GOULBURN-MURRAY WATER

Attachment 4 to Third Reedy Lake EES referral

GMW Connections Project

Kerang Lakes Bypass Project summary overview

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Glossary and abbreviations

Term/abbreviation	Definition
AAV	Aboriginal Affairs Victoria
Backbone	The GMID backbone channels comprise the major supply channels into and within GMW's irrigation areas that will be retained and modernised post the GMW CP.
B:C	Ratio of benefits to costs
CAMBA	China–Australia Migratory Bird Agreement
CBA	Cost-benefit analysis
Clth	Commonwealth Government
DEPI	Department of Environment and Primary Industries (Vic)
DTPLI	Department of Transport, Planning and Local Infrastructure (formerly Department of Planning and Community Development, DPCD)
discount rate	The exchange rate between a given value of money today and the same value in the future. Used in NPV analysis to reflect the opportunity cost of capital - for this analysis the GMW WACC was used.
EES	Environmental Effects Statement required in certain circumstances under the Environment Effects Act (1978) (Vic).
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Cth)
ERP	Expert Review Panel (GMWGCP)
ETAC	Environmental Technical Advisory Committee (GCP)
EVC	Ecological Vegetation Class
EWI	Environmental Watering Investigation – an investigation into wetland values, hydrology, objectives resulting in a recommended water regime that can be used to assess water savings and provide information for a business case. A EWI does not have the same status as a EWP. Information from a EWI can be used to develop a EWP at a later stage if required
EWP	Environmental Watering Plan (prepared for GMW by NCCMA). Plan setting out development of an appropriate environmental water regime and how it will be applied
FFG Act	Flora and Fauna Guarantee Act 1988 (Vic)
Flushing	The dilution of lake water to achieve acceptable and manageable salinity limits.
GL	Gigalitres
GMID	Goulburn Murray Irrigation District
GMW	Goulburn Murray Water
GMW CP	Goulburn Murray Water Connections Project (Formally NVIRP)
HRWS	High reliability water shares
JAMBA	Japan–Australia Migratory Bird Agreement
KLBP	Kerang Lakes Bypass Project
LAC	Limits of Acceptable Change
LTAAY	Long-term average annual yield (a weighted average probability of water allocation for a give water entitlement – which replaces the formerly-used LTCE)
LTCE	Long term cap equivalent (a weighted average probability of water allocation for a give water entitlement – now replaced by LTAAY)
mAHD	Metres Australian Height Datum (i.e., metres above 1966-1968 sea level)
ML, ML/d	Megalitres, megalitres/day (flow rate)
NC CMA	North Central Catchment Management Authority

Term/abbreviation	Definition
NPV	Net present value
NVIRP	Northern Victorian Irrigation Renewal Project, now known as the GMW Connections Project
PCG	Project Control Group (GCP Special Projects)
PRG	Project Reference Group (KLBP Phase 1)
Ramsar	The Convention on Wetlands of International Importance, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. Australia is a signatory. Wetlands listed on the Ramsar Convention are subject to particular protections.
REALM	REsource ALlocation Model (REALM)
RMCG	RM Consulting Group
ROKAMBA	Republic of Korea–Australia Migratory Bird Agreement
SCADA	Supervisory Control and Data Acquisition (used by GMW for remote computerised control of irrigation assets)
SKM	Sinclair Knight Merz
SRP	Scientific Review Panel (KLBP Phase 1)
TEV	Total Economic Value framework
TIA	Torrumbarry Irrigation Area (part of the GMID)
TRAMS	Torrumbarry Reconfiguration and Modernisation Strategy
Vic	Victoria
WACC	Weighted average cost of capital
WCMF	Water Change Management Framework (a requirement of the Victorian Minister for Planning's conditional 'no EES' decision, in response to GCP's referral under the Environment Effects Act (1978))

INTRODUCTION

This document provides a summary overview of the Kerang Lakes Bypass Project (KLBP). It will accompany the State and Federal environmental referrals providing background information on the KLBP. Reference is made to Attachments that should be sourced for further detail on the subject.

The KLBP is part of the Victorian Priority Project under the Intergovernmental Agreement on Murray-Darling Basin Reform (2008). The KLBP is a proposal under Stage 2 of Goulburn Murray Water's Connections Project (GMW CP), a $1 billion water saving project in northern Victoria's Goulburn Murray Irrigation District (GMID).

The GMW CP has sought to identify cost effective and value for money investments to generate water savings and environmental benefits. Several 'special environmental' projects including the KLBP, were included in Stage 2 and these projects provided opportunities for specific environmental and social benefits whilst generally improving the overall efficiency of the irrigation system.

1 THE KERANG LAKES

Referral Section	2	Source/more information	

The project region is in northern Victoria, close to Kerang and south of Swan Hill.

The Kerang Lakes complex is a system of over 100 permanent and freshwater wetlands comprising freshwater lagoons, lakes and marshes, and saline and hyper saline lakes, located to the north-west of Kerang, close to the Murray Valley Highway. They were non-permanent lakes and/or wetlands prior to European settlement.

Five of the lakes (First, Middle, Third Lakes, Little Lake Charm and Racecourse Lake) became permanently inundated freshwater lakes in 1925 when they were linked into the Torrumbarry Irrigation Area (TIA) supply system resulting in them being kept artificially full. (Stuart Simms pers comm). The KLBP refers to these five lakes as the 'Kerang Lakes' with all other lakes out-side the scope of the project.

The Kerang Lakes irrigation water storage and distribution system is a complex of lakes and channels located on the northern Loddon Plain, approximately 5 km northwest of the township of Kerang and near the western margin of the Riverine Plain in northern Victoria. This area of the Loddon Plain has previously been, and is today, a zone of regional groundwater discharge as evidenced by the numerous lake/lunette complexes, saline lakes and the upward hydraulic gradient of the regional aquifer systems *(Bartley J., 1992)*.

Twenty-three of the Kerang Lakes are protected under the Ramsar Convention (the Kerang Lakes Ramsar site) – an intergovernmental treaty which provides the framework for international co-operation for the conservation of wetlands. Middle Reedy Lake, in particular, contains an ibis rookery of National significance. Other lakes in this complex regularly support significant number of important groups of waterbirds such as ducks, cormorants, spoonbill and large populations of prevalent Australian species.

All wetlands lie on the floodplains of the Loddon River, near where it meets the Murray River floodplain. The area lies within the Victorian Riverina bioregion but is very close to the Murray Fans bioregion, and would be subject to flooding from either of two catchments. Proximity and hydrological influences make it likely that these wetlands have characteristics and/or species from both the Victorian Riverina and the Murray Fans bioregions.*(Ho et al., 2006)*.

1.2 Attributes

Referral Section	2 6	Source/more information	

The wetlands sit in a regional setting of cleared agricultural land. Intensity of agricultural use varies from annual surface and sub-surface irrigation, perennial irrigation and dryland cropping and grazing.

The water management arrangements (components of the irrigation system) for some of the Kerang Lakes result in raised water losses from evaporation and seepage; and adversely impact the ecological condition of the lakes (naturally subject to a regular cycle of wetting and drying).

The local community includes Kerang and Lake Charm. The population of Kerang is 3,872. The Lake Charm region has a population of 311 (ABS 2011)

There are five lakes that form an integral part of the delivery system for the TIA and the Victorian Mid Murray Storages (VMMS) and support irrigated agriculture in the region and downstream along the River Murray. The Kerang Lakes are an important part of the identity and social values of the local community:

- Reedy Lake includes Apex Park and is used for recreation (e.g. swimming, weekly rehabilitation programs for the local football team during the football season and fishing).
- Middle Reedy Lake is home to a major ibis rookery and other birds, and is celebrated as a tourist attraction.
- Third Reedy Lake is used for fishing and also is home to significant bird life.
- Little Lake Charm is used for fishing and duck shooting, and Scott's Creek, which feeds into the lake, also includes bird habitat.
- Racecourse Lake has a number of properties around its eastern end with views over the lake, is used for activities such as fishing and duck hunting, and has a caravan park and primary school on its eastern shore.

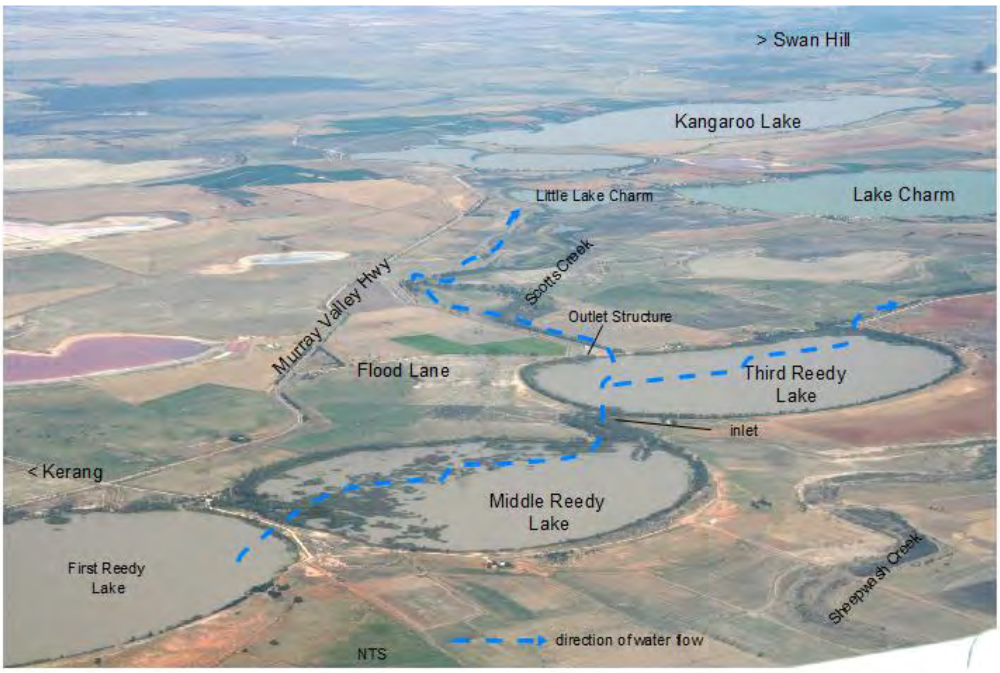


Figure 1 Overview of project area

1.3 Regional economics

Referral Section	2	Source/more information	

Urban Enterprise (2011) summarises the current economic and demographic situation in Gannawarra Shire drawing on existing research:

- Gannawarra Shire's population has stabilised at around 11,650 over the last decade although the longer term forecast is for a gradual decline of 0.4% per year over the next 15 years. The Shire is ageing rapidly as young people leave to find education and work - between 2001 and 2006 there was a significant increase in the 55-70 years age bracket with declines in most other cohorts;
- The major employing industry in the region is Agriculture, Fisheries & Food (30%) followed by Retail Trade (11%), Healthcare & Social Assistance (9%) and Manufacturing (8%);
- Gannawarra Shire has a diversified agricultural base. Dairying is the most prominent sector (50% of agricultural production in 2006) followed by cropping (28%) and livestock (20%);
- Tourism is currently a minor industry in Gannawarra Shire and accounts for less than 3% of jobs in the Shire, however there is opportunity for this sector to expand with new investment;
- Residential, rural and industrial land in Gannawarra Shire is very favourably priced and provides a key attractor for new investment.

1.4 Climate

Referral Section	2	Source/more information	

Mean annual rainfall is approximately 375 mm at Kerang. The average annual pan evaporation rate is around 1,600 mm; however this varies seasonally from up to 250 mm/month during the summer months to less than 50 mm/month in the winter, when rainfall can exceed evaporation.

1.5 Hydrogeology

Referral Section	2	Source/more information	

Large scale flood irrigation was introduced to the Loddon Plains in the late 1800's. The raising of the groundwater system, by surplus irrigation water, led to an increase in the size and number of individual discharge points, and ultimately to a consistently high water-table over the entire central and northern Loddon Plain (Macumber P.G., 1991). The high water-table (within 2 metres of the surface) causes waterlogging problems, and contributes to extensive soil salinization through the remobilisation and evaporative concentration of salts in the soil capillary zone.

2 HISTORY OF INVESTIGATIONS

Referral Section	3	Source/more information	

The concept of disconnecting the lakes from the irrigation system has been periodically explored since immediately after World War II. This section briefly outlines the various studies undertaken since 1946 up until the investigation phase of the current project.

2.1 Torrumbarry Main Channel investigation, 1946

Referral Section	3	Source/more information	

(Harding, 1946) proposed bypass of the “north west lakes” by construction of a Torrumbarry-Swan Hill main channel from Kow Swamp to the Swan Hill main channel, north of Lake Boga. Water could be passed into any of the lakes bypassed from the channel system. After the construction of a new main channel system the flow of water in the natural water courses would be irregular and at a lower level than under present conditions.

These proposals went no further.

2.2 Parliamentary Inquiry, 1965

Referral Section	3	Source/more information	

The 1965 Parliamentary Public Works Committee (PPWC, 1965) proposed, amongst other things, the remodelling of Box Creek, Pyramid Creek and the Lakes Channel, from Kow Swamp to Racecourse Lake, including the bypassing of Hird’s Swamp, Johnson’s Swamp and the Reedy Lakes (First Reedy, Middle Reedy, and Third Reedy Lake).

Works along Pyramid Creek were undertaken, but the Lakes Channel was not constructed. A channel was to be dredged (in fact it was started) through Middle and Third Reedy Lakes but was stopped because of the public outcry on the effects on the Ibis Rookery.

The existing No 7 channel was subsequently dredged, from Third Reedy, bypassing Scott's Creek and Little Lake Charm but terminated in the existing channel to Racecourse Lake just before the Murray Valley Highway. No regulator was constructed upstream of this junction and so Little Lake Charm and Scott's creek remained a part of the system and with permanent water and water backing back almost to Third Reedy anyway. A regulator was then constructed just downstream of the Murray Valley Highway to control the levels upstream and so better able to force water into Lake Charm itself.

At about this time the level of the Lakes system was dropped by about 1 foot. The level was maintained at the higher level simply to deliver water by gravity to the Third Lake irrigation System the 5/7 system and also the Mystic Park West System but also aggravated the salinization of surrounding low ground that still persists today. These gravity systems were then fitted with pumps, powered by Volkswagen petrol engines as it was before the advent of SEC power in 1965 (Stuart Simms pers comm 11/10/2015).

2.3 **Kerang Lakes Working Group, 1989**

Referral Section	**3**	**Source/more information**	

Lugg et al. (1989) noted the Kerang Lakes area were not in a steady state, but were still degrading. They stated that adopting a “do-nothing” option would inevitably lead to further deterioration, to the point where there are predominantly two types of wetland; permanent open freshwater lakes (irrigation supply lakes), and permanent and semi-permanent hypersaline wetlands. These types have the lowest value for conservation purposes.

Lugg (1990) commented on a proposal to divert saline inflows from Wandella Creek by removing Middle and Reedy Lakes from the irrigation system.

The proposal seems to have been abandoned.

2.4 **Kerang Swan Hill Future Land Use Study, 2003**

Referral Section	**3**	**Source/more information**	

This study (Rendell McGuckian et al., 2003) included a ‘regenerating the lakes’ component. This aimed either to prevent further decline in these ecosystems and maintain them at their current (undesirable) ecological condition (the minimum standard); or to choose a path of regeneration and attempt to return ecosystems to their former or more desirable ecological condition.

The changed regimes for the lakes were to be designed to create improved biodiversity for high value lakes and wetlands, as well as to reduce existing water supply losses (i.e., to create water savings for the River Murray).

2.5 TRAMS, 2007 and 2010

The Torrumbarry Reconfiguration and Asset Modernisation Strategy (TRAMS) (GMW, 2007) (RMCG, 2010) identified the KLBP as a potential water savings strategy. This involved bypassing lakes with a channel and then providing an environmental flow for affected lakes. The strategy covered Racecourse Lake and Little Lake Charm and possibly Reedy Middle and Third Lakes, but recognised the environmental risks for Reedy, Middle and Third might be prohibitive.

(SKM, 2010) undertook investigations into wetland water regimes and potential water losses (that could be realised as water savings) at the Kerang Lakes. Some of this work was used to develop the GCP Stage 2 Business Case (Hydro Environmental, 2010), and resulted in the provision of funding for Special Projects.

2.6 The Kerang Lakes Water Savings Project

Referral Section	**3**	**Source/more information**	

The Kerang Lakes Water Savings Project (this project) is a Goulburn Murray Water Connections Project (GMW CP) Stage 2 Special Project providing both water savings and environmental outcomes which commenced in late 2011. It was identified through the investigation phase that this project was in actual fact an environmental project more so than a water savings project. The project was renamed the Kerang Lakes By-Pass Project, and is referred to under this new branding throughout the document.

Referral Section	**3**	**Source/more information**	

3 KLBP Delivery Structure

3.1 GMW Connections Project

Referral Section	**3**	**Source/more information**	

The GMW Connections Project is a $2 billion works program to upgrade ageing irrigation infrastructure across the GMID to save water lost through seepage, leakage, evaporation and system inefficiencies. Works will include lining and automating channels, rationalising non-backbone channels, building pipelines and installing new, modern metering technology.

Stage 1 commenced in 2008 and is due to be completed in 2018. Funding of $1 billion from the Victorian Government and Melbourne Water is anticipated to generate 225GL of long term average water savings (Long Term Cap Equivalent (LTCE)) that are to be shared equally between GMID customers, the environment and the Melbourne Water Corporation urban supply customers.

Stage 2 commenced in late 2011 and is due to be completed in 2018. Funding of $1.059 billion from the Australian Government is anticipated to deliver 204 GL (LTCE). These savings are to be transferred to the Australian Government for environmental use making a significant contribution to bridging Victoria's Sustainable Diversion Limits gap under the Murray Darling Basin Plan. Stage 2 will continue the work of Stage 1 in addition to delivering service and environmental enhancement projects.

The Stage 2 Business Case provided for a number of 'Special Projects' to achieve benefits such as water savings, environmental enhancement and/or improved customer level of service including the Kerang Lakes By-pass Project.

3.2 Phase 1

Referral Section	**3**	**Source/more information**	

The KLBP Business Case was prepared to address Commonwealth Government Due Diligence Criteria for Basin State Priority Projects. In undertaking the due diligence assessment of priority projects the Commonwealth considers the social, economic, environmental, financial and technical aspects of the project. The Business Case was submitted in October 2014. It then underwent a due diligence process. There were several rounds of queries about aspects of the business case (principally the economics).

The story from Phase 1 is described in further detail in the Business Case which was presented to the Federal Government. The recommended option – Third Reedy by-pass was accepted as the preferred option. The approval to proceed came with the condition that environmental approvals would be sought prior to the release of further (construction) funding.

3.3 Phase 2

Referral Section	3	Source/more information	

Phase 2 will also contain two phases; a Phase 2 and Phase 2a. Phase 2 relates to environmental approvals from both the Commonwealth Government (*Environment Protection and Biodiversity Conservation Act 1999*) and State Government (*Environmental Effects Act 1978*). At the end of the environmental approvals process GMW CP will request approval to proceed with implementation (Phase 2A).The implementation Phase will include development of Environmental Watering Plans, detailed design and implementation (subject to approval).

There will also be a third phase (operation, monitoring and reporting).

4 THE KLBP DELIVERY (PHASE 1)

Referral Section	3	Source/more information	

The KLBP is part of the GMW CP, which is a major Victorian Priority Project under the intergovernmental Agreement on Murray-Darling Basin Reform (2008). The KLBP will support the objectives of the Basin Plan by:

- saving water that will be delivered in the form of a secure and transferable water entitlement to the Commonwealth Environmental Water Holder, capable of being used for purposes that reflect the Commonwealth's environmental priorities;
- restoring the ecological health of those Kerang Lakes that are within scope, which are Ramsar-listed; and
- implementing infrastructure that will enable the ecological health of the Lakes to be maintained with less water than that required at present.

4.1 Project Scope

Referral Section	3	Source/more information	

Stage 2 of the GMW CP commenced in late 2011. Initiation of Stage 2 included the development in 2010 of a business case, which included the KLBP as a special project that offered both water savings and environmental outcomes (Table 1).

Table 1: Initial project description as part of GMW CP stage 2 Business Case (NVIRP, 2010a).

Project description	Benefits
Kerang Lakes Bypass ($18.767M): A number of the Lakes in the Kerang Lakes Ramsar Site form part of the irrigation delivery system in the TIA. The lakes are permanently inundated to supply irrigation customers. Subject to positive outcomes from supporting studies and obtaining necessary approvals it is proposed this project will construct channel works so that some of the "Kerang Lakes", including First Reedy, Middle Reedy and Third Reedy Lake, and Racecourse can be bypassed and returned to a more natural water regime. (Little Lake Charm was added to the scope to ensure that all lakes were considered). A River Murray source supply will continue to be provided to Middle Reedy Lake to support its Ibis population. This would enhance the environmental value of the lakes and reduce water supply losses. The project will be subject to an EPBC referral, most likely in conjunction with lowering of Little Murray Weir.	The water savings calculations were based on annual savings associated with evaporation losses if the lakes were not filled with water every year. Based on the pattern of average and dry years, it is estimated that water savings will be approximately 3,860 ML LTCE. The KLBP will also deliver significant environmental benefits to the Kerang Lakes Ramsar Site. If the Kerang Lakes (First Reedy, Middle Reedy and Third Reedy Lake and Racecourse Lake) are removed from the TIA supply system and provided a preferred water regime linked to the historical unregulated flows in the Loddon River, existing high environmental values will be maintained and enhanced. Middle Lake which supports a large Ibis colony will be connected to the bypass channel to enable top up water to be provided as needed to support nesting habits and the general well-being of these birds.

The KLBP project investigated the feasibility of by-passing all or some of the five Kerang Lakes that are currently part of the irrigation system including:

- First Reedy Lake (also known as Reedy Lake)
- Middle Reedy Lake (also known as Middle Lake)
- Third Reedy Lake (also known as Third Lake)
- Little Lake Charm (including Scott's Creek)
- Racecourse Lake (which includes Bertram's Lake, as the two were joined when they were permanently filled).

Figure 2. Map of the project area. (RMCG modified from Google maps)

The project involved a comprehensive and rigorous review of the opportunities that existed to generate ecological enhancements from investment in the lakes system. The objective was to identify scenarios where significant water savings could be realised through cost effective by-pass infrastructure.

4.2 Project Investigations

Referral Section	3	Source/more information	

The KLBP commenced in 2011 with the aim of saving water lost to seepage and evaporation, and improving the ecological values of the lakes, by disconnecting the lakes from the irrigation system. Many investigations and assessments (summarised in Appendix 1) were undertaken to understand the values and attributes of the Kerang Lakes prior to determining water regimes, water savings and value for money. These investigations and assessments provided sufficient information on which to base assessment of options for further consideration.

4.3 Summary

Referral Section	3	Source/more information	

This information was the basis for the development of Environmental Water Investigations (EWI) that were developed for each individual lake based on the attributes and values within it. These EWIs were undertaken by the North Central Catchment Management Authority, each one considers:

- water dependent values
- hydrology
- alternative water regimes
- rationale for the recommended environmental water regime
- recommended environmental water regime
- management objectives including ecological and hydrological objectives
- potential risk, adverse impacts and benefits
- risk mitigation measures
- knowledge gaps.

5 KLBP DELIVERY (PHASE 1A)

5.1 Project Scope

Referral Section	3	Source/more information	

Phase 1A was determined through extensive engagement with stakeholders and increasingly detailed examination of the assessments, the feasibility, benefits and costs of options for all five lakes. (First, Middle and Third Reedy, Little Lake Charm and Racecourse Lake) using four generic watering scenarios (Table 2). This aimed to test the feasibility of the bypass.

Table 2: Watering scenarios

Scenario	Scenario Type	Comments
Scenario 1	The Base Case	Current regime - lakes always full
Scenario 2	Semi-permanent	Full nine years in ten
Scenario 3	intermittent	Full two years in three
Scenario 4	episodic	Full one year in four

5.2 Project Investigation

Referral Section	3	Source/more information	

These four scenarios were used to test the feasibility of bypassing the lakes via a process involving a number of studies. The following studies were conducted for each scenario:

Table 3: Studies conducted

Study	Comment/Note	Source
Water savings analysis	Primarily evaporation estimates	Gippel, 2012
Ecological impacts evaluation	Each scenario over time	NC CMA, 2012
Salinization of the water	Analysis of risks	URS, 2013d, URS, 2013c, URS, 2013b
Acid sulfate soil formation assessment	Analysis of risks	URS, 2013d, URS, 2013c, URS, 2013b

Socio-economic impact assessment	Excluding the value the community as a whole would put on the ecological impacts	RMCG, 2013

The studies recognised that in practice, each lake would be operated as part of a broader system (i.e., it should not be assumed all lakes would be operated according to the same scenario or all dried at the same time if a drying scenario was selected for all lakes).

From these early studies it was concluded that it was worth proceeding to more detailed investigations and that:

- the potential water savings, especially at the intermittent and episodic end of the spectrum were worth further investigation,
- the estimated cost of achieving water savings were within current estimates, although there were uncertainties,
- on balance, the project could deliver environmental benefits.

5.3 Summary

Referral Section	3	Source/more information	

As the project unfolded, regimes were developed that were midpoints between these regimes.

Little Lake Charm was excluded from the project scope because of the salinisation risk that GMW concluded could not be acceptably mitigated.

Middle Reedy was also excluded from consideration for bypass on the basis of the high environmental risks (e.g. the effect of a drying regime on the tangled lignum that provides the substrate for the ibis rookery). However, it was decided to continue to include consideration of Middle Reedy Lake in further investigations on the basis that the ecological uncertainties could be addressed in the future and the lake could then be considered for bypass later in the project; the information gathered during the current investigations would then provide valuable background information for assessments that would be required in the future.

The outcome of the investigations was that bypassing Third Reedy Lake was the only option that satisfied project success criteria (water savings, environmental benefits, cost per megalitre of water saved). The rationale for excluding other options is a follows:

Table 4: Rationale for exclusion

Option	Rationale for exclusion (Risks)			
	Salinity Risk	Low water savings	Enviro impact	High Cost
First Reedy Lake		√		√
Middle Reedy Lake		√	√	

Little Lake Charm	√	√		
Racecourse Lake				√
Racecourse/Bertram Lake				√
Lowering lake operating levels		√	√*	

**Little benefit of change*

The option of combining bypassing Third Reedy Lake and Racecourse/Bertrams was closely considered but failed to meet economic criteria.

6 Third Reedy Lake Bypass

Third Reedy Lake was approved by Commonwealth Government as the preferred option with

Referral Section	**3**	**Source/more information**	

funding to pursue environmental approvals prior to releasing funding for construction. This section describes Third Reedy Lake (and the KLBP – Phase 2 in further detail)

6.1 The environmental water regime

Referral Section	**3**	**Source/more information**	

The proposed watering frequencies for Third Reedy Lake are summarised in Table 5. The proposed environmental water regimes were developed in a series of environmental water investigations prepared by NC CMA (*(North Central CMA, 2014c, North Central CMA, 2014e, North Central CMA, 2014b, North Central CMA, 2014d, North Central CMA, 2014a)*).

In addition, refinement of the Third Reedy Lake environmental water regime was also informed by outcomes of water savings modelling and hydrogeological risk assessment (Section 0).

Table 5: Current and proposed environmental watering regimes:

(Based on Table E1 in NC CMA (2014a) and pp 10-11,62 in Gippel (2014b)**.**

Current Water Regime	Proposed Environmental Watering Regime
Irrigation regulation (FSL 74.56 mAHD). Permanently freshwater lake minimal fluctuations of water level between 74.2 – 74.56 mAHD)	3 × 4 year cycles, with the first year of the first two cycles rising to 74.0 with the first year of the third cycle rising to 74.56 and being held for 31 days to allow a flushing flow for salt management. It includes an option for an intermediate rise to about 73.2 m with a duration of 31 days which could be included in the third year of each cycle for ecological (frogs and turtles) purposes if necessary for adaptive management purposes. An establishment phase to provide opportunities for establishment of River Red Gums across the wetland floor is proposed. (NB An earlier proposal for a three year cycle was reviewed and updated).

6.2 Overview of ecological objectives and benefits

Referral Section	3	Source/more information	

The overarching ecological objective and benefit sought by the proposed project is to protect and enhance the ecological values of Third Reedy Lake (directly) the other Ramsar-listed wetlands (indirectly).

The specific ecological objectives outlined in the NC CMA environmental water investigation reports are summarised in Table 6. Objectives aim to maintain, restore, increase, rehabilitate and promote aspects of lake ecology.

These objectives will be further refined in the development of an EWP for Third Reedy Lake.

Table 6: Proposed ecological objectives and benefits for Third Reedy Lake (North Central CMA, 2014b)

Flora
Maintain health of existing Black Box fringing wetland vegetation (within Intermittent Swampy Woodland)
Restore opportunities for recruitment of River Red Gum trees through body of wetland
Restore diverse understory Intermittent Swampy Woodland vegetation (i.e., lignum and sedge communities) in the body of the wetland able to withstand fluctuating water levels
Fauna
Restore water-bird breeding opportunities
Restore water-bird feeding opportunities
Provide opportunistic turtle and frog feeding and breeding
Wetland
Maintain connectivity between Reedy Lakes
Restore ecological process associated with intermittent drying

6.3 Option assessment

Referral Section	3	Source/more information	

A number of options were considered and assessed during the course of Business Case preparation. Assessment considered water savings, cost of implementation (capital and O&M) and overall benefit vs. cost. Only the Third Reedy Lake bypass satisfied success criteria.

A simplified, stand alone, Business Case Addendum was prepared, focusing solely on the Third Reedy Lake bypass option. In summary, the Business Case proposed to construct a channel to disconnect Third Reedy Lake from the Torrumbarry Irrigation System. This proposal will reduce current water losses and reinstate a more natural watering regime to generate environmental benefits. The other options were not progressed as they involved either too high a cost for lower water savings and heightened risks to habitat or salinity impacts.

The water savings will contribute to the overall GMW CP Stage 2 water savings, delivered in accordance with the Project Schedule to benefit the Commonwealth Environmental Water Holder, to contribute to sustainable diversion limits within the Murray-Darling Basin Plan.

The cost of the proposal is $7.89 million from the Stage 2 Special Project. A contribution of $183,000 from the Connections program brings the total cost of the preferred option to $8.07 million (undiscounted, real inflated).

This proposal will deliver water savings of 1,607 ML/year representing a unit cost of $4910/ML (undiscounted, real inflated) for Commonwealth Government investment.

The Business Case confirms that the project provides an overall benefit to the whole of society, with a Benefit to Cost Ratio greater than 1, and meets measures for cost effectiveness in line with Commonwealth guidelines.

A series of investigations confirmed that Third Reedy Lake was the preferred option as a stand-alone project.

Third Reedy Lake will continue to require long term average environmental flows of 1,152ML/year, to meet its watering requirements. Most of that will come from local unregulated flows, but, on average, 279ML/year will need to be delivered through the Torrumbarry Irrigation system *(Gippel, 2014c)*.

6.4 Developing the Preferred Option

Referral Section	3	Source/more information	

Development of the Third Reedy Lake bypass option involved several iterations that considered:

- *Cost of by-pass* – once an alignment was decided this was a fixed variable

- Selection of a suitable *environmental water regime* – early work suggested this could be based on a three year wetting and drying cycle around the current lake full supply level. This evolved to a set of three four year cycles with one cycle based on the current lake full supply level and the other two cycles based on a lower full supply level. The rational for this was based on:
    - the lake's assumed natural water regime which would have seen wetting events at longer intervals than either First of Middle Reedy Lakes which are closer to sources of flood waters
    - the lake's natural full supply level being assumed to be lower than the current FSL (it is not known what this natural level would have been, other than it would be lower than the current FSL which is the result of irrigation supply works). We know that the current FSL was dropped by 300 mm in the 1960s.
    - concern expressed by the ERP that a 3 year cycle would have been too wet to achieve environmental objectives.
- Water savings from a number of variations on the 4 year cycle were estimated (Table 9). The scenario selected (scenario 13) provided an attractive outcome from an economic perspective. Other scenarios (eg scenario 12) gave higher water savings and therefore better economic outcomes, but had a higher salinity risk.
- Salinity risk associated with the water regime (Section 17.4.4). The salinity risk at P50 values was quite acceptable for all scenarios but there were marked variations at P80 values. Some options (eg Scenario 5) had a markedly higher salt load inflows (and therefore higher salinity risk) than other scenarios (Table 37). The salinity risk will need to be managed adaptively because it will change according to a number of factors that will vary over time (Section 20.7).
- Economic benefits were directly correlated with the water savings.

As a result of these considerations Scenario 13 was adopted in the Business Case as the water regime for Third Reedy Lake. This water regime is described as:

6.5 Benefits of implementing the preferred option

Referral Section	3	Source/more information	

In their current condition, the Kerang Lakes in the project area support opportunistic feeding and breeding opportunities for water-birds, although productivity under the current regime is significantly reduced and the value the wetlands could provide to significant colonial nesting water-birds breeding in the Ramsar site is somewhat diminished.

The proposed water regime changes will enhance the habitat value for water-birds across the KLBIP wetlands. For example Third Reedy Lake will provide breeding water-birds with habitat to forage (B. Lane *pers. comm*. to GMW [Brett Lane and Associates], 18 September 2013).

Promotion of diversity of littoral zone vegetation in turn will benefit wetland specialist fish species by providing greater cover, structural complexity and spawning sites. In addition, promoting a greater range of wetting and drying also has the potential to increase secondary productivity and provide improved feeding opportunities for larval and juvenile fish (i.e., increased zooplankton – which requires reestablishment of the zooplankton egg bank).

