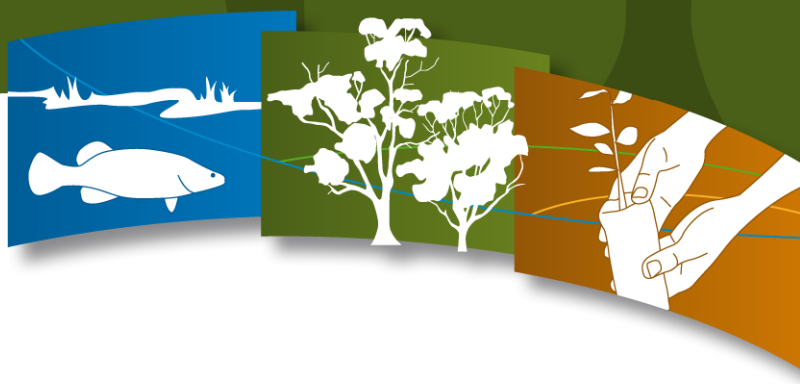
Connecting Rivers, Landscapes, People

Lake Boort
Environmental Water Management Plan
Final Draft

North Central Catchment Management Authority



NORTH CENTRAL
Catchment Management Authority
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State Government Victoria
Department of Sustainability and Environment

DOCUMENT CONTROL

Revision and distribution

Version no.	Description	Issued to	Issue date
1	Draft – March 2011	Environmental Flows Team – North Central CMA	22 February 2011
2	Draft – March 2011	Andrea Joyce – North Central CMA	31 March 2011
3	Draft – June 2011	North Central CMA representatives	08 June 2011
4	Draft – June 2011	Department of Sustainability and Environment / Expert Review Panel	30 June 2011
		Local Technical Group	30 June 2011
5	Final Draft – October 2011	Department of Sustainability and Environment / Expert Review Panel	13 October 2011
6	Final Draft	North Central CMA	7 February 2012

Management

Organisation	North Central Catchment Management Authority
Author(s)	Bridie Velik-Lord
Number of pages	64
Name of document	Lake Boort Environmental Water Management Plan Final Draft
Document Manager	60122

Front cover image: Lake Boort in flood, 13 December, 2010. North Central CMA (B. Velik-Lord)

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Please cite this document as: North Central CMA, 2011. Lake Boort Environmental Water Management Plan. North Central Catchment Management Authority, Huntly, Victoria.

EXECUTIVE SUMMARY

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

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

Lake Boort is a 420ha shallow freshwater marsh located on the Loddon River floodplain. It is a bioregionally important wetland which is managed by Parks Victoria. The wetland provides habitats characterised by open water, reeds, and dead timber. It is fringed by River Red Gums and Black Box vegetation types.

The wetland provides habitat for a range of fauna species listed under Victorian State legislation. The three Ecological Vegetation Classes of the wetland are considered endangered or vulnerable within the Victoria Riverina Bioregion. Lake Boort is considered a significant area of cultural heritage, with the wetland containing the densest group of Aboriginal scarred trees recorded in Victoria.

Lake Boort and the area surrounding the wetland have been highly modified since river regulation. During the mid to late nineteenth century, early settlers in the Boort district undertook a number of developments through the area with the aim of increasing the reliability of water supply.

The wetland was maintained with water on a regular basis through until the 1990s when it dried and then only received flood inundation and surplus channel water. Lake Boort is able to be managed with environmental water using the Pyramid-Boort irrigation system.

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

Lake Boort environmental water management goal

To provide a water regime that supports the recruitment and maintenance of River Red Gum habitats, and ensures opportunities for waterbird foraging, nesting and breeding.

Optimal watering regime

Fill wetland to full supply level (90.79m AHD) in spring of year one, inundating River Red Gum habitat and providing water to Black Box habitat. Allow wetland to drawdown naturally over summer of year one and two, promoting River Red Gum germination through the bed of the wetland.

Allow wetland to remain completely dry over years three and four to allow Red Gum growth and development, and provide a partial wetland fill in spring of year five. The target fill level should be based on the growth of Red Gums through the base of the wetland, and should not overtop the trees.

Allow wetland to drawdown and dry during years six and seven before providing another partial fill in year eight. Two more dry years should follow, before providing a wetland fill to full supply level again (year eleven).

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

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

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ACKNOWLEDGEMENTS

North Central CMA would like to acknowledge the input from Andrea Joyce in the planning and development of this Environmental Water Management Plan. We would also like to acknowledge the valuable input from members of the local technical group at both the workshop and in future reviews of this Plan:

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

In addition, the assistance provided by Lyndall Rowley, Darren White and Phil Slessar (North Central CMA) is greatly appreciated.

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

ABBREVIATIONS

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

1. INTRODUCTION

1.1. Background

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

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

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

1.2. Purpose

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

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

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

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

1.3. Site location

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

Lake Boort is classified as a shallow freshwater marsh (Parks Victoria 2003) within the Boort Wetland Complex and located within 1km of Boort township in northern Victoria. The wetland is approximately 220ha in size and has significant interactions with Little Lake Boort (to the west), and Lake Lyndger (to the north).

Figure 1. North Central CMA region

1.4. Consultation

Specific consultation in the development of this Plan was undertaken with a local technical group at a workshop held on 16 June 2011. Participants at this workshop were: Mark Tscharke (Parks Victoria – Land Manager), Shelley Heron (KBR), Emer Campbell (North Central CMA), Andrea Joyce, and Bridie Velik-Lord (North Central CMA). Representatives from regional DSE were unable to attend the workshop. Outcomes and key discussion points from the workshop are presented in Appendix 7.

1.5. Information sources

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

1.6. Limitations

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

2. SITE OVERVIEW

2.1. Catchment setting

Lake Boort is located in the Loddon River floodplain in northern Victoria (refer to Figure 2). It is associated with a complex of wetlands referred to as the Boort District wetlands which stretch from Boort to Kerang and include Woolshed Swamp, Lake Boort, Little Lake Boort, Lake Lyndger, Lake Yando, Lake Leaghur, Lake Meran, Little Lake Meran, Tobacco Lake, Round Lake and Spectacle Lake. Lake Boort (formerly a swamp) is in the southern section of this chain of scattered lakes and swamps which extend a total of 80km between the Avoca River and Loddon River catchments (Parks Victoria 2003).

Lake Boort receives significant flows from the Loddon River (to the east) via distributary flows during flood events; and from overland flows from the Borung Plains to the west. Lake Boort, along with the adjoining Little Lake Boort and Lake Lyndger, is bordered by sand lunettes formed during alternating wet and dry periods during the late Quaternary period (Parks Victoria 2003).

In its natural state, Lake Boort was fed from Kinypanial Creek (considered a distribuary channel of the Loddon River). Once the wetland filled, it would have spilled over to the west and the north, filling Little Lake Boort and Lake Lyndger (Parks Victoria 2003). These wetlands are now separated by roads and channels. There are two structures that take water under the highway on the northern edge of Lake Boort through a floodway to Lake Lyndger which is lower in the landscape than Lake Boort

Landuse surrounding Lake Boort is primarily cropping (irrigated and dryland) and grazing. The residential area of Boort is less than 1km away from the western side of Lake Boort.

The wetland holds particular significance from a cultural heritage perspective for the Dja Dja Wurrung traditional owners, and the wetland contains the highest density of Aboriginal scarred trees recorded in Victoria (Parks Victoria 2003).

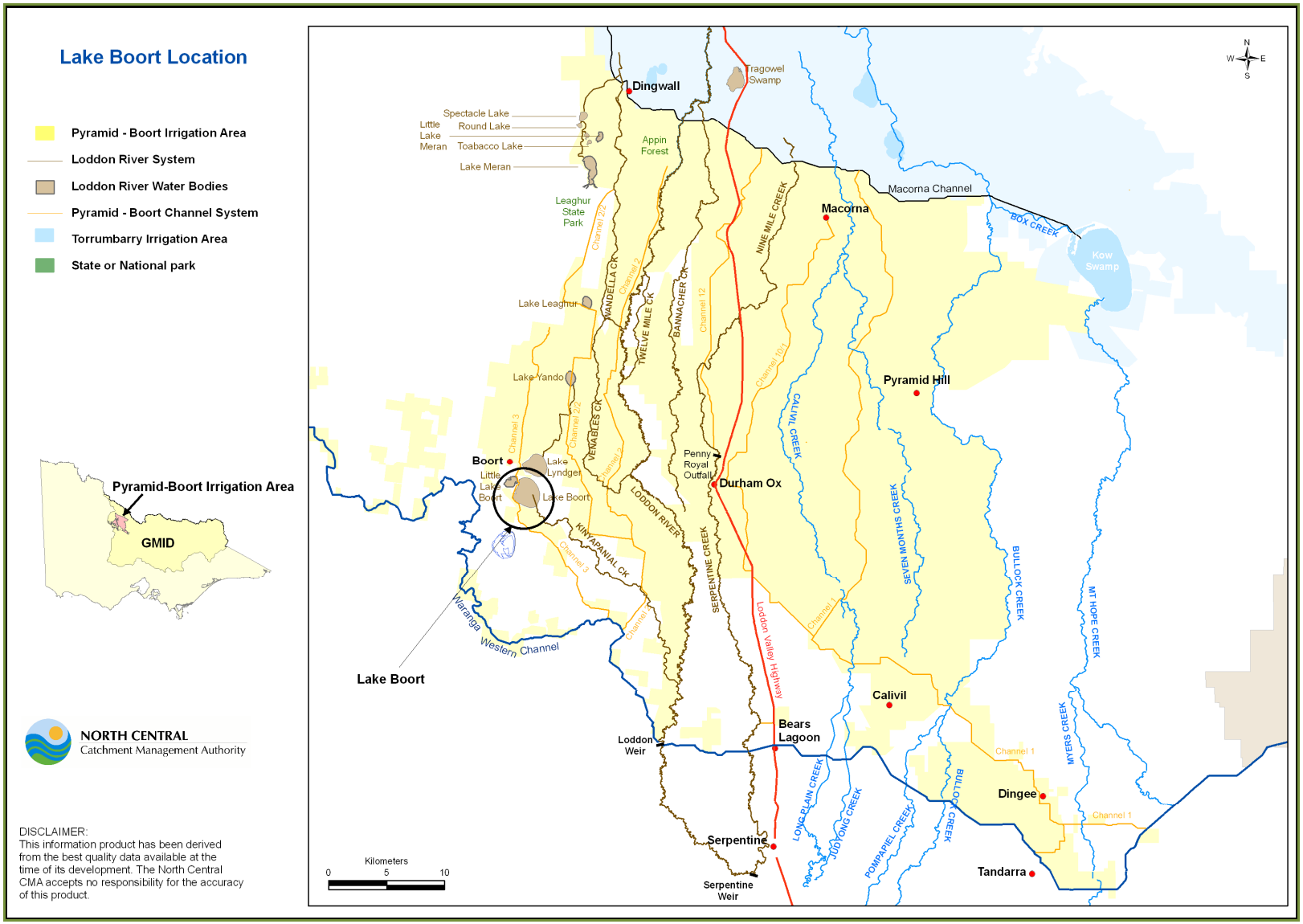

Figure 2. Lake Boort location.

2.2. Land status and management

Lake Boort is currently classified as a lake reserve and managed by Parks Victoria. VEAC (2008) recommended reclassifying Lake Boort as a bushland area under the natural features reserve category (Lake Boort is site G16), however the two classifications do not result in any substantial difference in relation to the activities able to be conducted on, or around Lake Boort.

