilenta s.l.	Annual Bluebell
	Wurmbea latifolia ssp. *vanessae*	Broad-leaf Early Nancy

(additional species within 3km of Kinnairds Swamp)

	Acacia montana	Mallee Wattle

*	*Acroptilon repens*	Creeping Knapweed
d	*Allocasuarina luehmannii*	Buloke
	Atriplex suberecta	Sprawling Saltbush
	Austrostipa nodosa	Knotty-spear Grass
*	*Avena fatua*	Wild Oat
v	*Brachyscome chrysoglossa*	Yellow Tongue Daisy
	Bromus spp.	Brome
	Carex spp.	
*	*Chenopodium album*	Fat Hen
	Chenopodium desertorum ssp. *microphylum*	Small-leaf Goosefoot
*	*Conyza bilbaoana*	Fleabane
	Cynodon dactylon	Couch
	Cynoglossum suaveolens	Sweet Hounds Tongue
*	*Cyperus eragrostris*	Drain Flat Sedge
	Erodium spp.	Herons Bill
	Danthonia s.l. spp.	Wallaby Grass
	Dillwynia cinerascens	Grey Parrot-pea
	Epilobrium billardierianum	Variable Willow Herb
	Euchiton sphaericus	Annual Cud Weed
	Euchiton spp.	
r	*Eutaxia diffusa*	Spreading Eutaxia
	Haloragis aspera	Rough Raspwort
*	*Hordium vulgare* spp. *Distichon*	Two-row Barley
*	*Hypochoeris radicata*	Cat's Ear
	Juncus spp.	
	Juncus subsecundus	Finger Rush
*	*Kickxia* spp.	
*	*Lactuca seriola*	Prickly Lettuce
*	*Lepidium africanum*	Common Paper-cress
*	*Lolium rigidum*	Wimmera Rye-grass
*	*Lolium x hybridum*	Hybrid Rye-grass
	Lomandra multiflora ssp. *Multiflora*	Many-flowered Mat-rush
*	*Malva* spp.	Mallow
*	*Onopordum acanthium*	Scotch Thistle
*	*Paspalum dilatatum*	Paspalum
	Persicaria hydropiper	Water-pepper
	Pimelea curviflora s.s.	Curved Rice Flower
	Plantago gaudichaudii	Narrow Plantian
*	*Plantago lanceolata*	Ribwort
	Poa sieberiana var. *sieberiana*	Grey Tussock Grass
*	*Polygonum aviculare* s.l.	Prostrate Knotweed
	Pseudognaphalium luteoalbum	Jersey Cudweed
*	*Romulea rosea*	Onion Grass
*	*Rumex conclomeratus*	Clustered Dock
	Senecio runcinifolius	Tall Fire Weed
*	*Sonchus asper* s.l.	Rough Sow Thistle
*	*Sonchus oleraceus*	Common Sow Thistle
*	*Themeda triandra*	Kangaroo Grass
*	*Trifolium* spp.	Clover
	Typha spp.	
	Typha orientalis	Cumbungi
*	*Vulpia bromoides*	Squirell-tail Fescue
	Wahlenbergia spp.	
	Wahlenbergia communis s.l.	Tufted Bluebell
*	*Xanthium spinosum*	Bathurst Burr

Flora species recorded in Kinnairds Swamp by Walsh (1997):

Status:
- * = introduced exotic
- d = depleted
- v = vulnerable
- e = endangered
- r = rare
- Rs = Regional significance (based on Beauglehole 1986)
- S = salt indicator species

Survey dates:
- sp = Spring survey (06-08 Nov '96)
- s = Summer survey (26-27 Feb '97)

FERNS AND FERN ALLIES

AZOLLACEAE			
	Azolla filiculoides	Pacific Azolla	sp,s
MARSILEACEAE			
	Marsilea drummondii	Common Nardoo	sp,s