The KLBP wetlands currently contribute to the Ramsar listing, and the changes proposed will enhance breeding, roosting and feeding for water-birds.

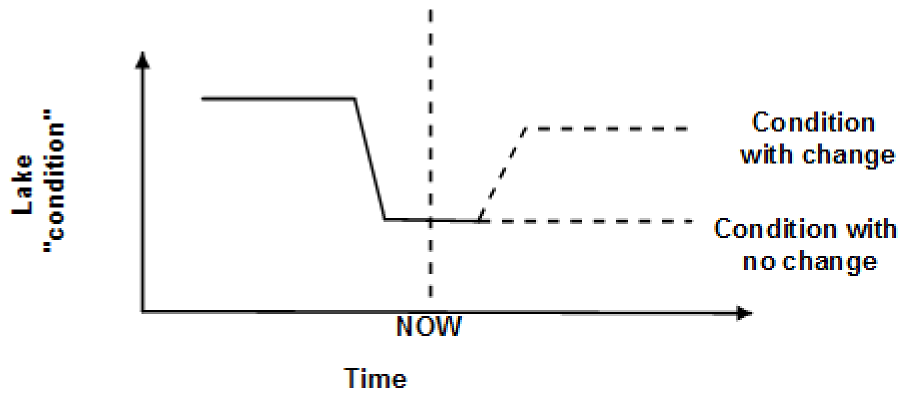
The wetlands will continue to provide:

- a range of habitat types suitable for water-bird nesting, resting and breeding (in particular tangled lignum at Middle Reedy Lake); and
- a range of terrestrial and aquatic food sources including insects, macro-invertebrates, fish, algae and plant matter.

The ERP considers that changing the water regime to include drawdowns as at Third Reedy Lake is an unparalleled ecological opportunity for this wetland complex, for two reasons. First, there is the chance to have a wetland where the negative effects of Common carp dominance can be ameliorated and serve as a public and high profile demonstration site, possibly becoming a special feature of the Kerang Lakes. Second, this should add considerably to the diversity of the wetland complex, by providing conditions favourable for certain migratory birds, frogs and a range of plants that currently are under-represented.

This business case assumes that after project implementation, the lakes will undergo an improved change in condition (as discussed above and illustrated in Figure 3).

Figure 3. Possible future trajectories following a step change deterioration in lake condition.



6.6 **Response to Business Case**

Referral Section	**3**	**Source/more information**	

On 11 May 2015 DELWP advised:

- The KLBP satisfies the due diligence criteria for State Priority projects. The draft due diligence report recommends the project proceed to seek approvals under Commonwealth and state environmental legislation.

- It is expected that identified knowledge gaps and risks associated with the proposed changes will be addressed as part of the environmental approval process (these relate mainly to the potential for emergence of acid sulphate soils and saline groundwater intrusion).
- If the outcomes of the approvals process do not have a material impact on the scope of the project, DELWP and DoE have agreed that the project will proceed.

6.7 Engineering design

Referral Section	3	Source/more information	

The GMW CP *(SKM, 2014a)* undertook preliminary design of bypass channel options to a standard appropriate to allow estimation of costs for input into the Business Case. Detailed design will be required before the project can be implemented.

As a result of the adoption of a bypass alignment on the east side of the Murray Valley Hwy around First Reedy Lake there was only one alignment option considered for the bypass of Third Lake, between Middle Lake and the No.7 Channel. That alignment follows the southern shore of Third Reedy Lake.

Geotechnical investigations undertaken as part of channel alignment selection are reported in *(SKM, 2013a)*.

The location of the existing structures and proposed infrastructure solutions are shown in Figure 4.

Table 7 gives a summary description of each piece of infrastructure.

Preliminary infrastructure drawings have been prepared.

Figure 4 Third Reedy Lake bypass infrastructure (from (SKM, 2014a)

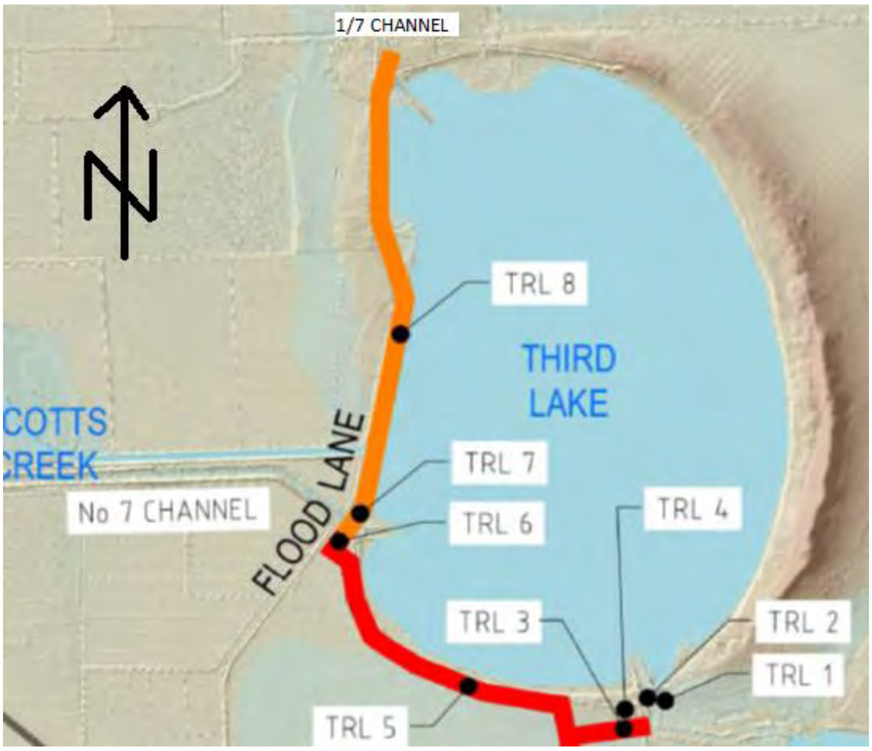


*Table 7 **Summary description of proposed Third Reedy Lake bypass infrastructure***

Structure	Description	Purpose
TRL 1	Third Lake Isolation Regulator	Isolate Third Reedy Lake from delivery system; provide water delivery to Third Reedy to allow water level management; unimpeded passage of flood flow. (Structure already existing)
TRL 2	Not required	
TRL 3	Third Lake Bypass Offtake	Control the diversion of flows from Middle Lake down the bypass channel (which is an extension of the No. 7 Channel). nominally designed for a flow rate of 750 ML/d. complimented by TRL 4 to provide fish passage when the bypass channel is in operation
TRL 4	Third Lake Bypass Fish Ladder	To allow fish to migrate through the bypass channel (73.76 mAHD nominal water level) into Middle Lake (74.88 mAHD). – vertical slot fish-way
TRL 5	Third Lake Bypass Channel	A proposed earthen channel required to deliver 750 ML/d of irrigation capacity from Middle Lake to the No.7 Channel, facilitating the isolation of Third Lake for an alternative watering regime. The bypass channel is to offtake from the channel between Middle Lake and Third Lake, upstream of TRL 1, and will connect with the No.7 Channel immediately upstream of Flood Lane. TRL 5 is an earthen channel with a bed width of 7 m, corresponding to a typical width between inside bank crests of 16.6 m. The proposed bypass channel is 1.38 km in length, and comprises the sections of channel identified as S4C and S4B-1 in the *Net Gain Assessment* report, see *(SKM, 2013b)* 1V:2H bank batters have been adopted, with a nominal water depth in the channel of 1.8 m. The 1.8 m water depth was determined to be the optimum profile to minimise earthworks and reduce the risk of intersecting the local groundwater table during construction. Channel banks have been designed with nominally 600 mm freeboard. Typically the design bank level of TRL 5 is within 500 mm of natural surface, therefore requiring minimal compacted banks to be constructed. However there is a large volume of cut to be distributed in spoil banks and as exported fill. Is proposed to be located on private land that would have to be acquired.
TRL 6	Occupational Bridge	A single-lane occupation bridge crossing to enable vehicle access across the bypass channel to access structures TRL 1, TRL 2, TRL 3 and TRL 4 for maintenance.

Structure	Description	Purpose
TRL 7	TO 1/7 Channel Pump Station	To replicate the current supply to the No. 1/7 Channel a pump station is required to lift water from the No.7 Channel downstream of Third Lake to a supply level suitable for customers on the No. 1/7 Channel. The flow rate to be delivered by TRL7 is 145 ML/d. The assumed lift of the pump station is 4500 mm, to service a proposed pipeline (TRL 8) that transfers flow to the existing No. 1/7 Channel. The design comprises four (4) axial flow pumps with 45 kW motors to be mounted on a concrete foundation positioned on the channel batter. The pump station is to be located on an existing channel nib immediately downstream of the No.7 Offtake at Third Lake. The provision of variable speed drives has been included in the design and a new switchboard is also required. It has been assumed that the pump station will not be required to be housed in a pump shed. The new pump station will be 500 m from the nearest residence, compared to the existing open air pump station being only 125 m from the nearest residence. There is power in close proximity to the site on Flood Lane,
TRL 8	TO 1/7 Pipeline	The proposed No. 1/7 Pipeline is required to deliver irrigation flows from the No.7 Channel, via TRL 7, to the existing No. 1/7 Channel north of Third Lake. Construction of a Ø1200 mm pipeline along the alignment of the existing No. 1/1/7 Channel, optimised to balance capital cost, hydraulic conditions and operating costs The flow rate to be delivered by TRL8 is 145 ML/d. TRL 8 is also required to service three meter outlets currently serviced by the No. 1C/1/7 Channel. The pipeline is proposed to be located entirely within the existing footprint of the No. 1C/1/7 Channel. The connection between the pipeline and the axial flow pumps at TRL 7 is proposed to be via a stainless steel manifold.
TRL 9	Third Lake Inflow Measurement	TRL 9 is proposed to be an in-stream ultrasonic flow measurement system, such as the SonTek IQ flow sensor, located between TRL 1 and the inlet to Third Lake. Flow measurement is only expected to be necessary during filling or topping-up cycles of the watering regime, and not during a normal irrigation delivery cycle through the lake system.
	Removal of existing 1/7 channel pump station at the north end of Third Reedy	Existing pump station will be redundant.

6.8 Connections Assessment

Referral Section	3	Source/more information	*(SKM, 2014c)*

A conceptual level assessment of the requirement for and cost of, customer connections at Third Reedy Lake was undertaken.

In addition to connections assessment the report also provides comment on issues raised during discussions with landholders and an assessment of the need for additional fencing resulting from changes in lake water regime.

Alternate supply options were investigated to supply existing customer connections at Third Reedy Lake. The alternate options involve installation of pumps and pipes to supply irrigation and D&S water to existing customers that the proposed bypass channel will not be able to directly supply.

The information was used during Business Case development.

Table 8: GMW customers on the lakes within project scope (Source: Pers. comm. GMW, 2014. GMW customers directly supplied from the Kerang Lakes***.***

Lake	Number of stock and domestic customers	Number of irrigation customers
Third Reedy Lake	0	5

Notably these figures are different from those shown in the Connection Assessment Report; the Connections assessment did not consider GMW customers who would be directly connected to the bypass channel as these customers are considered to be connecting directly to Backbone.

7 Water savings

Referral Section	3	Source/more information	

Water is currently lost from Third Reedy Lake due to evaporation and seepage. With the bypass project and implementation of the preferred environmental water regime, these losses can be reduced, leading to water savings. The water savings for the project will depend on the amount of water that would need to be retained to protect the ecological values of this Ramsar-listed wetland.

However, the bypass itself will lose some water to evaporation, leakage and seepage. The sources of potential water losses and savings were estimated as follows:

- Evaporation from the wetland in the base case and the 'with project' case was modelled by Fluvial Systems Pty Ltd to estimate savings;
- Groundwater exchange (including seepage) to or from Third Reedy in the base case and the 'with project' case was modelled by URS to estimate savings;
- Evaporation, leakage and seepage from channels and meters that would be decommissioning in the 'with project' case were modelled by GMW to estimate savings; and
- Evaporation, leakage and seepage from any new bypass channel and infrastructure was modelled by GMW to estimate offsetting losses.

Further information about these estimates is provided below.

7.1 Evaporation from wetlands modelling approach

Referral Section	3	Source/more information	

GMW commissioned Fluvial Systems Pty Ltd to develop water balance models of the watering scenarios recommended for the lakes by North Central CMA *(Gippel, 2012, Gippel, 2014b, Gippel, 2014a, Gippel, 2014c)*. The models were used to:

- estimate long term evaporative losses under existing conditions and possible future operational regimes, so that water savings potential of the bypass intervention could be estimated, and
- predict long-term daily water level regimes under a range of possible operational regimes so that their potential for ecological rehabilitation could be evaluated, and the regimes refined accordingly.

This hydrological modelling component of the Kerang Lakes bypass investigation project was undertaken in two stages:

- Stage I: Preliminary estimates of losses and savings potential for five Kerang Lakes wetlands under a wide range of possible water regimes, i.e., no change, episodic, intermittent and semi-permanent. The focus was on model development, model sensitivity and broad-scale estimation of water savings potential.
- Stage II: Pending the outcome of Stage I, refine a narrow set of water balance models that have the highest potential for conjointly achieving sufficiently high water savings, and potential for improving ecological values.

The SWET wetland water balance modelling method was used. The SWET model has been used extensively by the GCP (and previously NVIRP) when preparing Environmental Watering Plans (EWP) to be approved by the Minister, where those plans necessitated calculating mitigation requirements for high value wetlands and waterways impacted by the operation of the modernised system.

The Stage I report *(Gippel, 2012)* contained a literature review of previous investigations, and detailed the hydrological model (SWET) used to predict water levels and water savings. The refined models used to make the prediction in this Stage II report *(Gippel, 2014b)* are the same as those used in Stage I, except that parameter values relating to lake operation were altered according to the refined regimes provided by North Central CMA (2013a), North Central CMA (2013b) and other correspondence. Further detailed description of the SWET models can be found in *(Gippel, 2011)*.

GMW has confirmed that the water savings projections consider the appropriate climate and development scenarios from the CSIRO Murray Darling Basin Sustainable Yields Project to take into account the impacts of climate change over the life of the project (P Lacy, GMW Pers. Comm December 2013).

7.2 Scenario assessment

Referral Section	4	Source/more information	

The water balance model was used to assess the water savings at Third Reedy Lake under a range of environmental water management options (Table 9).

The averages were based on multiple model runs with different start years. Yellow shaded scenarios were specifically requested, while others are variations included to illustrate the sensitivity of savings to regime specifications.

Eventually option 13 was selected (Section 0).

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Table 9. Summary of long term average annualised water savings for various scenarios for Third Reedy Lake.

No.	Total cycle length (yrs)	Sub-cycles	Date of rise (date)	Peak of rise in each cycle (m AHD)	Duration at peak (days)	Mean annualised savings (ML) [1892 excl.]
1	3	none	15/8	74.00	1	1505
2	3	none	15/8	74.56	1	1308
3	3	none	15/8	74.00	62	1443
4	3	none	15/8	74.56	62	1228
5	3	none	15/8	74.00	31	1484
6	3	+ intermediate	15/8	74.00, intermediate 73.2	31, intermediate 31	1481
7	4	none	15/8	74.00	1	1565
8	4	none	15/8	74.56	1	1408
9	4	none	15/8	74.00	62	1517
10	4	none	15/8	74.56	62	1352
11	12	3 × 4 yr cycles, no intermediate	15/8	74.56, 74.00, 74.00	31, 1, 1	1473 [1479]
12	12	3 × 4 yr cycles, no intermediate	15/8	74.00, 74.00, 74.00	31, 1, 1	1525 [1531]
13	12	3 × 4 yr cycles, + intermediate	15/8	74.56, 74.00, 74.00; intermediate 73.2	31, 1, 1; intermediate 31	1469 [1475]
14	12	3 × 4 yr cycles, + intermediate	15/8	74.00, 74.00, 74.00; intermediate 73.2	31, 1, 1; intermediate 31	1521 [1528]
15	12	3 × 4 yr cycles, no intermediate	15/8	74.56, 74.00, 74.00	62, 1, 1	1462 [1469]
16	12	3 × 4 yr cycles, + intermediate	15/8	74.56, 74.00, 74.00; intermediate 73.2	62, 1, 1; intermediate 31	1456 [1462]
17	6	2 × 3 yr cycles, no intermediate	15/8	74.56, 74.00	31, 1	1390 [1394]
18	6	2 × 3 yr cycles, no intermediate	15/8	74.00, 74.00	31, 1	1491 [1495]
19	6	2 × 3 yr cycles, + intermediate	15/8	74.56, 74.00; intermediate 73.2	31, 1; intermediate 31	1387 [1390]
19	1	none	15/8	73.6	62	1291
20	10	9 × 1 yr cycles, + 1 × 10 yr cycle	15/8	73.6; 10 yr 74.56	62; 10 yr 62	1176

7.3 Modelled water savings

Referral Section	4	Source/more information	

The preliminary estimated losses and potential for savings are provided in Table 10. The saving presented is the water that would be saved after the environmental needs of the lakes have been taken into account.

Table 10: Estimated mean annual losses and savings, Kerang Lakes (ML/year) (Evaporative losses from (Gippel, 2014b), seepage from Pat Feehan GMW; summarized from URS (2013). KLBP Investigation: Monte Carlo Hydrogeological Risk Analysis: Salinity. Report prepared for the GMW CP. Tatura. Section 3.4; channel losses Peter Roberts, GMW, pers comm.)

Lake		Third Reedy
Evaporative water losses (annualised mean)	Benchmark losses	2619
	Future losses	1150
	Mean saving	1469
Seepage	Current loss	14
	Future Loss	0
	Saving (ML)	14
Savings from decommissioning channel and meter (ML/year)		157.0
Channel losses	Leakage	-
	Seepage	14
	Evaporation	19
Total saving (ML) net of channel losses		1607

Both Little Lake Charm and First Reedy Lake would represent net increases in water loss.

7.4 Option not considered

The possibility of simply lowering the lakes by one metre during the non-irrigation season was raised as an option by the Community Advisory Group.

This remains a management option for non-bypassed lakes. It was not considered a viable option for consideration in this Special Project due to:

- Minimal water savings achieved.
- Minor ecological benefit, because a drying cycle would only be applied to a small area of the lake. For example, drawing down First Reedy Lake by 1 metre only exposes 9% of the lake floor.

An annual water regime with a lowered full supply level was considered for Third Reedy Lake at the request of the Expert Review Panel. However, the water savings (Scenario 19, Table 9) .were not great enough for this option to be considered further.

7.5 Victorian environmental water holdings

Referral Section	**4**	**Source/more information**	

For those lakes that are bypassed, a volume of water will remain as Victorian environmental water holdings, transferred to the Victorian Environmental Water Holder to provide the environmental water regime outlined for the Kerang Lakes in the Environmental Water Investigation reports (this was also estimated in the Fluvial Systems report, and the water savings presented in Table 10 are the water that would be saved after the environmental needs of the lakes have been taken into account).

Use of this water will be formalised through the preparation of environmental watering plans. The process generally will follow the Water Change Management Framework *(NVIRP, 2010b)*.

Table 11. Estimated required environmental water holdings for each lake. (Derived from Gippel reports)

Lake	Average annual environmental water requirement (ML/year)
Third Reedy - Long term	1151 (made up of 279 ML regulated and 872 unregulated)

8 KLBP – Phase 2 Project - Third Reedy Lake

Referral Section	1; 7	Source/more information	

The KLBP in Phase 2 relates to approvals works and measures at Third Reedy Lake only. All other lakes have been removed from the scope of the project.

Third Reedy Lake lies immediately to the north of Middle Reedy Lake, at the northern extent of the Reedy Lakes Complex *(North Central CMA, 2014b)*. The lake has a high density and abundance of dead river red gums (*Eucalyptus camaldulensis*) across the entire shallow open water zone which is devoid of aquatic vegetation. Third Reedy Lake represents reasonable habitat for a range of fauna species (birds, fish, turtles and frogs) due to its extensive fringing aquatic vegetation, abundant snags which provide good perching, basking and roosting locations and permanent open water for fish. The boundary of the wetland is characterised by Intermittent Swampy Woodland, comprising a red gum and black box (*Eucalyptus largiflorens*) over-storey, with a shrubby understory (predominantly tangled lignum).

More details about the ecological characteristics of Third Reedy Lake (and other KLBP lakes) are provided in the specific environmental water investigation reports prepared by NC CMA.

8.1 Topography

Referral Section	2; 7	Source/more information	

The land around Third Reedy Lake sits on a very gently sloping alluvial plain with scattered permanent and intermittent lakes. It is part of a much larger unit known as the Riverine Plain, comprising the fluvial plains of the Murray, Murrumbidgee, Goulburn and Lachlan Rivers and their tributaries. Lacustrine (lake) elements are generally ephemeral or intermittent shallow lakes and are typically saline or brackish. The most distinctive aeolian (wind-blown) feature of these plains is the lunette, up to 4 or 5 m high a crescent-shaped ridge of fine sand, silt, clay often containing pellets of salts including gypsum and occurring on the eastern side of lakes *(Rosengren, 1992)*

8.2 Hydrogeological Conceptual model

Referral Section	4; 7	Source/more information	

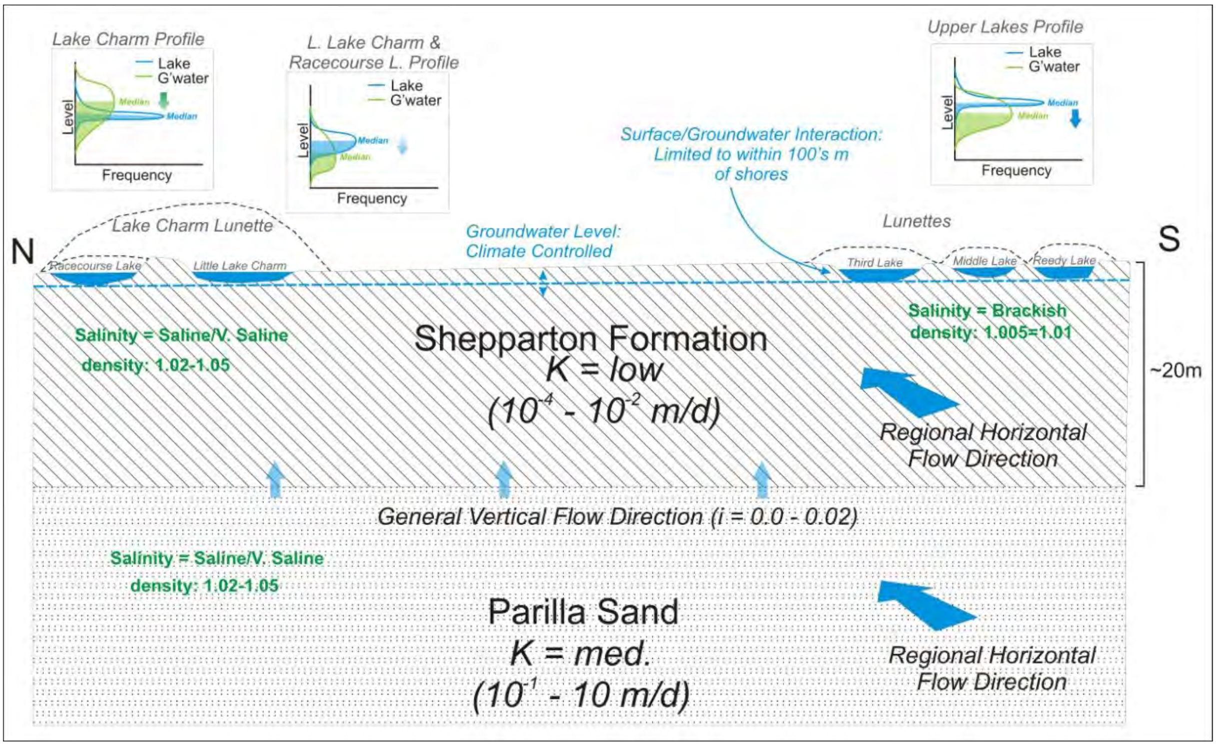
The key relationships and overall factors, which inform the conceptual model generated as part of hydrogeological investigations are summarised below. Figure 5 visually represents these key findings.

- Climate (regional rainfall recharge) is the more dominant driver for groundwater levels (Shepparton Formation & Parilla Sand aquifers) than localised lake levels;
- Lakes do have a minor influence on groundwater levels in the shallow aquifer (Shepparton Formation) but within a narrow fringe (< 500 m) around the lakes and may buffer levels from more extreme level variations;
- In the upper lakes (Reedy, Middle & Third), current operating levels were generally above the surrounding groundwater levels for much of the time, therefore acting as barriers to brackish groundwater inflow;
- Although not included for consideration as one of the bypass lakes, the current operating levels in Lake Charm are generally below the surrounding groundwater levels for much of the time allowing the potential for saline groundwater inflow;
- Bore 6050, located between Little Lake Charm & Racecourse Lake, suggests saline groundwater has been below the current operating levels of these lakes; the lake levels here also acting as barriers to groundwater inflow;
- Analysis of major cations and anions suggests there has been a limited direct connection between lake water and surrounding groundwater quality;
- A vertical upward hydraulic gradient exists away from the lake areas, closer to the lakes the vertical gradient can switch depending on prevailing climatic conditions; and
- Groundwater in the Shepparton Formation aquifer (and Parilla Sand aquifer) is generally brackish close to the upper lakes (Reedy, Middle and Third), but saline to very saline around the lower lakes (Little Lake Charm & Racecourse Lake). This can be seen as a benefit due to groundwater-surface water density differentials, associated with dissolved salt content.

On this basis, URS has developed a graphical representation of a conceptual model for the bypass lakes as shown in Figure 5. The Parilla Sand aquifer situated below the Shepparton Formation aquifer is an important aquifer at a regional scale but in the context of this assessment it plays little part in the salinity or acid sulphate risk assessment due to:

- The lower (by several orders on magnitude) hydraulic conductivity of the overlying Shepparton Formation sediments, and
- The relatively small vertical hydraulic gradient between the two formations (in the study area).

Figure 5 Kerang Lakes; Bypass Lakes Conceptual Model



8.3 Bathymetry

Referral Section	3; 7	Source/more information	

The bathymetry of Third Reedy Lake shows a maximum depth of 1.66 metres (bed elevation 72.9mAHD and full supply level at 74.56 mAHD)) with a slight gradient of 0.4 metres to the littoral zone (the shore of a wetland which usually includes the zone of shallow waters at the edge) at 73.6mAHD. The wetland bed is relatively flat, with only minor variations in depth (refer to the rating table (Table 12and Appendix 6 for the wetland bathymetry map). 50% of the area of the lake floor has a depth of 73.3 to 73.4 mAHD.

Table 12 Third Reedy Lake Stage, area, volume table (GMW 2006)

Height mAHD	Area_ha	Cumulative area (%)	Volume_ML	Cumulative volume (%)
72.9	0.02	0.0%	0.01	0.0%
73	0.05	0.0%	0.04	0.0%
73.1	0.12	0.1%	0.12	0.0%
73.2	11.11	4.8%	2.67	0.1%
73.3	76.53	33.3%	38.61	1.6%
73.4	124.59	54.1%	135.01	5.5%
73.5	152.59	66.3%	272.63	11.1%

73.6	174.32	75.7%	435.64	17.7%
73.7	187.41	81.4%	616.31	25.1%
73.8	199.02	86.5%	809.59	32.9%
73.9	206.59	89.8%	1012.64	41.2%
74	211.51	91.9%	1221.77	49.7%
74.1	215.21	93.5%	1435.18	58.4%
74.2	218.42	94.9%	1652.00	67.2%
74.3	221.63	96.3%	1872.03	76.1%
74.4	224.86	97.7%	2095.28	85.2%
74.5	228.10	99.1%	2321.76	94.4%
74.56	230.13	100.0%	2459.23	100.0%

8.4 **Soils**

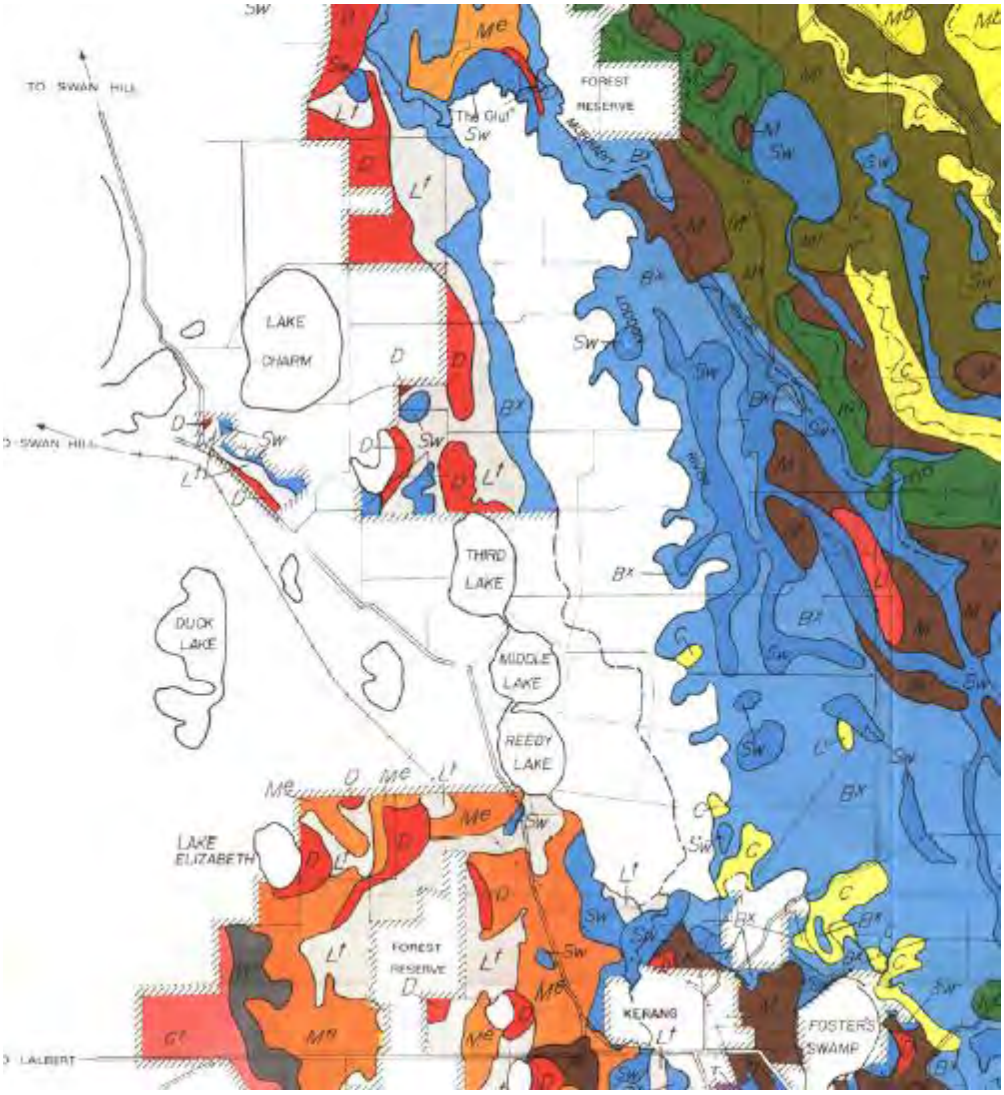
Referral Section	**7**	**Source/more information**	

The available soil mapping unfortunately did not cover the lakes or surrounding areas *(Sargeant et al., 1978)*. They did however map landscape units (Figure 6) from which it is possible to infer soil properties around Third Reedy Lake.

Table 13: Landscape units and associated soils (inferred from)Sargeant et al. (1978)

Landscape unit	Description	Soil Association	Description
Black Box	The overall topography is almost flat, and originally supported on open woodland. When uncleared, the surface is characteristically uneven, with a network of interconnected shallow drainage lines, one to two feet deep.	Box Clay	Grey clay surface soil and a yellowish brownish grey heavy clay subsoil. Heavy clays continue to at least 4 feet.
		Laton Clay	Grey friable clay surface soil, frequently with a high coarse sand component. This overlies a brown clay containing slight amounts of lime; generally saline.
Lake Swamp and Depression	Lakes, swamps and major depression lines throughout the surveyed area.	Swamp	Dark grey swamp soils
Dune and Ridge	Lunettes	Dune	Many widely-differing soils – clay and clay loams

Figure 6 Extract from Torrumbarry soil map (Sargeant et al., 1978)



Some soil information is provided in *Thomas et al. (2011)*. The soils of the Kerang Wetlands Ramsar site typically fall into one of three categories:

(i) grey heavy clay, typically with prominent red-brown mottles, and often cracking and self-mulching when dry (Vertosols and Hydrosols);

(ii) sands (Tenosols and Hydrosols) and

(iii) blue-grey medium to heavy clays often overlain by a peaty or gel layer (Vertosols and Hydrosols). Along the shores of the saline lakes, surface salt crusts (varying in thickness from a few mm to 200 mm) were common above a sandy upper layer. Monosulfidic material was commonly observed in saline lake profiles, occurring beneath a surface crust of halite.

8.5 Hydrology

Referral Section	7	Source/more information	

Third Reedy Lake currently receives inflow from Middle Reedy Lake to the south and provides water to Little Lake Charm via the Torrumbarry No. 7 channel. The wetland supplies irrigation areas to the north via the Torrumbarry 1/7 channel. Scotts Creek to the west can also engage during flood events.