The land manager of Lake Boort is Parks Victoria, the local water authority is Goulburn-Murray Water and the regional environmental water manager is North Central CMA. Table 1 describes key stakeholders with possible involvement in the management of Lake Boort, and Table 2 shows a summary of the site characteristics of Lake Boort.

Table 1. Agencies and stakeholder groups with a responsibility or interest in the environmental water management of Lake Boort.

Agency / Stakeholder Group	Responsibility / Interest
Commonwealth Environmental Water Holder	Management of Commonwealth environmental water entitlements.
Department of Primary Industries	Provision of technical and extension support for the sustainable management of agriculture surrounding Lake Boort.
Department of Sustainability and Environment	Provision of financial, policy and strategic support for the management of public and private land (including wetlands). Currently manage environmental water entitlements on behalf of the Minister for Environment.
Dja Dja Wurrung traditional owners	Traditional owners of the area encompassing Lake Boort.
Loddon Shire Council	Local council for area including Lake Boort. Responsible for regulation of local development through planning schemes and on-ground works.
Goulburn-Murray Water	Rural water corporation responsible for the management of water-related services in the irrigation area of northern Victoria. Resource manager responsible for making seasonal allocations in the region.
Local and non-local community	Recreational users of Lake Boort, including passive recreational pursuits (walking, bird watching, canoeing), hunting.
Local landholders	Management of private land surrounding Lake Boort.
Murray-Darling Basin Authority	Responsible for preparing, implementing and enforcing the Murray-Darling Basin Plan. Responsible for planning integrated management of water resources across the Murray-Darling Basin.
North Central CMA	Coordination and monitoring of natural resource management programs in north central Victoria. Local operational management of the Environmental Water Reserve to rivers and wetlands including Lake Boort.
Parks Victoria	Custodian and land manager of Lake Boort.
Victorian Environmental Water Holder	Due to be operational from 1 July 2011. Will manage Victorian environmental water entitlements into the future.

2.3. Wetland characteristics

Wetlands in Victoria are currently classified using a system developed by Corrick and Norman which includes information on water depth, water permanency and salinity (Corrick and Norman 1980 in DSE 2007) (refer to Appendix 1 for further information about the wetland categories). Wetlands through Victoria were mapped and classified between 1975 and 1994 and developed into spatial GIS layers. These layers represent the wetland characteristics at the time of mapping (referred to as Wetlands 1994 layer), as well as a categorisation of the wetland characteristics prior to European settlement (referred to as Wetlands 1788 layers) (DNRE 2000a; DNRE 2000b).

Under the Wetlands 1994 layer, Lake Boort is classified as a permanent open freshwater wetland with shallow, Red Gum and dead timber habitats (Lugg *et al.* 1991). Under the Corrick classification, shallow open freshwater wetlands are considered to be permanently inundated to a depth less than 5m. During the time that these wetlands were mapped (1975 to 1994), Lake Boort was maintained with water on a permanent basis. Therefore, its classification was representative of its hydrological

condition at the time. Since 1997, Lake Boort has been allowed to dry completely and is now managed as an intermittent wetland with the ability to receive environmental water, rather than a permanent one. An intermittent wetland is characterised by the wetland alternating between holding water and being completely dry (but not on an annual basis). Surface water in these wetlands is considered to persist for months to years (Roberts and Marston 2011).

Based on an assessment of Lake Boort undertaken in the early 2000s, Parks Victoria (2003) classifies Lake Boort as a shallow freshwater marsh which is characterised by a period of inundation up to eight months per year. This classification is most closely aligned to the recent history of the wetland during the late-1990s and early-2000s where the wetland was not maintained with water on a permanent basis and therefore did not display characteristics of its 1994 classificaiton of an open water wetland. Current management objectives for the wetland focus on maintaining its intermittent nature, allowing the wetland to experience both wet and dry cycles. It is the intent of this Plan to formalise the environmental water management objectives of Lake Boort.

Table 2 shows the wetland characteristics of Lake Boort.

Table 2. Summary of Lake Boort characteristics

Characteristics	Description
Name	Lake Boort
Mapping ID (Wetland 1994 layer)	7625 465980
Area	420 ha
Bioregion	Victoria Riverina
Conservation status	Bioregionally important wetland
Land status	Lake Reserve, Recreational Reserve (proposed Bushland Area [VEAC 2008])
Land manager	Parks Victoria
Surrounding land use	Cereal production, irrigated cropping, grazing
Water supply	Pyramid-Boort Channel 3 directly to wetland; Channel 2/2 to Kinypanial Creek, then to wetland; Channel 3 to Little Lake Boort, then flushing channel to Lake Boort
1788 wetland category	Deep freshwater marsh
1994 wetland category and sub-category	Open water with shallow water, dead timber and Red Gums.
Current condition (Parks Victoria 2003)	Shallow freshwater marsh[1]
Wetland capacity	5,817.62 ML at environmental FSL (90.79m AHD at top of gate); maximum FSL of 90.97m AHD and 6,579.21m AHD
Wetland depth at capacity	Approximately 1.8m at environmental FSL

[1] The classification of Lake Boort as a shallow freshwater marsh is considered to be the most appropriate classification of the wetland, due to its episodic flooding nature. Therefore, this classification has been used throughout the remainder of the Plan.

2.4. Environmental water

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

Table 3. Environmental water that may be used at Lake Boort

Water entitlement	Environmental water management agency
Bulk Entitlement (Loddon River – Environmental Reserve) Order 2005 (incl. Amendment Orders 2007 and 2010)	Victorian Environmental Water Holder
Bulk Entitlement (River Murray – Flora and Fauna) Conversion Order 1999 (incl. Amendments Orders and Notices 2005, 2006, 2007 and 2009)	Victorian Environmental Water Holder
Environmental Entitlement (River Murray Environmental Water Reserve) 2010	Victorian Environmental Water Holder
Commonwealth Environmental Water Holdings	Commonwealth Environmental Water Holder

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

2.5. Legislative and policy framework

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

International treaties, conventions and initiatives:

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

Commonwealth legislation and policy:

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

Victorian legislation:

- *Aboriginal Heritage Act 2006*
- *Catchment and Land Protection Act 1994*
- *Water Act 1989*
- *Wildlife Act 1975*
- *Flora and Fauna Guarantee Act 1988* (FFG Act)

Victorian policy, codes of practice, charters and strategies:

- North Central Regional Catchment Strategy (North Central CMA 2003)
- Northern Region Sustainable Water Strategy (DSE 2009b)
- Our Water Our Future (DSE 2004b)
- State Environment Protection Policy (Waters of Victoria) 2003
- State Environment Protection Policy (Groundwaters of Victoria) 1997
- Victorian threatened flora and fauna species (advisory list).

2.6. Related plans and activities

A number of complementary works have been completed at Lake Boort over the past decade. These works are detailed below:

- the structure linking Lake Boort and Lake Lyndger was upgraded the early 2000s to lower to FSL of the wetland by 900mm with the aim of reducing the extent and duration of inundation (GHD 2005)
- archaeological surveys have been completed by Parks Victoria and documented (Parks Victoria 2003)
- invasive plant control has been undertaken by Parks Victoria during the period when Lake Boort was dry
- the outfall structure to Lake Boort from Pyramid-Boort Channel 3 was upgraded in 2010 and delivery can now occur at a maximum rate of 180ML/day (G-MW, pers. comm. 2010).

In addition, a number of plans and reports have been completed for the management of Lake Boort, as detailed below:

- Environmental Values and the Effects of Salinity on the Flora and Fauna of the Boort-West of Loddon Salinity Management Planning Area (Lugg *et al.* 1993)
- Development of Water Management Strategy for Boort Wetlands (DNRE 1996)
- Notes on a Hydrologic Review of Lake Boort and Lake Lyndger of the Boort West of Loddon plan area (1998) (author unknown)
- Lake Boort Preliminary Heritage Assessment (AAV 1999)
- Lake Boort Vegetation Condition and Environmental Values Assessment (Parks Victoria 2001)
- Lake Boort Integrated Action Plan (Parks Victoria 2003)
- Serpentine to Boort Floodplain Management Plan (draft) (GHD 2005)
- Boort District Wetlands Vegetation Assessment (Ecos 2007)
- Impact of water availability on significant wetlands – A working document for Northern Region Sustainable Water Strategy (Heron and Joyce 2008).

As Lake Boort is specified as a priority wetland in the Bulk Entitlement (Loddon River – Environmental Reserve) Order 2005, its environmental water management has been detailed in the Environmental Operating Strategy for the Management of the Bulk Entitlement (Loddon River – Environmental Reserve) Order 2005 (North Central CMA, 2006) and associated Annual Watering Plans, developed by North Central CMA.

3. WATER DEPENDENT VALUES

3.1. Environmental

3.1.1. Listings and significance

Lake Boort is considered a bioregionally important wetland (Heron Environmental Consulting, 2006). Its value primarily relates to its habitat diversity, corresponding waterbird carrying capacity and waterbird species diversity (Lugg *et al.* 1991). In 1991 there was in excess of 8,000 waterbirds recorded using Lake Boort (Lugg *et al.* 1991).

Table 4 details the legislation, agreements, conventions and listings that are relevant to Lake Boort (based on information generated through DPI [2011]). As can be seen, management of Lake Boort falls within three international listings, one national listing and two Victorian state listings.

Table 4. Legislation, agreements, convention and listings relevant to the site, or species recorded at Lake Boort.

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

3.1.2. Fauna

Lake Boort provides habitat for a range of fauna species. A number of these species are considered threatened under various legislations (as detailed in Section 2.5). Some species which rely on Lake Boort are considered water-dependent and require the presence of water to undertake breeding and feeding (e.g. waterbirds). Other species of significance do not require the presence of water, but depend on functioning terrestrial ecosystems to thrive (e.g. terrestrial bird species). Therefore, the provision of an appropriate watering regime to improve or maintain the ecological condition of Lake Boort (the wetland itself as well as the riparian zone) is important for all species that use the wetland in both dry and wet times.

Lugg *et al.* (1991) note that the waterbird use of Lake Boort is considered important, with carrying capacity rated as high, species diversity rated as very high, and ability to support breeding rated as high. This assessment was undertaken when Lake Boort was maintained with water on a more permanent basis than it is currently. However, waterbird monitoring undertaken during 2010-11 anecdotally suggests that it is still an important site for waterbird habitat and feeding opportunities in the landscape.

During 2010-11, while holding water, a wide range of waterbirds from the following waterbird feeding groups were recorded at the wetland:

- Piscivores (Kingsford 1997): bitterns, cormorants, egrets, grebes, herons, ibis and spoonbills that feed on fish, frogs, large crustaceans and large insects
- Herbivores (Kingsford 1997): Australian wood duck, swans and teal that feed on aquatic macrophytes and terrestrial plants
- Omnivores (Kingsford 1997): Hardhead and Pacific black ducks that feed on small insects, small crustaceans, aquatic macrophytes, molluscs and seeds.

Lake Boort also supported waterbird breeding of colonial and single breeders in 2010-11 including

the following:

- Little Black Cormorants (colonial breeders nesting in trees [Kingsford 1997])
- Great Crested Grebes (colonial breeders nesting on platforms of reeds, lignum and rushes [Kingsford 1997])
- Grey Teal and Australasian Grebes (single breeders nesting on top or below aquatic vegetation [Kingsford 1997]).

Table 5 shows listed fauna species recorded at Lake Boort, and has been generated through DSE threatened species mapping service (DSE 2011a). As discussed earlier, the species presented below are only those that are considered significant. There are numerous other species that have been recorded utilising Lake Boort, such as waterbirds, terrestrial birds, reptiles (including turtles) and mammals (refer to Figure 3 and Figure 4).