MONOCOTYLEDONS

ALISMATACEAE			
	Alisma plantago-aquatica	Water Plantain	s
	Damasonium minus	Star-fruit	s
	Carex inversa	Common Sedge	sp
*	Cyperus eragrostis	Umbrella sedge	sp,s
	Eleocharis acuta	Common Spike-sedge	sp,s
e	Eleocharis minuta	Variable Spike-sedge	sp
JUNCACEAE			
	Juncus sp.	Rush	sp,s
LEMNACEAE			
	Spirodela oligorrhiza	Thin Duckweed	sp
POACEAE			
*	Avena fatua	Wild Oat	s
*	Echinochloa crus-galli	Common Barnyard Grass	s
*S	Lolium rigidum	Wimmera Rye-grass	sp,s
	Panicum sp	Panic sp.	sp
*	Phalaris paradoxa	Paradoxical Canary-grass	sp
	Potamogeton tricarinatus	Floating Pondweed	sp,s
	Pseudoraphis spinescens	Moira Grass	sp,s
	Stipa sp.	Spear-grass	s

DICOTYLEDONS

AMARANTHACEAE			
	Alternanthera denticulata	Lesser Joyweed	s
ASTERACEAE			
*	Carduus sp.	Thistle sp	s
	Centipeda cunninghamii	Common Sneezeweed	sp,s
*	Lactuca serriola	Prickly Lettuce	sp,s
*	Xanthium spinosum	Bathurst Burr	s

BORAGINACEAE			
*	Heliotropium europaeum	Common Heliotrope	s
HALORAGACEAE			
*	Myriophyllum aquaticum	Brazilian Water Milfoil	sp
	Myriophyllum papillosum	Robust Milfoil	sp
	Myriophyllum trachycarpum	Water Milfoil	sp,s
	Myriophyllum verucosum	Red Water Milfoil	sp
MYRTACEAE			
	Eucalyptus camaldulensis	River Red Gum	sp,s
ONAGRACEAE			
	Ludwigia peploides	Water primrose	sp,s
POLYGONACEAE			
	Muehlenbeckia florulenta	Tangled Lignum	sp,s
	Persicaria decipiens	Slender Knotweed	sp,s
*	Rumex crispus	Curled Dock	sp,s
	Rumex tenax	Dock	sp
RANUNCULACEAE			
	Ranunculus inundatus	River Buttercup	sp

Appendix 2: Fauna species recorded in Kinnairds Swamp, Numurkah

Status:

- ce Critically Endangered
- e Endangered
- v Vulnerable
- r Lower risk
- i Data deficient
- * Introduced exotic species

ANZECC (Environment Conservation Council) 1995, national status:

- E Endangered
- V Vulnerable

Flora and Fauna Guarantee Act 1988 schedule II listing status:

- L Listed
- R Recommended for listing
- # Rejected for listing

Observer:

- W Recorded by Walsh (1997) in Kinairds Swamp.
- D Listed on NRE fauna database for Kinnairds Swamp.
- O Recorded by other incidental observations (as provided by various reviewers of this document).

Status	Common Name	Scientific Name	Observer
	MAMMALS		
	Possums & Gliders		
	Common Brushtail Possum	*Trichosurus vulpecula*	W
	Common Ringtail Possum	*Pseudocheirus peregrinus*	W
	Mice & Rats		
	Water Rat	*Hydromys chrysogaster*	W
	Bats		
	Little Red Flying-fox	*Pteropus scapulatus*	D
	Southern Freetail Bat (long penis)	*Mormopterus sp. 1*	D
	Introduced Mammals		
*	Brown Hare	*Lepus capensis*	W
*	Fox	*Vulpes vulpes*	WD