Under natural conditions, Third Reedy Lake would have been an intermittent wetland receiving water irregularly during flood events in the cooler winter months of wet years. Originating from the Loddon River, the water would have entered Washpen Creek before discharging into First Reedy Lake. Once First Reedy Lake was full, water would travel to Middle Reedy Lake then onto Third Reedy Lake. The nature of water movement within the Reedy Lakes Complex would have meant that Third Reedy Lake flooded less frequently and experience more prolonged drying phasing compared to its neighbouring counterparts *(SKM, 2006)*. During high flow events, Third Reedy Lake could also receive water via Sheepwash Creek to the east and would convey water to Little Lake Charm via Scotts Creek at the western boundary *(SKM, 2010)*.

SKM (2010) showed that under both historical and current levels of development the average recurrence interval for floods in the Loddon River that would have resulted in unregulated flows into the Reedy Lakes was 1 in 2 years with the maximum interval between events being 4 years up until 1996.

The management of the Third Reedy Lake for irrigation has altered its natural watering regime. The modification of its natural watering regime began in the 1880s with the construction of a weir across Loddon River to divert water into the Reedy Lakes for storage and extraction, and then again when the Reedy Lakes were included in the Torrumbarry Irrigation System in the 1920s. Third Reedy Lake's inclusion in the Torrumbarry Irrigation System resulted in the lake remaining inundated since the 1920s through good quality fresh water inflows from First and Middle Reedy Lakes. Its water level is maintained at a maximum depth of 74.56m AHD and a minimum of 74.2m AHD *(NC CMA, 2012)*; *(SKM, 2010)*. The table below shows a range of water level percentiles based on data from June 1986 and July 2013 for Third Reedy Lake. The data shows that the wetland actually operates above 74.47 m AHD for 95% of the time, with a level of 74.55m AHD for 50% of the time. There is very little water level variation.

Table 14: Third Reedy Lake water level percentiles (June 1986 to July 2013)

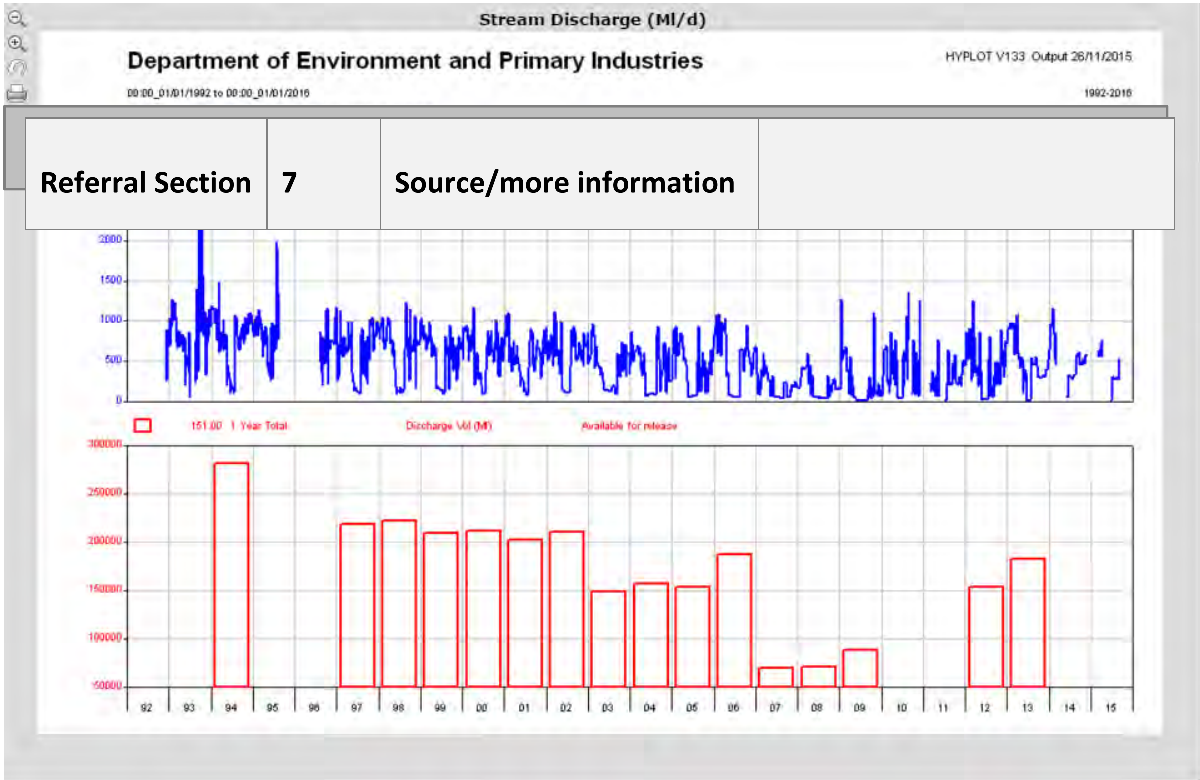
Percentile	5%	10%	25%	50%	75%	90%	95%
Water level (m AHD)	74.47	74.49	74.52	74.55	74.56	74.58	74.6
Source: pers. comm. R. Stanton (GMW 2013)							

The wetland currently receives inflow from Middle Reedy Lake to the south and provides water to Little Lake Charm via the Torrumbarry No. 7 channel. The wetland supplies irrigation areas to the north via the Torrumbarry 1/7 channel. Scotts Creek to the west can also engage during flood events.

Flow from the River Murray is routed to the lakes via Kow Swamp, Pyramid/Box Creek and Loddon Weir. Box Creek flows are highly seasonally variable (Figure 7) with flows around 750 ML/day during the irrigation season.

The wetland is constantly kept at full supply level between 1 August and 31 January. After 31 January, Third Reedy Lake is drawn down for irrigation purposes by up to 30 cm. At the end of the irrigation season the wetland can be further drawn down by evaporation. The outflow released from Third Reedy Lake to the No. 7 Channel is determined by downstream demands and the volume required to meet the needs of the downstream storages. The No. 7 Channel flows through Little Lake Charm and then onto Racecourse Lake and Lake Kangaroo *(SKM, 2010)*.

Figure 7 Flow at SINO 407295 Box Creek at Mansfield's Bridge



Referral Section	7	Source/more information	

8.6 **Ecology**

Third Reedy Lake (and many other Kerang Wetlands) is an example of an ephemeral deflation basin lake (EDBL) *(Scholz et al., 2004)* that are widespread throughout the arid and semi-arid regions of the Murray-Darling Basin. EDBLs are important both as wetlands and as components of the larger floodplain ecosystem. They support diverse and productive plant and animal communities. A growing body of evidence suggests that the impacts of water resource and agricultural development on arid-zone EDBL have generally been detrimental in terms of net ecosystem productivity and diversity (Kingsford 2000a, b).

Both wet and dry periods are important in maintaining ecosystem integrity in ephemeral wetlands. Disturbances, such as flooding and drying, drive aquatic and terrestrial successional processes and facilitate biotic and abiotic exchanges between elements of the floodplain and the riverine environment; because of this EDBL are potentially sites of high productivity and diversity within arid zone floodplain ecosystems. As a consequence, the management of these systems has implications for the productivity and diversity at a landscape scale.

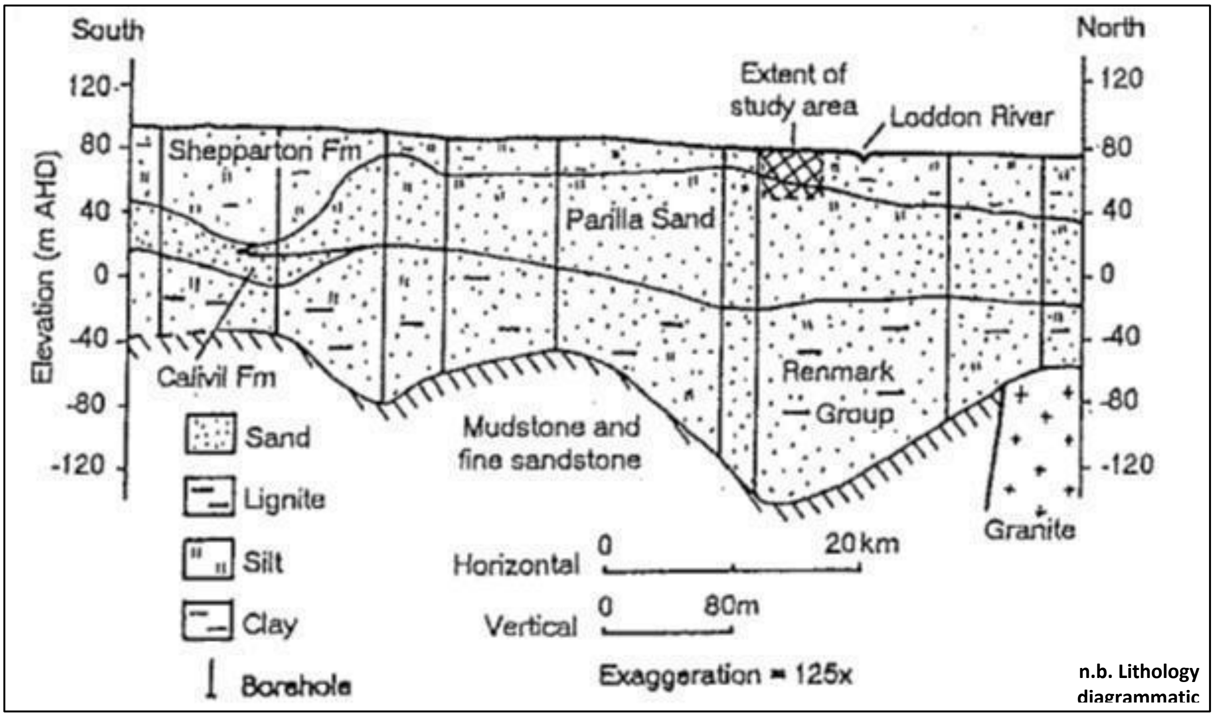
Geomorphically, EDBL are floodplain depressions formed by wind and wave action moving material from their beds eastwards with the prevailing winds. Sand dunes or lunettes formed by the deposition of these eroded materials commonly occur on the eastern margin of lake basins. Lakebeds generally consist of fertile clay soils deposited by successive flooding events, and differ markedly from the soils on surrounding higher ground (*(Bowler, 1986)*, Pressey 1990). These lakes receive water only intermittently through connection to their riverine supply during periods of high flow or from local rainfall. Thus they are subject to episodes of rapid flooding followed by more protracted periods of evaporative drying. The periodicity of these wet/dry phases varies considerably between lakes.

8.7 **Stratigraphy and Regional Groundwater Flow**

Referral Section	**7**	**Source/more information**	Extracted from *URS (2013d)*.

Pre-Tertiary bedrock underlies the Loddon Plain and comprises Ordovician mudstone, fine-grained sandstone and shale, and Devonian granite. Permian siltstone and mudstone has been identified in a north-west trending down-faulted trough south of Kerang in the central Loddon Valley. Overlying the bedrock is up to 600 metres of unconsolidated Cainozoic sediments, within which there are at least four major aquifer systems *(Bartley J., 1992)*. Three of these, the Renmark Group, Parilla Sand and the Shepparton Formation occur within the study area where these fluvial and marine sediments are around 150 m combined thickness (Figure 8).

Figure 8 Geological cross-section through study area Source: Bartley, 1992



8.8 Water quality

Referral Section	7; 8	Source/more information	

There is no regular water quality monitoring program at Third Reedy Lake.

The nearest monitoring station in on the Loddon River at Kerang. Water quality in Third Reedy Lake will approximate the quality of the Loddon River site because both are influenced by flows of water from the River Murray via deliveries for the TIA. Flood flows in the Loddon can make their way via Washpen Creek to the Reedy Lakes.

In 2013, data extracted from the Victorian Water Management System (VWMS) indicates high turbidity, occasionally high EC, high Total Nitrogen (TN) levels dominated by organic nitrogen (TKN) and very low levels of NOX, high level of Total Phosphorus (TP), but relatively low levels of bioavailable phosphorus.

P75 values for TP, TN and turbidity exceed Victorian SEPP (WOV) objectives.

Table 15 Water quality summary SINO407202 Loddon River at Kerang – deciles (from VWMS)

Parameter	Count	min	10%	25%	50%	75%	90%	max	SEPP(WOV) objective P75
pH	49	6.9	7	7	7.2	7.3	7.4	7.8	6.5-8.3
Dissolved Oxygen (ppm)"	49	7.1	7.9	8.2	9.3	10.1	10.52	11.7	-
Water Temperature (°C)"	49	10	11.4	13.2	18.2	22.1	26	29.6	-
Turbidity (NTU)	49	47.5	59.9	78.8	122	173	192	229	<30
Conductivity (µS/cm)"	49	83	93.6	101	136	197	331.2	1253	<1500
Colour (True Filtered) (PCU)"	49	16	20	25	40	50	70	80	-
Nitrate + nitrite as N - total (mg/l)	48	0.003	0.003	0.003	0.0065	0.03575	0.106	0.26	-
Kjeldahl Nitrogen (mg/l)	49	0.38	0.54	0.7	0.85	0.98	1.26	1.9	-
Total Nitrogen TN mg/L		0.41	0.54	0.7	0.86	1.1	1.37	2.16	0.9
Total Phosphorus as P (mg/l)	49	0.05	0.08	0.09	0.13	0.16	0.18	0.22	0.045
Filtered Reactive Phosphorus (mg/l)	49	0.003	0.003	0.003	0.003	0.004	0.0052	0.037	-
Silica as SiO2 - reactive (mg/l)"	49	0.1	0.28	0.4	1.9	3.3	4	5.2	-

8.9 Local Groundwater and Surface Water Flow

Referral Section	7	Source/more information	

u

the surrounding area falls.

The lower lakes, Little Lake Charm and Racecourse Lake, are adjoined by Lake Cham and Kangaroo Lake, respectively. Although groundwater levels in this area often exceed the levels in the lakes, the larger lakes buffer their smaller counterparts against the intrusion of much saltier groundwater.

The net upward hydraulic gradient between the Parilla Sand and the surficial Shepparton Formation aquifers in the area allows no deep vertical drainage of recharge waters – whether from lake, channel, rain or irrigation. Groundwater flow is directed to the near-surface aquifer, which significantly contributes to:

- the maintenance of a high watertable;
- the evaporative concentration of salts; and
- discharge of saline water into low-lying areas nearby, such as the Sheepwash Creek depression.

The lakes act as a buffer against regional pressure fluctuations. Nonetheless, the regional flow system is a major controlling factor on lake/groundwater interactions; with a strong upward gradient and, at times, pressure heads above ground surface.

The cumulative monthly deviation from average rainfall (residual mass) curve (Figure 21) shows a drier period from 1936 to around 1950, followed by an extended period of above average rainfall, with notable large jumps, in the mid-1950s to early 1970s. After the 1982-83 drought, shallow groundwater levels in the Kerang Lakes region experienced a slight upwards trend until the mid-1990s; followed by a relatively steep downwards trend until 2009, when in 2010/2011 the area, like much of Victoria, experienced significantly above average rainfall and flooding *(URS, 2013d)*.

9 Flora and Fauna

9.1 Values

Referral Section	12	Source/more information	

A number of investigations of flora and fauna were undertaken during the investigation. These are summarised in *NC CMA (2014b)* and below.

- *Rakali Consulting (2013)* undertook EVC mapping.
- *Biosis (2013)* undertook fauna investigations,
- *Sharpe (2014)* undertook investigation into the presence of Murray hardyhead and its habitat.
- *SKM (2013b)* also undertook some flora and fauna assessment and ground-truthing of previous investigations.

Survey methods are described in the reports.

The surveys described above were undertaken at some or all of the five lakes within the scope of the investigation. At the end of the investigation, the only live option was to propose works at Third Reedy Lake. Accordingly only information relevant to Third Reedy Lake is presented below.

9.2 Flora

Referral Section	12	Source/more information	*(North Central CMA, 2014b)*

Third Reedy Lake is characterised as a permanent open freshwater lake. The wetland has a high density and abundance of dead River Red Gums (*Eucalyptus camaldulensis*) across the entire shallow open water zone which is devoid of submerged aquatic vegetation. In the 1990s, the open water zone was noted to support an abundance of Robust Water-milfoil (*Myriphyllum papillosum*) and Clove-strip (*Ludwigia peplodies* subsp. *montevidensis*) (McDonnell *et al.* 1990). The Ecological Vegetation Class (EVC) Tall Marsh (EVC 821) (various combinations i.e. Tall Marsh/Cumbungi (*Typha* spp.), Tall Marsh/ Giant Rush (*Juncus* spp.) etc) extends for approximately 50 metres from the edge of the wetland to depths of around 0.3-0.7 metres. The boundary of the wetland is characterised by Intermittent Swampy Woodland (EVC 813), comprising of a Red Gum and Black Box (*Eucalyptus largiflorens*) overstory, with a shrubby understory (predominately Tangled Lignum (*Duma florulenta*)). Small 10m^2 patches of Aquatic Herbland (EVC 653) (which is characterised by rushes and aquatic herbs) is also present particularly in a small depression on the south-east boundary of the wetland (Rakali, 2013).

North Central CMA (2014b) note that aquatic vegetation is severely depleted and negligible in the open water zones of Third Reedy Lake and this may account for the reduction in Murray

River Turtle records between 2013 (Biosis, 2013) and the abundant surveys in 2006 (Ho et al. 2006) and 1989 (Lugg *et al.* 1989). In addition, the habitat value of the dead River Red Gums (particularly roosting and nesting) will eventually be lost under a permanent regime, as timber will decay (process occurs when inundated for over ninety years) and new trees will be unable to establish. *Sharpe (2014)* (Section 4.1.1) also commented on the absence of submerged aquatic macrophytes in Middle and Third Reedy Lakes.

Permanent inundation of Third Reedy Lake has resulted in an outward shift in the zone once occupied by River Red Gums (i.e. historically the wetland body but now the boundary zone). This has allowed Intermittent Swampy Woodland to occupy a zone that was once supporting Black Box dominated communities (fringing zone) (Rakali, 2013). Table 16 shows all the EVCs present at Third Reedy and their conservation status within the Victorian Riverina bioregion. Figure 9 shows the location of EVCs.

Table 16: Current EVCs within Third Reed Lake and their bioregional conservation status (Rakali, 2013)

Bioregion	EVC No.	EVC	Bioregional Conservation Status in the Victorian Riverina[1]
Victorian Riverina	98	Semi-arid Chenopod Woodland	Endangered
	103	Riverine Chenopod Woodland	Vulnerable
	104	Lignum Swamp	Vulnerable
	653	Aquatic Herbland	Not listed for Victorian Riverina (Vulnerable in Murray Fans bioregion)
	813	Intermittent Swampy Woodland	Depleted
	821	Tall Marsh	Depleted
	823	Lignum Swampy Woodland	Vulnerable
[1]EVC Bioregional Conservation Status updated using revised wetland BCS spreadsheet supplied by DEPI (compiled by D. Frood)			

DSE pre-1750s mapping predicts that the wetland would have historically been a deep freshwater marsh made up of Lignum Swampy Woodland (EVC 823) with fringing zones of Riverine Chenopod Woodland (EVC 103) and Semi-arid Chenopod Woodland (EVC 98). Lignum, the dominant understory species in Lignum Swampy Woodland, can tolerate a flooding duration of three to seven months at a depth less than one metre. With the maximum depth of the wetland being 1.36 metres at full supply level (FSL); it is likely that in reality the wetland may have flooded too frequently and for too long to support Lignum Swampy Woodland. A recent survey identified the EVC Intermittent Swampy Woodland (EVC 813) to be the most likely historical EVC. This is supported by the presence of a large number of dead River Red Gum trees throughout the base of the wetland, at a density uncharacteristic of Lignum Swampy Woodland (Rakali, 2013).

Of the 67 native flora species recorded (see Appendix B in *North Central CMA (2014b)*) at Third Reedy Lake, seven are listed as significant (DEPI, 2013 Ho et al. 2006; SKM, 2010; Rakali, 2013). (Table 17). Four of these are considered water dependent- Branching Groundsel (*Senecio cunninghamii* var. *cunninghamii*), Short Water-starwort (*Callitriche brachycarpa*), Spiny Lignum (*Muehlenbeckia horrida* subsp. *horrida*) and Twin-leaf Bedstraw (*Asperula gemella*). The Short Water-starwort (*Callitriche brachycarpa*) which is located within Intermittent Swampy Woodland EVC is the only species listed under the *Flora and Fauna Guarantee Act 1988* (FFG). There are no listed EPBC flora species recorded at Third Reedy Lake.

All water dependent significant species except for Twin-leaf Bedstraw (*Asperula gemella*) were recorded in the recent survey by Rakali Consulting (2013). A total of 45 exotic species have been recorded at Third Reedy Lake with 82% of these located within Intermittent Swamp Woodland EVC.

Figure 10 shows the location of rare flora at Third Reedy Lake.

Table 17: Significant flora species recorded at Third Reedy Lake (extracted from (North Central CMA, 2014b). Location of these species is shown in (Rakali Consulting, 2013) Map 14

Common Name	Scientific Name	Water dependency[1]	Last record	IUCN Red List	EPBC status	FFG status	Victorian Conservation status
Branching Groundsel	*Senecio cunninghamii var. cunninghamii*	W	2013				r
Brown Beetle-grass	*Leptochloa fusca* subsp. *fusca*	T	U				r
Dark Roly-poly	*Sclerolaena muricata* var. *semiglabra*	T	2013				k
Flat-top Saltbush	*Atriplex lindleyi* subsp. *lindleyi*	T	2013				k
Short Water-starwort	*Callitriche brachycarpa*	A	2013			L	v
Spiny Lignum	*Muehlenbeckia horrida* subsp. *horrida*	W	2013				r
Twin-leaf Bedstraw	*Asperula gemella*	T / W	1996				r

Conservation Status:

Water dependency: T- River terrestrial, A- River aquatic, W- wetland dependent

IUCN: EX- Extinct, EW- extinct in the wild, CR- critically endangered, EN- endangered, VU- vulnerable, NT- near threatened, LC- least concern, DD- data deficient

EPBC: VU – Vulnerable, EN- Endangered

FFG status: L – Listed as threatened

Victorian Conservation status: e - Endangered, v- Vulnerable, r - Rare, n- Near Threatened, k- Poorly Known, d- Data Deficient

U- unknown year of record

[1]Water Dependency advised by Significant wetland-dependent flora species spreadsheet supplied by DEPI (compiled by D. Frood) and VEAC, 2008.

Figure 9 EVCs Third Reedy Lake ((Rakali Consulting, 2013)

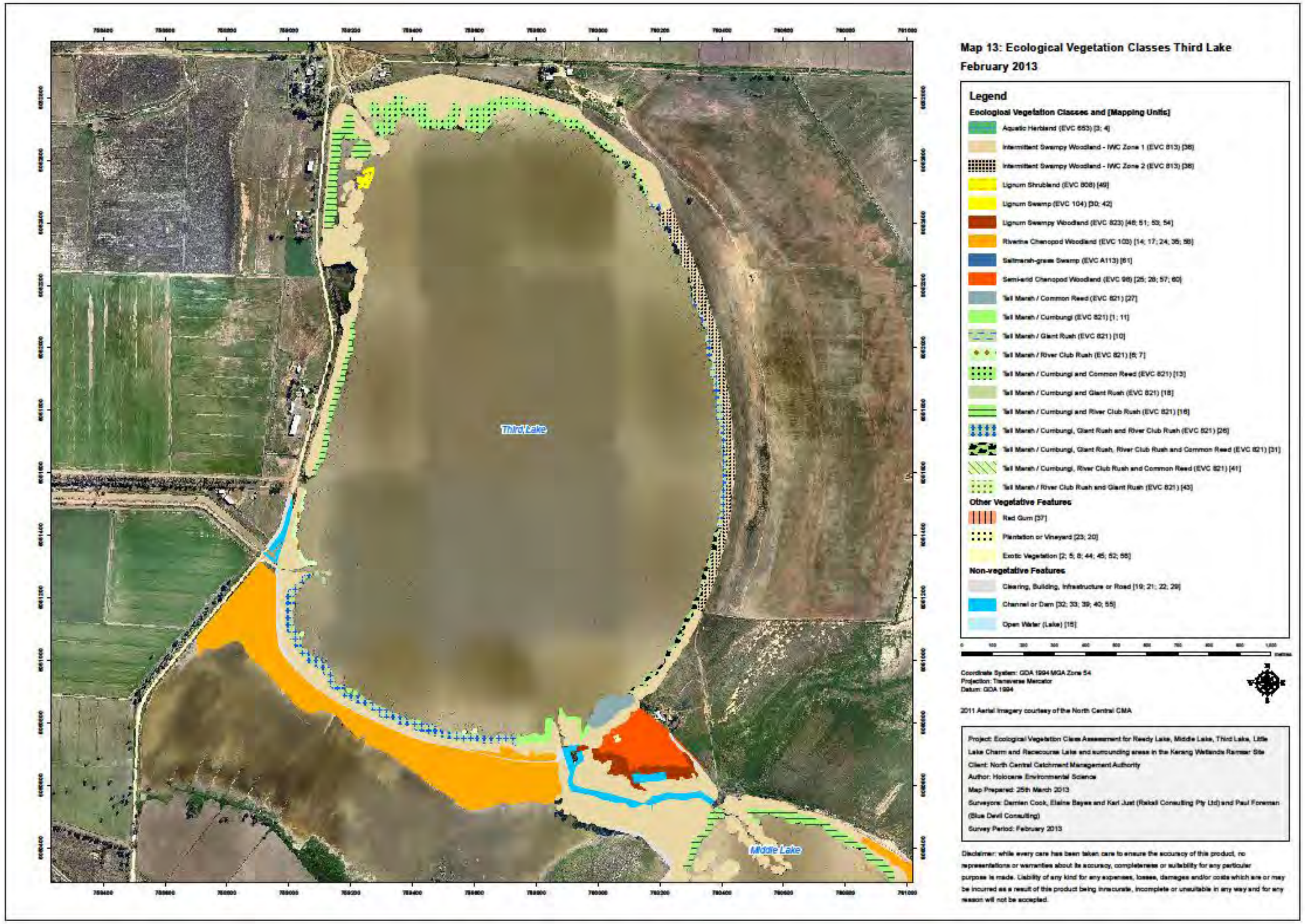
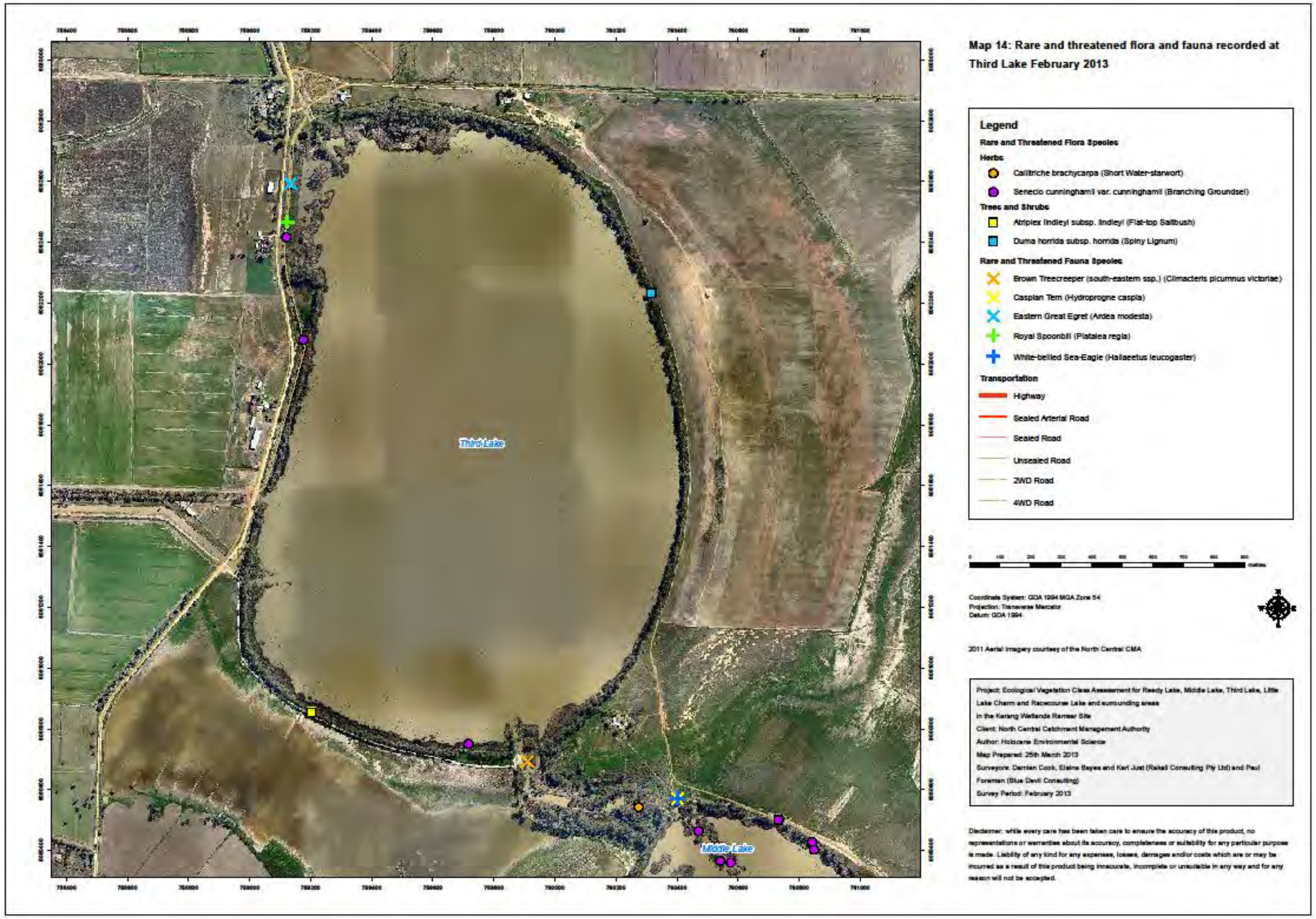


Figure 10 Third Reedy Lake location of rare flora ((Rakali Consulting, 2013) Map 14)



9.3 Fauna

Referral Section	12	Source/more information	*North Central CMA (2014b).*

Table 18 lists significant fauna species recorded at Third Reedy Lake.

Table 18: Significant fauna species recorded at Third Reedy Lake

Common Name	Scientific Name	Water depend-ency[1]	Last record	Inter-national treaty	IUCN Red List	EPBC status	FFG status	Victorian Conservation Status
Birds								
Brown Treecreeper	*Climacteris picumnus*	Y	2013		LC			NT
Caspian Tern	*Sterna caspia*	Y	1998	J/C	LC	M	L	NT
Eastern Great Egret	*Ardea modesta*	Y	2013	J/C		M	L	VU
Hardhead	*Aythya australis*	Y	2006		LC			VU
Musk Duck	*Biziura lobata*	Y	2006					V
Nankeen Night Heron	*Nycticorax caledonicus*	Y	2013					NT
Pied Cormorant	*Phalacrocorax varius*	Y	2013		LC			NT
Royal Spoonbill	*Platalea regia*	Y	2013		LC			NT
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	Y	2013	C	LC	M	L	VU
Fish								
Freshwater Catfish	*Tandanus tandanus*	Y	1981				L	EN
Silver Perch	*Bidyanus bidyanus*	Y	2013		VU		L	VU
Unspecked Hardyhead[2]	*Craterocephalus stercusmuscarum fulvus*	Y	2013				L	
Golden Perch	*Macquaria ambigua*	Y	2013					NT
Murray Cod	*Maccullochella peelii*	Y	2006		CE	VU	L	VU
Reptiles								
Murray River Turtle	*Emydura macquarii*	Y	2006					VU
Common Long-necked Turtle	*Chelodina longicollis*	Y	2013					DD

Significant fauna key:

Water dependency: Y- water dependent, N- not water dependent

International Treaty: J-JAMBA, C- CAMBA, R-ROKAMBA, B-BONN

IUCN: EX- Extinct, EW- extinct in the wild, CE- critically endangered, EN- endangered, VU- vulnerable, NT- near threatened, LC- least concern, DD- data deficient

EPBC status: VU – Vulnerable, M- Migratory

FFG status: L – Listed as threatened

DSE status: EN- Endangered, CR- Critically Endangered, VU- Vulnerable, NT– Near Threatened, K- Poorly known, DD- data deficient

U- unknown record

Common Name	Scientific Name	Water depend-ency[1]	Last record	Inter-national treaty	IUCN Red List	EPBC status	FFG status	Victorian Conservation Status
[1]Water Dependency advised by Significant Wetland Dependent Fauna Species spreadsheet supplied by DEPI (compiled by R. Loyn (birds), N. Clements (Reptiles), M. Scrogie (Frogs), P. Papas (Invertebrates), L. Lumsden (Mammals) and J. Kohen and T. Raadik (Fish)). [2]Unspecked Hardyhead was not included in the April 2013 release of the Advisory List of Threatened Vertebrate Fauna in Victoria (DSE, 2013). The species has been reassessed as abundant across many locations within Victoria, however it is currently gazetted under FFG (October 2012) and management options that impact this species may trigger the *Environmental Effects Act 1978*.								