In addition to the species listed in Table 5, Parks Victoria (2003) note that 80 species of birds have been recorded using Lake Boort, 42 of which are waterbirds using the wetland for feeding, resting and breeding when Lake Boort holds water. Black Wallabies (*Wallabia biocolor*) and Water Rats (*Hydromys chrysogaster*) have also been recorded at Lake Boort (Parks Victoria 2003).

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

Common name	Scientific name	Type	International agreements	EPBC status	FFG status	DSE status
Australasian Shoveler	*Anas rhynchotis*	B	-	-	-	VU
Baillon's Crake	*Porzana pusilla*	B	-	-	L	VU
Blue-billed Duck	*Oxyura australis*	B	-	-	L	EN
Brown Treecreeper[1]	*Climacteris picumnus*	B	-	-	-	NT
Eastern Bearded Dragon[1,2]	*Pogona barbata*	R	-	-	-	DD
Freckled Duck	*Stictonetta naevosa*	B	-	-	L	EN
Golden Perch[3]	*Macquaria ambigua*	F	-	-	-	VU
Great Egret[2]	*Ardea alba*	B	-	-	L	VU
Grey-crowned Babbler[1]	*Pomatostomus temporalis*	B	-	-	L	EN
Growling Grass Frog	*Litoria raniformis*	A	-	VU	L	EN
Hardhead[2]	*Aythya australis*	B	-	-	-	VU
Latham's Snipe	*Gallinago hardwickii*	B	C, J, R	-	-	NT
Musk Duck	*Biziura lobata*	B	-	-	-	VU
Nankeen Night Heron	*Nycticorax caledonicus*	B	-	-	-	NT
Whiskered Tern	*Chlidonias hybridus*	B	-	-	-	NT
Woodland Blind Snake[1]	*Ramphotyphlops proximus*	R	-	-	-	NT

[1] Species not considered water dependent
[2] Species also recorded in 2010-11
[3] Species no longer likely to occur due to intermittent nature of the wetland

Legend

Type: Invertebrate, Fish, Amphibian, Reptile, Bird, Mammal
International: Camba, Jamba, Rokamba, Bonn
EPBC status: EXtinct, CRitically endangered, ENdangered, VUlnerable, Conservation Dependent
EPBC presence: Known to occur, Likely to occur, May occur
FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing
DSE status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known

Figure 3. Ibis utilising Lake Boort during the filling event in late-2010. P. Haw

Figure 4. Eastern bearded dragon at Lake Boort

3.1.3. Flora

Vegetation communities

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

Parks Victoria (2003) note that the vegetation communities of the Victorian Riverine Plain have been severely degraded since European settlement. Furthermore, historic landuses on Lake Boort have impacted the ecological condition of the wetland. Stock grazing and timber harvesting along with changes to the flooding regime of the wetland modified vegetation communities and the persistence of dependent fauna species (Parks Victoria 2003).

There are three main types of vegetation within Lake Boort. River Red Gum woodland fringes the lakebed and is dominated by River Red Gums (*Eucalyptus camaldulensis*) and occasional scattered Black Box (*Eucalyptus largiflorens*) (Figure 5). Tangled Lignum (*Muehlenbeckia florulenta*), Ruby Salt-bush (*Enchylaena tomentosa var. tomentose*) and Nodding Salt-bush (*Einadia nutans subsp. nutans*) occur in the shrublayer. The groundlayer is dominated by Southern Cane-grass (*Eragrostis infecunda australasica*), Spiny Flat-sedge (*Cyperus gymnocaulos*), Common Blown-grass (*Agrostis avenacea*) and Rat-tail Couch (*Sporobolus mitchellii*). Buloke (*Allocasuarina luehmannii*), Weeping Pittosporum (*Pittosporum angustifolium*) and Hooked Needlewood (*Hakea tephrosperma*) were also found at the wetland (CEM 2001 in Parks Victoria 2003).

Black Box woodland occurs beyond the Red Gum woodland in Lake Boort (Figure 5). Within this area, the overstorey is dominated by mature Black Box, and the understorey is dominated by Tangled Lignum and a small number of Spiny Lignum (*Muehlenbeckia horrida*) plants (CEM 2001 in Parks Victoria 2003). Spiny Lignum is listed as rare under the DSE advisory list.

Ecological Vegetation Class mapping reveals that there are three EVCs recorded at Lake Boort (DSE 2011b). These are presented in Table 6 (more detail is provided in Appendix 4).

Table 6. Ecological vegetation classes recorded at the site

EVC no.	EVC name	2005	Bioregional Conservation Status
			Victoria Riverina
292	Red Gum Swamp	✓	Vulnerable
803	Plains Woodland	✓	Endangered
104	Lignum Swamp	✓	Vulnerable

The characteristic components of the EVCs found at Lake Boort include:

- Red Gum Swamp: Open woodland to 15m tall with a diverse understorey dominated by sedgy or grassy-herbaceous aquatics and species tolerant of intermittent to seasonal flooding (DSE 2011b)
- Lignum Swamp: Treeless shrubland to 4m tall with lignum dominating and subject to infrequent inundation (DSE 2011b)
- Plains Woodland: Open woodland similar to that noted above, however with an understorey consisting of few sparse shrubs over species-rich grassy and herbaceous groundlayer with chenopods often present (DSE 2011b). This EVC occurs higher in the wetland margins and is therefore unlikely to receive widespread inundation, but may be maintained by access groundwater and very shallow inundation during large flow events.

The distribution of EVCs through Lake Boort is representative of the level and duration of inundation that specific areas receive. For example, the Red Gum Swamp occurs through the base of the wetland while the Plains Woodland and Lignum Swamp occur in the fringing areas. Appendix 4 shows a map of the EVCs through the area.

Figure 5. Distinct River Red Gum and Black Box communities surrounding the western side of Lake Boort.

Flora species

Beauglehole (1979 and 1986) in Lugg *et al.* 1991 recorded Pale Spike-sedge (*Eleocharis pallens*) and Sweet Fenugreek (*Trigonella suavissima*) at Lake Boort. Both these species are listed under the DSE advisory lists of rare or threatened plants in Victoria (DSE 2005).

The most recent vegetation survey at Lake Boort was completed in 2007 (Ecos 2007). As with other wetlands in the region, this survey was completed during a dry period (the wetland had been dry for eight years at the time of sampling), and therefore results show a lack of aquatic species present. It was noted that River Red Gums and Cumbungi were the only plant species recorded that were characteristic of wetland environments (Ecos 2007).

The vegetation across the lakebed of the wetland during 2003 was dominated by Common Blown-grass (*Agrostis avenacea*), Ruby saltbush and Creeping Monkey-flower (*Mimulus repens*) (Parks Victoria 2003). The outfall structure to Lake Boort is known to maintain a moist area on the bed of Lake Boort, creating habitat for Pale Knotweed (*Persicaria lapathifolia*) and Cumbungi (Parks Victoria 2003).

In 2007, Spiny Lignum (*Muehlenbeckia horrida*) was recorded in the Black Box community on the western edge of Lake Boort (Ecos 2007), and Southern Cane Grass (*Eragostis infecunda*) was observed in the River Red Gum zone of the wetland (Ecos 2007). At the time of the survey, there was considerable invasion of the wetland zone by terrestrial species including pasture grasses and members of the Asteracae family (Ecos 2007). Prior the wetland filling in 2010, the wetland bed was dominated by introduced Giant Mustard (*Rapistrum rugosum*).

Table 7 shows flora species of significance recorded at Lake Boort.

The vegetation compositions and floristic characteristics of Lake Boort mean that there is a large ratio of open water to marginal vegetation, resulting in benefits to species that forage in open water or water with emergent vegetation (Ecos 2007).

Table 7. Significant flora species recorded at the site

Common name	Scientific name	EPBC status	FFG status	DSE status
Pale Spike-sedge[1]	*Eleocharis pallens*	NL	NL	PK
Sweet Fenugreek[1]	*Trigonella suavissima*	NL	NL	R
Spiny Lignum[2]	*Muehlenbeckia horrid*	NL	NL	R

[1] Source: Beauglehole (1979 and 1986) in Lugg *et al.* 1991
[2] Source: Ecos 2007

Legend

EPBC status: EXtinct, CRitically endangered, ENdangered, VUlnerable, Conservation Dependent, Not Listed
FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing
DSE status: presumed EXtinct, ENdangered, Vulnerable, Rare, Poorly Known, Not Listed

3.1.4. Wetland depletion and rarity

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

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

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

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

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

Lake Boort is classified as an open water wetland, with areas of dead timber, red gum and shallow water under the Wetlands 1994 layer. As discussed in Section 2.3 however, Parks Victoria (2003) classify Lake Boort as a shallow freshwater marsh. As this is considered more representative of its current and proposed hydrological regime (i.e. short duration of inundation and frequent spells of drying), this section considers the wetland in this state. Table 8 shows the current area of shallow freshwater marshes in the landscape, and details the proportion of the total that Lake Boort contributes.

As can be seen in Table 8, Lake Boort contributes a large proportion of shallow freshwater marsh habitat within the North Central CMA region (8.1%). Lugg *et al.* (1991) note that Lake Boort has a moderate value based on its size. Table 8 shows the current level of shallow freshwater marshes across the landscape, and the proportion of the regional total that Lake Boort represents.

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

Classification	Region			
	North Central CMA region	Goulburn-Murray Irrigation District	Victorian Riverina bioregion	Victoria
Shallow freshwater marsh (ha)	5,173	17,222	10,194	55,039
Lake Boort (ha)	420	420	420	420
Lake Boort as a proportion of the region	8.1%	2.4%	4.1%	0.8%

3.1.5. Ecosystem functions

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

3.2. Social

3.2.1. Cultural heritage

A total of 179 Aboriginal heritage sites have been identified in Lake Boort consisting of 150 scarred trees (with a total of 357 scars), 20 mounds, seven artefact scatters, one isolated artefact and one hearth (Parks Victoria 2003). Lake Boort contains the densest group of Aboriginal scars identified in Victoria to date (Parks Victoria 2003). Parks Victoria (2003) note that the early death of the host trees occurred as a result of the wetland being flooded and maintained with water in the 1850s. Most of the trees are entirely hollow as in an advanced state of decay and without treatment, Thorn and Long (2001) in Parks Victoria (2003) estimate that many of the scarred trees will be lost in 20 to 50 years.

Further information regarding the cultural significance of Lake Boort is provided in Parks Victoria (2003).

3.2.2. Recreation

Lake Boort is used for passive recreational pursuits including camping, bird watching, and non-motorised water sports. During the 1990s it was used for water-skiing, however the vegetation through the bed of the wetland now makes this pursuit dangerous. It is also used by hunters during duck-hunting season.

3.3. Economic

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

There are direct and indirect uses of wetlands which generate economic benefit on a local scale, regional and wider scale (ACF 2010). Direct uses of Lake Boort include the income generated from recreational pursuits and tourism, while indirect uses include such mechanisms as groundwater recharge, nutrient treatment and carbon storage (DEWHA 2010). Lake Boort's proximity to Boort township means that the economic value of the wetland from tourism can be significant when the wetland is holding water.

There were once irrigation diversion licenses on Lake Boort, however these have now been removed. There are three small dams located on the north-eastern side of the lake (Figure 6) which receive one fill per year from a G-MW channel for stock and domestic use.

Figure 6. Dam located on north-eastern side of the wetland. October 2010.