BIRDS

	Cormorants & Darters		
	Darter	*Anhinga melanogaster*	D
	Great Cormorant	*Phalacrocorax carb*	D
	Little Pied Cormorant	*Phalacrocorax melanoleucos*	WD
	Large Waterbirds		
	Australian Pelican	*Pelecanus conspicillatus*	W
	Herons & Egrets		
e L	Great Egret	*Ardea alba*	D
	Pacific Heron	*Ardea pacifica*	WD
	White-faced Heron	*Ardea novaehollandiae*	WD
	Spoonbills & Ibis		
V	Royal Spoonbill	*Platalea regia*	WD
	Yellow-billed Spoonbill	*Platalea flavipes*	W
	Sacred Ibis	*Threskiornis aethiopicus*	WD
	Straw-necked Ibis	*Threskiornis spinicollis*	D
	Grebes		
	Australasian Grebe	*Tachybaptus novaehollandiae*	D
	Ducks, Swans & Geese		
	Grey Teal	*Anas gibberifrons*	W
	Pacific Black Duck	*Anas superciliosa*	W
	Hardhead	*Aythya australis*	W
	Wood Duck	*Chenonetta jubata*	W
	Black Swan	*Cygnus atratus*	WD
	Mountain Duck	*Tadorna tadornoides*	WD
	Plumbed Whistling-Duck	*Dendrocygna eytoni*	D
	Pink-eared Duck	*Malachorhynchus membranaceus*	O
	Eagles		
	Wedge-tailed Eagle	*Aquila audax*	W
	Quail		
	Stubble Quail	*Coturnix novaezelandiae*	W
	Rails, Crakes & Gallinules		
	Eurasian Coot	*Fulica atra*	W
	Dusky Moorhen	*Gallinula tenebrosa*	WD
	Purple Swamphen	*Porphyrio porphyrio*	D
	Plovers & Waders		
	Black-fronted Plover	*Elseyornis melanops*	D
	Red-kneed Plover	*Erythogonys cinctus*	O
	Masked Lapwing	*Vanellus miles*	WD
	Thicknees		
e L	Bush Thicknee	*Burhinus grallarius*	D
	Snipe		
E	Latham's Snipe	*Rostratula benghalensis*	O (Note 1)

	Pigeons & Doves		
	Crested Pigeon	*Ocyphaps lophotes*	W
	Cockatoos		
	Sulphur-crested Cockatoo	*Cacatua galerita*	W
	Galah	*Cacatua roseicapilla*	W
	Lorikeets & Parrots		
	Red-rumped Parrot	*Psephotus haematonotus*	W
	Rosellas		
	Eastern Rosella	*Platycercus eximius*	W
	Owls		
	Barn Owl	*Tyto alba*	D
	Kookaburra & Kingfishers		
	Laughing Kookaburra	*Dacelo novaeguineae*	W
	Sacred Kingfisher	*Halcyon sancta*	W
	Swifts, Swallows & Martins		
	Welcome Swallow	*Hirundo neoxena*	W
	Cuckoo - Shrikes		
	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	W
	Fantails		
	Willie Wagtail	*Rhipidura leucophrys*	W
	Wattlebirds, Friarbirds & Honeyeaters		
	Noisy Miner	*Manorina melanocephala*	W
	White-plumed Honeyeater	*Lichenostomus penicillatus*	W
	Starlings & Orioles		
*	Common Starling	*Sturnus vulgaris*	W
	Myna, Magpie Lark & Choughs		
	Australian Magpie Lark	*Grallina cyanoleuca*	W
	White-winged Chough	*Corcorax melanorhamphos*	W
	Currawongs & Magpies		
	Australian Magpie	*Gymnorhina tibicen*	W
	Ravens		
	Australian Raven	*Corvus coronoides*	W

FROGS

Warty Bell Frog	*Litoria raniformis*	D
Pobblebonk Frog	*Limnodynastes dumerili dumerili*	D

REPTILES

Snakes

	Eastern Brown Snake	*Pseudonaja textilis*	WD
	Tiger Snake	*Notechis scutatus*	W

Lizards

I	Lace Monitor	*Varanus varius*	W

FISH

*	Carp	*Cyprinus carpio*	W
v L	Freshwater Catfish	*Tandanus tandanus*	O (Unconfirmed)

Note 1: Record by ANCA (1993) states that Latham's Snipe is found in Kinnairds Swamp; supported by observations of Paul O'Connor in 1993 (*pers. comm.*). However, ANCA (1993) also states that the species breeds at Kinnairds Swamp, though this is clearly erroneous as the internationally migratory species only breeds in Japan in the northern hemisphere (Emison *et al.* 1987).