Third Reedy Lake represents reasonable habitat for a range of fauna species due to its extensive fringing aquatic vegetation, abundant snags which provide good perching, basking and roosting locations for birds and permanent open water for fish. Seventy-three bird species, two native turtles, three native frogs and eleven native fish species have been recorded at the wetland (*(Ho et al., 2006) (SKM, 2010)*, *(Rakali Consulting, 2013)*, *(Biosis, 2013)*,*(DEPI, 2013)*, *(Birdlife Australia, 2013)*). A number of these species are listed as significant, including nine waterbirds and five fish species as well as two turtles. A total of 32 waterbird species are identified as water dependent at Third Reedy Lake, approximately 44% of which can be categorised as fish-eating, 15% as shoreline foragers and 12% as deep-water foragers and 12% as waders. Of particular importance at Third Reedy Lake is the presence of White-bellied Sea Eagle (*Haliaeetus leucogaster*), Caspian Tern (*Anas caspia)* and Eastern Great Egret (*Climacteris picumnus victoriae*) which are listed under international migratory bird agreements.

In recent surveys by *(Biosis, 2013)* and *(Rakali Consulting, 2013)* White-bellied Sea Eagle, Eastern Great Egret, Brown Treecreeper (*Climacteris picumnus)*, Nankeen Night Heron (*Nycticorax caledonicus)*, Pied Cormorant (*Phalacrocorax varius*) and Royal Spoonbill (*Platalea regia*) were recorded. Records indicate that the northern section of the wetland has supported small rookeries of Australian White Ibis (*Threskiornis molucca*) and Straw-necked Ibis (*Threskiornis spinicollis*) in the past with two colonial nesting events recorded by *(Ho et al., 2006)*, *(SKM, 2010) (Clunie, 2010)* identified a total of eight waterbird breeding events at Third Reedy Lake; including Black Swan (*Cygnus atratus*) and White-bellied Sea Eagle (*Haliaeetus leucogaster*); however these breeding events were not referenced in those reports and a subsequent search of the literature failed to confirm two of the eight events recorded (DEPI, 2013; BirdLife Australia, 2013). Table 19 summarises the recorded bird breeding events at Third Reedy Lake.

Only two of the 24 species making up the FFG Victorian Temperate Woodland Bird Community have been recorded at Third Reedy Lake.

Table 19: Bird breeding events at Third Reedy Lake since 1988

Common Name	Scientific Name	Year
Australian White Ibis	*Threskiornis molucca*	2005, 2006
Straw-necked Ibis	*Threskiornis spinicollis*	2005, 2006
Black Swan	*Cygnus atratus*	1988
White-bellied Sea Eagle	*Haliaeetus leucogaster*	1998 (not verified)
Source: *(Ho et al., 2006)*, *(Clunie, 2010, Birdlife Australia, 2013, DEPI, 2013)*.		

9.4 Fish

Referral Section	12	Source/more information	

9.4.1 Silver Perch (Bidyanus bidyanus)

Silver Perch has been recorded from the Reedy Lake System and from Racecourse Lake. Although this species would not occur throughout most of the proposed bypass area, it may occasionally utilise the channel system between Little Lake Charm and Racecourse Lake *(Rakali Consulting, 2013)*. Silver Perch were detected within the channel between Middle and Third Reedy Lakes only and it is, therefore, difficult to make assumptions in regards to this species movement throughout the system. Silver Perch is suspected to be a long term resident in the system in low abundance and is known from a handful of historical records in the Kerang Lakes *(Biosis, 2013)*. Silver perch have a wide range of habitat preferences including large impoundments and irrigation channels, but are usually found within the main stream channel and often within flowing water reaches.

9.4.2 Freshwater Catfish (Tandanus tandanus)

Freshwater Catfish has been recorded from several locations in the Reedy Lake System. The most recent record is from 1981. It is unlikely to be impacted by the proposed works *(Rakali Consulting, 2013)*.

9.4.3 Murray Hardyhead

A single Murray Hardyhead was located in the adjacent, and hydraulically connected, Middle Reedy Lake in 2013 *(Biosis, 2013)*.

A reconnaissance survey undertaken by Mick Dedini (DEPI) (email report dated 2 May 2013) in Middle Reedy Lake in May 2013 failed to locate any Murray Hardyhead. This may have been due to the timing of this survey and potentially the extremely low abundance of Murray Hardyhead within this system.

Detailed survey *(Sharpe, 2014)* was undertaken in 2014, with the specific aim of targeting the collection of Murray Hardyhead. Murray Hardyhead were not detected in Middle Lake or Third Lake.

The absence of submerged aquatic plants and the relatively low salinity levels for each lake (recorded as electrical conductivity) are two habitat features considered likely to influence the status of Murray Hardyhead in Middle and Third Reedy Lake. In other locations where the species occurs, a close association between the occurrence Murray Hardyhead and the presence of submerged aquatic plants has been identified *(Wedderburn SD et al., 2007)*; *(Hammer et al., 2008)*). In particular, it has been noted that dense beds of aquatic plants are required for the species to proliferate, with plants offering critical spawning substrate and shelter from predation.

Combined with the absence of submerged aquatic plants, it appears that Middle and Third Reedy lake do not offer the key habitat conditions conductive to the proliferation of Murray Hardyhead as has been suggested for populations at other locations *(Ebner et al., 2003)*, *(Wedderburn SD et al., 2007)*; *(Stoessel, 2008)*).

9.4.4 Unspecked hardyhead

Unspecked hardyhead *Craterocephalus stercusmuscarum fulvus (FFG listed) were r*ecorded in large numbers in the adjacent Middle Reedy Lake and also in Little Lake Charm.. Has similar habitat requirements to that of Murray Hardyhead; key MHH habitat not encountered.

9.4.5 Murray Cod (*Maccullochella peelii*; Vulnerable EPBC; DSE 2013)

Murray Cod were again recorded in 2013 along with Golden Perch. These species are presumed to persist in the Kerang Lakes as the result of stocking. Several thousand Murray Cod (tagged yearlings and fingerlings) and Golden Perch (fingerlings) have been released into Reedy, Kangaroo and Charm Lakes over the past ten years (*(Biosis, 2013)*,Appendix 9). *Ho et al. (2006)* recorded a single fingerling and three tagged Murray Cod. Two fingerling Murray Cod were recorded at Racecourse and First Reedy in 2013 (Biosis 2013). While the origins of Murray Cod does not affect its status or its level of protection under the EPBC Act, 'natural populations' of Golden Perch are specified under DSE advisory list (2013) criteria and as such the presence of 'natural populations' of Golden Perch is questionable *(Biosis, 2013)*.

Despite the annual stocking of 500 yearling Murray Cod from 2008 to 2010 and 10,000 fingerlings in 2011-2012, no adult Murray Cod were recorded in 2013. Three tagged yearling cod (recently released) were recorded in 2006. It may be plausible that the Murray Cod fingerlings become a ready food source for Golden Perch and the piscivorous bird guilds which were well represented in the survey area or that competition for resources from the Golden Perch population (itself extensively augmented since 2003) make the viability of this species in the system untenable *(Biosis, 2013)*.

Lake habitat is unlikely to be suitable for long term survival of this species.

9.4.6 Golden Perch (Macquaria ambigua)

For Golden Perch (*Macquaria ambigua*), the E*nvironmental Effects Act 1978* will only be triggered if the population is natural occurring. Native populations of Golden Perch are listed as Near Threatened under the DSE Advisory List, and were collected at all lakes and channel sites except Scotts Creek connecting Third Reedy and Little Lake Charm. It was the most widespread native species collected within the study area. It is difficult to ascertain the origins of the Golden Perch collected and it is therefore assumed that a significant proportion of the individuals collected are a result of the stocking of this species within and adjacent to the study area. *(Hunt et al., 2010)* determined that 47% (±9%) of the Golden Perch population within the nearby and hydraulically connected First Reedy Lake is attributed to stocked individuals, although the resultant offspring of these stocked individuals was not assessed, and therefore the actual overall resulting input of stocked fish on these lakes is assumed to be substantially higher than reported *(Biosis, 2013)*. The presence of Golden Perch is therefore assumed to be mostly the result of fish stocking.

9.4.7 Unspecked Hardyhead (Craterocephalus stercusmuscarum fulvus)

Un-specked Hardyhead prefers slow-flowing or still habitats with aquatic vegetation on sand, gravel or mud substrates. It is typically found in the margins of large, slow-flowing, lowland rivers, and in lakes, backwaters and billabongs. Biosis *(Biosis, 2013)* and Sharpe *(Sharpe, 2014)* collected Un-specked Hardyhead in low numbers at Third Reedy Lake. It was more common in the adjoining Middle Reedy Lake. Biosis also collected one specimen from Little Lake Charm.

9.5 Lowland Riverine Fish Community of the Southern Murray-Darling Basin (LRFCSMB)

Referral Section	12	Source/more information	

Some elements of the Lowland Riverine Fish Community of the Southern Murray-Darling Basin exist in Third Reedy Lake and adjacent lakes. (These are underlined below) The fish fauna is predominantly characterized by the following native fish species: Agassiz's Chanda Perch (*Ambassis agassizii*), Silver Perch (*Bidyanus bidyanus*), Murray Hardyhead (*Craterocephalus fluviatilis*), Non-specked Hardyhead (*Craterocephalus stercusmuscarum fulvus*), Flat-headed Galaxias (*Galaxias rostratus*), Western Carp Gudgeons (*Hypseleotris klunzingeri,* now considered to be a species complex), Trout Cod (*Maccullochella macquariensis*), Murray Cod (*Maccullochella peelii,* previously *Maccullochella peelii peelii*), Golden Perch (*Macquaria ambigua*), Macquarie Perch (*Macquaria australasica*), Murray Rainbow Fish (*Melanotaenia fluviatilis*), Southern Purple-spotted Gudgeon (*Mogurnda adspersa*), Bony Bream (*Nematalosa erebi*), Flat-headed Gudgeon (*Philypnodon grandiceps*) and Freshwater Catfish (*Tandanus tandanus*). Other widespread or uncommon species may also occur over parts of the distribution of this community: Southern Pigmy Perch (*Nannoperca australis*), River Blackfish (*Gadopsis marmoratus*), Two-spined Blackfish (*Gadopsis bispinosus*), Australian Smelt (*Retropinna semoni*), Short-headed Lamprey (*Mordacia mordax*), Short-finned Eel (*Anguilla australis*), Broad-finned Galaxias (*Galaxias brevipinnis*) and Barred Galaxias (*Galaxias fuscus*).

Under natural conditions Third Reedy Lake would have regularly dried and the presence of parts of this community is an artefact of the lake's use for irrigation supply.

Biosis (2013) note that the fish community within Third Reedy was dominated by exotic species with 70 individual Carp accounting for 37% of all individuals collected and representing 99% of the total biomass. The overall native biomass for Third Reedy was 0.1%.

9.6 Turtle species

Referral Section	12	Source/more information	

Two turtle species, the Murray River Turtle (*Emydura macquarii*) and Common Long-necked Turtle (*Chelodina longicollis*) have been recorded at Third Reedy. Although Murray River Turtle was recorded in high numbers in 2006 (total of 19 individuals), no individuals were caught during the Biosis (2013). Further to this only one Common Long-necked Turtle was surveyed compared to three by Ho *et al.* (2006).

9.7 Wetland representativeness and distinctiveness

Referral Section	**12**	**Source/more information**	From *(North Central CMA, 2014b)*

Th
Victorian wetland classification system *(Corrick et al., 1980)*. In the NC CMA region the area of this wetland type has almost doubled in size since European occupation and this wetland type is now considered over represented in the landscape (NC CMA, 2005). In the Kerang Wetlands Ramsar site, eight wetlands are currently classified as permanent open water. Due to their close proximity and connectivity, as a complex these wetlands are considered significant in the context of the Murray-Darling Drainage Division and nationally (R. Butcher (Water's Edge Consulting) *pers comm.,* 18 September 2013).

The original pre-European extent of deep freshwater marsh is considered the most depleted wetland category in Victoria and it is estimated that there has been approximately 70% decrease in area since European settlement (*(Clunie, 2010)*). Table 20 illustrates the area and proportion of permanent open water across various defined landscapes and highlight the relative minor contribution of Third Reedy Lake to the whole Kerang Wetland Ramsar site and the NC CMA region.

Table 20: Current area of Permanent Open water across the landscape ((North Central CMA, 2014b), Table 7)

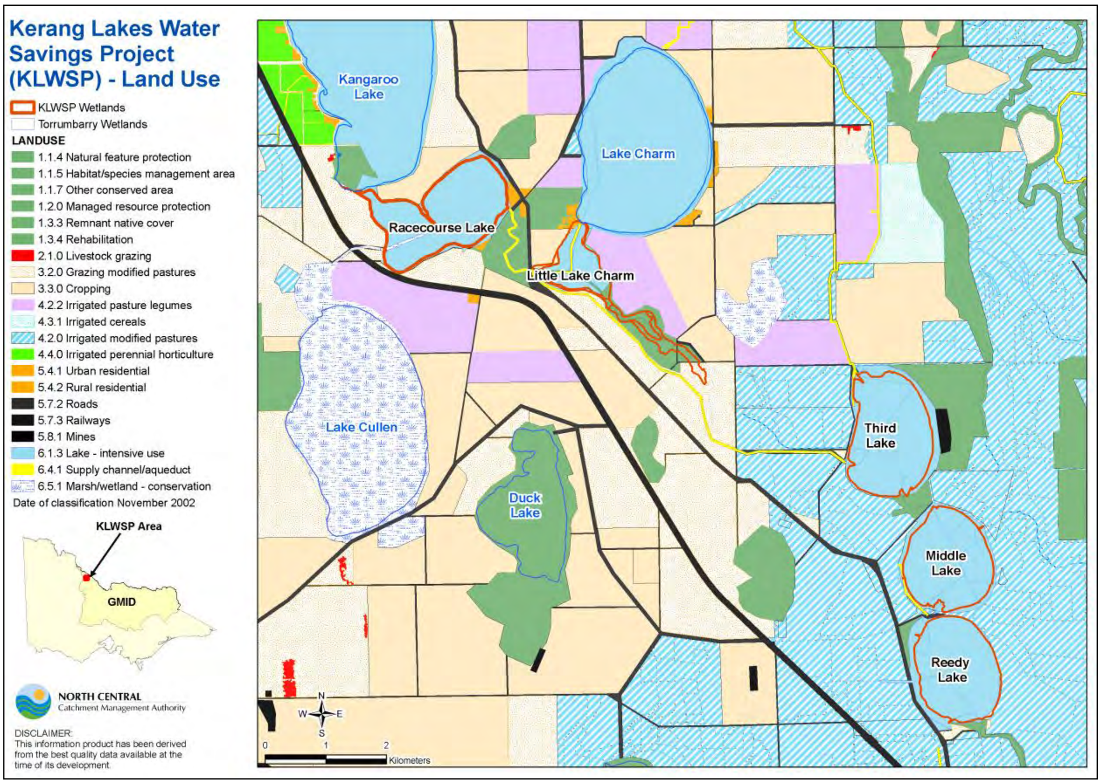
	North Central region	Kerang Wetlands Ramsar site (9,938 ha)	Goulburn-Murray Irrigation District (GMID)
Permanent Open Water (ha)	28,360	3,840	48,330
Third Reedy Lake (230 ha)	0.78%	5.76%	0.46%

10 **Land Use**

Referral Section	9	Source/more information	

Figure 11 shows land use in the vicinity of the Kerang Lakes.

Figure 11 2011 Land use in Third Reedy Lake region (NC CMA, 2011)



10.1 **Social and economic**

Referral Section	13	Source/more information	RMCG (2013)

RMCG (2013) undertook a preliminary social and economic impact of the proposal in early to mid 2013. This utilised the four preliminary environmental watering scenarios (Table 2) as the basis for determining impacts. They assessed the social and economic impact of the different watering regimes on each lake by activity type.

Thirty-five people were interviewed during the course of the project. These people represented potentially affected landholders and businesses, recreation groups, council and agencies.

During the course of their work they collated a range of community responses to the early stages of the investigation. They also suggested measures to mitigate the potential social and economic impacts and manage risk (see below).

Note that the responses they received were based on a scenario of all lakes being bypassed, which is quite different to the final proposal of bypassing Third Reedy Lake only.

They also assessed the use of the lakes for recreation by locals and visitors to the region. Table 22). The main uses of the lakes by local people are swimming at Reedy Lake and fishing at Reedy Lake, Third Lake and Racecourse Lake.

The five lakes are less developed and less commonly used for recreation than the larger nearby lakes in the Kerang wetlands system, Lake Charm and Lake Kangaroo. Their value as tourism assets is largely as adjuncts to those larger lakes, providing another activity for visitors, rather than being drawcards in themselves. The likely impact of the lakes drying out will be a reduction in the average length of stay, that is, visitors will not be held as long in the region. This is with the exception of Racecourse Lake, which is the site of a caravan park.

For the Third Reedy Lake option the impact is minimal; none the less an impact will be experienced. It is likely these negative impacts will be countered by the benefits from water savings and flood mitigation.

Table 21: Residential properties next to the lakes (Based on visual count of existing land from Google Maps https://maps.google.com/.)

Criteria	Unit	Reedy Lake	Middle Reedy Lake	Third Reedy Lake	Little Lake Charm	Racecourse Lake
Land value	No of properties	2	2	6	5	6
Assumed additional demand based on council policy	No of properties	0	0	0	0	1.6
Assumed additional demand based on advice from Kilter	No of properties	1.5	0	2.5	0	0
TOTAL	No of properties	3.5	2	8.5	5	7.6

Table 22: Current recreation use of the lakes (from RMCG (2013)

Activity	Unit	Reedy Lake	Middle Reedy Lake	Third Reedy Lake	Little Lake Charm	Racecourse Lake
Duck Hunting (locals)	Visits/year	0	0	0	25	25
Duck Hunting (visitors)	Visits/year	0	0	0	100	100
Recreational fishing (locals)	Visits/year	200	200	300	200	300
Recreational fishing (visitors)	Visits/year	120	160	215	145	100
Boating (locals)	Visits/year	100	10	10	0	10

Activity	Unit	Reedy Lake	Middle Reedy Lake	Third Reedy Lake	Little Lake Charm	Racecourse Lake
Boating (visitors)	Visits/year	50	10	10	0	10
Swimming (locals)	Visits/year	1000	100	0	0	100
Swimming (visitors)	Visits/year	120	0	0	0	50
Walking, sight-seeing, bird watching (locals)	Visits/year	50	150	150	90	50
Walking, sight-seeing, bird watching (visitors)	Visits/year	70	510	100	0	50
Camping (locals)	Visits/year	0	0	0	0	50
Camping (visitors)	Visits/year	30	50	15	0	10,833

While the social and economic impact is significant, it is small relative to the financial cost of the project, and the value of the water savings. The project requires a significant environmental benefit to be of net benefit to society.

Ways of mitigating the social and economic impacts were discussed, including risk management.

10.1.1 Social and Economic Impacts of the Proposed Third Reedy Lake bypass.

A summary of the impact of the bypass on social uses of the lakes is shown in Table 23.

Table 23: Summary of social and economic impact of the bypass (Discounted over 25 years with a 7% discount rate).

Criteria	Reedy Lake	Middle Reedy Lake	Third Reedy Lake	Little Lake Charm	Racecourse Lake
Swimming (locals)	-$22,636	-$2,264	$0	$0	-$2,988
Boating (locals)	-$2,264	-$226	-$299	$0	-$299
Walking, sight-seeing, bird watching (locals)	$0	$0	$0	$0	$0
Recreational fishing (locals)	$0	$0	-$13,581	$0	-$13,581
Duck Hunting (locals)	$0	$0	$0	$0	$0
Camping (locals)	$0	$0	$0	$0	-$1,494
Swimming (visitors, Victoria level)	-$3,390	$0	$0	$0	-$1,865
Boating (visitors, Victoria level)	-$1,413	-$283	-$373	$0	-$373
Walking, sight-seeing, bird watching (visitors, Victoria level)	$3,955	$28,815	$5,650	$0	$2,825
Recreational fishing (visitors, Victoria level)	$0	$0	-$12,148	$0	-$5,650
Duck Hunting (visitors, Victoria level)	$0	$0	$0	$0	$0
Camping (visitors, Victoria level)	$0	$0	-$1,119	$0	-$403,970
Property Value	-$21,875	-$12,500	-$318,750	$0	-$287,625
Flood mitigation	$0	$0	$49,299	$0	$97,132

Total	-$47,622	$13,543	-$291,320	$0	-$617,888

The Business Case undertook economic analysis concluding that bypassing Third Reedy Lake would have a cost of $7.892 million from Stage 2 Special Project budget. A contribution of $182,000 from the Connections program brings the total cost of the preferred option to $8.075 million (undiscounted, real).

The investment in bypassing Third Reedy Lake would generate positive outcomes for the Australian economy with a benefit cost ratio of 1.1:1.

Cost effectiveness in terms of real costs ($ with 2.5% inflation) was determined for Third Reedy Lake $4908/ML which was very close to the Connections Project target for cost effectiveness of $4885/ML.

Another option (bypassing Third Reedy Lake together with Bertram’s Lake was not pursued as it did not meet the $/ML target criterion.

11 Shire of Gannawarra

The Shire of Gannawarra advised that the lakes are of importance to the local and visiting community (letter dated 11 June 2013). Amongst other things, they noted the Kerang wetlands system plays an important role in the economic and social well-being of the Shire. The Shire is recognised for its significant natural features, of which the Kerang wetlands system is a highly valued component.

11.1 Gannawarra Planning Scheme

Referral Section	**13**	**Source/more information**	

The Gannawarra Planning Scheme Municipal Strategic Statements includes as an objective for Natural Resource Management (Section 21.04-2) Management of public land (State Forests and Parks, river and stream reserves, wetlands and lakes) that provide for a range of opportunities including nature conservation, recreation, and tourism.

Gannawarra Planning Scheme Zones and Overlays relevant to Third Reedy Lake are shown below.

Table 24*: Zones and Overlays relevant to Third Reedy Lake*

Zone	**Applicable to**
PCRZ (Public conservation and resource zone)	The lakes and adjacent public land.
FZ (Farming Zone)	Private land surrounding the lakes (but not the lakes)
Overlays	
ESO3 (Environmental Significance Overlay) (Lake Environs)	The lakes
LSIO (Land subject to inundation)	Areas surrounding the lakes (but not the lakes)
Rural floodway (RFO)	The lakes

11.1.1 Farming Zone Purpose

- To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.
- To provide for the use of land for agriculture.
- To encourage the retention of productive agricultural land.
- To ensure that non-agricultural uses, including dwellings, do not adversely affect the use of land for agriculture.
- To encourage the retention of employment and population to support rural communities.
- To encourage use and development of land based on comprehensive and sustainable land management practices and infrastructure provision.

11.1.2 PCRZ Purpose

- To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.
- To protect and conserve the natural environment and natural processes for their historic, scientific, landscape, habitat or cultural values.
- To provide facilities which assist in public education and interpretation of the natural environment with minimal degradation of the natural environment or natural processes.
- To provide for appropriate resource based uses.

ESO3 Environmental objective to be achieved:

- To recognise the important function and significance of existing lakes in the land pattern
- To protect the visual and environmental quality and character of the lakes and their environs.
- To provide for appropriate development on land adjacent to Lake Charm, Kangaroo Lake and Racecourse Lake, consistent with the inherent use of the area for tourist, holiday and recreational purposes, while protecting the natural beauty and amenity of the land and lakes themselves.
- To maintain the function of the lakes as a flood control basin
- To protect the natural beauty of the area.

11.1.3 LSIO Purpose

The purpose of the LSIO is:

- To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.
- To identify land in a flood storage or flood fringe area affected by the 1 in 100 year flood or any other area determined by the floodplain management authority.
- To ensure that development maintains the free passage and temporary storage of floodwaters, minimises flood damage, is compatible with the flood hazard and local drainage conditions and will not cause any significant rise in flood level or flow velocity.
- To reflect any declaration under Division 4 of Part 10 of the Water Act, 1989 where a declaration has been made.
- To protect water quality in accordance with the provisions of relevant State Environment Protection Policies, particularly in accordance with Clauses 33 and 35 of the State Environment Protection Policy (Waters of Victoria).
- To ensure that development maintains or improves river and wetland health, waterway protection and flood plain health.

11.1.4 **RFO Purpose**

The purpose of the RFO is:

- To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.
- To identify waterways, major floodpaths, drainage depressions and high hazard areas which have the greatest risk and frequency of being affected by flooding.
- To ensure that any development maintains the free passage and temporary storage of floodwater, minimises flood damage and is compatible with flood hazard, local drainage conditions and the minimisation of soil erosion, sedimentation and silting.
- To reflect any declarations under Division 4 of Part 10 of the Water Act, 1989 if a declaration has been made.
- To protect water quality and waterways as natural resources in accordance with the provisions of relevant State Environment Protection Policies, and particularly in accordance with Clauses 33 and 35 of the State Environment Protection Policy (Waters of Victoria).
- To ensure that development maintains or improves river and wetland health, waterway protection and flood plain health.

Figure 12: Gannawarra Planning Scheme - Farming Zone (FZ) and Public Conservation and Recreation Zone (PCRZ) around Third Reedy Lake

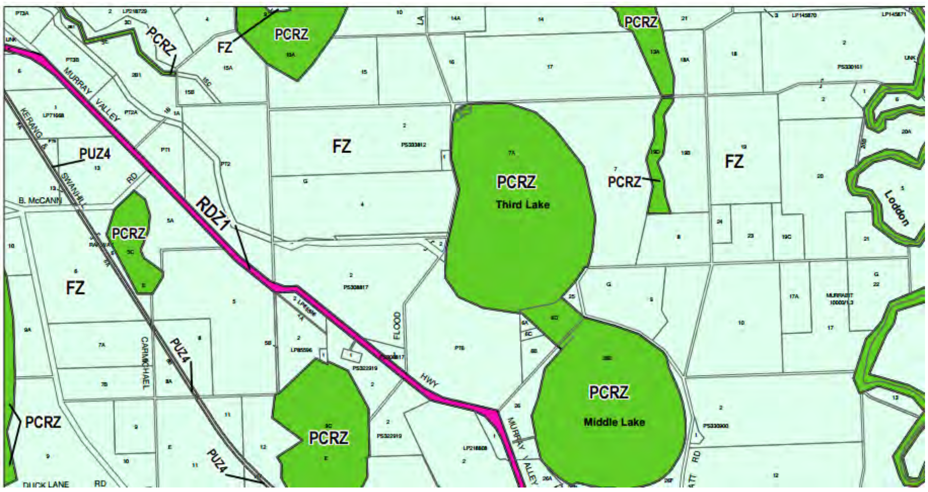


Figure 13: Gannawarra Planning Scheme – Environmental Significance Overlay (ESO3) around Third Reedy Lake

Figure 14: Gannawarra Planning Scheme – Land Subject to Inundation Overlay (LSIO) around Third Reedy Lake

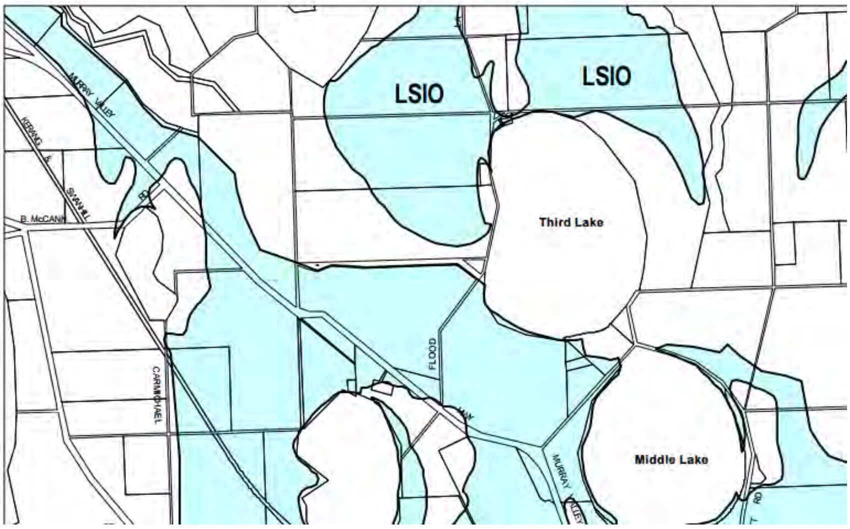
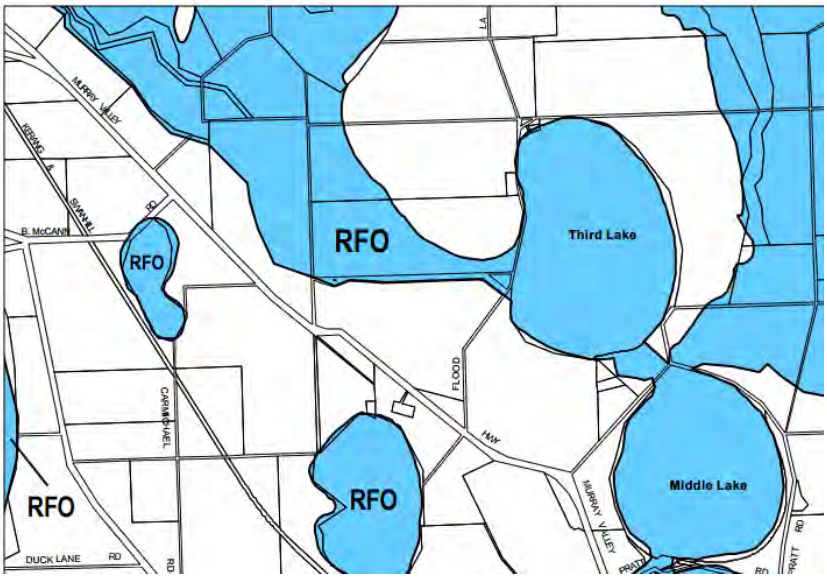


Figure 15: Gannawarra Planning Scheme – Rural Floodway Overlay (RFO) around Third Reedy Lake



12 Cultural Heritage

Referral Section	15	Source/more information	*SKM (2013c)*

The activity area is predominantly within an area of cultural heritage sensitivity.

SKM (2013c) undertook a cultural heritage assessment along potential bypass alignments as part of the Investigation.

A Notice of Intent to Prepare a CHMP (NOI) has been lodged with OAAV and the owners or occupiers of any land within the area to which the CHMP relates have been notified.

Aboriginal stakeholder participation in the conduct of the assessment of this CHMP was undertaken via phone, email and meetings. The BBNAC (Barapa Barapa Nations Aboriginal Corporation) and BBNTG (Barapa Barapa Native Title Group) indicated a willingness to participate in meetings and field assessments for the standard phases of the CHMP.

Informal discussions have occurred via the Kerang Indigenous Network.

The cultural heritage assessment was conducted both as a desktop and field assessment.

Following an analysis of previous archaeological investigations, land systems information and Aboriginal Places in the region, the following predictive statements were made for the activity area:

- The activity area is of moderate to high archaeological potential
- Most Aboriginal Places will occur within 200 m of a hydrological feature (Kangaroo Lake, Racecourse Lake, Little Lake Charm, Third Reedy Lake, Middle Lake and Reedy Lake)
- Preservation of Aboriginal Places other than scarred trees will be dependent on the level of ground disturbance
- Scarred trees and earth features are predicted to be the most common Aboriginal Place types in the activity area
- Scarred trees will only be present where suitably mature native vegetation occurs (Box or River Red Gum)
- Earthen mounds are obtrusive sites and do not rely on ground surface visibility for detection
- Detection of stone artefact scatters and shell deposits will rely on ground surface visibility
- Earthen mounds, stone artefact scatters and shell deposits are likely to be highly disturbed through past and current agricultural activities and rabbit activity
- Earthen mounds are most likely to be associated with existing or prior waterways (including creeks, swamps, lagoons and rivers) or sand dunes and are most likely to be located within 100 m of water

- Artefact scatters are predicted to be low density (< 10 artefacts within a 10 m² area) or isolated artefacts predominantly comprised of quartz artefacts
- Burials are likely to occur as a component of earthen mounds, but also in sand bodies (including deflated dunes).

The desktop assessment concluded:

- The activity area is located within the elevated alluvial plain land system.
- It is associated with the lakes in the region, including Kangaroo Lake, Racecourse Lake, Little Lake Charm, Third Lake, Middle Lake and Reedy Lake.
- The activity area is likely to have been a favourable location for Aboriginal occupation and resource procurement as evidenced by the ethnographic record as well as the availability of food, fresh water and raw material resources associated with the lakes.
- Although there are no Aboriginal Places with in the activity area, there are two Aboriginal Places within 100 m of the activity area and the activity area is predominantly located within an area of CHS.
- The VAHR search and the review of regional and local archaeological studies shows that scarred trees, earth mounds and artefact scatters were likely to be present in the activity area.

Therefore there is a moderate to high potential for Aboriginal cultural heritage to be present in the activity area.

A systematic field survey of the activity area was undertaken over three days in 2013. Ground surface disturbance was extensive within the activity area due to the agricultural land use within the area. This disturbance was predominantly due to ploughing and grazing activities which have occurred in the area. Option Five (1C/7 channel) was significantly disturbed due to a channel already being constructed along the entire alignment.

No trees with evidence of cultural scarring were identified during the survey. The potential for surface Aboriginal cultural heritage to exist within the activity area is low due to the moderate to high level of ground disturbance in the activity area. There is a moderate to high potential for sub-surface Aboriginal cultural heritage as the disturbance caused by the agricultural activities is unlikely to have completely destroyed cultural heritage that may be present. No Aboriginal Places were located during the survey. The section of Option Four B (which is of archaeological potential is immediately adjacent to the south western bank of Third Reedy Lake. Within this area a small amount of clay pieces were found in areas of exposure. These clay pieces were insufficient to record the area as a site; however the presence of the clay pieces increases the archaeological sensitivity of the area.