4. HYDROLOGY AND SYSTEM OPERATIONS

The hydrology of a wetland will affect the chemical and physical aspects of that wetland (North Central CMA, 2009). The chemical and physical aspects will in turn influence the flora and fauna communities that the wetland supports (DSE, 2005). A wetland's hydrology is determined by surface and groundwater inflows and outflows in addition to precipitation and evapotranspiration (Mitsch and Gosselink, 2000 in DSE, 2005). Duration, frequency and seasonality (timing) are the main components of the hydrological regime for wetlands and rivers. Appendix 5 details the recent watering history of Lake Boort.

4.1. Water management and delivery

The catchment surrounding Lake Boort has been the subject of numerous landscape modifications since it was settled by Europeans during the mid nineteenth century. The information contained in this section refers to three distinct timeframes and the impacts on Lake Boort:

1. Prior to any modifications of the wetland catchment, and prior to any infrastructure developments around Lake Boort (referred to as 'pre-regulation')
2. Infrastructure and catchment modifications that were undertaken by early European settlers around the local district during the late nineteenth century (referred to as 'during regulation')
3. Loddon River regulation during the early twentieth century (referred to as 'post-regulation').

4.1.1. Pre-regulation

Prior to regulation in the Loddon River system, Lake Boort would have received water during flood events primarily in winter and spring, and would have dried during summer. Water entering Lake Boort originates from the Kinypanial Creek (refer to Figure 7 and Figure 8), which is fed by two mechanisms. In large flood events water from the Loddon River would have overtopped and entered Kinypanial Creek (prior to the two systems being linked as they are now), while smaller rainfall events on the Borung Hills contribute flows to Kinypanial Creek which flows into Lake Boort (Haw and Munro, 2010). At this time the wetland was considered to be a Red Gum dominated freshwater marsh approximately 1.5m deep (Parks Victoria 2003).

Figure 7. Kinypanial Creek flowing to Lake Boort, September 2010.

Figure 8. Kinypanial Creek flowing into Lake Boort. September 2010.

Once Lake Boort filled, water would have spilled west to Little Lake Boort, and north to Lake Lyndger. Once engaging these wetlands, water would then have flowed northwards, picking up water from the distributary channels out of the Loddon River, and filled the rest of the wetlands between Boort and Kerang.

4.1.2. During regulation

During the mid to late nineteenth century, a number of developments in the Loddon floodplain (including the area influencing Lake Boort) were undertaken by the early settlers. There was a desire to make water more reliable in the wetlands around Boort during the mid-1800s, and the following projects were undertaken (Haw and Munro 2010):

- construction of a weir across Kinypanial Creek as it runs into Lake Boort to increase the duration of water being held in Lake Boort
- 'Blackfellows Creek' was constructed to link the Loddon River with Kinypanial Creek (this was not a natural linkage as Kinypanial Creek runs parallel to the Loddon River) and divert more water to the Boort wetlands
- the full supply level of Lake Boort was artificially increased through the construction of a sill on the northern drainage point of the wetland so as it held more water and was a more reliable source of water particularly for stock (Parks Victoria 2003).

The effects of these projects were significant on the ecology and environmental condition of Lake Boort. Water entered the wetland on a more frequent basis, and was held for longer duration. It is likely that at this time the River Red Gums through the bed of Lake Boort begun to die from excess inundation (Figure 9) (Haw and Munro 2010).

In 1883 the excess water entering Lake Boort was somewhat controlled when a structure was constructed on Blackfellows Creek which was then used to directly divert water for irrigation rather than passing all water into Lake Boort (Figure 10) (Haw and Munro 2010).

Widespread deforestation of Red Gums from Lake Boort occurred during the war years when 250,000 tonnes of dead timber was removed from the bed of the wetland and sent to Melbourne (Haw and Munro 2010).

Figure 9. Drowned River Red Gums in the bed of Lake Boort. December 2010

Figure 10. Blackfellows Creek with disused regulating structure, Loddon River in background.

4.1.3. Post-regulation

With regulation of the Loddon River System and irrigation system development in the early 1920s (North Central CMA 2010), Lake Boort was often used as a discharge area for excess or poor quality water that could not be used for other purposes. Therefore, while the incidence of natural floods in the catchment declined due to river regulation and floodplain modification (e.g. through the construction of levees), water was artificially maintained in the lake through system operations. During the late-twentieth century, the sill level of Lake Boort was lowered by 900mm and new culverts were installed under the road surrounding the wetland. These activities were undertaken to allow inundation to be more indicative of a natural inundation extent, and assist with floodwater movement through the floodplain (Parks Victoria 2003; Hillemacher and Ivezich 2008). GHD (2005) note that the lower Loddon floodplain has been highly modified through the construction of levees.

As the floodplain is extremely flat, even small levees can alter water movement through the landscape. As such, it is anticipated that less natural flows reach Lake Boort in comparison with natural conditions (GHD 2005).

Current environmental water delivery to Lake Boort can occur through various mechanisms. Water from the Waranga Western Channel can be delivered directly to the western side of Lake Boort via the Pyramid-Boort Channel 3 (with a capacity of 100ML/day [Hillemacher and Ivezich 2008]) (Figure 11). In addition, water can be delivered through this channel to Little Lake Boort (western side of the channel at 80ML/day [Hillemacher and Ivezich 2008]) and then passed through the Little Lake Boort Flushing Channel which outfalls to Lake Boort (Figure 12). Finally, water from the Pyramid-Boort Channel 2/2 can be delivered to Kinypanial Creek via Boag's Weir (Figure 13) which outfalls to Kinypanial Creek and then Lake Boort from the south (Figure 8).

While water can still naturally enter Lake Boort (i.e. it is not disconnected from the floodplain), this will occur primarily via overland flows from the west (Borung and Wedderburn) entering Kinypanial Creek. In large enough floods the structure on Blackfellows Creek will be overtopped and/or water will flow around the sides of the structure and enter Kinypanial Creek.

The combination of these three methods were utilised during late-2010 in order to maximise the delivery capacity to Lake Boort and assist with flood mitigation.

Figure 11. Pyramid-Boort channel 3 outfalling to Lake Boort. September 2010

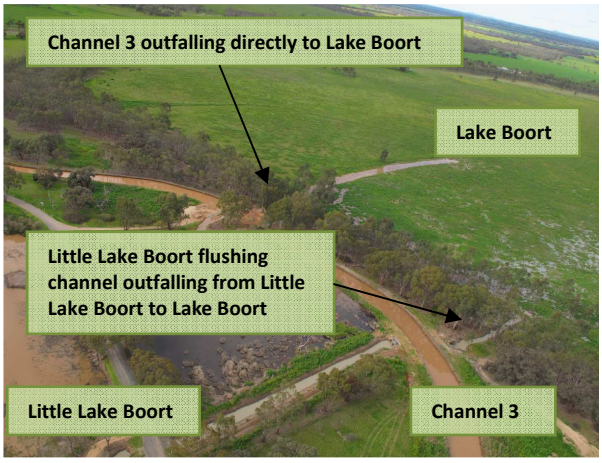

Figure 12. Lake Boort, Little Lake Boort, Pyramid-Boort channel 3 and flushing channel in operation in September 2010.

Figure 13. Boag's Weir linking Pyramid-Boort Channel 2/2 with Kinypanial Creek.

5. CONDITION AND THREATS

5.1. Current condition

A detailed vegetation assessment was completed on Lake Boort in 2001 by Hadden and Ellice (2001) which collected baseline data on the nature and condition of vegetation in Lake Boort. They found that the wetland was in moderate condition with higher native species richness and cover recorded than those of introduced species (Hadden and Ellice, 2001 in Ecos, 2007). The areas of highest conservation significance were recorded around the edge of the wetland and the Black Box woodland (Hadden and Ellice, 2001 in Ecos, 2007). The improvement of these areas into the future will occur through the provision of environmental water to the EVC classes Red Gum Swamp (EVC 292) and Plains Woodland (803).

An additional field survey on Lake Boort was completed in 2007 which investigated vegetation zones rather than individual vegetation species (Ecos 2007). At this stage the wetland had been dry for eight years, and as such the wetland biota was particularly typical of a site dominated with terrestrial species such as annual pasture grasses (Ecos 2007). It is expected that the 2010-11 flood inundation will have drowned these terrestrial species, and begun recruitment of species more typical of a wetland environment. The provision of environmental water into the future will ensure that that favourable EVCs in Lake Boort (those that were described in section 3.1.3) will improve in condition into the future.

It is recommended that a full Index of Wetland Condition (IWC) assessment be undertaken on Lake Boort during the wetland draw-down phase of the watering regime to gain baseline data about the state of the biological, physical, and chemical components of the wetland ecosystem and their interactions (refer to Appendix 6) (DSE 2005).

5.2. Water dependent threats

General threats to wetlands analysed through the Plan process have been informed by the Aquatic Value Identification and Risk Assessment (AVIRA) process developed by DSE (DSE 2009a). The threat categories are outlined below and these have been used to identify specific threats and their likelihood of impacting Lake Boort (shown in Table 9).

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

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

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

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

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

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

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

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

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

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

Degraded habitats (soil disturbance in particular):

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

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

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

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

Reduced connectivity (reduced wetland connectivity):

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

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

Table 9. Possible threats and likelihood of detrimental impacts occurring Lake Boort Boort (as compared to pre-regulation condition detailed in section 4).

Threat	Likelihood of detrimental impact on wetland	Comment
Altered water regime	Medium-High	The watering regime for Lake Boort has been significantly altered during early settlement (e.g. construction of Blackfellows Creek linking the Loddon River and Kinypanial Creek). Outfalls to Lake Boort from the irrigation supply system no longer occur. Natural flood events generated from the Borung Plains can still provide water to Lake Boort via Kinypanial Creek.
Altered physical form	Low	Physical form has changed significantly from historical, however is unlikely to alter significantly from current physical form.
Poor water quality	Medium	Environmental water entering Lake Boort is from the irrigation supply system and therefore is likely to be of reasonable quality. If irrigation tailwater is disposed of in Lake Boort again, the threat of poor water quality will rise.
Degraded habitats	Low	Low likelihood of habitat degradation occurring.
Exotic flora and fauna	Medium-High	Invasive flora species can create a monoculture within the wetland bed, to the detriment of native flora species and fauna species which rely on them. Where native flora species regenerate, there is a threat that they may be detrimentally impacted by browsing by invasive fauna species such as rabbits. Predation by exotic fauna on native species recruitment (e.g. fox predation on birds).
Reduced connectivity	Medium	Connectivity has reduced as compared to natural conditions, however there are still opportunities for fauna species in particular to move through the landscape.
Note: Ratings have been informed by Ecos (2007)		

5.3. Condition trajectory

One of the main detrimental impacts to Lake Boort's ecological condition historically was the maintenance of artificially high levels of inundation (due to an artificially high sill level prior to modification in early 2000s). In addition, the input of irrigation outfall water maintained the water in the wetland rather than allowing it to dry out naturally.

Since both these issues have been rectified, Lake Boort is considered to be on a much more preferable condition trajectory. However, the first decade of the twenty-first century saw Lake Boort remaining completely dry due to a prolonged drought, promoting the growth of invasive herbs, grasses and shrubs (Ecos 2007).

In 2001 Hadden and Ellice noted that there were three major factors influencing the vegetation condition at Lake Boort (Hadden and Ellice 2001 in Ecos 2007). These included the invasion by weeds, particularly annual grasses; grazing by rabbits (and historically sheep) which has disturbed shrub and ground-layers and increased the gaps for weed invasion; and artificially high water levels being maintained, influencing the health of River Red Gum and Black Box communities (Hadden and Ellice, 2001 in Ecos, 2007).

Without the input of environmental water to Lake Boort in accordance with the recommended watering regime (refer to Section 6), it is likely that the wetland will remain dominated by annual pasture grasses and weed species across the base of the wetland, thereby out-competing the native species typical of a wetland environment.

6. MANAGEMENT OBJECTIVES

6.1. Management goal

The environmental water management goal for Lake Boort has been based on information produced in Ecos (2007), and refined by the regional technical workshop participants. Workshop notes from this meeting are provided in Appendix 7.

Lake Boort environmental water management goal

To provide a water regime that supports the recruitment and maintenance of River Red Gum habitats, and ensures opportunities for waterbird foraging, nesting and breeding.

6.2. Ecological and hydrological objectives

6.2.1. Ecological objectives

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

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

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

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

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

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

The ecological objectives developed for Lake Boort are based on optimising the ecological values that the wetland provides. The ecological objectives for the site are described in Table 10 and have been reviewed by the regional technical workshop participants.

Table 10. Ecological objectives for the site

Ecological objective	Justification (value based)
Restore the distribution of live River Red Gums and associated floristic community (EVC 292) across the bed of Lake Boort. The number of live River Red Gums should be approximately ten per hectare with 10% canopy cover (as per the EVC benchmark) in the areas that are currently dominated by dead trees (~60% of wetland bed). Reinstate populations of non-tufted graminoids typical of EVC 292 such as Southern Cane Grass and Common Spike-sedge.	▪ Provision of habitat (including nesting areas in tree hollows for various duck species) and food source for waterbird species.[1] ▪ Provision of vegetation seed source for on-going recruitment.
Restore and rehabilitate vegetation species diversity typical of aquatic and semi-aquatic environments when the wetland is inundated.	▪ Provision of habitat for waterbird nesting (e.g. duck species that nest in aquatic vegetation).[2] ▪ Provision of secluded areas for waterbirds to be concealed from predators.[1] ▪ Provision of food source for herbivorous waterbirds.[1] ▪ Provision of shelter for macroinvertebrates and frogs, and promotion of these species as a food source for piscivores, omnivores and invertebrate waterbird feeders.[1,2]
Maintain current extent and restore health of Black Box vegetation surrounding the high water mark of Lake Boort (EVC 803: Plains woodland). Support the provision of open woodland consisting primarily of Black Box trees at approximately 15 trees per hectare (as per the EVC benchmark).	▪ Provision of habitat (roosting and nesting areas) for waterbird and terrestrial species.
[1] Source: Kingsford 1997 [2] Source: Roberts and Marston 2011	

6.2.2. Hydrological objectives

Hydrological objectives describe the components of the water regime required to achieve the ecological objectives at this site. The hydrological objectives are derived from an understanding of the local hydrology, using a 'landscape logic' for the site (Figure 14). The landscape logic identifies the relationship between vegetation communities, ecological objectives, position in the landscape and hydrological objectives (i.e. flow requirements).

The components of Lake Boort's wetland characteristics, along with the ecological objectives in Section 6.3.1 have been used to inform the following hydrological objectives. In particular, the watering requirements for each vegetation component have been established to optimise the responses, and provide for additional value (e.g. waterbird use) to be achieved.

Ecos (2007) describe habitat characteristics for Lake Boort in relation to two components of its hydrological regime.

When full, Ecos (2007, pg. 42) note that there is:

- *'Heavily vegetated areas adjacent to open water (margins on western shore where Cumbungi exists – this area will increase after successive full periods)*
- *Lightly vegetation areas adjacent to open water with roosting trees (majority of lake margin)*
- *Woodland near water*
- *Submerged (e.g. Eel grass and Milfoil) and floating vegetation in the open water…'*

In addition to the habitat characteristics listed above, it is expected that Lake Boort will also include a significant community of live River Red Gums across the bed of the wetland, replacing the dead

standing timber. These will be promoted by natural recruitment during water draw-down phases, and the provision of environmental water will need to consider the species requirements to optimise growth (as detailed below).

River Red Gums flower in during December and January and flowering lasts for four to six weeks (George 2004 in Roberts and Marston 2011). Seed fall occurs throughout the year, but peaks in September to November and germinate readily, thriving when conditions are favourable (Roberts and Marston 2011).

Seedlings and juvenile River Red Gum plants experience stress when fully submerged (Roberts and Marston 2011) so depth of inundation needs to be considered at Lake Boort according to the height of the recruiting plants. The depth of inundation becomes less important as seedlings grow taller (Roberts and Marston 2011). In addition, duration of inundation needs to be considered according to the developing plants. Once seedlings reach approximately 60cm tall, they can survive four to six months of shallow inundation (Dexter 1978 in Roberts and Marston 2011).

When drying out, Ecos (2007, pg. 42) states that Lake Boort is considered to have a:

- *'Heavily vegetated area with no adjacent open water (margins on western shore where Cumbungi exists – this area will increase after successive full periods*
- *Lightly vegetated area with no adjacent open water (majority of wetland floor)*
- *Shallow water, mudflats*
- *Woodland near water'*

Lake Boort should be managed with both wetting and drying cycles so as to promote the vegetation components detailed above. In particular, the wetland will need to have an extended drying/dry regime (of up to three seasons) in order to promote the recruitment, growth and maintenance of Red Gums through the bed of the wetland. It is expected that their development will eventually replace the important ecological component provided by large trees in the bed of the wetland which was lost when the wetland was held artificially full and trees drowned.

It should be noted that the proposed hydrological regime relates to managed environmental water deliveries specifically for Lake Boort, and does not account for natural flood events. When these events occur, the ecological outcomes should be maximised by supplementing them with environmental water according to the identified ecological needs.

Table 11 details the hydrological objectives for Lake Boort.

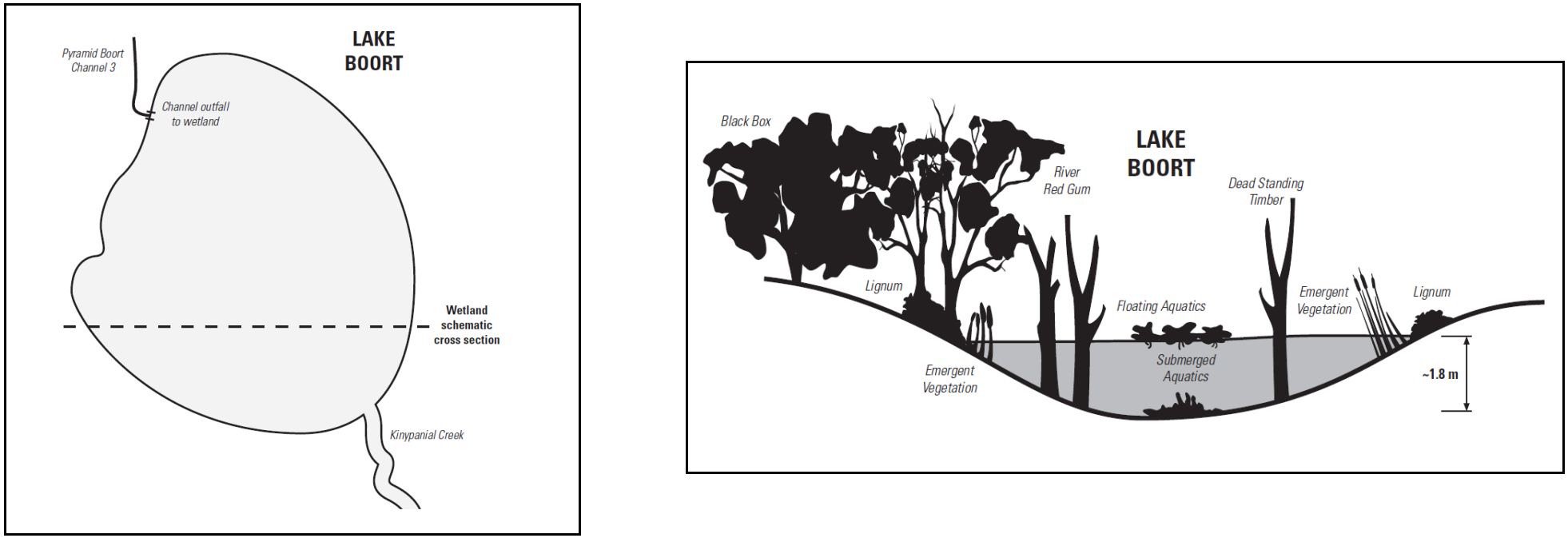

Figure 14. Schematic representation of the ecological components of Lake Boort.

Table 11. Hydrological objectives for the site

Ecological objective	Water management area	Hydrological objectives						
		Recommended frequency of events (number per 10 years)	Duration of flooding (months)	Preferred timing of inflows[1]	Target supply level (m ADH)	Volume to fill to target supply level[2] (ML)	Volume to maintain at TSL[3] (ML)	Total volume per event[4] (ML)
Restore the distribution of live River Red Gums and associated floristic community (EVC 292) across the bed of Lake Boort. The number of live River Red Gums should be approximately ten per hectare with 10% canopy cover (as per the EVC benchmark) in the areas that are currently dominated by dead trees (~60% of wetland bed). Reinstate populations of non-tufted graminoids typical of EVC 292 such as Southern Cane Grass and Common Spike-sedge.	Bed	To achieve vigorous growth of RRG, the general recommendation is three events per ten years[A]. Specifically for Lake Boort, a watering frequency of between two and four events per ten year period is proposed (ideal number is three events)[C]. Note: this will include partial top up avoiding inundation of saplings[C].	Duration of flooding in the target recruitment area should be between approximately five and seven/ eight months[A]. As juvenile RRG begin encroaching through the wetland bed, flood depth should be modified to ensure inundation of saplings does not exceed nine months[C].	Late winter / spring	90.79 (FSL fill, **event 1**)	5,818 + losses (FSL fill)	-	~6,370 required to fill to FSL
					Between 89.50 and 90.00 (**events 2 and 3**)	Between 831 and 2,591 + losses	-	Between ~ 1,000 and 3,000
Restore and rehabilitate vegetation species diversity typical of aquatic and semi-aquatic environments when the wetland is inundated.	Bed / Riparian	Between annual inundation and three events per ten years will promote growth[A].	Between eight and 12 months approximately[A].	Late winter / spring	Between 89.50 and 90.79	Between 831 and 5,818 + losses	-	Between 1,000 and ~6,370
Maintain current extent and restore health of Black Box vegetation surrounding the high water mark of Lake Boort (EVC 803: Plains woodland). Support the provision of open woodland consisting primarily of Black Box trees at approximately 15 trees per hectare (as per the EVC benchmark).	Riparian	To achieve vigorous growth of BB, the general recommendation is between one and three events per ten years[A]. Specifically in Lake Boort, a watering frequency of one event per ten year period is proposed[C].	Between three and six months approximately[A].	Late winter / spring	90.79	5,818 + losses	-	~6,370 required to fill to FSL

Note: Flooding frequency and duration of flooding have been based on: [A] Roberts and Marston (2011); [B] Stakeholder opinion on the tolerances of species specifically at Lake Boort (this may differ slightly to the published information and has only been used where there is a lack of published data); [C] A combination of published data from Roberts and Marston (2011) and Rogers and Ralph (2011) combined with stakeholder opinion.

[1] Based on information provided in Roberts and Marston (2011).