Their report concludes (note that only option 4B is relevant to Third Reedy Lake Bypass):

- No Aboriginal Places were recorded during the field assessment.
- Four areas of potential archaeological sensitivity were recorded and these areas should be tested through sub-surface excavations in order to determine if Aboriginal cultural heritage is present within these Option sections.
- The likelihood of finding subsurface Aboriginal cultural material is low for two of these areas (Option Three and Four B (Third Reedy Lake)) which are situated upon the floodplain and moderate for the other two areas (Option Two C and Seven) where these options are within a dune and higher ground above the floodplain respectively.

At this stage of assessment there are no Aboriginal cultural heritage factors that would require modification of the proposed Options as they presently stand. All Options appear to be suitable however further assessment is required in those four area mentioned above in order to determine the presence and nature of Aboriginal cultural heritage within the study area.

Further assessment by sub surface testing (or avoidance) is recommended. This should be done as part of detailed design.

Figure 16 Aboriginal cultural heritage testing areas

12.1 **Historic sites**

Referral Section	**15**	**Source/more information**	*SKM (2013c)*

SKM (2013c) also determined if there were any historical sites within the study area and whether there was potential for the proposed channel to harm any historical heritage sites.

A Notice of Intention to Carry out a Historical Archaeological Survey was lodged with HV on 11 October 2013.

There are no known historical heritage sites located within, or immediately adjacent to the study area. There are two historical heritage site located within a two km radius of the study area, the Reedy Lake Farm House in Reedy Lake and the Former Post Office in Lake Charm.

Field survey was undertaken. During the survey three historical sites were located. Two of the sites are historical artefact scatters (Option Seven, Kangaroo Lake Road Artefact Scatter and

Option Two C, Pratt Road Artefact Scatter) and the third was a stockyard (Option One, Apex Park Road Stockyard).

None of these sites will be affected by the Third Reedy Lake proposal.

13 The Kerang Wetlands Ramsar Site

Referral Section	**7**	**Source/more information**	

The Kerang Wetlands Ramsar Site was listed by Australia as a wetland of international importance in 1982. The site is located near Kerang in North West Victoria, approximately 300 km North West of Melbourne. The site occupies 9,419 ha and is made up of 23 named permanent and temporary wetlands, including permanent freshwater lakes, permanent saline/ brackish/ alkaline lakes, permanent freshwater marshes and seasonal/ intermittent freshwater marshes *(Clunie, 2010)*.

The Ramsar criteria for which the site is listed, the ecological character of the site and threats to the ecological character of the Ramsar site are described in the ecological character description (ECD) for the site *(KBR, 2011)*.

The 23 wetlands within the Ramsar site fall into four broad hydrological categories and represent six wetland types (using the Ramsar Convention wetland classification system) Table 25).

Table 25 Area of wetland categories in Kerang Lakes Ramsar site in relation to Victoria and bioregions (from Clunie (2010))

					Kerang Lakes Ramsar Site			
Wetland type (after (Corrick and Norman 1980)	Pre-European area (ha) in Victoria	Area (ha) remaining in Victoria	Area remaining in Victorian Riverina Bioregion (ha)	Area remaining in Murray Fans Bioregion (ha)	Area (ha)	% of remaining natural wetlands in Kerang Lakes Ramsar site	% of wetland type in Victorian Riverina Bioregion	% of wetland type in Murray Fan Bioregion
Shallow Freshwater Marsh	125,916	54,496	10,717	366	247	0.5	1.3	30.3
Deep Freshwater Marsh	176,135	54,664	7071	418	2088	3.8	29.5	0
Permanent Open Freshwater	70,590	180,396	36,340	126	3839	2.1	10.5	0
Semi-Permanent Saline	61,385	64,264	1736	720	428	0.7	6.3	44.2
Permanent Saline	62,627	61,327	2092	190	1625	2.6	77.8	0
Sewage Pond		3793	695	6	6	0.2	0	100

13.1 Ramsar criteria

Referral Section	7	Source/more information	

The Kerang Wetlands Ramsar Site currently meets six of the Ramsar criteria for listing (KBR 2011).

Table 26: Kerang Wetlands Ramsar site satisfied criteria (KBR, 2011)

Group A: Sites containing representative, rare or unique wetland types	
Criterion 1	A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
Group B: Sites of international importance for conserving biological diversity	
Criteria specific to species and ecological communities:	
Criterion 2	A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
Criterion 3	A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.
Criterion 4	A wetland should be considered internationally important if it supports plants and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
Criteria specific to waterbirds:	
Criterion 5	A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.
Criterion 6	A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

13.1.1 Third Reedy Lake in the Ramsar site context

Overall, Third Reedy Lake is not a significant contributor to the ecological character of the Kerang Lakes Ramsar site (Table 27)

Table 27 Contribution of Third Reedy Lake towards meeting Kerang Ramsar site criteria ('supported' – i.e. be recorded regularly or evidence to suggest the lake is important habitat)

Ramsar criterion no.	Criterion	Contribution of Third Reedy Lake	Explanation

1	A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.	Minimal	Third Reedy Lake is not a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region (KBR, 2011, Table 2.5). However, it does contribute to the overall diversity of wetland types within the Ramsar site.
2	A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.	Minimal	A number of vulnerable, endangered and/or critically endangered species with two EPBC listed and three significant IUCN listed water dependent species have been recorded at Third Reedy Lake. There is no evidence to suggest it is important habitat for any of these species.
3	A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.	Minimal	Seventy-three bird species, two native turtles, three native frogs and eleven native fish species have been recorded at Third Reedy. Analysis of the significance of Third Reedy Lake for these species suggests the lake is of very limited significance in supporting these populations.
4	A wetland should be considered internationally important if it supports plant/or animal species at a critical life stage in their life cycles, or provides refuge during adverse conditions.	Minimal	Migration – regularly supports migratory species - White-bellied Sea Eagle , Caspian Tern and Eastern Great Egret . Breeding Open lakes (such as Third Reedy Lake) have few plants and serve as poor food sources. Little breeding occurs in these areas as they are also subject to disturbance from recreational activities. Available areas of fringe reed beds however, may be used for nesting by black duck and purple swamphen (KBR 2011). Middle Reedy Lake is an exception (KBR 2011). Third Reedy Lake is not listed in *KBR (2011)* as supporting colonial nesting breeding events. Moulting of waterfowl Drought refuge – not fully understood *(Clunie, 2010)*
5	A wetland should be considered internationally important if it regularly supports 20 000 or more waterbirds.	Minimal	Open lakes have few plants and serve as poor food sources. Little breeding occurs in these areas as they are also subject to disturbance from recreational activities. Available areas of fringe reed beds however, may be used for nesting by black duck and purple swamphen. Highly unlikely that Third Reedy Lake on its own can support enough waterbirds to meet Criterion 5 although its habitat contributes to this criterion being met by the Kerang Wetlands Ramsar Site as a whole.
6	A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.	None	(Banded Stilt, Australian White Ibis or Straw-necked Ibis) Unlikely to be fulfilled at Third Reedy Lake as the Ramsar site as a whole supports 10% of the regional breeding population of Straw-necked Ibis and Australia White Ibis and more than 5% of the Victorian breeding population of Royal Spoonbill *(Clunie, 2010)*.

13.1.2 **Ramsar and Landscape consideration**

NC CMA (2014a) provided a summary of the Ramsar site and associated legal requirements in ensuring the ecological character is maintained. It also documents the recommended environmental watering regime as part of the KLBP Investigation, salinity and Acid Sulfate Soil (ASS) risks and whether the Limits of Acceptable Change (LAC) are potentially triggered (Section 17).

In addition, a report providing a summary of the Ramsar site and associated legal requirements in ensuring the ecological character is maintained has also been prepared *(NC CMA, 2014a)*. The report considers:

- general description of the Kerang Wetlands Ramsar site within which lie the five lakes assessed as part of this project,
- the contribution of the five lakes to the meeting of Ramsar criteria against which the broader site is listed,

- the recommended environmental watering regime for each of the five lakes,
- the potential impacts and predicted gains associated with the recommended environmental watering regime against the draft 'Limits of Acceptable Change' (LACs) assigned to the Kerang Wetlands Ramsar site,
- whether the proposed bypass would be likely to result in a potential change in character at the scale of the Ramsar site, and
- general operational issues associated with managing the five lakes.

The approach used aims to determine whether or not the proposed changes to a lake will exceed the previously determined LACs.

14 Government policy context

14.1 The Murray-Darling Basin Plan

Referral Section	7	Source/more information	

The Basin Plan is a strategic plan for the integrated and sustainable management of water resources in the Murray-Darling Basin. It provides a framework for setting environmentally sustainable limits on the amount of surface water and groundwater that can be taken from the Murray-Darling Basin. In addition, through its implementation, it will identify, and seek to protect and rehabilitate, key environmental assets which are essential to the life of the rivers, their surrounding landscapes and the cultural values of the communities which depend on those water resources.

The Environmental Works and Measures (EWM) Program aims to improve the health of the River Murray System through infrastructure that delivers and manages water for the six environmental icon sites of The Living Murray.

Over the next six years the Basin states will receive funding from the Australian Government to implement the Basin Plan including the development of regional waterway Environmental Water Management Plans to support the state's Long-term Environmental Watering Plan (as required under Chapter 8 of the Basin Plan) and to inform annual watering priorities.

14.2 Water reform criteria

Referral Section	7	Source/more information	

All activities associated with the proposed KLBP are in accordance with Council of Australian Governments and National Water Initiative agreements.

Victoria is progressing well on key water reforms, including those previously agreed to by jurisdictions under the National Water Initiative, as was reported by the National Water Commission 2011 biennial assessment *(NWC, 2011)*.

14.3 Victorian statutory water planning and NRM planning

Referral Section	7	Source/more information	

Statutory water planning in Victoria is undertaken through sustainable water strategies. Sustainable water strategies identify threats to water availability in each region and identify policies and actions to help water users, water corporations and catchment management authorities manage and respond to those threats over the next 50 years. The KLBP is consistent with the policies set out in the Northern Region Sustainable Water Strategy.

NRM planning in Victoria primarily is undertaken through Regional Catchment Strategies. The KLBP is consistent with the North Central Regional Catchment Strategy, which recognises the importance of the Kerang Lakes Ramsar site *(NC CMA, 2013)* Table 14. The NC CMA has prepared the recommended environmental watering regimes that are proposed to be implemented through the KLBP.

14.4 Northern Loddon Mallee Regional Strategic Plan

Referral Section	7	Source/more information	

Strategic Direction 2 of the Northern Loddon Mallee Regional Strategic Plan *(RDA, 2015)* is to build the connecting infrastructure for our diverse economy. It notes that connecting infrastructure underpins industry growth and efficiency, increases access to employment and education, improves road safety and strengthens our regional economy

Key Initiative 2.6 is to “Continue modernising our Region’s irrigation system”.

As such, this project is recognised in the Regional Strategic Plan.

14.5 Kerang Wetlands Ramsar site

Referral Section	7	Source/more information	

The Kerang Wetlands Ramsar Site was listed by Australia as a wetland of international importance in 1982. The site is located near Kerang in North West Victoria, approximately 300 km North West of Melbourne. It comprises a total of 23 wetlands and covers an area of 9419 hectares. The Kerang Wetlands Ramsar Site currently meets six of the Ramsar criteria for listing.

KBR (2011) identifies four critical components, processes and services (CPS) that significantly contribute to the recognised ecosystem value and importance of the Kerang Wetlands Ramsar Site:

- Hydrology (percentage full, depth/volume, frequency of inundation) is a critical process that influences water quality, habitat and wetland type.
- Salinity is a critical physiochemical component that maintains wetland type and distinctive flora and fauna assemblages.
- Waterbird abundance is a critical component that contributes to the site’s Ramsar listing.

- Colonial breeding/nesting waterbirds (ibis, darters, cormorants, spoonbills) are a critical component that contributes to the site's Ramsar listing.

The site's Ecological Character Description (ECD) describes these and sets limits of acceptable change (LACs) for each of the critical CPS.

Of these critical components, Limits of Acceptable Change (LAC) have been established at Third Reedy Lake for hydrology and water quality/salinity.

14.6 GMW CP Environmental Approval, Water Change Management Framework and CEMF

Referral Section	7	Source/more information	

Development of the Kerang Lakes Investigation and management of proposed changes has occurred outside GMW CP's current environmental approval framework which is one of the conditions of approvals granted by the Victorian Minister for Planning and the Commonwealth Minister for Environment Protection, Heritage and the Arts. The framework has been used to guide the investigation and application of the framework during construction and implementation of the proposed change would be a sensible and cost effective solution for environmental management of the site. Key elements of the framework include the Water Change Management Framework (WCMF) and the Construction Environment Management Framework (CEMF).

14.6.1 Water Change Management Framework

The GMW CP's WCMF is a requirement of the Victorian Minister for Planning and was approved by the Victorian Minister for Water on 14 August 2009. An update was approved by the State Minister for Water in 2013 following consultation with the Minister for Environment and Climate Change and written advice from the Expert Review Panel (ERP). The WCMF was also approved by the Minister for Environment Protection, Heritage and the Arts.

The WCMF describes the means by which GMW will protect aquatic and riparian ecological values through management of water allocations and flows that may be impacted by implementation of the GMW CP within the modernised GMID. The WCMF outlines procedures for monitoring, reporting and auditing changes in hydrological conditions in relevant wetlands or waterways associated with the project's operation. It provides the environmental commitments, processes and methods for the relevant operations of the modified system.

Various documents prepared under the WCMF aim to identify and assess potential impacts associated with GMW CP and recommend suitable mitigating actions. Each of these documents is relevant to the use and management of environmental water. Mitigation actions can include

- Development of EWPs
- Environmental Infrastructure Register
- Localised groundwater impact assessments.

Each of these can result in the commitment of mitigation water to be used to overcome any adverse impacts of GMW CP implementation.

In addition, the WCMF required preparation of regional environment and groundwater assessments of the cumulative impacts of GMW CP. These assessments have been prepared and approved.

Preparation of many of these documents is overseen by GMW CP's Environmental Technical Advisory Committee (ETAC) and the ERP.

In addition, operating arrangements to specify the procedures to deploy mitigation water according to the specifications in the EWP (Mitigation Water Operating Arrangements) were endorsed by the Secretary DSE (now DELWP) on 14 December 2011.

14.6.2 **Environmental Watering Plans (EWPs)**

GMW CP has undertaken a rigorous process to identify wetlands and waterways potentially at risk from GMW operation and has gone on to prepare EWPs for relevant sites *(NVIRP, 2010b)*.

The development of EWPs for sites considered potentially "at risk" from GMW operation is an appropriate mechanism to ensure that management of environmental water entitlements is based on the best information available and agreed management objectives. GMW CP EWPs have been the product of rigorous processes that:

- Documented management objectives based on wetland or waterway ecological needs and community consultation
- Determined water regime requirements to achieve management objectives based on water balance modelling
- Set up an adaptive management process of monitoring and regular review.

The WCMF sets out the content and the processes to be followed in development, of EWPs. EWPs provide a sound basis for the development of full wetland management plans and determining watering priorities beyond the extent of a mitigation water obligation during GMW CP implementation.

Using the WCMF as guidance, EWPs should be prepared for all wetlands and waterways which may benefit from the allocation of environmental water entitlements. This framework could be applicable across Victoria.

In addition to EWPs, GMW CP has prepared a Mitigation Water Operating Protocol that will guide the decision making processes for allocation of GMW CP mitigation water across wetlands and waterways. This protocol should be considered in decisions concerning the future use of environmental water entitlements.

14.6.3 **Construction Environmental Management Framework (CEMF)**

Referral Section	7	Source/more information	

The purpose of the CEMF is to describe the means by which the GMW CP will manage and control the construction works associated with the modernisation of the northern Victorian irrigation system.

In particular, the CEMF addresses the requirements of Condition 1 of the Minister for Planning's decision that an Environment Effects Statement (EES) is not required for the GMW CP, as described in the referrals accepted on 20 February 2009 and 8 April 2011. Table 28 sets out how the CEMF addresses each of the requirements in Condition 1.

The CEMF enables the achievement of the environmental commitments set for the planning, design and construction of the capital works and the connections program. This CEMF establishes the environmental management controls to be implemented by GMW, its employees and contractors in carrying out the GMW CP.

Table 28 CEMF - Requirements in Condition 1 of the Minister's Decision (2009 and 2011)

Condition Number	Requirement	CEMF Reference
1	Prior to commencing any works involving either removal of native vegetation or direct construction impacts on wetlands or natural waterways, NVIRP must prepare a framework for environmental management of works to the satisfaction of the Minister for Planning, having regard to written advice to be sought from the Minister for Environment and Climate Change (2009 and 2011).	CEMF
1(i)	This environmental framework for construction is to include but is not limited to: A statement of environmental commitments or performance requirements in relation to proposed physical works, including compliance with *Permitted clearing of native vegetation* – Biodiversity assessment guidelines (2013), applicable Regional River Health Strategies and relevant Regional Catchment Management Strategies (2009 and 2011).	Environmental Commitments – Capital works (Attachment A) Environmental Commitments – Connections (Attachment F)
1(ii)	This environmental framework for construction is to include but is not limited to: Processes and methodologies for assessing potential impacts on native vegetation as well as flora and fauna species listed under the *Flora and Fauna Guarantee Act 1988* (FFG Act) due to the implementation of the NVIRP works (2009). Processes and methodologies for assessing potential impacts on native vegetation as well as flora and fauna species listed under the *Flora and Fauna Guarantee Act 1988* (FFG Act) due to the implementation of the NVIRP Adjunct Works (2011).	Native Vegetation Management Strategy (Attachment B) Flora and Fauna Management Strategy (Attachment C)
1(iii)	A framework for managing impacts and assigning accountabilities for impacts on biodiversity, cultural heritage and potential acid sulphate soils, as well as drainage and flooding patterns, including but not limited to (2009 and 2011):	CEMF

Condition Number	Requirement	CEMF Reference
1(iii) dot point 1	Preparation and implementation of management strategies or plans for mitigation and offsetting of impacts on native vegetation (2009 and 2011).	Native Vegetation Management Strategy (Attachment B)
1(iii) dot point 2	Preparation and implementation of management strategies or plans for flora and fauna species listed under the FFG Act (2009 and 2011).	Flora and Fauna Management Strategy (Attachment C)
1(iii) dot point 3	Preparation and implementation of management strategies or plans for cultural heritage (2009 and 2011).	Cultural Heritage Management Strategy (Attachment D)
1(iii) dot point 4	Monitoring, reporting and auditing of relevant activities and environmental outcomes, including the role of an independent auditor to be appointed by NVIRP (appointee to be agreed with the Secretary, Department of Sustainability and Environment (DSE)) (2009 and 2011).	CEMF, particularly Section 11
1(iii) dot point 5	Mechanisms to ensure compliance by NVIRP and its contractors, as well as landholders and/or their contractors, for all construction activities within both Stages 1 and 2 (2009). Mechanisms to ensure compliance by NVIRP and its contractors, as well as landholders and/or their contractors, for all construction activities within the project (2011).	CEMF

15 Committees – Communications, Review, Governance

Referral Section	20	Source/more information	

A number of groups provided technical oversight of investigation or peer review of reports.

15.1 Environmental Technical Advisory Committee

GMW CP has convened an (Environmental) Technical Advisory Committee (ETAC) to provide advice on assessment approaches and the development of the documents outlined in the WCMF, to ensure that:

- a proper process is being followed
- the information provided is appropriate,
- the recommendations are practical and feasible.

The ETAC includes agencies which will be responsible for ongoing delivery and review of management and mitigation measures and includes representation from:

- Catchment Management Authorities
- Goulburn Murray Water
- Department of Economic Development, Jobs, Transport and Resources (DEDJTR)
- Parks Victoria
- Department of Environment, Land, Water and Planning (DELWP).

There may also be occasional representation from other stakeholders (e.g. the land manager of a particular wetland).

Formal agreements to implement the actions of the WCMF will be coordinated via the ETAC.

15.2 Expert Review Panel (ERP)

Referral Section	20	Source/more information	

The Expert Review Panel (ERP) was appointed for the entire GCP to provide advice to the Minister for Water, the Secretary, DEPI and the CP in relation to the conditions of the Minister for Planning's 'no Environment Effects Statement' decision (i.e., that no EES was required subject to conditions). Although this decision does not apply to the KLBI, the ERP still was used for the project. They provided advice on matters including:

- environmental management
- advice on environmental water investigation reports.

The ERP consists of Jane Roberts and Terry Hillman, independent consultants experienced in the relationships between hydrology and ecology, and in evaluating the ecological consequences of changing hydrology.

The ERP reviewed drafts of environmental water technical reports and commented on the appropriateness of the environmental water regimes proposed.

The GCP Expert Review Panel (ERP) has reviewed the 6 environmental investigation reports produced for the Kerang Lakes Investigation.

The ERP's comments are shown in Appendix 5.

15.3 Project Reference Group

Referral Section	20	Source/more information	

Preparation of most of these Kerang Lakes investigations was overseen by an agency based Project Reference Group. The GMW CP ERP reviewed drafts of environmental water technical reports and commented on the appropriateness of the environmental water regimes proposed. Some project specific peer reviews were commissioned and project progress and outcomes were reviewed by the (Community) Project Reference Group.

The KLBP Investigation Project Reference Group (see Section 21.3.1) also has a technical review role. PRG members participated in sub project steering committees.

15.4 Scientific Review Panel (SRP)

Referral Section	20	Source/more information	

Following development, Technical Reports were reviewed by a Scientific Review Panel (SRP) which met for two days during September 2013. The purpose of the SRP was to provide quality assurance and methodological critique regarding the development of the watering regime proposals at the technical report stage. This Panel was charged with ensuring that:

- the ecological objectives are scientifically sound;
- the proposed regimes are appropriate to achieve the ecological objectives;
- other issues are considered; and
- the recommendations will mitigate the expected impact.

The SRP consisted of experts in specific fields that are relevant to the lakes. Also present were GMW staff responsible for overall project delivery, and NC CMA staff responsible for the development of the Technical Reports.

Membership is set out in Table 29.

Table 29*Table 30. SRP membership.*

Name	Organisation	Role
Rhonda Butcher	Water's Edge Consulting	Wetland and aquatic ecosystems
Daniel Stoessel	Arthur Rylah Institute (ARI)	Fish specialist
Brett Lane	Brett Lane and Associates	Bird specialist
Doug Frood	Pathways Bushland and Environment	Flora
Damien Finlayson	URS	Hydrogeology
Ross Plunkett	GMW Connections Project	Manager Planning
Andrea Keleher	DEPI	Senior Program Officer - Water Environments
Janet Holmes	DEPI	Program Leader, Wetland Management
Peter Foster	Parks Victoria	Ranger in Charge – Swan hill
Fiona Murray	Regional Development Victoria	Senior Regional Planner
Anne Graesser	G-MW	Manager Natural Resource Services
Rohan Hogan	North Central CMA	Science & Strategy Leader
Tim Shanahan	North Central CMA	Acting Executive Manager - Murray, Campaspe and Avon-Richardson Catchments
Bree Bisset	North Central CMA	Wetland Planner
Michelle Maher	North Central CMA	Wetland Planner

15.5 **Specific project reviews**

In addition to the processes outlined above some projects underwent specific peer review:

- *Webb (2013)* reviewed the URS work on hydrology and salinity (See Section 17.4.2).
- GHD reviewed the engineering design prepared by SKM.

16 Vegetation Removal

Referral Section	12	Source/more information	

16.1 Net Gain Assessment 2013

SKM (2013b) undertook a net gain assessment as part of the investigation. This involved a field and net gain assessment of potential bypass channel alignments. It did not assess native vegetation changes that might result from changes in the lake water regime.

Habitat zones assessed are shown in Figure 19. NB only options S4B-1, S4C and S5 HZ1, 2, 3, 4, 6 and 8 are relevant to the Third Reedy Lake proposal. Other habitat zones were assessed as part of the overall assessment of bypass options.

Table 30EVCs that may be affected at Third Reedy Lake (from (SKM 2013a))

Habitat Zone	HZ1	HZ2	HZ3	HZ4#	HZ5	HZ6	HZ7	HZ8
Bioregion	Victorian Riverina							
EVC #: Name	103: RCW	813: ISW	103: RCW	813: ISW	813: ISW	103: RCW	103: RCW	813: ISW
EVC Bioregional Conservation Status	Vulnerable	Depleted	Vulnerable	Depleted	Depleted	Vulnerable	Vulnerable	Depleted

 # alignment highly likely to be designed to preclude affecting this area

Along the southern investigation area (Reedy Lakes area) the vegetation has been predominantly mapped as two EVCs; EVC 103: Riverine Chenopod Woodland (Figure 17) and EVC 813: Intermittent Swampy Woodland (). Three additional EVCs were mapped within the investigation area; EVC 813: Intermittent Swampy Woodland, EVC 823: Lignum Swampy Woodland and EVC 98: Semi-arid Chenopod Woodland. Areas that supported no overstory and supported less than 25% cover of indigenous species were classified as degraded treeless vegetation in accordance with the Native Vegetation Management Framework (NVMF).(SKM 2013a)


Figure 17 Riverine Chenopod Woodland ***Figure 18 Intermittent Swampy Woodland***

The assessment overstates the potential area of clearing by assuming clearing will be required along a buffer 25 or 50 m wide. It is highly likely that siting of the channel alignment will result in a smaller cleared area along the HZ4 alignment.

Where a buffer of 25m either side of the alignment was not possible the buffer was moved to still encompass a width of 50m. (for example alignment section Five and alignment section Four – Option B, which run along the embankment of Third Reedy Lake).

Table 31: Estimated area and EVC to be cleared along channel and pipeline alignments.

Option	Habitat Zone	EVC	Conservation Significance	Conservation Status	Loss (Ha)
S4B-1	HZ4	EVC 813	Vulnerable	Very High	1.88
S4B-1	HZ6	EVC 103	Vulnerable	Medium	6.74
Total Offset Option South 4B-1					**8.62**
S4C	HZ6	EVC 103	Vulnerable	Medium	1.99
S4C	HZ8	EVC 813	Depleted	High	0.34
Total Offset Option South 4C					**2.33**
S5	HZ1	EVC 103	Vulnerable	Very High	0.25
S5	HZ2	EVC 813	Depleted	Very High	0.43
S5	HZ3	EVC 103	Vulnerable	Very High	0.13
S5	HZ4	EVC 813	Depleted	Very High	0.33
S5	HZ6	EVC 103	Vulnerable	Medium	0.01
Total Offset Option South 5					**1.14**
Grand Total ha					**12.09**
Grand Total EVC 103 ha					**9.12**
Grand Total EVC 813 ha					**2.98**

A total of 12.09 ha could be affected.

16.1.1 **Field assessment**

Referral Section	**12**	**Source/more information**	

A field assessment was conducted in July, 2013 by SKM ecologists. Previous mapping of flora and fauna values within the study area presented in Rakali (2013) was ground-truthed by ecologists.

The mapping was amended where native vegetation present was not found to meet the minimum requirements to be classified as remnant vegetation under the NVMF, which is a 25% cover of indigenous species.

Ecological values, such as threatened species, EVC and scattered trees within the current assessment areas that had not been mapped previously were recorded. An assessment of the quality of all native vegetation mapped within the proposed work areas was completed in accordance with the *Vegetation Quality Assessment Manual – Guideline for applying the habitat hectares scoring method* (Version 1.3) (DSE, 2004).

16.1.2 Net Gain Assessment

Referral Section	12	Source/more information	

Based on the results of the field assessment, a Net Gain Assessment was completed to determine the potential offsets required to account for the removal of native vegetation for each proposed option. The Net Gain Assessment was completed in accordance with the NVMF and the NC CMA (2005) Native Vegetation Plan. Information provided within the Rakali (2013) assessment was used to inform the presence of threatened species for input into the Net Gain Assessment. The NVMF was replaced by the *Permitted Clearing Regulations* (DEPI, 2013) in September, 2013. The Regulations include a new methodology for the assessment of native vegetation and the calculation of offsets. Depending when approvals are sought will determine whether this new methodology is used to determine offsets. Native vegetation assessments completed prior to the changes being implemented will not need to be re-assessed.

The Net Gain Assessment includes a general buffer of 25m either side of each of the proposed alignment options. The exceptions to this buffer include areas of alignment section Five and alignment section Four – Option B, which run along the embankment of Third lake, and alignment section Eight and Eight – Option B, which run within the rail corridor. Where a buffer of 25m either side of the alignment was not possible the buffer was moved to still encompass a width of 50m. The extent of the construction area was advised by SKM project managers.

Up to 12.09 ha to be cleared (S4B-1; S4C, S5), based on a buffer of 25 m each side of the alignment *(SKM, 2013b)*.

Figure 19 Kerang Lakes Ecology assessment (from (SKM, 2013b).

NB only HZ1, 2, 3, 4, 6 and 8 are relevant to the proposal i.e. Alignments S5, S4B-1 and S4C

16.2 **Native Vegetation Assessment 2016**

Referral Section	12	Source/more information	

Jacobs (2016) undertook an assessment of off-set requirements for works at Third Reedy Lake using the Permitted Clearing of Native Vegetation Biodiversity Assessment Guidelines. This assessment used a slightly different bypass channel alignment than the 2013 assessment.

The impact area in this assessment assumes a 20 m wide footprint at the proposed pipeline (10 m either side of the existing channel) and a 50 m wide footprint for the construction of the new channel. This is considered to be worst case scenario and total vegetation loss is likely to be less.

Habitat Hectare assessments relevant to this footprint are adapted from assessments undertaken by SKM in 2013. Six habitat zones were mapped in this footprint and the two EVC mapped throughout the impact area are EVC103: Riverine Chenopod Woodland and EVC813 Intermittent Swampy Woodland.

The Native Vegetation Information Management (NVIM) system was used to generate a Biodiversity Assessment Report (BAR) for vegetation removals. The total extent of vegetation loss associated with this project is 6.8 ha of remnant vegetation and five scattered trees.

The vegetation removal is entirely within Location risk A and combined with greater than 1 ha of native vegetation removal means the proposed works are considered to be Moderate risk under the risk-based assessment pathway detailed in the Biodiversity Assessment Guidelines. Projects considered to be of Moderate risk require a shapefile to be sent to DELWP to calculate offset requirements and any specific offsets require to consider threatened species listed under the Victorian Advisory Lists, the Flora and Fauna Guarantee Act (FFG) and the Environment Protection and Biodiversity Conservation Act (EPBC). All offsets will need to be secured within the NC CMA area.

17 Risks - Potential impact on ecological character description

Referral Section	13	Source/more information	

In developing the project plan and via discussion with a range of stakeholders, including the local community a range of potential environmental risks and issues associated with the bypass proposal were identified.

A series of investigations helped assess these risks and determine appropriate control measures.

17.1 Limits of acceptable change (LAC)

Referral Section		Source/more information	

The Kerang Wetlands Ramsar Site currently meets six of the Ramsar criteria for listing.

KBR (2011) identifies four critical components, processes and services (CPS) that significantly contribute to the recognised ecosystem value and importance of the Kerang Wetlands Ramsar Site:

- Hydrology (percentage full, depth/volume, frequency of inundation) is a critical process that influences water quality, habitat and wetland type.
- Salinity is a critical physiochemical component that maintains wetland type and distinctive flora and fauna assemblages.
- Waterbird abundance is a critical component that contributes to the site's Ramsar listing.
- Colonial breeding/nesting waterbirds (ibis, darters, cormorants, spoonbills) are a critical component that contributes to the site's Ramsar listing.

The sites Ecological Character Description (ECD) describes these and sets limits of acceptable change (LACs) for each of the critical CPS.

Of these critical components, Limits of Acceptable Change (LAC) have been established at Third Reedy Lake for hydrology and water quality/salinity (Table 32). Both LACs have low levels of confidence.

***Table 32**. Baseline condition and Limits of Acceptable Change for the critical process of hydrology – percentage full, depth, volume, frequency of inundation - and water quality/salinity(from (KBR, 2011)*

Water bodies	Baseline condition and range of natural variation where known	LAC	Basis of LAC	Level of confidence
Lake Charm Little Lake Charm Third Lake	These lakes are influenced by the Torrumbarry Irrigation System established in 1923. The lakes are maintained at or near full supply level to maintain ecological condition of littoral zone, with annual fluctuations of up to 1000 mm. These lakes were flooded in the extreme flood event of 2011. The water regimes of these wetlands are artificially managed. There is uncertainty about whether a more natural water regime, such as that which existed prior to 1923, would represent an unacceptable change. As such, the LAC is set around conditions prevailing at the time of listing (1982).	Permanently inundated. Not to exceed the 1000 mm range of fluctuation in water levels two years in a row.	Based on knowledge of the prevailing operating conditions at and since the time of listing.	Low
Third Lake	Mean salinity level is 360 EC; maximum is 1200 EC (KLAWG 1992).	Salinity levels to be less than 4000 EC when lake is more than 75% full.	Based on expert opinion of project steering committee and tolerance levels of biota to salinity cited in PPK Environment and Infrastructure (2000).*(PPK Environmental, 2000)*	Low

Table 33 Potential LAC changes at Third Reedy Lake (from (NC CMA, 2014a) Table 5)

KLBIP Wetland	LAC (Based on draft ECD Report, KBR, 2011)	Effect of proposed water regime change	LAC triggered	Critical CPS affected	Potential for change in character
Third Reedy Lake	Permanently inundated. Not to exceed the 1000 mm range of fluctuation in water levels two years in a row.	Fill once every four years to 74.00m AHD with every third fill to 74.56m AHD. Maintain at 74.56m AHD for one month before natural drawdown and for other events fill to 74.00m AHD before natural drawdown with wetland remaining dry for the following three years before filling again.	Yes	Hydrology – frequency of inundation extent of inundation, depth, salinity, waterbirds, vegetation, fish, and ecosystem services	No – Detailed benefit / risk assessment has been undertaken indicating improvements in River Red Gum and understorey species extent and increases bird breeding and feeding opportunities during wetting phase (North Central CMA, 2014c). Drying allows establishment of Red Gum seedlings (under assumption that there is appropriate seed source available). Health of trees is maintained through an appropriate cycle of wetting and drying (Roberts and Marston, 2011). Drying will allow understory vegetation to establish in wetland body (expansion of Intermittent Swampy Woodland). Variability in water level promotes diversity of vegetation (Rogers and Ralph, 2011; Roberts and Marston, 2011). Flooding acts as a stimulus for breeding in most waterbirds. Depth and duration of flood water as well as drawdown impact on the success (Rogers and Ralph, 2011). Wetlands are highly productive during the re-wetting and drawdown phase (i.e. organic matter, insects, shoots, seeds etc) (Rogers and Ralph, 2011).
	Salinity levels to be less than 4000 EC when lake is more than 75% full.	Salinities are estimated to range between 500 and 3,600EC. Salinity will be managed by maintaining wetland level above surrounding groundwater levels. Further investigations are required (North Central CMA, 2014c).	Potential	Hydrology – frequency of inundation extent of inundation, depth, salinity, waterbirds, vegetation, fish, and ecosystem services	No – Saline groundwater intrusion into Third Reedy Lake will be managed by maintaining the wetland level above surrounding groundwater levels. Wetland flushing and changes to the operation of the Kerang Lakes will also be considered. A detailed monitoring and adaptive management program is required to ensure wetland level is maintained above surrounding groundwater levels. *Further investigation on salinity and ASS is required.

17.2 LAC impact assessment

An assessment of the potential impacts on the ECD of Third Reedy Lake was undertaken by *Feehan Consulting (2015b)*. The outcomes are summarized in Table 34

Table 34 LAC Impact Assessment

LAC	Assessment
Hydrology	The wetland will be substantially modified by the proposed change in water regime. This change will affect volume, timing, duration and frequency of surface water flows and potentially affect ground water flow into the wetland. This will be a significant impact. There are substantial benefits from the proposed change and it is likely to beneficial to the LAC
Water quality/salinity	The salinity LAC is unlikely to be triggered providing salinity water quality objectives are adopted and management is implemented to ensure target achievement.

This is further discussed below.

17.3 Hydrology

Referral Section	**13**	**Source/more information**	

Implementing the Third Reedy Lake bypass will substantially modify the wetland. It will change from permanent open water to a deep freshwater marsh. The wetlands hydrological regime will be substantially modified by the proposed changes. This change will affect volume, timing, duration and frequency of surface water flows and potentially affect ground water flow into the wetland. This will be a significant impact. A change in the water quality of the wetland, especially salinity is possible and any potential change due to ASS has yet to be assessed *(Feehan Consulting, 2015b)*.

*NC CMA (*2014a*)* reviewed potential changes and concluded there would be no change in ecological character. Detailed benefit / risk assessment was undertaken indicating improvements in River Red Gum and understorey species extent and increases bird breeding and feeding opportunities during wetting phase *(North Central CMA, 2014b)*. They noted:

- Drying allows establishment of Red Gum seedlings (under assumption that there is appropriate seed source available). Health of trees is maintained through an appropriate cycle of wetting and drying *(Roberts et al., 2011)*).
- Drying will allow understory vegetation to establish in wetland body (expansion of Intermittent Swampy Woodland). Variability in water level promotes diversity of vegetation (*(Rogers et al., 2011)*; *(Roberts et al., 2011)*).

- Flooding acts as a stimulus for breeding in most waterbirds. Depth and duration of flood water as well as drawdown impact on the success *(Rogers et al., 2011)*.
- Wetlands are highly productive during the re-wetting and drawdown phase (i.e. organic matter, insects, shoots, seeds etc) *(Rogers et al., 2011)*.

There are substantial benefits from the proposed change and it is likely to beneficial to the LAC. There is an extensive literature (reviewed in *(Feehan Consulting, 2015b)*) about the importance of wetting and drying phases for the ecology of wetlands such as Third Reedy Lake. The loss of a drying phase can affect physical and geomorphic processes, habitat availability at both local and landscape scales, biological and ecological processes for riverine and floodplain flora and fauna (e.g. breeding, migration, recruitment, metabolism, and competition), water quality and the cycling of nutrients and energy and resilience to invasive flora and fauna species.

None of the literature reviewed suggests that maintaining the current water regime at Third Reedy Lake will result in the occurrence of natural processes. The reinstatement of wetting and drying to Third Reedy Lake will clearly have a beneficial effect. The review of relevant literature clearly indicates that lakes such as Third Reedy Lake, which was originally an ephemeral wetland, would benefit from provision of a water regime that included both wet and dry phases.

Case studies of reinstatement of the drying phases in lakes in the Murray Darling Basin *(Feehan* Consulting*, 2015b)* suggest a general overall improvement in the condition of the subject lakes. There is no indication that drying phase reinstatement has resulted in adverse ecological outcomes. In some cases, beneficial outcomes have been achieved quite quickly.

This indicates that a more natural water regime, such as that which existed prior to 1923, would represent an acceptable change.

The low confidence rating for the hydrology LAC is correct and that the LAC should be amended.

17.4 **Salinity**

Referral Section	**13**	**Source/more information**	

Assessment of potential salinity impacts was based on information provided in the URS reports *(URS, 2013d, URS, 2013c, URS, 2013a, URS, 2014a, URS, 2014b)*.

The assessments were iterative. They were initially based on general scenarios, but as proposed environmental water regimes were refined the salinity assessments became more specific.

17.4.1 **Phase 1 – scenario assessment**

Phase 1 salinity assessment uses the groundwater investigation undertaken by *(URS, 2013c)* as one of a number of investigations during the project investigation phase.

This analysis considered the salinity risk of four alternative water regimes. It should be noted that the proposed watering regime for Third Reedy is most closely aligned with the Intermittent or Deep Freshwater Marsh watering scenario.

***Table 35**: Third Reedy Groundwater Risk Assessment (URS, 2013c)*

Watering regime scenario	Hydrogeological Risk Assessment	Salt risk rating
Dry- episodic	Has the greatest salinity risk with 80th percentile. The salinity of Third Reedy Lake is estimated to increase by 3,103 EC upon refilling. The 90th percentile salinities are estimated to be above 10,000 EC upon refilling indicating a higher salinity risks. The episodic watering scenario has a higher probability of significantly more salt in the wetland.	Moderate to High
Deep Freshwater Marsh- intermittent	Relatively low salinity risk with 80th percentile. The salinity of Third Reedy Lake is estimated to increase by less than 309 EC upon refilling. The 90th percentile salinities are estimated to increase by approximately 1,900 EC upon refilling indicating low salinity risks.	Low
Open Freshwater Lake- semi-permanent	Relatively low salinity risk with 80th percentile. Third Reedy Lake salinities of less than 547 EC increase upon refilling.	Low

*URS (*2013d*)* have suggested that salinity risk can be reduced in all cases by:

- reducing the duration when wetland levels are low (or absent) especially times when surrounding groundwater levels are elevated (following sustained years of average or above rainfall)
- reducing the depth to which wetland levels are reduced between filling phases.
- Initiate a bypass lake flushing program to ensure the lakes do not develop a regime of gradually increasing salinity over time.
- Adopt an appropriate bore monitoring program.

17.4.2 **Peer Review**

The URS work was peer reviewed by Associate Prof John Webb, Environmental Geoscience at La Trobe University *(Webb, 2013)*. He concluded (amongst other things):

- These are competent reports and I agree with their overall conclusions. However, there are some aspects that have been insufficiently emphasised, so that the conclusions need some modification.
- …the amount of saline inflow could well be less than that presently modelled, so the results of the current modelling can probably be regarded as a worst case scenario.
- The overall conclusions of the Monte Carlo simulations are valid:
  - The potential salinity risks to the proposed Bypass Lakes are related to the level differential between lake levels and groundwater levels and the salinity of the surrounding groundwater, so that the salinity risk can be reduced by reducing the level of lake water drawdown and the duration of drawdown, particularly when surrounding groundwater levels are elevated.

- Any saline water within the Bypass Lakes resulting from groundwater inflows could be released in a flushing event, with potential impacts on Kangaroo Lake and downstream water users, and ultimate discharge of salt to the Murray River.

- I concur with the recommended primary salinity risk mitigation measures:
  - Limit the magnitude and duration of lake level drawdown, particularly during periods of elevated groundwater levels
  - Initiate a Bypass Lake flushing plan to ensure the lakes do not develop a regime of gradually increasing salinities over time:
- I also concur with the URS recommendations on groundwater monitoring:
  - Restore monthly groundwater level monitoring to those bores selected as the Bypass Lakes' groundwater monitoring network;
  - Install at least two new monitoring bores in close proximity to Little Lake Charm and Racecourse Lake.

17.4.3 **Regional impacts**

In Phase 1 of assessing the salt impacts *(SKM, 2014b)* undertook a preliminary assessment of regional salinity impact of bypass options. Using the Kerang Lakes REALM model they simulated regional salt load impacts of managed 'flushing flows' that will support the wetting/drying watering regimes for Third Reedy Lake and the now out-of scope Racecourse Lake.

They used the P80 salt load inflow estimates provided by URS for a 1 in 3 year wetting cycle scenario (NB this is different to the final preferred option) (ie a worst case scenario). Their flushing regime assumed the same rate of inflow as was used to fill the lakes. There was no management of the rate of flushing to limit impacts.

During the flushing event, the flow passed out of Third Reedy Lake increases salinity downstream in the Torrumbarry Irrigation System. Based on this assumption, there is a significant impact to downstream lakes, irrigation supplies (areas as Tresco, No 9 Channel, Lake Kangaroo Diverters, Channel 4/7, Channel 5/7, Mystic Park, Fish Point) and discharge to the River Murray for each of the proposed bypass scenarios.

This work highlighted the need to manage potential salt impacts.

17.4.4 **Phase 2**

URS was requested to assess the salinity impact (EC increase at refill) of the preferred water regime, using a similar Monte Carlo method to that used in earlier assessments *(URS, 2013d, URS, 2013c)*. Some enhancements to the original method were introduced to account for correlation of lake levels with groundwater levels and inverse correlation of groundwater levels with intervals between lake filling. As part of this process URS also assessed the salinity impacts of a number of different water regime scenarios, with the aim of helping provide information to optimise water savings and salinity impacts *(URS, 2014a, URS, 2014b)*.

The preferred water regime is referred to as Scenario 13 of a number of alternative scenarios modelled to assess potential water savings *(Gippel, 2014c)* (Table 9)

Outputs of salinity modelling are summarised in Table 36 and Table 37 below (Scenario 13 is described above (this is the one adopted for business case purposes); Scenario 17, based on a 3 year water cycle, did not provide enough water savings; salinity impacts of Scenario 5 (also based on a 3 year cycle) and Scenario 12 (3x4 year cycle) were considered excessive)).

***Table 36 – Summary of Monte Carlo Simulations – Lake Salinity Increase on filling (EC)* (URS, 2014a)**

Lake	Scenario	Percentile[1]		
		P20	P50	P80
Third Reedy	Current	0	0	65
	Scenario 5	0	600	4,660
	Scenario 12	0	565	4,160
	Scenario 13	0	500	3,360#
	Scenario 17	0	240	2,730

Note – values are rounded.# later calculations (see table below) arrive at a slightly higher EC on filling. The value here was selected from a range of possible outcomes derived from the Monto Carlo simulation (Damien Finlayson (URS) pers comm 6/10/2015)).

The URS report also includes a table showing salt inflow to the lakes at P50 and P80.

***Table 37 – Summary of Monte Carlo Simulations – Salt Inflow to Lakes (tonnes)** (URS, 2014a)*

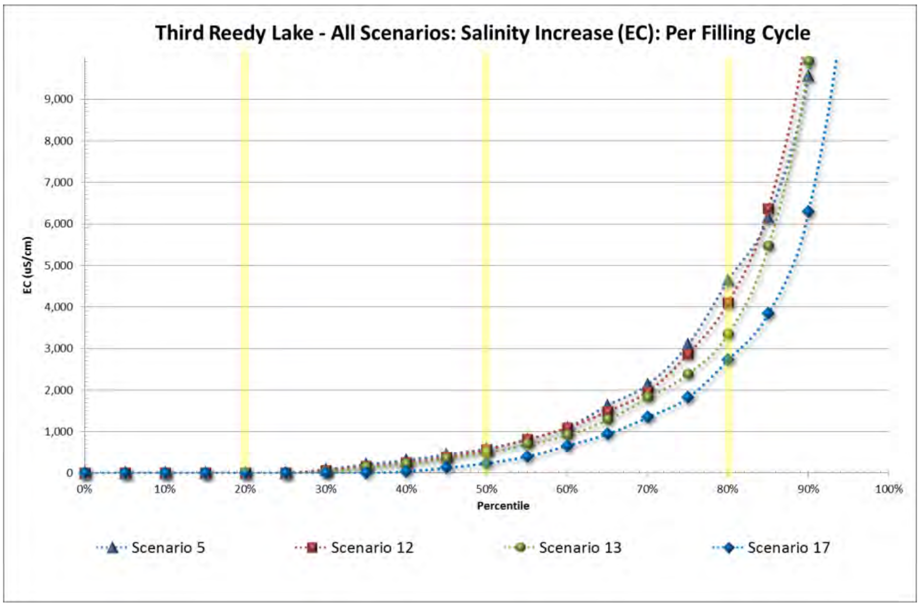
Lake	Scenario	Percentile		
		P20	P50	P80
Third Reedy	Current	0	0	100
	Scenario 5	0	960	7,450
	Scenario 12	0	900	6,560
	Scenario 13	0	800	5,370
	Scenario 17	0	390	4,360

[1] The P20 figure represents the lowest 20% of values and will be exceeded 80% of the time. It can be considered the best case scenario. It will occur when groundwater levels are below the level of the lake bed.

The P50 figure represents the median and will be exceeded 50% of the time.

The P80 figure represents the highest 20% of values and will be exceeded 20% of the time. It can be considered the worst case scenario. It will occur when groundwater levels are near, or above, the level of the lake bed.

Figure 20 *Third Reedy Lake – selected scenarios; salinity increase (EC) on filling.*



URS concluded that all scenarios had the potential to allow ingress of groundwater to the lake footprint, but this can be mitigated by adopting an interventionist (adaptive) approach to lake water management. For example, duration of drying period might be extended during dry climate phases when groundwater levels are expected to be lower than during wetter phases.

Recent assessments of groundwater levels suggests high groundwater levels are associated with relatively wet climatic periods and lower groundwater levels are associated with drier climatic periods*(GB CMA, 2012, GB CMA, 2014)*.

Analysis of residual mass rainfall from three regional Shepparton Irrigation Region rainfall stations illustrates that the period 1900 to 1950 was “dry”; the period 1950 to 2000 was “wet”; post 2000 has been dry (Figure 21). Groundwater levels in the recent dry period have dropped, although they rose after the recent floods and are now receding (

Figure 22). Unfortunately, groundwater level data is only available for relatively recent years so we have no way of confirming groundwater levels in earlier “dry “periods.

Figure 21 Residual mass rainfall (source URS)

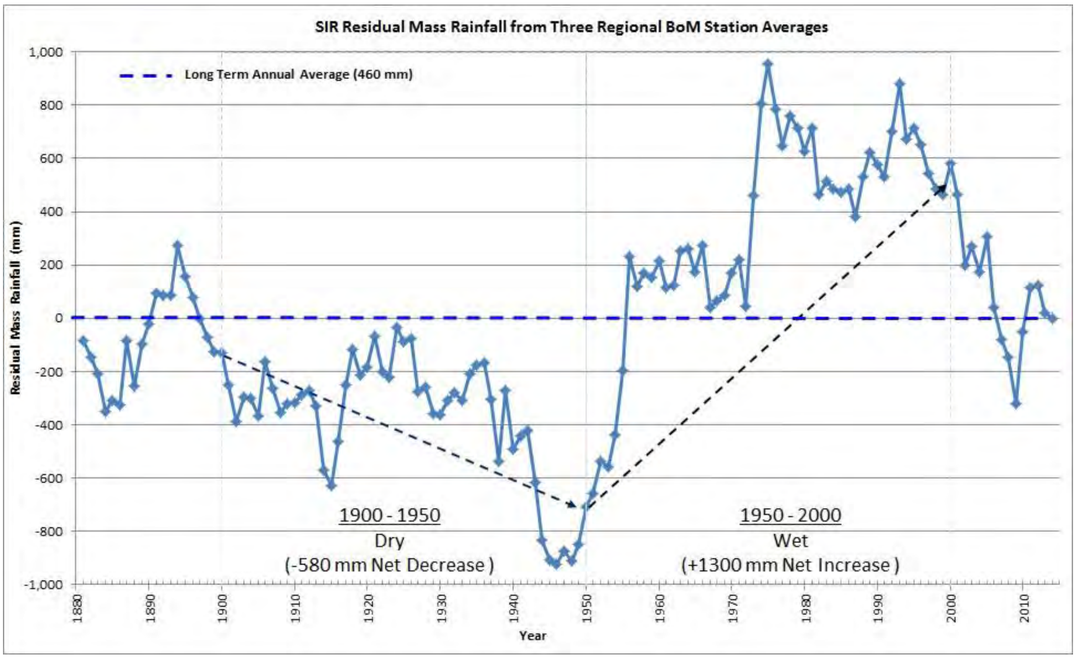
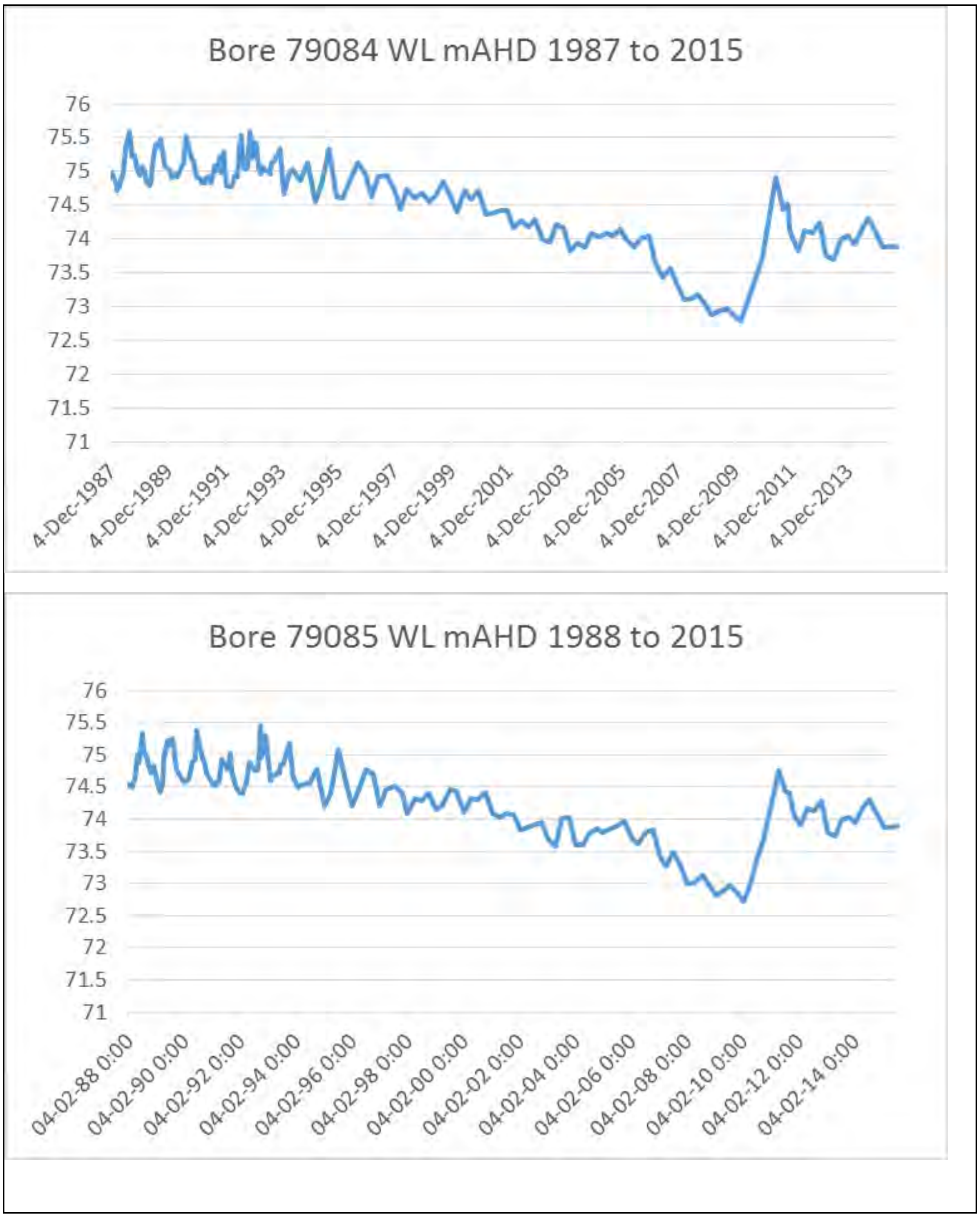


Figure 22 Hydrographs of nested bores 79084 and 79085 (southern end of First Reedy Lake) 1988 to 2015.

NB (79084 is screened at 24 m in the Parilla Sand; 79085 is screened at 9.5 m in the Shepparton Formation). Natural surface is at 75.68 m.



17.4.5 **Salt inflow to channels**

URS (2013c) Section 2.5 and 3.5 also estimated the salt load impacts of saline groundwater inflows to three proposed bypass channel alignments.

Table 38 Channel alignment used by URS to assess salt inflow impacts (NB channel 1 and 3 alignments were abandoned)

Alignment	Description
Channel 1	First Reedy Lake bypass

Channel 2	Third Reedy bypass
Channel 3	Racecourse Lake bypass

The potential inflows of groundwater (m^3/d) and salt (tonnes/day) to the three bypass channels over their respective alignments are summarised in the following tables:

Table 39 Salinity risk percentile

	Groundwater Inflow (m^3/d)		
Percentile	**20%**	**50%**	**80%**
Channel 1	**0.0**	**0.5**	**4.5**
Channel 2	**0.0**	**0.6**	**4.5**
Channel 3	**0.0**	**0.0**	**0.0**

	Salt Inflow (tonnes/day)		
Percentile	**20%**	**50%**	**80%**
Channel 1	**0.000**	**0.003**	**0.023**
Channel 2	**0.000**	**0.005**	**0.043**
Channel 3	**0.000**	**0.000**	**0.000**

URS concluded that the results suggest that the magnitude of risks posed to the three proposed bypass channels (at current levels of understanding) from groundwater and salt inflows are negligible to very low.

Accordingly salt inflow to channels has been ignored assessing salinity LAC impacts.

Assessment of the impact of these salt inflows on LACs is shown in Section 20.

18 Risks – Other

18.1 Blackwater

Referral Section	**13**	**Source/more information**	*SKM (2013d)*

A Blackwater event occurs when there is low or no dissolved oxygen in the water column.

SKM was engaged to provide a preliminary assessment of the risks associated with Blackwater and changes in nutrient dynamics during lake filling. Their findings are reported in *SKM (2013d)*

During the dry phase there is potential for terrestrial vegetation to establish in the lake bed *(Boulding et al., 2009)* that on re-wetting that could consume dissolved oxygen during decomposition and lead to de-oxygenation of the water column (a Blackwater event). Macrophyte growth during the wet phase can also contribute to organic matter accumulation in the sediments *(*e.g. *Baldwin et al., 2012)*.

The drying and rewetting of sediment can also lead to an increase in release of nutrients from the sediments, although this may help to promote macrophyte growth during the wet phase as part of the restoration process *(Olde Venterink et al., 2002)*.

A model of oxygen consumption based on the ponding model documented in *Howitt et al. (2007)* was developed and applied.

The preliminary modelling of the potential for dissolved oxygen (DO) decline to occur during the filling of Kerang Lakes (based on modelling of First Reedy Lake) suggests that it is likely that low DO conditions could occur depending on the amount and nature of accumulated organic matter (OM) on the lake bed and the volume of water already in the lake at the commencement of inundation.

If the lake is empty, then for low lake bed organic matter loads low DO conditions may last a few days at the commencement of filling. However, for high organic matter loads the duration of low DO could last for the entire filling period. If the lake is already partly full, the initial DO decline and the duration of low DO conditions is reduced.

Based on the modelling competed, the risk associated with low DO is estimated in the table below using the following criteria:

- High risk - DO declines to < 2 $mg.L^{-1}$ for longer than 2 days.
- Medium risk – DO declines to 2-4 $mg.L^{-1}$ for longer than 7 days.
- Low risk – Do remains >4 $mg.L^{-1}$ for duration of the filling phase. Or if filling from empty, the period of initial low DO only last for a few days (see comment below).

If the lake is filling from empty, then an initial period of zero DO will be of little risk to fish because there will be no fish in the lake to begin with. However, assuming fish enter the lake with incoming flood waters, if DO remains below 2 mg/L for an extended period of time, then fish entering the lake may be at risk.

Table 40: Risk associated with DO decline for each organic matter starting loads and lake level relative to potential water management scenarios (red - high risk, yellow - moderate risk, green - low risk)

Starting lake level (% of FSL)	**Starting organic material load (g dry weight per m² bed)**					
	10	20	40	80	160[a]	320[a]
0	Episodic inundation, low OM accumulation		Episodic inundation, medium OM accumulation		Episodic inundation, high OM accumulation	
20						
60	Frequent inundation, low OM accumulations		Frequent inundation, medium OM accumulation		Frequent inundation, high OM accumulations	
80	Near permanent inundation, low OM accumulation		Near permanent inundation, medium OM accumulation		Near permanent inundation, high OM accumulation	
90						

(a) These are unlikely values but are included for risk analysis purposes.

18.2 Acid Sulphate Soils

Referral Section	**14**	**Source/more information**	

The presence of ASS within the Kerang Lakes complex has been mapped by CSIRO (ASRIS) *(Merry et al., 2011)* .The presence of ASS at Third Reedy Lake with selected soil samples from the edge of the lake exceeding the Victorian coastal acid sulfate soil action criterion of 0.03 % S was documented. The assessments completed by CSIRO did not include any field investigations from the lake bed, (i.e. the area that would be subject to wetting and drying (draining)).

A desktop ASS risk assessment was completed in 2013 *(URS, 2013b)* which concluded there is a low to medium risk for ASS for the Kerang Lakes under current conditions. Field investigations were not completed as part of that assessment and *URS (2013b)* recommended that additional soil and water sampling be undertaken to increase confidence in the output from the desktop risk assessment.

The Department of Economic Development, Jobs, Transportation and Resources (DEDJTR) has raised a number of concerns regarding the proposal to bypass Third Reedy Lake. These concerns include:-

- The assessments completed by the MDBA and CSRIO did not evaluate the lake bed sediments where pre-bypass inundation is continuous. DEDJTR inferred that these sediments may contain higher concentrations of sulphide than that recorded from the lake edge.
- The potential for oxidation of any ASS present when the lake is drained.
- Inundation of the lake following 'dry' periods may results in the mobilisation of any heavy metals released during the oxidation of ASS.

- The potential for, enhanced sulphide production during lake bed inundation phases, and acidification during lake drying phases.
- The potential for acidification may be high which could result in adverse effects to local flora and aquatic fauna.

Accordingly a proposal to further investigate ASS risk at Third Reedy Lake has been requested, and received, from consultants GHD.

The proposal has not been implemented due to cost and difficulties associated with obtaining sediment samples from the inundated lake bed. Depending on the outcome of environmental assessment and approval this proposal can be activated.

The GHD proposal included provision for

- Drilling and sampling location siting based in the geology of the lake bed
- Soil sampling and lithological logging
- Laboratory analysis
- Preparation of a technical report.

The investigation will generally follow the protocol outlined in *MDBA (2010a)*.

19 Risk Mitigation recommendations

Referral Section	14	Source/more information	

Table 41 sets out recommendations from the NC CMA to manage environmental risks to achieving the ecological objectives sought in this business case. The table includes a response to the recommendation. A more comprehensive list of risks and mitigations is included in the EEA referral document and is reproduced below (Table 42).

Table 41: Environmental risk management recommendations – Third Reedy Lake. (Appendix B in (NC CMA, 2014a))

Recommendations	Response
Development of an Environmental Watering Plan	Agreed
Groundwater: there are risks associated with altering the current permanent regime at Third Reedy Lake which are largely related to the relationship between wetland levels and the level of the surrounding groundwater. Further investigations are required to estimate the salinity impacts of the proposed one in four filling regime and consideration of the salinity effects of implementing the above operating rules. A more detailed groundwater model may be required to better estimate the implications of an adaptive management approach.	Salinity aspects have been assessed (Feehan) based on final recommended watering regime. It is not intended to develop further groundwater models. An adaptive management approach involving monitoring of groundwater and lake levels is proposed.
Native fish: further fish investigations including the status of Murray Hardyhead at Third Reedy Lake may be required. Biosis (2013) identified this wetland as having suitable habitat for this species, although Sharpe (2014) failed to detect Murray hardyhead and noted that the key habitat conditions are not conducive to their proliferation.	No further investigation proposed. Adaptive management based on monitoring and assessment is proposed.
Acid Sulfate Soils: a more detailed Acid Sulfate Soils analysis is required to better understand the risk from drying the wetland, field investigations have not been undertaken to date.	Further analysis is proposed after outcomes of environmental applications are determined and before work commences.
Reptiles: the impact of drying Third Reedy Lake on Turtles (e.g. Murray River Turtle) and Frogs (e.g. Spotted Marsh Frog) is recommended.	No further investigation proposed.
Landscape scale: Third Reedy Lake has been assessed in isolation of the KLBIP, consideration of the wetland system and connectivity with the landscape is required	Done as part of *NC CMA (2014a)*

Table 42 List of impacts (risks) and proposed mitigations

Potential impact	Mitigation
Acid sulfate soil	Investigation proposed prior to commencing project. Adverse risk of ASS will stop the project.
Construction	Site Environmental Management Plan

Decommissioning	Utilise existing approvals process
Planning Scheme	Planning permit application
Flora	CEMF Permit to remove native vegetation. The loss of native vegetation by construction activities is expected to be offset, in part at least, by the improvement in quality of native vegetation achieved through re-instatement of the lake's natural watering regime [or a more natural watering regime]. Any offset requirements that cannot be met by reinstating the watering regime will be achieved through GCP normal vegetation off-set processes.
Fauna	FFG permits – already held by GCP
Ramsar LAC hydrology	Environmental watering plan (in line with GCP WCMF)
Ramsar LAC Water quality - salinity	Monitoring Salinity management operational plan - operational rules and a plan to manage flows and salinity in the lake depending on a number of environmental variables. These variables will include: • Groundwater levels under, and adjacent to, the lake • EC in lake – dependent on groundwater levels and inflows during dry phase • Flow rates and EC in bypass channel • EC in Kangaroo Lake and Little Lake Charm.
Salinity downstream	Operational plan (see above)
Cultural heritage	Cultural Heritage Management Plan
Environmental water management	Environmental water management plan (in line with GCP WCMF)
Works on waterway	Application to be submitted to North Central CMA for work on waterway linking Middle and Third Reedy Lakes.
Fish management	Fish management plan
Fish passage	Provision of fish passage along bypass channel.
Carp	Installation of carp screen on Third Reedy Lake inflow structure
Flooding	Impact highly unlikely but works will be subject to planning permit.
Governance – future management	Formalise agreement to amend land status and manager.

20 SALINITY MITIGATIONS

20.1 General

Referral Section	13	Source/more information	

Potential salinity inflows are summarised in Section 17.4.4. Table 44 shows the modelled EC impact of these inflows (from *Feehan (2015)*). The 50th percentile salinity increases (all less than 600 EC) are very manageable. The Scenario 13 P80 salinity increase is a concern, and exceed the LAC, but it:

- is a worst case scenario (on top of what already may be worst case modelling scenario (see Webb comments above))
- is based on high EC readings from bores that are a short distance from the lake (it is more than likely there is a freshwater lens beneath the lake)
- does not take into account "natural" flushing provided by unregulated flow events (floods). *SKM (2010)* noted that apart from the drought maximum duration between flood events is 4 years. Chris Gippel also commented that during wet periods, unregulated flushing flows (ie floods) are much more frequent, and although there are higher groundwater levels and salt inflows their impact is mitigated by the frequency of natural flushing.
- requires high groundwater levels to allow groundwater ingress to the lake (assumes no intervention in environmental water management; lake water levels can be managed adaptively). High groundwater is likely to be associated with wet periods which will provide natural flushing. Low groundwater levels are associated with drier periods and lower risk of groundwater intrusion.

In the absence of natural flushing from unregulated flows, P80 salinities can be managed operationally (see Section 20.5).

Ecologically, salinity impacts might expect to begin at around 1500 to 3000 EC *(Cant B. et al., 2003, Nielsen et al., 2003)* (ie at about P70). *Roberts et al. (2011)* classify "fresh" water quality as less than 4500 EC. This indicates P80 salinities should be avoided if possible but may not be a major concern ecologically (See Section 20.4).

Based on these considerations Scenario 13 was adopted for business case purposes.