[2] Based on rating table and survey information by Price Merrett Consulting (2006). Refer to Appendix 8.

[3] As above.

[4] As above.

[5] For this objective, not every event should target filling to full supply level (refer to 6.3.3 for further discussion on this).

6.2.3. Watering regime

The wetland watering regime has been derived from the ecological and hydrological objectives. To allow for adaptive and integrated management, the watering regime is framed using the seasonally adaptive approach. This means that a watering regime is identified for optimal conditions, as well as the maximum and minimum tolerable watering scenarios. The minimum watering regime is likely to be provided in drought or dry years (as per the seasonally adaptive approach [DSE 2009b]), the optimum watering regime in average conditions, and the maximum watering regime in wet or flood years.

The optimal, minimum and maximum watering regimes are described below. Due to the inter-annual variability of these estimates (particularly the climatic conditions), determination of the predicted volume requirements in any given year will need to be undertaken by the environmental water manager when watering is planned. Furthermore, the watering regimes proposed only consider environmental water management. For example, should natural inundation of Lake Boort occur through flood flows, environmental water should be provided to maximise the ecological outcomes. This environmental water may be required in a different regime to those proposed below.

Minimum watering regime

Fill wetland to full supply level (90.79m AHD) in spring of year one, inundating River Red Gum communities and providing water to Black Box trees. Allow wetland to drawdown naturally over summer of year one and two, promoting River Red Gum germination through the bed of the wetland.

Allow wetland to remain completely dry over years three, four and five to allow River Red Gum growth and development, and provide a partial wetland fill in spring of year six. The target fill level should be based on the growth of River Red Gums through the base of the wetland, and should not overtop the trees.

Allow wetland to drawdown and dry during years six to ten before providing a wetland fill to full supply level again (year eleven).

Optimal watering regime

Fill wetland to full supply level (90.79m AHD) in spring of year one, inundating River Red Gum communities and providing water to Black Box trees. Allow wetland to drawdown naturally over summer of year one and two, promoting River Red Gum germination through the bed of the wetland.

Allow wetland to remain completely dry over years three and four to allow River Red Gum growth and development, and provide a partial wetland fill in spring of year five. The target fill level should be based on the growth of River Red Gums through the base of the wetland, and should not overtop the trees.

Allow wetland to drawdown and dry during years six and seven before providing another partial fill in year eight. Two more dry years should follow, before providing a wetland fill to full supply level again (year eleven).

Maximum watering regime

Fill wetland to full supply level (90.79m AHD) in spring of year one, inundating River Red Gum communities and providing water to Black Box trees. Allow wetland to draw down over summer and top up wetland in spring of year two, avoiding watering of the Black Box communities.

Allow wetland to drawdown naturally over summer of year two and three, promoting River Red Gum germination through the bed of the wetland.

Allow wetland to remain completely dry over years four and five to allow River Red Gum growth and development, and provide a partial wetland fill in spring of year six. The target fill level should be based on the growth of River Red Gums through the base of the wetland, and should not overtop the trees.

Allow wetland to drawdown and dry during years seven and eight before providing another partial fill in year nine. Two more dry years should follow, before providing a wetland fill to full supply level again (year eleven).

6.3. Implementation

6.3.1. Seasonally adaptive approach

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

The seasonally adaptive approach identifies the priorities for environmental watering, works and complementary measures, depending on the amount of water available in a given year. It is a flexible way to deal with short-term climatic variability and helps to guide annual priorities and manage droughts. The approach is outlined in Table 12.

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

While Lake Boort can provide drought refuge functions within the landscape, its size and the volume of water required to fill the wetland to full supply level means that Lake Boort is less receptive to environmental watering during drought conditions than some of the other wetlands within the Boort wetland complex (e.g. Lake Yando and Lake Leaghur). As water availability increases with average and wet scenarios, there is a requirement to provide all aspects of the flow regime and to promote breeding and recovery (refer to Table 12). In these scenarios a wetland fill for Lake Boort should be considered a priority due to its value as a shallow freshwater marsh, and its ability to provide habitats for waterbirds.

Wetland watering events for Lake Boort should not always promote a wetland fill to full supply level. In some seasons there will be a need to only provide a partial fill so as not to overtop regenerating River Red Gums from previous watering events. Therefore, volumes of environmental water required will vary considerably from season to season, depending on the level of inundation required.

Lake Boort's position in the landscape and connectivity with the irrigation system means that the wetland can be relatively quickly and easily supplied with surplus water in a high rainfall or flood event. As surplus water arrives at Loddon Weir from further upstream, it can be transferred into the Waranga Western Channel and fed into Pyramid-Boort Channel 3 for delivery directly to Lake Boort (subject to the availability of channel capacity for delivery).

Table 12. The seasonally adaptive approach to river and wetland management (DSE, 2009b)

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

7. POTENTIAL RISKS OF AND MITIGATION MEASURES FOR ENVIRONMENTAL WATERING

A risk identification process has been undertaken to investigate the risks associated with environmental water delivery and site management at Lake Boort and is presented in Table 13.

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

Table 13. Possible risks and mitigation measures associated with environmental water delivery to Lake Boort.

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

Continued

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

8. ENVIRONMENTAL WATER DELIVERY INFRASTRUCTURE

8.1. Constraints

The only current constraint to environmental water delivery at Lake Boort relates to its reliance on the irrigation system to deliver flows. When water is targeted for delivery to Lake Boort, irrigation demand will have to be considered to ensure sufficient channel capacity is available for full delivery of environmental water to occur. While there is no unallocated channel capacity if all entitlement holders wanted to access their water at the same time (Hillemacher and Ivezich 2008), it is anticipated that there will be times when demand on the system is low and environmental water could be delivered through the system. Goulburn-Murray Water as the rural water corporation will be engaged in the planning for environmental water use at Lake Boort to ensure delivery can occur at the required rate over the optimal timeframe.

8.2. Irrigation modernisation

The Northern Victorian Renewal Project (NVIRP) is a program which aims to upgrade existing irrigation infrastructure in the Goulburn-Murray Irrigation District to achieve water savings. The outfall structure to Lake Boort was upgraded in this process and there are no further plans to modify delivery structures or channels that feed Lake Boort.

In addition to the infrastructure upgrade at Lake Boort, there may be implications on the ability to deliver environmental water to Lake Boort in response to changed demands on the irrigation system by other entitlement holders (e.g. through demand and supply of water through various channel systems).

8.3. Infrastructure recommendations

No infrastructure recommendations are made at this time. The implications of NVIRP activities on the long-term ability to provide environmental water through the irrigation system to Lake Boort should be investigated further.

9. KNOWLEDGE GAPS AND RECOMMENDATIONS

There are currently a number of knowledge gaps in relation to environmental water management at Lake Boort. While none of these impact the ability to provide water to the wetland and generate ecological benefit, the addressing of these knowledge gaps would significantly improve the accuracy of environmental water bids, and provide long-term ecological understanding of the site.

Specifically, the following activities are recommended to be undertaken along with long-term investment of environmental water to Lake Boort:

- complete IWC assessment to determine baseline wet phase / drawdown conditions
- complete a full aquatic and riparian flora survey (including mapping wetland EVCs)
- develop a long and short-term monitoring program to be used in conjunction with environmental watering proposals and delivery plans including the following:
    - identifying ecological indicators for monitoring long-term ecological condition and change
    - identifying ecological indicators for monitoring the ecological response of the wetland to flooding
    - quantifying 'triggers' for mitigation measures as identified as potential risks
- support Parks Victoria with site management activities at Lake Boort, including cultural heritage management and recreational use of the wetland.

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APPENDIX 1: CORRICK AND NORMAN CLASSIFICATION OF WETLAND CATEGORIES

Source: DSE 2007b

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

APPENDIX 2: ENVIRONMENTAL WATER SOURCES

Commonwealth Environmental Water Holder (CEWH)

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

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

Victorian Environmental Water Holder (VEWH)

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

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

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

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

River Murray Unregulated Flow (RMUF)

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

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

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

APPENDIX 3: LEGISLATIVE FRAMEWORK

International agreements and conventions

Ramsar Convention on Wetlands (Ramsar)

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

Bilateral migratory bird agreements

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

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

These agreements require that the parties protect migratory birds by:

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

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

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

Commonwealth legislation

Environment Protection and Biodiversity Conservation Act 1999 (EPBC)

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

Water Act 2007 (Commonwealth Water Act)

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

Aboriginal and Torres Straight Islander Heritage Protection Act 1984

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

State legislation and listings

Flora and Fauna Guarantee Act 1988 (FFG)

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

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

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

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

Environmental Effects Act 1978

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

Planning and Environment Act 1987

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

Water Act 1989 (Victorian Water Act)

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

Aboriginal Heritage Act 2006

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

Other relevant legislation

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

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

APPENDIX 4: ECOLOGICAL VEGETATION CLASSES

Figure 15 shows the Ecological Vegetation Classes mapped at Lake Boort.

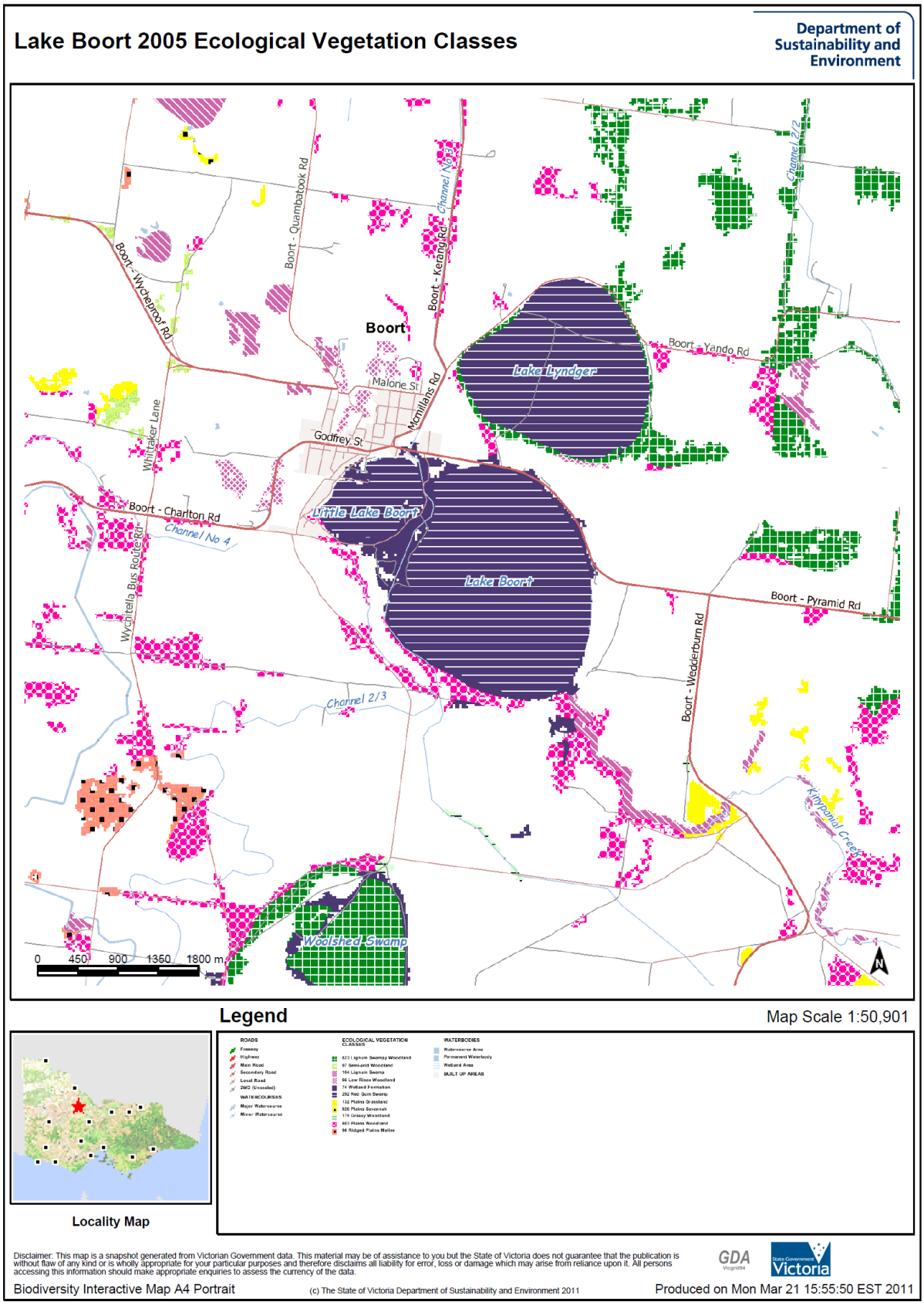


Figure 15. EVCs recorded at Lake Boort, and their location

Department of Sustainability and Environment

EVC/Bioregion Benchmark for Vegetation Quality Assessment

Victorian Riverina bioregion

EVC 292: Red Gum Swamp

Description:
Open woodland to 15 m tall with a diverse understorey dominated by sedgy or grassy-herbaceous aquatics and species tolerant of intermittent to seasonal inundation. Occurs on alluvial plains in the seasonally wet depressions of shallow drainage lines or prior stream meanders, typically associated with heavy paludal soils, sometimes with gilgai development. The annual rainfall across its distribution is generally below 700 mm, and the period of inundation may range from 2 to 6 months.

Large trees:

Species	DBH(cm)	#/ha
Eucalyptus spp.	80 cm	10 / ha

Tree Canopy Cover:

%cover	Character Species	Common Name
10%	*Eucalyptus camaldulensis*	River Red-gum

Understorey:

Life form	#Spp	%Cover	LF code
Immature Canopy Tree		5%	IT
Understorey Tree or Large Shrub	1	10%	T
Medium Herb	1	15%	MH
Large Tufted Graminoid	2	5%	LTG
Medium to Small Tufted Graminoid	2	10%	MTG
Medium to Tiny Non-tufted Graminoid	2	40%	MNG
Bryophytes/Lichens	na	10%	BL
Total understorey projective foliage cover		**90%**	

LF Code	Species typical of at least part of EVC range	Common Name
MH	*Potamogeton tricarinatus s.l.*	Floating Pondweed
MH	*Gratiola peruviana*	Austral Brooklime
SH	*Lobelia pratioides*	Poison Lobelia
LTG	*Juncus flavidus*	Gold Rush
LTG	*Carex tereticaulis*	Hollow Sedge
MTG	*Triglochin procerum s.l.*	Water Ribbons
MTG	*Whalleya proluta*	Rigid Panic
MTG	*Lachnagrostis filiformis var. filiformis*	Common Blown-grass
MNG	*Eleocharis acuta*	Common Spike-sedge
MNG	*Eragrostis infecunda*	Southern Cane-grass

Recruitment:
Episodic/Flood. Desirable period between disturbances is 5 years.

Organic Litter:
20 % cover

Logs:
15 m/0.1 ha.

Weediness:

LF Code	Typical Weed Species	Common Name	Invasive	Impact
SH	*Callitriche hamulata*	Thread Water-starwort	high	low

EVC 292: Red Gum Swamp - Victorian Riverina bioregion

Published by the Victorian Government Department of Sustainability and Environment October 2005

For more information contact: Customer Service Centre, 136 186

www.dse.vic.gov.au

Department of Sustainability and Environment

EVC/Bioregion Benchmark for Vegetation Quality Assessment

Victorian Riverina bioregion

EVC 803: Plains Woodland (*syn. Riverina* Plains Grassy Woodland)

Description:
An open, eucalypt woodland to 15 m tall occurring on a number of geologies and soil types. Occupies fertile clays and clay loam soils on flat or gently undulating plains at low elevations in areas with <600 mm annual rainfall. The understorey consists of a few sparse shrubs over a species-rich grassy and herbaceous ground layer and chenopods are often present.

Large trees:

Species	DBH(cm)	#/ha
Eucalyptus spp.	70 cm	15 / ha
Eucalyptus largiflorens	50 cm	
Allocasuarina spp.	40 cm	

Tree Canopy Cover:

%cover	Character Species	Common Name
15%	*Eucalyptus microcarpa*	Grey Box
	Eucalyptus melliodora	Yellow Box
	Eucalyptus camaldulensis	River Red Gum
	Eucalyptus largiflorens	Black Box
	Eucalyptus leucoxylon	Yellow Gum
	Allocasuarina luehmannii	Buloke

Understorey:

Life form	#Spp	%Cover	LF code
Immature Canopy Tree		5%	IT
Medium Shrub	2	1%	MS
Small Shrub	1	1%	SS
Large Herb	1	5%	LH
Medium Herb	11	25%	MH
Small or Prostrate Herb	2	5%	SH
Large Tufted Graminoid	1	5%	LTG
Medium to Small Tufted Graminoid	15	45%	MTG
Medium to Tiny Non-tufted Graminoid	2	5%	MNG
Bryophytes/Lichens	na	10%	BL

LF Code	Species typical of at least part of EVC range	Common Name
MS	*Acacia montana*	Mallee Wattle
MS	*Acacia acinacea* s.l.	Gold-dust Wattle
MS	*Acacia pycnantha*	Golden Wattle
MS	*Pittosporum angustifolium*	Weeping Pittosporum
SS	*Pimelea curviflora* s.l.	Curved Rice-flower
SS	*Eutaxia microphylla var. microphylla*	Common Eutaxia
SS	*Enchylaena tomentosa* var. *tomentosa*	Ruby Saltbush
SS	*Sclerolaena diacantha*	Grey Copperburr
LH	*Ajuga australis*	Austral Bugle
LH	*Senecio quadridentatus*	Cotton Fireweed
MH	*Calocephalus citreus*	Lemon Beauty-heads
MH	*Maireana enchylaenoides*	Wingless Bluebush
MH	*Einadia hastata*	Saloop
MH	*Einadia nutans* ssp. *nutans*	Nodding Saltbush
SH	*Crassula sieberiana*	Sieber Crassula
SH	*Actinobole uliginosum*	Flannel Cudweed
SH	*Oxalis perennans*	Grassland Wood-sorrel
SH	*Calotis hispidula*	Hairy Burr-daisy
LTG	*Austrostipa aristiglumis*	Plump Spear-grass
MTG	*Austrodanthonia caespitosa*	Common Wallaby-grass
MTG	*Dianella revoluta* s.l.	Black-anther Flax-lily
MTG	*Austrostipa scabra*	Rough Spear-grass
MTG	*Enteropogon acicularis*	Spider Grass

Victoria The Place To Be

EVC 803: Plains Woodland (*syn. Riverina* Plains Grassy Woodland) - Victorian Riverina bioregion

Recruitment:
Continuous

Organic Litter:
10 % cover

Logs:
10 m/0.1 ha.

Weediness:

LF Code	Typical Weed Species	Common Name	Invasive	Impact
MS	*Lycium ferocissimum*	Boxthorn	low	high
LH	*Brassica tournefortii*	Mediterranean Turnip	high	high
LH	*Sonchus oleraceus*	Common Sow-thistle	high	low
LH	*Opuntia* spp	Prickly Pear	low	high
MH	*Gazania linearis*	Gazania	high	high
MH	*Spergularia rubra* s.l.	Red Sand-spurrey	high	low
MH	*Silene apetala* var. *apetala*	Sand Catchfly	high	low
MH	*Silene longicaulis*	Portuguese Catchfly	high	low
MH	*Hypochoeris radicata*	Cat's Ear	high	low
MH	*Trifolium angustifolium* var. *angustifolium*	Narrow-leaf Clover	high	low
MH	*Arctotheca calendula*	Cape Weed	high	low
MH	*Trifolium campestre* var. *campestre*	Hop Clover	high	low
MH	*Trifolium arvense* var. *arvense*	Hare's-foot Clover	high	low
MH	*Trifolium subterraneum*	Subterranean Clover	high	low
MH	*Hypochoeris glabra*	Smooth Cat's-ear	high	low
MH	*Trifolium dubium*	Suckling Clover	high	low
SH	*Trifolium glomeratum*	Cluster Clover	low	low
SH	*Medicago minima*	Little Medic	high	low
LTG	*Phalaris aquatica*	Toowoomba Canary-grass	high	high
MTG	*Lolium rigidum*	Wimmera Rye-grass	low	low
MTG	*Schismus barbatus*	Arabian Grass	high	low
MTG	*Poa bulbosa*	Bulbous Meadow-grass	high	high
MTG	*Pentaschistis airoides* subsp. *airoides*	False Hair-grass	high	high
MTG	*Romulea rosea*	Onion Grass	high	high
MNG	*Bromus rubens*	Red Brome	high	high
MNG	*Vulpia myuros*	Rat's-tail Fescue	high	low
MNG	*Romulea rosea*	Onion Grass	high	low
MNG	*Briza minor*	Lesser Quaking-grass	high	low
MNG	*Briza maxima*	Large Quaking-grass	high	low
MNG	*Vulpia bromoides*	Squirrel-tail Fescue	high	low
MNG	*Aira elegantissima*	Delicate Hair-grass	high	low
MNG	*Juncus capitatus*	Capitate Rush	high	low
SC	*Asparagus asparagoides*	Bridal Creeper	high	high

Published by the Victorian Government Department of Sustainability and Environment May 2004

www.dse.vic.gov.au

Department of Sustainability and Environment

EVC/Bioregion Benchmark for Vegetation Quality Assessment

Victorian Riverina bioregion

EVC 104: Lignum Swamp

Description:
Typically treeless shrubland to 4 m tall with robust (but sometimes patchy) growth of lignum. Widespread wetland vegetation type in low rainfall areas on heavy soils, subject to infrequent inundation resulting from overbank flows from rivers or local runoff.

Life forms:

Life form	#Spp	%Cover	LF code
Medium Shrub	1	20%	MS
Large Herb*	4	5%	LH
Medium Herb*	8	25%	MH
Small or Prostrate Herb*	2	10%	SH
Large Non-tufted Graminoid	1	5%	LNG
Medium to Small Tufted Graminoid	2	5%	MTG
Medium to Tiny Non-tufted Graminoid*	2	5%	MNG
Scrambler or Climber	1	1%	SC
Soil crust*	na	10%	S/C
Total understorey projective foliage cover		**75%**	

* Largely seasonal life form

LF Code	Species typical of at least part of EVC range	Common Name
MS	*Muehlenbeckia florulenta*	Tangled Lignum
MS	*Chenopodium nitrariaceum*	Nitre Goosefoot
SS	*Sclerolaena tricuspis*	Three-spined Bassia
SS	*Sclerolaena muricata*	Five-spined Bassia
LH	*Rumex* spp.	Dock
MH	*Marsilea drummondii*	Common Nardoo
MH	*Goodenia* spp.	Goodenia
MH	*Ranunculus* spp.	Buttercup
LNG	*Eragrostis australasica*	Cane Grass
MNG	*Eragrostis infecunda*	Barren Cane grass
MTG	*Juncus* spp.	Rush
MNG	*Eleocharis* spp.	Spike-sedge
SC	*Asperula gemella*	Twin-leaf Bedstraw

Recruitment:
Continuous

Organic Litter:
5% cover

Weediness:

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

EVC 104: Lignum Swamp - Victorian Riverina bioregion

Published by the Victorian Government Department of Sustainability and Environment October 2005

For more information contact: Customer Service Centre, 136 186

www.dse.vic.gov.au

APPENDIX 5: RECENT WATERING HISTORY

Lake Boort was maintained with channel outfall water during the 1990s. Between 1990 and 1997 the wetland held water at levels between half and full capacity. The wetland dried during 1997-98, and remained dry until spring 2010 when environmental water provided though surplus water availability in the Loddon System, followed by natural flooding events in late 2010 and early 2011.