20.2 EC on drying

Referral Section	13	Source/more information	

The EC of lake water will increase as the lake dries and the amount is salt is gradually concentrated in smaller volumes of water. A simple spread sheet model has been used to assess the potential rise in EC.

Assume lake is full and EC is same as Torrumbarry system water (ie 250 EC).

Two scenarios

- Drying from 74.56, volume 2459 ML, salt present in lake; drying takes about 365 days. At 75% full (74.3 mAHD) EC is 327.
- Drying from 74.0, volume, 1221 ML, salt present in lake; drying takes 180 days. At 75% full (73.8 mAHD) EC is 375.

The EC on drying scenario presents no risk to LAC.

Table 43 Third Reedy Lake EC on drying from 74.56 and 74.0 mAHD

Elevation mAHD	Volume ML	EC on drying 74.56	Day	EC on drying 74.0	Day
74.56	2459.23	249	1		
74.5	2321.763	263.7428			
74.4	2095.28	292.2513			
74.3	1872.032	327.1035			
74.2	1652.004	370.6701			
74.1	1435.184	426.6688			
74	1221.766	501.1994		249	1
73.9	1012.644	604.7028		300.4214	
73.8	809.5941	756.3647	26	375.7682	45
73.7	616.3071	993.5767		493.6171	
73.6	435.6407	1405.627	57	698.3273	
73.5	272.6309	2246.071		1115.867	
73.4	135.0082	4535.638		2253.343	
73.3	38.60508	15861.86	112	7880.305	136
73.2	2.673204	229069.1		113803.4	162
73.1	0.116239	5268024		2617198	

20.3 EC on filling

Referral Section	13	Source/more information	

EC of Third Reedy Lake on filling is summarized in Table 44 and concludes that the salinity LAC would be triggered unless salinity water quality objectives are adopted and management is implemented to ensure objective achievement. A management objective to have EC levels at acceptable levels when filling has been completed can be achieved by salt flushing with irrigation water until desired levels are reached (See Section 20.5).

Table 44 Estimated EC impact of filling Third Reedy Lake under two salt load scenarios.

	Scenario1 fill to 74.56		Scenario 2 fill to 74.0	
	EC at 75% volume level (74.3 m)	EC at 100% volume	EC at 75% volume level (73.8 m)	EC at 100% volume
EC @ P50 salt load	934	770	1831	1298
EC @ P80 salt load	4840	3744	10863	7282

20.4 Salinity target

Referral Section	13	Source/more information	

A discussion paper, prepared by Pat Feehan (draft dated 9/4/2015), documents and investigates salinity of lake water on filling and drying.

20.4.1 Aquatic ecosystems

The paper suggests adopting a salinity water quality target of 830 EC based on *MDBA (2014)* which reviewed scientific literature about salinity trigger levels for managing aquatic ecosystems. They noted system resilience is a concept that is difficult to measure, so exceedance of a resource condition limit does not necessarily imply a permanent decline in the ecological character, as presented in the generic response function. Similarly, salinity levels below the resource condition Limit do not necessarily guarantee complete protection.

Aquatic ecosystems have evolved to cope with wet and dry periods and corresponding alternating salinity levels. The outcome of exposure beyond the resource condition limit will depend on a number of inter-relating components mentioned above, but the complexity of assessing risks increases with rising salinity.

MDBA (2014) proposed adopting salinity water quality targets based upon a maximum of 500 mg/L (830 EC) to provide a pragmatic approach for the protection of biota, given current knowledge and in light of the application of the ‘no deterioration’ principle in the final recommendation on targets

20.4.2 Irrigation

MDBA (2010b) propose a salinity threshold of 700 EC for the TIA. This can be used as a target to ensure lake water EC remains within acceptable limits for irrigation. This is a more stringent target than the ecological limit of 830 EC discussed above. Dilution and flushing by natural floods or by managed flushing are the two most likely mechanisms salt concentrations and loads in the Lake can be kept within desirable limits.

Table 45 *Resource condition limits developed for Torrumbarry Irrigation Area (MDBA, 2010b)*

Irrigated area	Most sensitive crop	Salinity Threshold	
		ECW	Mg/L
Torrumbarry Irrigation	Pasture, cereals and other crops, cut	700	420

20.5 Salinity mitigation

Referral Section	13	Source/more information	

Dilution and flushing by natural floods or by managed flushing are the two most likely mechanisms salt concentrations and loads in the Lake can be kept within desirable limits.

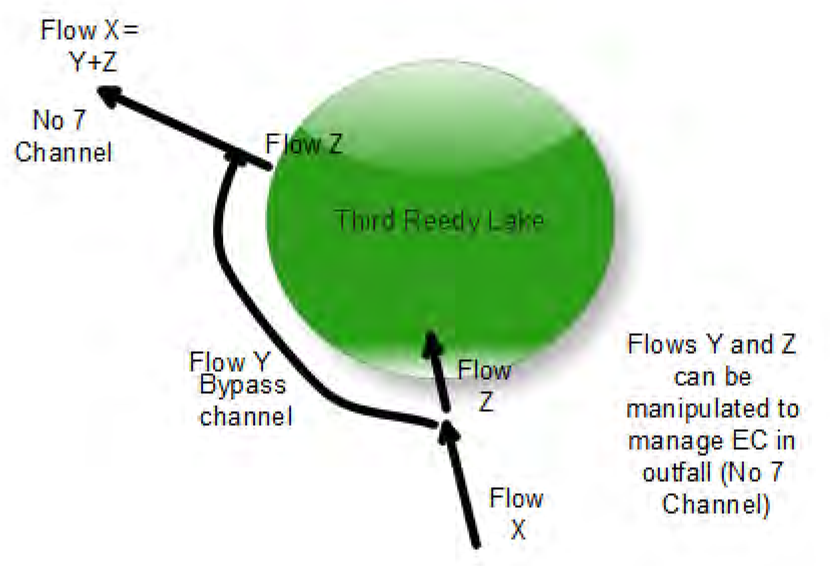
Salt flushing means the dilution and downstream transport of lake water to acceptable limits. The aim is to ensure lake water EC remains within acceptable limits for irrigation. (Assumed to be 700 EC *(MDBA, 2010c)*).

20.6 Managing EC by flushing

Referral Section	13	Source/more information	

In the absence of natural flushing from unregulated flows, elevated EC levels can be managed operationally. Advice from Ross Stanton (GMW) suggests flushing from Third Reedy Lake is possible down to about 73.0 mAHD and very achievable at 74.0 (Lake is full at 74.56mAHD, empty at 72.9 mAHD). This provides plenty of scope to flush salt from Third Reedy Lake with minimal downstream EC impact. Water and salt flushed from Third Reedy Lake can be shandied using the bypass channel (Figure 23). Varying the ratio of lake water to bypass channel water provides the means of keeping No 7 channel EC within acceptable limits. Simple modelling suggests impacts in Kangaroo Lake, downstream, can be limited to less than 100 EC. Impacts in Little Lake Charm and the 1/7 channel system will be greater but can be maintained below irrigation guideline values (700 EC *(MDBA, 2010c)*). Model variables can be manipulated until acceptable outcomes are shown.

Figure 23 Schematic – flow manipulation to manage EC downstream of Third Reedy Lake



20.7 **Requirement for operational plan**

Referral Section	**13**	**Source/more information**	

The management of salinity in Third Reedy Lake highlights the need for operational rules and a plan to manage flows and salinity in the lake depending on a number of environmental variables. These variables will include

- Groundwater levels under, and adjacent to, the lake (slow rate variable)
- Flow rates and EC in bypass channel (fast rate variable)
- EC in lake (slow rate variable)
- EC in Kangaroo Lake and other downstream lakes (slow rate variable).

The rate of change of the variable will determine the temporal scale at which the variable can be managed.

20.8 **Salinity literature review**

Referral Section	**13**	**Source/more information**	

A literature review *(Feehan, 2015)* indicates that salinity levels, even in natural systems, can vary over time, often in excess of impact threshold levels; however it is important to ensure mean salinities do not increase towards threshold levels.

21 COMMUNCATION AND ENGAGEMENT

21.1 Stakeholder engagement – Phase 1

Referral Section	20	Source/more information	

The KLBP has involved significant stakeholder engagement to date, including direct engagement with potentially affected landholders, a range of working groups involving government and non-government entities, and dissemination of information on the progress of the project. Stakeholder engagement activities have been reported in *Feehan Consulting (2015a)*

21.2 Overview

Referral Section	20	Source/more information	

Stakeholder reaction to the project has changed over the course of the project. In the initial phases reaction could be characterized as "why are you doing this; go away; we don't trust you; you already know the answer". Reaction bordered on the hostile.

Towards the finish of the investigation, with the scope reduced to one lake, community reaction mellowed to neutral; some community members supported the project.

Stakeholder support of the project is mixed. Key concerns raised during the project include:

- Trust in Government agencies, including GMW, to effectively allocate on-going resources and to manage risks such as lake salinization, dust, pest plants and animals, acid sulphate soils etc. This is a legacy of history issue with the community having long memories about impacts of earlier projects that had been vigorously opposed by the community,
- Concern about potential loss in land value and tourism if lakes are not kept permanently full; and
- Wanting the community to be involved in the implementation of the project (if it does proceed), including wanting to be empowered to develop the tourism potential of the lakes.

These concerns have been mitigated to a substantial extent by the refinements in project scope, particularly:

- Removing First and Middle Reedy Lake, Little Lake Charm and Racecourse Lake from scope;
- The intention of community members, GMW, Council, DELWP and other agencies to form a collaborative, community-based arrangement for future management of some or all of the lakes. These discussions are underway at present, so the terms of reference and membership of that group are not yet resolved.

Despite the substantial range of local stakeholder interactions there remains a real possibility that a small minority group will continue to oppose the project. GMW will continue to provide local stakeholders the opportunity for engagement, however some individuals may remain unsatisfied.

On-going stakeholder support will depend significantly on the establishment of trust in the on-going risk management of the lakes, and engaging the community effectively in their development and care.

21.2.1 **Community Advisory Group (CAG)**

The purpose of the Community Advisory Group was to advise the GMW CP on the implementation of the KLBP Investigation which provided local understanding and experience. The CAG was not a decision making body. Decisions about the project were made by GMW and the Project Control Group. The CAG was one of a number of sources of local input to the investigation.

Key Selection Criteria for membership of the CAG (as stated on the Nomination Form) were:

- Demonstrated links to local community, community groups or user groups
- Knowledge of the Kerang Lakes which may include their ecology, social values and historical background.

The CAG was not set up to be representative of particular interest groups or localities.

The CAG comprised 9 members with representatives of the Barapa Barapa and Wamba Wamba communities also invited to join the group.

Calls for nomination to join the Group were advertised in local newspapers, discussed at a public meeting at Lake Charm and e-mailed to local contacts.

A total of fourteen nominations were received.

Nominations were assessed against key selection criteria by a panel of three members comprising a former Councillor of the Borough of Kerang, former CEO of Shire of Gannawarra) and the GMW CP KLBP Investigation Project Manager.

Advice on the suitability of nominees was also received from GMW staff.

The following persons were selected:

- Cr Mark Arians
- Josh Ellis
- Charlie Gillingham (Deputy Chairman)
- Ben Hall
- Gaby Hogg
- Tom Lowe
- Colin Myers
- Stuart Simms (Chairman)

The Advisory Group met 10 times since their first meeting in February 2013.

21.2.2 Responses to Business Case

Responses were not been publicly sought to the business case; however two groups, the CAG and the NC CMA, have provided comment.

CAG

The CAG was provided with all information about the project and received briefings on work undertaken. The CAG has prepared their independent comment on this business case (See Appendix 3).

North Central CMA

The NC CMA supports the project in principle (see letter copy Appendix 4)

The Expert Review Panel provided comment on the Environmental Water Investigations undertaken (Appendix 5)

21.3 Implementation-phase engagement

Referral Section	20	Source/more information	

A communications strategy was prepared for the project. The approach to this strategy is underpinned by the IAP2 spectrum of community engagement (http://www.iap2.org.au/resources). The spectrum spans a range of engagement types from inform to empower (Table 46).

Table 46: IAP2 engagement spectrum

Engagement type	Public participation goal	Promise to the public
Inform	To provide the public with balanced and objective information to assist them in understanding the problems, alternatives, opportunities and/or solutions.	We will keep you informed.
Consult	To obtain public feedback on analysis, alternatives and/or decisions.	We will keep you informed, listen to and acknowledge concerns and provide feedback on how public input influenced the decision.
Involve	To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.	We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision.
Collaborate	To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution.	We will look to you for direct advice and innovation in formulating solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible.
Empower	To place final decision-making in the hands of the public.	We will implement what you decide.

For the KLBP engagement types ranged from inform through to collaborate. Empowerment is not feasible – the final decision is not GMW's to make.

Different engagement types will be most applicable at different phases, to different sub projects and to different stakeholders, of the investigation project. Stakeholders identified included:

- Bypass route landholders;
- Irrigators supplied from the lakes
- D&S customers supplied from the lakes
- Floodway owners
- Recreation users –
    - hunting,
    - fishing,
    - power boats,
    - bird observers,
- Apex Park,
- NCCMA NRM Committee
- Kerang Lakes Development Committee (Gaby Hogg)
- TRAMS
- Torrumbarry WSC
- Indigenous people – Barapa Barapa/Wamba Wamba
- Environment Vic/Australian Conservation Foundation
- Shire
- Councillors
- Economic development, planning, etc
- Federal/State politicians
- Kerang community
- Business and broader community

Identified stakeholders were classified according to the IAP2 framework.

Types of activities are summarized in Table 47. Further detail is provided in Appendix 2.

Table 47 Kerang Lakes Bypass Investigation – summary of engagement activity types

Activity type	**Description**	**Comment**
Community Advisory Group	To advise the Connections Project on the implementation of the Kerang Lakes Bypass Investigation project to provide local understanding and experience.	8 members; 10 meetings; provided with detailed information about investigation activities.
Project Reference Group	To provide advice to GMW on development and implementation of components of the project, and to facilitate the development of the value for money assessment. It comprised agency and municipal representatives	14 meetings.

Activity type	Description	Comment
Newsletters	Provide general information about the project and investigations.	Distributed in electronic or hard copy to circulation list x6 Contributions to Lake Chatter (newsletter of Lakes Community)
Letters	Responses to letter received from the public.	
Fact sheets	Provide information about the project.	x5
Media articles	To local print and electronic media	
Briefings	Shire of Gannawarra	x6
	GMW Water Service Committee North Central CMA Kerang Local Aboriginal Network Agencies	
One on One discussions	Drop in sessions for interested people to meet project discuss and discuss issues.	Five sessions (2 hour) Kerang and Lake Charm. Advertised in local print media. 13 attendees
One on one discussions	Face to face meetings with landholders potentially affected by bypass channel alignment.	x6 landholders.
Shopfronts	Drop in sessions for members of the public to meet project staff and discuss issues	Advertised in local print media. July 2013 – total of 3 sessions at Kerang Library (25 attendees) December 2013 – 2 sessions at Kerang Library (8 attendees) October 2014 – 1 session at Kerang Library; 1 at Lake Charm Hall (total of 11 attendees)
Project reports	Hard copies made available at Kerang Library. Electronic copies lodged with Government Library.	
Meetings	Public meeting – Lake Charm Public meeting Kerang Regular interactions at Kerang Lakes Community Development Group meetings	~ 50 attendees (28/11/2012) ~ 40 attendees (23/1/2013)
Project Specific – eg Preliminary social and economic impacts study; cultural heritage	Amongst other things, documented community views of the preliminary stages of the project.	interview with 35 stakeholders

21.3.1 **Project Reference Group**

GMW CP convened a Project Reference Group (PRG) to advise it on the implementation of the KLBP to ensure that:

- a proper process was being followed;
- the information provided was appropriate; and
- the recommendations were practical and feasible.

The role of the PRG was to provide advice to GMW CP on development and implementation of components of the project, and to facilitate the development of the value for money assessment. It comprised agency and municipal representatives.

The PRG membership is set out in Table 48.

Table 48: PRG membership.

Organisation	Name/Role
GMW	John Ginnivan, Manager Salt Interception Daniel Irwin, Manager Central Murray Operations
Shire of Gannawarra	Geoff Rollinson, Director Infrastructure, Planning and Regulatory Services
DEPI Fisheries	Corresponding Anthony Forster, Freshwater Fisheries Manager, DEPI
DEPI	Janet Holmes, Senior Policy Officer Andrea Keleher, Senior Program Leader for Water Environments
GMW Connections Project	Ross Plunkett, Manager Planning Pat Feehan, Project Manager
North Central CMA	Emer Campbell, Exec Manager of Murray, Campaspe and Avon Richardson Catchments Tim Shanahan, Acting Executive Manager - Murray, Campaspe and Avon-Richardson Catchments
AAV/Indigenous	Corresponding Marlon Parsons Manager Loddon Mallee Region Heritage Program
DPCD Region	Fiona Murray, Senior Regional Planner
Parks Victoria	Corresponding Peter Foster Ranger In Charge – Swan Hill

21.3.2 Environmental Managers

The Project has already built on existing relationships within agencies regarding the project. Phase 2 will continue this collaboration with the following Environmental Agencies

NC CMA managed the many of the field investigations, developed the 5 environmental watering Technical Reports, and were engaged at the:

- Project Reference Group (PRG)
- Scientific Review Panel (SRP)
- Expert Review Panel (ERP)
- Project Control Group (PCG)
- Environmental Technical Advisory Committee (ETAC)

The KLBP will continue to work and communicate closely with the NC CMA to deliver the project.

DEPI (now DELWP and DEDJTR) has been involved throughout the project at varying levels:

- PRG

- SRP
- PCG
- ETAC

Parks Victoria has been engaged in different forums (as a corresponding member):

- PRG
- SRP
- ETAC

KLBP will continue to work closely with the environmental managers. Technical discussions will occur at officer level whilst management discussions will be provided in updates at the PCG.

21.3.3 Other groups

Department of the Environment (Clth): The Commonwealth Government will be briefed on the project through regular GCP meetings and monthly and quarterly milestone reporting. Specific presentations have been given to both the funding unit and the Assessment unit, relevant to EPBC referrals, as the project has developed.

Department of Economic Development, Jobs, Transport and Resources (Vic) Presentations have been given to DEDJTR to keep them informed of project development in preparation of a possible referral under the Environment Effects Act 1978 (Vic).

Shire of Gannawarra: Presentations have been given to Council on approximately a six-monthly basis since 2012, and Council is represented on the PRG.

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APPENDICES

Appendix 1 List of investigation reports

List of relevant reports as attachments to EEA referral (shaded = not to be attached – not relevant to referral)

Phase	Title	Reference	Brief summary
1	Kerang Lakes Bypass Project preliminary infrastructure design Phase 2 report	*SKM (2014a)*	Preliminary design and costing of bypass infrastructure
1	Infrastructure design drawings		
1	Kerang Lakes Connections Assessment.	*SKM (2014c)*	Preliminary design and costing of options to supply irrigation water to GMW customers
1	Kerang Lakes Bypass Investigation. Peer Review of Bypass Infrastructure and Costing	*GHD (2014)*	Peer review of Jacobs/SKM bypass infrastructure reports.
1	Business Case		
1	Kerang Lakes Bypass Benefit Cost Analysis	*G-MW (2015)*	Business Case economic and benefit cost analysis
1	Kerang Lakes Bypass Channel Geotechnical Interpretive Report		Geotechnical input to design of bypass and associated structure.
1	Ecological Vegetation Class Assessment for the Reedy Lake system, Little Lake Charm and Racecourse Lake and surrounding areas in the Kerang Wetlands Ramsar Site.	*Rakali Consulting (2013)*	Flora survey of lakes
1	Kerang Lakes Bypass Investigation. Net Gain Assessment	*SKM (2013b)*	Assessment of impacts of clearing native vegetation.
1	Kerang Lakes Fauna Assessment	*Biosis (2013)*	Fauna survey of lakes – birds, fish, invertebrates, etc
1	Kerang Lakes Bypass Investigation Project Technical Report – First Reedy Lake	*North Central CMA (2014c)*	Environmental water investigation- develop plausible environmental water regimes that can be used to assess the potential water savings should any of the Kerang Lakes be bypassed
1	Environmental Watering Scenarios for Kerang Lakes Bypass Investigation Project – Phase 1	*NC CMA (2012)*	Outlined a set of water regime scenarios for each of the wetlands within the Kerang Lakes By-Pass Project to provide input to estimation of indicative and potential water savings from the implementation of the bypass project and to provide de guidance on values supported by the alternative regimes.
1	Kerang Lakes Bypass Investigation Project Technical Report – Middle Reedy Lake	*North Central CMA (2014e)*	Environmental water investigation- develop plausible environmental water regimes that can be used to assess the potential water savings should any of the Kerang Lakes be bypassed

Phase	Title	Reference	Brief summary
1	Kerang Lakes Bypass Investigation Project Technical Report – Little Lake Charm (including Scotts Creek),	*North Central CMA (2014d)*	Environmental water investigation- develop plausible environmental water regimes that can be used to assess the potential water savings should any of the Kerang Lakes be bypassed
1	Kerang Lakes Bypass Investigation Project Technical Report – Racecourse Lake	*North Central CMA (2014a)*	Environmental water investigation- develop plausible environmental water regimes that can be used to assess the potential water savings should any of the Kerang Lakes be bypassed
1	Kerang Lakes Bypass Investigation Project – Ramsar and Landscape Scale Considerations	*NC CMA (2014a)*	Consolidation of environmental water investigation in context of Ramsar and other landscape scale consideration.
1	Preliminary hydrological modelling for Kerang Lakes bypass investigation project.	*Gippel (2012)*	Assessed water savings associated with a number of preliminary water regime scenarios
1	Modelling preferred hydrological regimes for Kerang Lakes bypass investigation project.	*Gippel (2014b)*	Assessed water savings associated with preferred water regime scenarios
1	Kerang Lakes Bypass Project Cultural Heritage Field Assessment Report	*SKM (2013c)*	Cultural heritage field assessment.
1	Kerang Lakes Bypass Investigation Project. Hydrogeological Risk Assessment: Conceptual Model and Project Summary Report.	*URS (2013d)*	Development hydrogeological conceptual model for Kerang Lakes Investigation area.
1	Kerang Lakes Bypass Investigation: Acid Sulfate Soil Risk Assessment	*URS (2013b)*	Preliminary acid sulfate soil risk assessment – all lakes
1	Kerang Lakes Bypass Investigation: Monte Carlo Hydrogeological Risk Analysis: Salinity.	*URS (2013c)*	Salinity risk assessment for various lake environmental water regime scenarios.
1	Review of URS Kerang Lakes Bypass Investigation Reports for G-MW	*Webb (2013)*	Peer review of URS hydrological and salinity assessments.
1	Kerang Lakes Bypass Salinity Investigation. Phase 1 Report	*SKM (2014b)*	Preliminary assessment of regional salinity impact of bypass options
1	Kerang Lakes Preliminary Blackwater Risk Assessment	*SKM (2013d)*	Assessment of the risk of black water events associated with a range of alternative environmental water scenarios.
1	Preliminary Assessment: Social and Economic Impacts of the Proposed Kerang Lakes Bypass.	*RMCG (2013)*	Assessment of the social and economic impacts associated with lake bypass options.
2	Third Lake Present Value Analysis	*Jacobs (2014)*	Economic analysis to support business case development
2	Results of Third Reedy water savings modelling	*Gippel (2014c)*	Assessed water savings associated with preferred water regime for Third Reedy Lake
2	Kerang Lakes Murray hardyhead Survey	*Sharpe (2014)*	Murray hardyhead and associated habitat survey undertaken in Middle and Third Reedy Lakes

Phase	Title	Reference	Brief summary
2	Further hydrogeological risk assessment: Third Reedy Lake and Racecourse Lakes.	*URS (2013a)*	Hydrogeological and salinity risk assessment of possible environmental water regimes for Third Reedy and Racecourse Lakes
2	Further hydrogeological risk assessment - Third Reedy Lake	*URS (2014a)*	Hydrogeological and salinity risk assessment of preferred environmental water regimes for Third Reedy Lake
2	ECD Discussion Paper		
2	Kerang Lakes Bypass Investigation. Third Reedy Lake bypass – salinity impacts and management. Working Draft	*Feehan (2015)*	Detailed assessment of salinity impacts and mitigation
2	Third Reedy Lake Permitted Clearing of Native Vegetation	*Jacobs (2016)*	Memo report calculating offset requirement under the Permitted Clearing of Native Vegetation Biodiversity Assessment Guidelines for Third Reedy Lake. Updates previous net gain assessment.
1, 2	Kerang Lakes Bypass Investigation Project Technical Report – Third Reedy Lake	*North Central CMA (2014b)*	Environmental water investigation- develop plausible environmental water regimes that can be used to assess the potential water savings should any of the Kerang Lakes be bypassed
1,2	Engagement and Communications	*Feehan Consulting (2015a)*	Include newsletters and factsheets

Appendix 2 Summary of engagement activities

summary list of engagement and communication activities (Prepared 5 November 2013, updated 21 February 2014 and 19 March 2015 by Pat Feehan)

ID	Date	Activity	Description
	Dec 2012	Discussions	One on one discussion sessions 11/12/2012 – Kerang and Lake Charm 14/12/2012 – Kerang and Lake Charm 10/1/2013 Lake Charm
		Fact sheets	Project Fact Sheets (x5) – publically available material
		Reports	Copies of project reports publically available at Kerang Library
		Meeting	Field work for Social and Economic Impact study – interviews with potential affected landholders and groups
		Meeting	Discussions with potentially affected landholders along possible route of bypass channels
		Web	Project information on G-MW web site
		Meeting	Connections assessments – meeting with individual G-MW customers potentially affected by bypass channels
	2012/2013	Meeting	Kerang Lakes Bypass Investigation Community Advisory Committee 9 meetings to February 2014
	2012/2013	Meeting	Community Advisory Group meeting summaries – publically available
	2012/2013	Meeting	Kerang Lakes Bypass Investigation Project Reference Group – agency representatives 13 Meetings to February 2014
	2013	Media	Contribution to Kerang Lakes Chatter newsletter - various
	2013	Letters	Responses to letters (various)
	10/11/2011	Meeting	Briefing for DSE and SEWPaC staff in Melbourne
	20/11/2011	Workshop	Planning workshop - agencies
	7/2/2012	Briefing	Board of North Central Catchment Management Authority
	22/2/2012	Meeting	Kerang Lakes Community Development Association, approx. 20 attendees; range of issues and concerns raised
	2/3/2012	Briefing	Canberra SEWPaC

ID	Date	Activity	Description
	3/4/2012	Briefing	TRAMS
	5/4/2012		SWET Model workshop – Chris Gippel presented a seminar on the SWET model.
	27/4/2012	Meeting	Meeting with Kilter – major landholder
	2/5/2012	Meeting/briefing	TRAMS –Torrumbarry Reconfiguration and Asset Modernisation Strategy Committee
	9/5/2012	Briefing	North Central Catchment Management Authority Natural Resource Management Committee
	15/6/2012	Meeting	Meeting with landholders (2)
	13/7/2012	Media	Northern Times article
	2/8/2012	Meeting	DPCD at Bendigo
	19/9/2012	Meeting	Lake Charm Development Group
	28/11/2012	Meeting	Public meeting at Lake Charm Hall – about 50 people attend
	30/11/2012	Media	Northern Times article “Lakes Bypass outrage”
	23/1/2013	Meeting	Kerang Progress Association public meeting – about 40 attendees
	25/1/2013	Media	Northern Times article “Lake bypass no certainty”
	19/2/2013	Briefing	Presentation to DPCD
	5/4/2013	Meeting	Kerang district indigenous groups
	6/2/2014 3/10/2013	Meeting	Kerang Local Aboriginal Network (KLAN) – project briefing
	15/5/2013	Media	Northern Times article
	25/6/2013	Briefing	Project update summary for Kerang Progress Association
	16/7/2013 23/7/2013 30/7/2013	Shop front	Shop front drop in sessions held at Kerang Library multi-purpose room. Each session 2 ours long.
	10/12/2013	Shop front	2 Shop front drop in sessions held at Kerang Library multi-purpose room. Each session 2 ours long.
	16/7/2013	Media	Kerang Lakes Bypass Investigations Project – Investigations help define project goals
	19/7/2013	Media	Northern Times article “Studies saves lakes”
	14/9/2013	Media	Press release
	20/9/2013	Briefing	Canberra Department of Environment
	3/10/2013	Meeting	Kerang Local Aboriginal Network meeting

ID	Date	Activity	Description
	15/10/2013	Meeting	Lake Charm Development Committee
	June 2013	Briefings	Briefings to CAG and PRG about outcomes of technical assessments
	Mid 2012	Strategy	Preparation of Engagement Strategy
	Sept 2012	Board paper	Information paper for G-MW Board
	various	Newsletters	Five newsletters produced to date, distributed to over 100 people; electronic versions distributed by e-mail May 2014
	various	Briefing	Shire of Gannawarra 1/4/2012 4/9/2012 7/5/2013 1/8/2013 December 2013 3/6/2014
	9 November 2012; DPCD Bendigo	Meeting	Meeting with Harry Webber (Heritage Policy Officer) AAV, Marlon Parsons (Manager Loddon Murray Heritage Program) AAV, Fiona Murray (DPCD), Ross Plunkett and Pat Feehan.
	November 2012	Invitation	Letter to Tony Kelly, Native Title Services, seeking advice about the appropriate Aboriginal groups to contact and also the contact details of those groups.
	16 April 2013	Invitation	Letter from Tony Kelly (attached). Subsequently invitation for representatives to participate in Community Reference Group.
	various	Project information	Project updates provided to Tony Kelly (Native Title Services) to pass on to relevant people.
	18 March 2014	Meeting	Briefing for Kerang Lakes Development Group at Lake Charm
		Newsletter	Contributions to Lakes Chatter (Lake Charm and Kangaroo Lake) newsletter
	September 2014	Board	Connections Committee
	10/6/2014	Phone briefing	VEWH – Beth Ashworth

ID	Date	Activity	Description
	30/5/2014	Media	Northern Times articles Two Lakes to be diverted?
	19/6/2014	Meeting	Filed and Game – briefed David McNabb
	25/3/2014	Meeting	Briefing for Torrumbarry WSC
	26/9/2014	Briefing	DOTE
	7/10/2014		Fact sheet
	23/10/2014	Meeting	Briefing for Torrumbarry WSC
	21/10/2014	Shop front	Shopfronts x2
	28/10/2014	Meeting	Kerang Lakes Development Group meeting
	??		CAG/PRG email updates
	Early mid 2013	Interviews	to gather information about the current use and values of the lakes, and how that use/value would be affected if the lakes were bypassed for the RMCG socio-economic study. 35 people interviewed
	2012-2013	Project specific	Consultation undertaken during the preparation of Cultural Heritage Assessment.(Table 3.3 in *SKM (2013c)*)

Appendix 3 CAG response to proposal

Mr Pat Feehan 24th March 2014

Project Manager

Kerang Lakes Bypass Investigation Project

Dear Pat

As the Kerang Lakes Bypass Investigation Project draws to a close, the 9 member Community Advisory Group [CAG], which has been part of those investigations and has welcomed the opportunity to have input, feels obliged to make some final comments and conclusions.

Even though the original driver of the investigations was “water savings”, as so often happens, it has become more evident as we proceed that there are much wider considerations to be taken than the original concept and to this end, we have already attempted to instigate a meeting of all interested parties, so as an all-encompassing Management Plan for the Kerang Lakes System can be formulated. As the role of CAG nears its termination, it is hoped that the Shire of Gannawarra will continue this initiative with some manner of urgency before individual agencies implement measures that aren't part of a long-term, sustainable and well planned vision.

It is common knowledge that, for perhaps thousands of years, these lakes, were "intermittent", that is, they may have been dry for a decade or more and then filled to overflowing in wet years becoming an abundant food bowl for all manner of life. There is evidence of this with the lunettes on the east side of all depressions formed from the prevailing westerly winds blowing silt from the lake bed during the dry, to the scatter of water crustacean remains as the Indigenous communities partook in the food bonanza during the wet. We also know that the water was fresh to the very last as we have evidence of our ancestors fishing for Murray Cod in shallow waters with pitch forks. We believe the water table in surrounding areas in those days may have been in the region of 10 metres below the surface by the depth of domestic wells.

The construction of Torrumbarry Weir in 1923 and permanent water in the Lakes system by 1925 changed all that. While permanent water was a blessing to the local residents and all other forms of life, it is reported that within 10 years the water table had risen to within 1 metre of the surface, bringing with it, water with a salinity of the sea and within capillary action of the surface, rendering vast areas of our flood plain salinised and non-productive.

However, over the first 50 years of permanent water the wetlands themselves adapted to the new environment and flourished bringing in a plethora of flora and fauna possibly never seen in the area before. Then in 1975 European Carp appeared with the population exploding and were to cause, possibly the greatest degradation to the system in its history. The dredging of the Pyramid Creek in the 60's and some scouring since, brought muddied waters to the Lakes area, impeding the growth of aquatic life by blocking out the sunlight. Carp not only muddied the waters further but removed the aquatic growth in its entirety leaving only the shoreline reed beds to flourish. This was to change the whole ecology of the Lakes system, which after a further 45 years we now observe to have plateaued at a lower level.

It's interesting to note, that few members on the community committee and none of those drafting studies on the area, have witnessed the system in its pristine, pre-Carp condition

The question now is, should we attempt to return the Lakes system, or some parts of it, to its original wetting and drying regime of pre-Torrumbarry Weir, either for the sake of water savings or for the "Triple Bottom Line"? Keeping in mind there have been 2 previous investigations over the last 50 years, both of which were rejected, but acknowledging that this current review is the most detailed and a great opportunity to enhance our waterways provided the methods are practical and convincing.