Wetland		1990-1991	1991-1992	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000
Lake Boort	Status *	W	W	W	W	W-D	W-D	D	W	W	W
	Water source #	U	U	U	U	U	-	-	U	U	U
	Volume delivered (if available)	-	-	-	-	-	-	-	-	-	-

Wetland		2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
Lake Boort	Status [1]	D	D	D	D	D	D	D	D	D	D	W
	Water source [2]	-	-	-	-	-	-	-	-	-	-	E/F
	Volume delivered (if available)	-	-	-	-	-	-	-	-	-	-	> 4,852

[1] Water present / dry wetland
[2] Environmental water allocation / Boort irrigation system / Flood mitigation / Unknown / Channel outfall / na

APPENDIX 6: INDEX OF WETLAND CONDITION METHOD

Sub-indices

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

IWC sub-indices and measures

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

Scoring method

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

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

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

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

APPENDIX 7: WORKSHOP OUTCOMES

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

Lake Boort overview:

- Live River Red Gums (RRG) surround Lake Boort, with dead timber present across the bed of the wetland.
- Modifications to the wetland (e.g. raising outlet level) resulted in drowning of the RRG through the wetland bed.
- The sill level was reduced in late 1990s to lower full supply level of wetland.
- Key question was raised to inform the management objectives: Do we want to target/promote live RRG across the bed of the wetland, or only around the edge?
- If RRG recruitment through the wetland bed is the aim, we would need to target a shorter wet cycle / longer dry cycle to promote growth and survival of the saplings (without drowning them).
- In order to get RRG through wetland bed, there may need to be active restoration in conjunction with environmental water (active planting, rabbit control etc).
- Lake Boort is considered one of the most culturally significant sites in Victoria due to the number of scarred trees, mounds etc (within bed and around lunette). Therefore, any active management (plantings etc) would need to be carefully considered to avoid any disturbance.
- There is an old cropped area (on the north-western side of the wetland) that has been heavily disturbed in the past. Perhaps this area could receive active planting without cultural heritage disturbance? Presumably all channels would have to covered off (e.g. Cultural Heritage Management Plan) prior to undertaking any works in any section of the wetland.
- Black Box trees between Little Lake Boort and Lake Boort would receive water in the big wetland fill events, but still wouldn't get completely inundated. It is expected that a full inundation will not be required to maintain/improve their condition.
- During the dry phase of Lake Boort, there was a large load of dry grasses which was considered to pose a fire risk for the town.
- Regime being proposed is wetter than has been observed over the past decade and may aid with reducing the risk of fire in the wetland.
- With the promotion of RRG recruitment, do we need to think about rabbit control as well? It is not considered as high a priority as other wetlands, but worth keeping an eye on.
- During wet years there is a need to consider the flooding regime and implications for Lake Lyndger and downstream wetlands. Need to make sure there is 'dead-storage' within the floodplain when we are considering environmental water management in Lake Boort.

Lake Boort recommendations:

- It was agreed that live RRG across the bed of Lake Boort would be a good outcome for the wetland. It is a Red Gum Swamp and therefore the goal of RRG recruitment would be a good goal.
- Need to be mindful of not overtopping young saplings in any subsequent watering event, but promote growth.
- Natural recruitment would need watering but not very often – 3-4 years between events (probably at low level of inundation so as not to drown out).
- When wet, aquatic and semi-aquatic species will be prevalent.
- Recommended watering regime developed by group is shown below:

Year	Optimal watering regime
One	Flood wetland to full supply in spring, inundating existing River Red Gum communities surrounding wetland.
Two	Allow wetland to draw down naturally (allowing River Red Gum germination through the bed of the wetland).
Three	Allow wetland to dry / remain dry (promoting River Red Gum growth through wetland bed).
Four	Allow wetland to remain dry (promoting River Red Gum growth through wetland bed).
Five	Partially fill wetland with level of fill to be based on height and distribution of River Red Gum growth (i.e. do not want to drown out individuals so no a full supply fill).
Six	Allow wetland to draw down naturally (promoting River Red Gum growth through wetland bed).
Seven	Allow wetland to remain dry (promoting River Red Gum growth through wetland bed).
Eight	Partially fill wetland with level of fill to be based on height and distribution of River Red Gum growth (i.e. do not want to drown out individuals).
Nine	Allow wetland to draw down naturally (promoting River Red Gum growth through wetland bed).
Ten	Allow wetland to remain dry (promoting River Red Gum growth through wetland bed).

- After the first ten-year cycle, subsequent events can be targeted to promote encroachment of RRG in toward the centre of the wetland , therefore a fill to FSL would not always be required
- Complex of wetlands within Boort area (Woolshed Swamp, Lake Boort, Lake Lyndger, Lake Yando, Lake Leaghur, Lake Meran) gives a good diversity of habitats within the region.

APPENDIX 8: CONTOUR PLAN AND CAPACITY TABLE

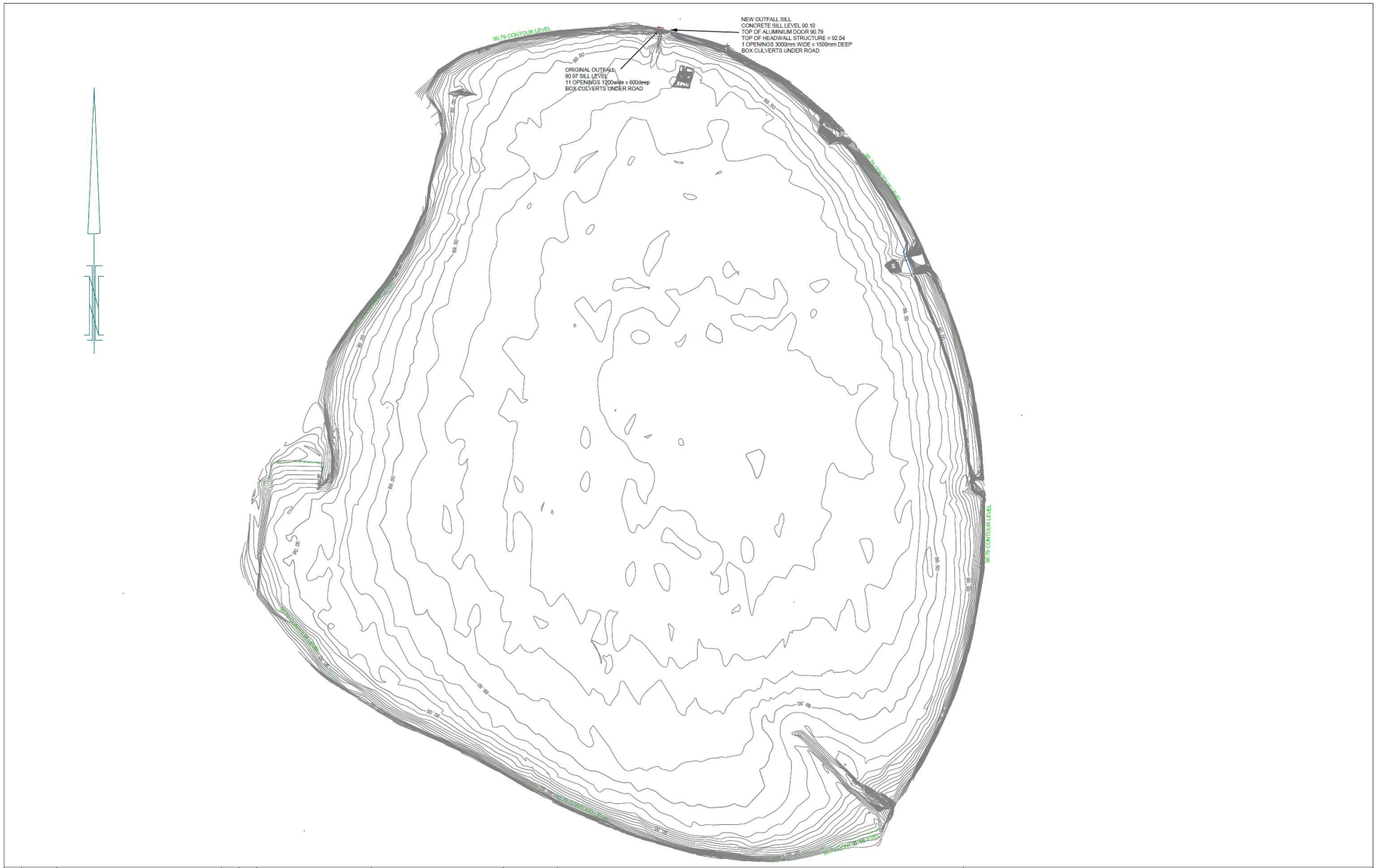
Source: Price Merrett Consulting (2006)

LAKE BOORT

RATING CURVE TABLE

ELEVATION AHD	SURFACE AREA (Ha)	VOLUME STORED (MEGALITRES)	
89.00	0.630	0.43	
89.10	5.286	18.02	
89.20	156.550	124.24	
89.30	215.030	311.56	
89.40	261.740	550.89	
89.50	297.860	831.29	
89.60	325.250	1143.14	
89.70	348.170	1480.32	
89.80	364.750	1837.26	
89.90	377.250	2208.18	
90.00	387.780	2591.18	
90.10	395.640	2983.00	CONCRETE SILL ELEVATION - NEW OUTFALL STRUCTURE
90.20	401.790	3381.81	
90.30	406.500	3786.05	
90.40	410.330	4194.51	
90.50	413.670	4606.55	
90.60	416.590	5021.74	
90.70	419.050	5439.59	
90.79	421.030	5817.62	TOP OF ALUMINIUM DOOR (OVERFLOW LEVEL) - NEW OUTFALL STRUCTURE
90.80	421.260	5859.73	
90.90	423.560	6282.13	
90.97	425.220	6579.21	CONCRETE SILL OF OLD OUTFALL

Note - volumes are cumulative volumes



0	6/11/2006	ORIGINAL CREATED	NHC	RJM
		REVISIONS	DRN	CHKD

JOB DETAILS

DESIGNED :
DRAWN : N.H. CARMICHAEL
SURVEY DATE : OCTOBER 2006
DATUM : A.H.D.
GRID INTERVAL : RANDOM
LEVEL BOOK :
FIELD BOOK :
AREA :

SCALE OF METRES
75 0 150 300
ORIGINAL DRAWING SCALE
1 IN 7500 (A2 SHEET SIZE)

GDA ZONE 54

Price Merrett Consulting Pty.Ltd.
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NORTH CENTRAL CATCHMENT MANAGEMENT AUTHORITY

CONTOUR LEVEL SURVEY

LAKE BOORT

CROWN ALLOTMENT	SECTION	PARISH	FILE NUMBER	SHEET NUMBER	DRAWING No.	REVISION	SHEET SIZE
			F3982	1 of 1	2230	0	A2