Both First and Second Reedy Lakes have already been taken out of consideration because of the cost of the Bypass in relation to the water savings, also the social value of First Reedy, and the fragile nature of Second Reedy with the renowned Ibis Rookery, and the presence of Murray Hardyhead.

Third Reedy is still in contention as it is shallow, so less likely to attract ground water intrusion, and can quickly be returned to the system if problems arise. Considering that the cost per megalitre saved is far above our budget and the history of authorities in generating problems and slow to alleviate them, this option, likewise, curries little favour with the CAG

Little Lake Charm, including Scott's Creek, has also been eliminated for similar reasons to First and Second Reedy, but also the fear of saline ground water intrusions.

And so we are left with Racecourse and Bertram's as a part of the original concept, with several alternatives not yet defined. Keeping in mind, these comments are going to print before the Business Case is finalised

General comments

The group takes some exception to the statement made by some officials, that [quote] "the Lakes cannot continue to be managed as they are without further ecological decline". We are more aligned with the thinking of Jane Roberts, of the Expert Review Panel, whose graph in the agenda papers of Meeting No 9, indicates that there was a constant level of environmental values after Torrumbarry, a sudden decline with the advent of European Carp, but now a return to a constant value of the Environment albeit at a lower level.

We also agree with Jane's thoughts that [quote] " the lakes flipped from a clear water macrophyte dominated state supporting large numbers of breeding birds to a turbid, algal dominated lake not supporting as many breeding birds, with large biomass of carp and with lower diversity and with little macrophyte growth" . Also noting that Nebraska University Prof. P.A. Johnsgard's observations pre-carp were [quote] Lakes such as Kangaroo Lake in Northern Victoria are greatly favoured and evidently are regular wintering areas for birds that breed further north in the Murray River drainage. [See appendix 2] We must also consider that the Lakes were still valuable enough to be Ramsar listed in 1982, after the advent of carp.

The Group had some reservations with both the flora and fauna studies, arguing that these outcomes could vary even from month to month, and that they missed the point – damage, in the main, has been done by European Carp, [see appendix 1] not permanent water [and it has been indicated that Carp can represent up to 90% of the Bio-mass]. One of the advantages of a wetting and drying regime is the opportunity of eliminating Carp. Round Lake near Lake Boga is an example of a permanent water lake with an exceptionally large population and diversity of birds in the absence of carp.

Maintaining a carp free environment given the advent of large volumes of irrigation water, floods, human intervention and even birds would be nigh on impossible. The problem here is that, until we eliminate the presence of carp and so turbid water, we will only refill a dry wetland with more turbid water and so return it to the same situation. To this end we see the need for greater education of the current generation of decision makers to the environmental damage created by carp and the pursuance of biological methods to eliminate them e.g. daughterless carp.

To add weight to our reservations, we note in the North Central CMA's Jan 2014 "Water bird Report" on Racecourse Lake [quote] "Low numbers and diversity of species present. This might have a lot to do with its permanent nature, hence low productivity levels". A short survey of this lake, done soon after by a noted local Ornithologist reported - 13 Water Birds and Reed Dwellers, 17 Passerines and other and 4 Birds of prey - 34 species in total – hardly "low numbers"!!- not including reports of sightings of the rare Bittern [see appendix 3] This also illustrates the value of the existing and flourishing shoreline reed beds that are home to many of these species and will be lost with a drying regime [We also noted that the "Gull Bill Terns" named in the Lake Tutchewop Photo were actually "Caspian Terns"?].

The CAG did not accept the Socio-Economic survey, believing that the study did not conduct adequate and appropriate consultation with the local indigenous communities

[Although they were kept abreast of the progress of the investigations and had a seat on the CAG] or consider fully other social and economic values and the low dollar value placed on the lakes. The wider community certainly values them more highly and also recognizes their potential to attract tourists and residents, even in their existing state. Caution is required then, when considering the Bypass of any of the lakes, that all options identify the risks cloaked in the promise of improvement. Where there is doubt, that doubt should fall in favour of the status quo. The Community no longer accepts degradation of their environment as a trade-off for improved irrigation efficiency and that the losses to these water efficiencies be sourced elsewhere e.g. irrigation water losses be replaced by environmental water allocations.

The Gannawarra Shire recognizes the value of our wetlands, the risk of interference and the loss of recreational and potential land values, if some lakes in our midst revert to wetting and drying, particularly those close to existing school, caravan park and residences

While returning the Lakes to a wetting and drying regime may be returning them to their historic operation, we believe the situation now with high water tables, no longer enables this concept to be feasible – we only have to look at Cullen's Lake that was full just 3 years ago but is now dry with a ring of salinised land around its fringes that will sustain only salt bush and with trees at a higher elevation, now in the throes of dying. While this lake explodes into life when fresh water is introduced, [as the small wetland just immediately below the leaking regulator indicates], when it dries, it is a dismal wasteland creating a dust hazard and unpleasant odours. We must remember, after all, that our Lakes system is the lowest point in the landscape.

The Lake Charm Flushing Pumps were designed to reduce the level of that lake by no more than 1 metre for fear of the intrusion of saline ground water below that level – to now drop Racecourse or Bertram's by 2.5 metres and claim no intrusion is grossly misleading. Saline groundwater intrusion is not a risk but inevitable, so then we have the loss of the existing valuable and unique reed beds housing rare reed dwellers, lose the old established trees around its perimeter and will generate a salt load to be eventually flushed to the downstream water users.

It is an unfortunate fact of life, that should such a problem arise, be it similar to Pyramid Creek dredging, Lake Charm salinity, the Lake Tutchewop saga or just 2 Brolgas trying to make Scotts Creek their home, the authorities have a sad history of lack of action in remedying the problem with no compassion to the community it effects in the meantime. So, perhaps, better the devil we know than the devil we don't know!!

There is also the notion from remote irrigators in the Torrumbarry system that the Kerang Lakes Bypass will bring cheaper water to all through water savings. This indicates the further lack of appreciation of the role of these lakes – agreed, the lakes are the drainage system but are also the flood carrier, the irrigation water carrier and irrigation water storage, so often capturing water from sudden shut down upstream that would otherwise be lost to the Torrumbarry Bulk Entitlement. On many occasions the Lakes irrigators pump water through their metered outlets that is in fact, Loddon flood water, captured in the Lakes System and nothing to do with Torrumbarry.

Conclusions

The Community Advisory Group to the Kerang Lakes Bypass Investigation Project, a diverse and open minded group, have appreciated the opportunity to be a part of these investigations and, I believe, have conducted themselves in a responsible and orderly fashion making themselves aware of the information presented to them and progressing to in-depth considerations.

Pat Feehan and his team should also be mentioned for the manner in which they have conducted these investigations, their attempt to come to terms with a complex area, to listen and debate the views of the CAG and other community people and to make themselves available at public meetings and the like to present what, at times, were sensitive issues.

The CAG have weighed up this information with the vast array of local knowledge they have accumulated over the years and have come to the conclusions that in this fragile environment in which we live, the risks of many of the proposals put forward are too great to contemplate. Third Reedy Lake is possibly the only lake with potential to be incorporated into a wetting and drying regime, but even then with extreme caution and deep reservations, employing the ability to reverse to the existing regime at a moments notice if problems become apparent.

It must also be remembered that all the lakes in these investigations can currently be lowered by 1 metre, albeit only for the duration of the “Off Irrigation” period, with infrastructure already in place and so at no cost other than some loss of irrigation water, and to this end a good argument for the replacement with environmental water

On any major management plan that may eventuate as a result of this exercise, we see it as imperative that there be secure, long term funds put into place to manage the lakes and be allocated enough expertise and time to do this consistently. Included must be adequate representation from the local community with real input into any future decisions.

While we are aware of the need to be progressive and embrace any means to improve this environment, we must also use our experience to identify what we see as shortfalls, as we are, after all, responsible to the community we represent and so must do what, we believe, is in their best interest

Stuart Simms

Chairman, Kerang Lakes Bypass Investigation Project Community Advisory Group

Attachments

Attachments to CAG Comment

Attachments to CAG Comment

Nadine Schiller - Honours Student, University of Adelaide. Appendix 1.

THE IMPACT OF CARP ON A WETLAND

In late February 1996, I commenced a project to assess the impact of carp on flora and fauna in a wetland with abundant carp (Lock 6 wetland) and a wetland where carp numbers are controlled (at Pilby Creek). Both are situated on the Chowilla floodplain near Lock 6 in South Australia (not far from Renmark).

* Pilby Creek is a wetland in which the water regime has been altered and the amount of fish entering the system controlled. Every year, an outlet pipe is opened to drain Pilby Creek water. Once drained, Pilby Creek is refilled, a grill placed over the inlet stops large fish entering the system. Pilby Creek was refilled in January 1996. The Lock 6 wetland has not been artificially drained since 1926.

Observations during 13 visits reveal major differences between the two wetlands. The first noticeable difference with Pilby Creek is the unbelievably clear water. Ribbonweed has returned and now covers the entire wetland. Duckweed is prominent along the edges and other plant species are also evident. In the Lock 6 wetland, apart from the *Typha* species, no other vegetation is found in the area.

The density and diversity of macroinvertebrates found in Pilby creek is incredible. I recorded 30 different macroinvertebrates, ranging from the dominant shrimps, waterboatmen, damsel flies, chironomids and caddis flies to the less dominant limpets and various larvae. The number of macroinvertebrates found in the Lock 6 wetland was 12, shrimps being the most dominant.

The comparison of the native fish species has been less obvious. Initially, there was a variety of fish in Pilby Creek such as the native western-carp, flat-headed gudgeons, mosquito fish and juvenile carp. In recent months, I have also caught native species such as callop and flat-headed gudgeons in Pilby. The prominent fish in the Lock 6 wetland have been carp and bony bream.

* There are major differences between Pilby Creek and the Lock 6 wetland in the diversity and density of macrophytes, macroinvertebrates and native fish. The amount of phytoplankton and zooplankton present in Pilby creek has also been noticeable. The remarkably clear water and abundant bird and invertebrate life in Pilby Creek are significant. The project is nearing completion for 1996 as River Murray water is now flowing unscreened into Pilby. It is likely that carp have jumped the barrier and have already started destroying the system.

Nadene Schiller - Honours Student, University of Adelaide

(The project was initiated by the Murray Darling Association and funded through the NRMS program)

Prof. Paul A. Johnsgard. University of Nebraska. Appendix 2

"Ducks, Geese and Swans of the World".

Comments on Blue-Billed Ducks – pre Carp.

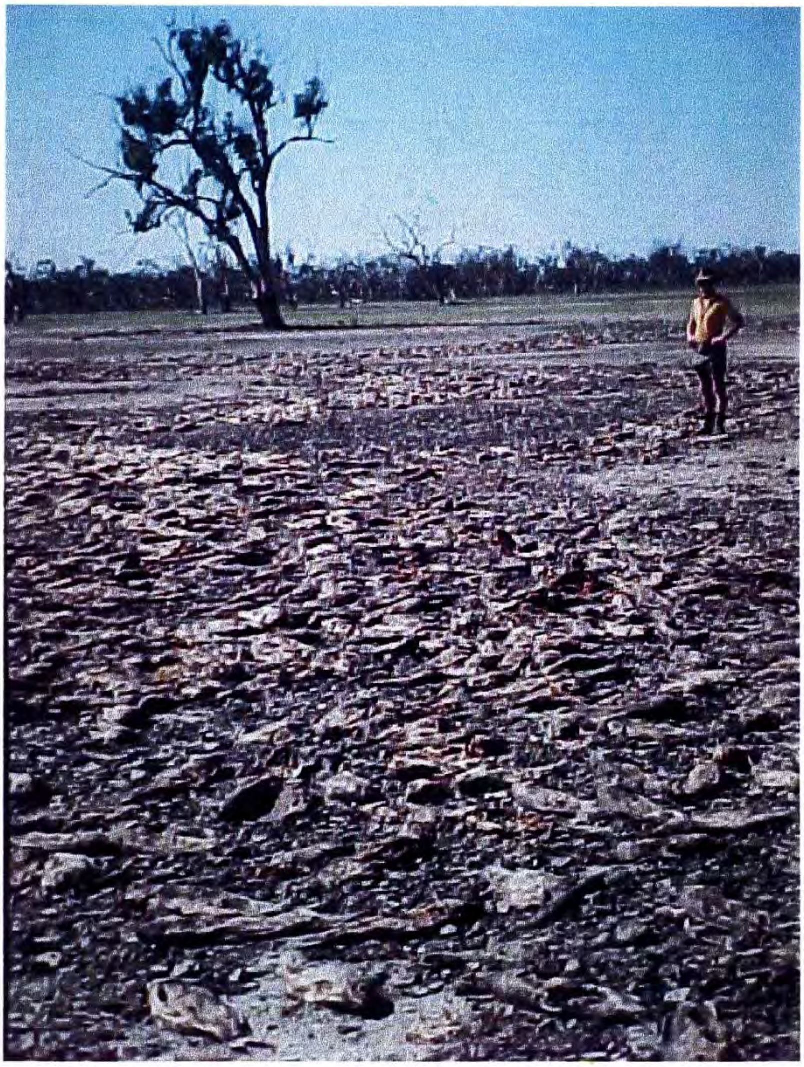
Social behavior. On wintering areas such as Lake Kangaroo, the majority of the blue-bills are in nonbreeding condition and obviously unpaired. In late July, I counted over 1,300 birds along a mile of Lake Kangaroo's shoreline, and the vast majority of the males were partly or entirely femalelike in coloration, with no pair bonds evident. By late July, a few males in breeding plumage were beginning to dis-

and tea tree thickets in coastal regions. Lakes such as Kangaroo Lake in northern Victoria are greatly favored and evidently are regular wintering areas for birds that breed farther north in the Murray River drainage; here the birds mingle with musk ducks,

VEGETATION IN THIRD MARSH
BEFORE CARP

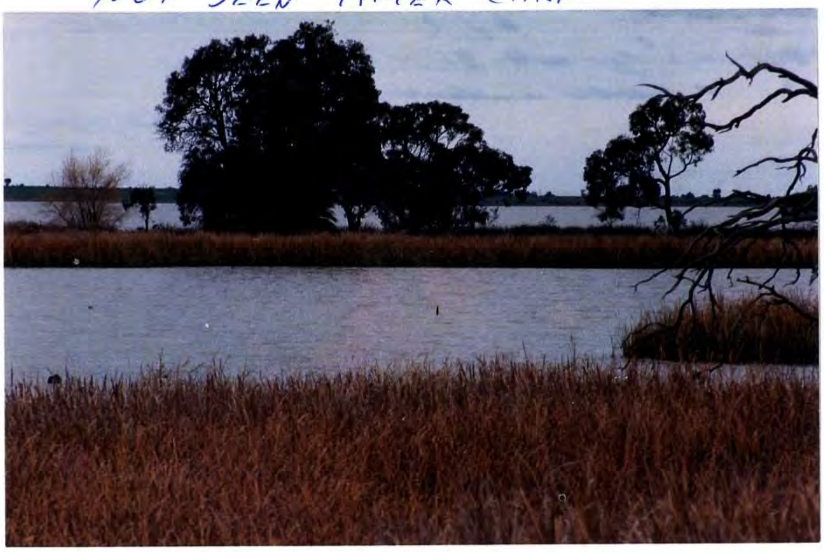
SOIL DISTUBANCE BY
CARP

CARP IN THIRD MARSH.



LAKE KANGAROO

NESTING CRESTED GREBE
BEFORE CARP
NOT SEEN AFTER CARP



SAME BACKWATER
AFTER CARP. AQUATIC VEG GONE

Appendix 3.

Bitterns and Racecourse Lake

Racecourse Lake is likely to be important for 2 species of rare birds

Australasian Bittern has recently been heard and seen on reed beds on the south west end of Kangaroo Lake within a kilometre of Racecourse Lake.

Bitterns were also heard at the north west corner of Cullens Lake where a very good small valuable wetland has developed. This site is also less than 2 kilometres from Racecourse Lake.

There is also a record and photo of an Australasian little bittern for Kangaroo Lake.

With Kangaroo Lake and Cullens Lake either side of and close to Racecourse it is likely that these 2 bittern species inhabit the extensive reed beds around Racecourse Lake. With this in mind management of Racecourse Lake should continue without change ....no drying out. This regime is also appropriate for a lot of other reed bed dwellers that are present.

Tom Lowe.
Jan. 2014.

Appendix 4 North Central CMA response to proposal

NORTH CENTRAL
Catchment Management Authority
Connecting Rivers, Landscapes, People

ref: NCCMA-63-34204

28 March 2014

Mr. Ross Plunkett
Planning Manager Connections Projects
Goulburn-Murray Water
PO Box 165
TATURA VIC 3616

Dear Mr Plunkett,

Goulburn-Murray Water Connections Project
Kerang Lakes By-Pass Project

I refer to the Goulburn-Murray Water Connections Project Kerang Lakes By-Pass Project Business Case.

The North Central CMA has been involved throughout the development of the business case through participation in the Project Control Panel and the Project Reference Group. The environmental technical reports outlining the recommended water regimes for the five lakes considered in the business case were developed by the North Central CMA in conjunction with key stakeholders.

The North Central CMA provides in principle support to the business case subject to the clarification, agreement and resolution of ongoing operational costs associated with the long term management of the by-passed lakes.

Please contact me on 0429 132 827 if you would like to discuss further.

Yours sincerely

Damian Wells
Chief Executive Officer

Connecting Rivers, Landscapes, People

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Appendix 5 ERP response to proposal.

Goulburn-Murray Water Connections Project: Expert Review Panel

To: Ross Plunkett and Chris Solum
Re: Kerang lakes Bypass Investigation Project: Technical Reports
From: Jane Roberts and Terry Hillman (ERP)
Date: 8th October 2014

Thank you for the opportunity to read the six Technical Reports dealing with developments in the Kerang Lakes Bypass Investigation Project (KLBIP). This long letter is intended to provide a clear statement of support by the ERP for this project - its philosophical basis, the methods used and the preliminary outcomes – and a brief outline of the ecological considerations underlying ERP's opinions drawing on its assessment of the six Investigation Reports.

In line with the ERP's role, our opinions are based on the potential ecological outcomes of the KLBIP, particularly the opportunities afforded by decoupling the lakes from the irrigation system. This allows (presumably within engineering and financial constraints) the opportunity to design and provide alternative watering regimes that, other considerations aside, should enhance the ecosystems of the lakes.

1. Overview

Stage 2 of the Goulburn-Murray Water Connections Project seeks to develop changes to the current management of GMW water resources resulting in water-savings that are cost-effective in terms of three criteria:

- *a.* The cost of infrastructure and on-going management versus the value of water recovered,
- *b.* The continued reliable provision of water for human use including consumptive use, recreation, and amenity.
- *c.* Support and enhancement (particularly where further degradation is expected if current management is not changed) of local and regional ecological values associated with the water resource.

In this context, the KLBIP considers five wetlands ("lakes") that are hydrologically connected in series. All five have been part of the Torrumbarry irrigation scheme since the 1920s. Large storages and carriers within an irrigation system generally indicate opportunities for water savings, but in this instance there are particular bounds to criteria ***b*** and ***c***. Not only must the lakes continue their irrigation function of supply, but the water must continue to be of appropriate water quality (freshness) and the lakes must be considered in terms of being part of the Kerang Wetlands Ramsar site, a complex of 23 wetlands, a listing that carries certain obligations.

Complexes require special consideration, as their values, particularly their ecological values, are more than the sum of their parts, so go beyond those of the constituent wetlands. For the Kerang Lakes, its Ramsar values are expressed for the complex of 23 wetlands. Thus whilst management actions generally apply to individual wetlands, their effects or outcomes need to be assessed both at the individual (subject) scale and at the scale of the total complex. In other words, the benefit/cost assessment of criterion ***a*** needs to be positive at the landscape scale.

In general, wetlands that have been entrained into an irrigation system have very different water regimes relative to their regional and/or their undeveloped conditions, and function quite differently from wetlands that have not been entrained. For example, seasonal inversion favours certain types of plants; the lack of a dry phase allows biota such as the introduced fish Common carp *Cyprinus carpio* and the native Australian emergent macrophyte Cumbungi *Typha spp* to become abundant and usually dominant; the patterns of nutrient cycling and productivity became stabilised and the *boom and bust* pattern that is typical of inland wetlands is lost; woody perennials dependent on periodic flooding such as River Red Gum die under continuous flooding; a different array of wetland habitats is available; and there is a loss of biotic diversity.

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These general points broadly apply to the five lakes being considered in the KLBIP. The water levels of these lakes are very stable with minimal fluctuations and no marked seasonal pattern; there is no dry phase, and hence no ecological re-setting; and through being kept surcharged relative to their natural sill level, they have quite a different array of wetland plant habitats. The challenge facing the KLBIP is to identify water regimes that result in water savings that can redress some of the ecological issues whilst not negating the ecological values of Kerang Lakes as a Ramsar site. This is a complex issue, involving questions of scale: short-term and long-term, and local and landscape.

2. *Overall approach*

The ERP believes that, overall, the two-step approach used in this investigation is a sensible way to tackle these complex questions. This two-step approach is a separation of what is appropriate and feasible for each wetland individually (the five individual reports) from the considerations of the wetlands as part of a Ramsar site (the landscape scale report). The advantage of this two-step approach is that it reveals how some feasibility and ecological considerations are best applied at the site scale and some at the broader scale.

For the five Kerang Lakes, detailed assessment was carried out on a one-by-one basis for five lakes ,viz for First, Middle, and Third Reedy Lakes, Little Lake Charm and Racecourse, that, through constructing by-pass channels and other infrastructure, could have the potential to satisfy the three criteria above. e. A landscape-scale study also evaluated the criteria at the regional scale. All six studies aimed at providing scientific support with which to address the third criterion, criterion ***c*** (see above), and to recommend a future watering regime as a contribution to addressing the other two criteria.

3. *Wetlands individually*

The Reedy Lake Complex, is composed of three lakes in series. They are of similar area (around 200ha) and originally would have been filled (sequentially) from high flows in the Loddon River. The three lakes are closely connected and producing different water regimes in them would probably require the construction of regulators.

First Reedy Lake is the most upstream of this 3-lake complex and since its incorporation into the Torrumbarry irrigation system in the 1920s has remained a permanent freshwater lake. As such it now supports a thin annulus of emergent plants and is considered to have low vegetation diversity (which, however, includes traces of Tangled Lignum). By-passing First Reedy will result in water savings. It will be possible to provide a variable, though still permanent, water regime which is expected to stimulate plant diversity in the littoral zone, promote growth of submerged vegetation, and enhance shelter and feeding for native fish and colonial waterbirds. Current water levels are above the surrounding groundwater levels but there is a risk of 'moderate' salinity fluxes under the proposed regime.

Apart from possible increases in Common carp densities (already the dominant fish species) there is no indication that the ecosystem of First Reedy Lake will deteriorate further if management remains unchanged.

The Technical Report recommends maintaining First Reedy as a permanently inundated water body with some seasonal pattern introduced. The ERP agrees that such a water regime would enhance the extent and diversity of the vegetation in the littoral area, and thereby improve the range and quality of native fish and waterbird habitat.

Middle Reedy Lake is similar in size and ecological condition to First Reedy Lake , but does have an active ibis rookery, substantial stands of Tangled Lignum and a single sighting of a Murray Hardyhead, consequently its goals and recommended hydrological regimes are similar. It is not clear from the available information if First and Middle Reedy Lakes can be managed as one unit or (as is more likely) infrastructure will be needed to treat them separately. However the recommended watering regime is designed to extend and enhance vegetation communities through more variable depth with resultant benefits to waterbirds and fish.

Third Reedy Lake. Being the furtherest downstream in the Reedy Lakes series, Third Reedy Lake would have been the driest of the three, and is thought to have had an intermittent wetland before the 1920s. The management objective favoured in the Investigation report is to provide a water regime that will return Third Reedy Lake to being a living River Red Gum woodland, as opposed to its current state of Open Water with

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dead timber.. The proposal does not seek to reinstate the supposed pre-European water regime of Deep Freshwater Marsh but to provide a water regime that is episodic and is considerably drier than it has been over the last 90 years. This is expected to reverse at least two of the current symptoms of a stable permanent water regime: the development of a live River Red Gum woodland, and conditions unfavourable to building up numbers of Common carp.

A 2-stage watering regime is proposed, first establishing then maintaining a red gum based ecosystem. . The report acknowledges that periods of complete dryness may incur a risk of salinity increase due to groundwater incursion. There are indications that this can be adaptively managed so as to not incur ecological risk or affect downstream consumptive users but more precise scenario-based modelling is needed to quantify this, and the potential for long-term accumulation, clarify this, with a better network of piezometers. .

Unlike the other two Reedy lakes, the recommended water regime for Third Reedy is expected to result in a change in "ecological character". This can be expected to trigger an obligation to notify under the Ramsar convention on the grounds that the wetland is being changed from its registered description at the time of listing through "human-induced alteration" (i.e. exceeds the limits of acceptable change). However, the fact that the change is likely to increase overall diversity, and that it aims to provide a pre-settlement ecosystem (as opposed to a modified or novel one) is thought to make it acceptable.

Little Lake Charm. As with the Reedy Lakes complex, Little Lake Charm forms part of the Torrumbarry Irrigation System and has been a permanent lake with a fairly constant water level for about 90 years. As a result, and like the other lakes, it supports a narrow band of fringing vegetation with a large area of open water and restricted diversity of aquatic plants. However the lake provides habitat for a number of listed bird species and supports the most diverse frog population of all KLBIP wetlands surveyed. The report indicates that the lake ecosystem is stabilised under the current hydrological regime and that further decline in ecological values is not expected. Further, surrounding groundwater levels are high and saline, and represent a threat of significant salinisation during extended dry periods. For these reasons the investigation does not recommend a drying phase but instead recommends a water regime similar to the current hydrology be maintained with (perhaps opportunistic) fluctuations in water level to support vegetation diversity.

The ERP agrees that the risks posed by saline groundwater, and possibly ASS mean that full advantage of bypassing Little Lake Charm cannot be taken at this time and agrees that endorses the minor proposed changes may improve the lake ecosystem's resilience.

Racecourse Lake is a relatively large (239 ha) freshwater lake that receives water from Little Lake Charm and other sources (including Kangaroo Lake) and is integrated into the Torrumbarry Irrigation System. Its current hydrology is similar to that of the other KLBIP lakes and, like them, it supports a narrow fringe of aquatic vegetation. However it supports populations of a number of flora and fauna species listed under international, national, and State legislation, as well as diverse fish and frog communities.

The investigation indicated that, as well as representing significant water savings, a watering regime that included enhanced water level variability with periodic, short, dry periods would encourage aquatic plant diversity and extent and, with extensive drawdown zones, diversity and biomass of fish frogs and birds. Preliminary assessment indicated that by-passing the entire lake would require expensive infrastructure (threatening criterion ***a*** above) and an alternative is proposed, of dividing the lake in two using an existing natural levee, leaving the eastern section operating as part of the irrigation system and applying the recommended watering regime to the by-passed western section. This alternative would significantly reduce by-passing costs whilst still producing water savings and ecological benefits. Details of this option including management of connectivity between the two sections of Racecourse Lake are currently being investigated. However the recommended water regime and associated objectives remain valid either for the whole lake or for one part of it.

The ERP agrees that the proposed water management changes are ecologically sensible, and commends the imaginative work that produced a choice of management options in Racecourse Lake.

Conclusions. All five lakes are in a similar condition, showing parallel responses to some ninety years of permanent and relatively stable water levels. Despite their slightly differing starting points, the lakes share

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characteristics such as suppressed extent and diversity amongst plant communities, prevalence of competitive species whether native or exotic, , and substantial areas of open water. The recommended water management regimes differ significantly amongst the lakes, from minimal change (Little Lake Charm), through permanent or near permanent inundation with substantially increased fluctuations (First and Middle Reedy) to regimes that include fluctuations and periods of complete dryness (Third Reedy Lake and Racecourse Lake). These different recommendations to similar sets of (human-induced) hydrological circumstances were driven by differences in the value of potential ecological gains, and threats associated with changing water regimes (e.g. saline groundwater intrusion). The imaginative approach to these technical studies and the 'customised' responses to the ecological conditions surrounding five apparently similar lakes is to be highly commended.

The degree of resolution in investigating the five lakes demonstrates the value of this program undertaken by GMW and indicates that Stage 2 of the Connections Project provides a means of basing benefit/cost evaluations on the best available scientific knowledge. As well as supporting the optimisation of water saving actions the studies on the five KLBIP lakes have provided guidance in avoiding serious risk of failure in the future.

The ecological value of being able to reintroduce fluctuating water regimes in the future is set out in the Technical Reports. There are other benefits. Isolating a lake is an opportunity for future innovations in ecological management, and new knowledge will certainly be gained. Particularly in lakes that experience a dry phase, there will be opportunity to 'engineer' the fish community at the time of refilling. Removal of medium to large fish would substantially benefit frog recruitment in the first years of filling; and significant reduction of Common carp numbers would increase submerged plant establishment and reduce competition for native fish species. These are all additional reasons to support the effort being expended by GMW Connections Project on the KLBIP.

4. *Wetlands in the landscape context*

The report on the landscape scale assessment examines three risks that could follow as a result of introducing a drawdown or drying phase: the risk of salinisation as a result of groundwater intrusion; the risk of acidification resulting from exposure of acid sulphate soils; and the likelihood of exceeding the presumed natural range of conditions, called Limits of Acceptable Change (LAC) as quantified in the ECD report (KBR 2011). The implementation is systematic, and done at the local (or site) scale: all five wetlands in the KLBIP are evaluated, even though drawdowns are proposed for only Third Reedy and Racecourse Lakes. For these two, the salinity risks are deemed to be low, and low to moderate, respectively (Table E1); the risk of ASS could not be resolved for either lake without additional sampling (Table E1); and although the proposed water regime exceeds the LAC for hydrology, this is not considered detrimental overall, as the introduction of a dry phase is expected to increase the productivity of Third Reedy Lake and increase habitat for migratory birds at Racecourse Lake.

These three risks are indeed important, and address some serious questions. The issue of potential salinisation is central to criterion ***b***; ASS at their extreme have resulted in near-sterile conditions in wetlands along the Murray; and LAC if triggered would require a bureaucratic response.

5. *Additional Points*

Although the ERP agrees with the findings of this risk-based landscape appraisal, and believes this has been done responsibly, it feels strongly that it is equally important to present the ecological gains. As outlined in the Overview, periodic drawdowns should result in productivity pulses and types of within-wetland diversity likely to suit an array of waterbirds other than those suited to permanent water regime, and without penalising them.

The ERP considers that changing the water regime to include drawdowns as at Third Reedy lakes is an unparalleled ecological opportunity for this wetland complex, for two reasons. First, there is the chance to have a wetland where the negative effects of Common carp dominance can be ameliorated, and serve as a public and high profile demonstration site, possibly becoming a special feature of the Kerang Lakes. Second,

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this should add considerably to the diversity of the wetland complex at the landscape-scale, by providing environmental conditions that are currently under-represented.

The Kerang wetlands are renowned for the waterbirds, abundance and richness, and this was the principal motive driving the original 1982 nomination. Since then, the Ramsar criteria have been somewhat broadened, to encompass other aspects of aquatic biodiversity. The projects commissioned in support of the KLBIP have taken this broader view of wetland ecology, and the ERP was particularly pleased to see frogs and turtles included, and wetland vegetation mapping brought up to date. The value of doing this is evident in Table 1 of the Landscape Report, which gives specific details for these five wetlands which were previously reported across the whole wetland complex.

6. *Further Investigations*

Further to our point above (Overview) about the special characteristics of complexes, the ERP considers that certain aspects of the landscape-scale ecological effects of changing the water regimes, and of changing ecological character remain outstanding.

An appraisal at the whole-of-Kerang Lakes complex scale needs to be done, if the Business Case proceeds. This should focus on spatial (and temporal) characteristics of this 23-wetland complex and its principal sub-catchments in terms that are relevant to wetland biota, by considering passive dispersal, movements, availability of resource patches, refuges. For reasons given above (under 3: Wetlands individually), the ERP does not anticipate that such an appraisal would be negative, but it needs to be done for completeness, and in recognition of obligations.

7. *Concluding Remarks*

The assessments provided in the Technical Reports at individual-lake and landscape scale demonstrate a high-level use of scientific information and ecological appreciation in developing potential management strategies that simultaneously result in water-savings and substantial ecological benefits in a highly modified wetland complex. They also deal with external risks and their amelioration. It is expected that this use of applied ecology in managing natural resources as part of the Connections Project will be of significant benefit to the regional ecosystem. as well as avoiding or at least significantly reducing the unintended disbenefits that have often attended resource management of this scale in the past.

The ERP considers that these five Environmental Watering Investigations are fit-for-purpose. They have lead to informed benefit/cost assessment in the Business Case, and can be a solid platform for developing sound Environmental Watering Plans in the future. The process of incorporating applied ecology in assessment of future management actions as developed within the KLBIP is a blueprint for similar work in the Connections Project and indeed elsewhere. It also provides a foundation for further refinement in the future, including the incorporation of new ecological knowledge.

The ERP is pleased to have had the opportunity to comment on this substantial and important work. This is a significant contribution to the KLBIP, and to the effective operation of the modernised irrigation for which the GCP has responsibility.

Yours sincerely,

JANE ROBERTS

TERRY HILLMAN

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Appendix 6 Bathymetry