

FINAL REPORT

LAKE MOODEMERE / SUNDAY CREEK RECONFIGURATION PROJECT - ENVIRONMENTAL IMPACT STATEMENT

Prepared for Goulburn Murray Water Connections Project

April 2018



**Aquaterra
Scientific**

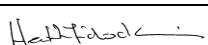
Ecology | Planning | NRM

FINAL REPORT

Lake Moodemere / Sunday Creek Reconfiguration Project - Environmental Impact Statement

To: Goulburn Murray Water Connections Project
55 Welsford Street, Shepparton Victoria 3632

DOCUMENT REVISIONS				
Revision	Date	Details	Checked By (ATS)	Issued to (Client)
0	7/2/18	Draft for review	H. Fidock	L. O'Connor
1	30/4/18	Final report	H. Fidock	L. O'Connor

DOCUMENT APPROVAL			
Name	Signature	Position	Date
Heath Fidock		Author	30 April 2018

Issued by: Aquaterra Scientific Pty Ltd PO Box 298
ACN: 600300427 Tatura VIC 3616

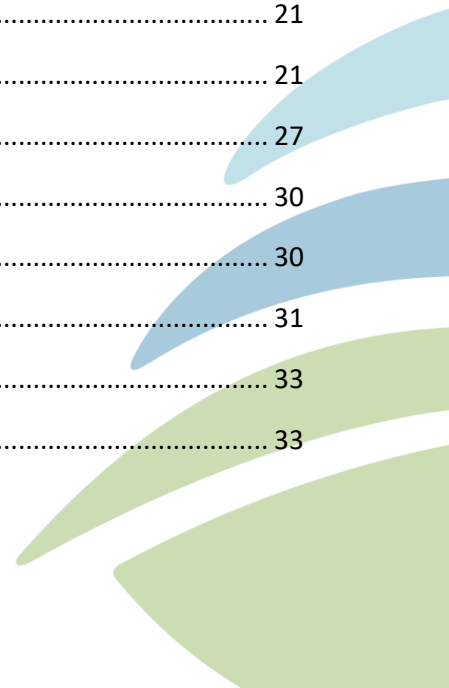
Aquaterra Scientific Pty Ltd provides this document in either printed format, electronic format or both. The printed version is considered to be binding. If no printed version is supplied the secured electronic pdf is considered binding. The electronic format is provided for your convenience and we request that you ensure the integrity of this electronic information is maintained. Storage of this electronic information should at a minimum comply with the requirements of the Electronic Transactions Act 2000 (Cth).

© Document Copyright: Aquaterra Scientific Pty Ltd

The contents of this document are and remain the intellectual property of Aquaterra Scientific Pty Ltd and are not to be provided or disclosed to third parties without our prior written consent. No use of the contents, concepts, designs, drawings, specifications, plans, etc included in this document is permitted unless and until they are the subject of a written contract between Goulburn Murray Water Connections Project and the addressee of this document. Aquaterra Scientific Pty Ltd accepts no liability of any kind for any unauthorised use of the contents of this document and reserves the right to seek compensation for any such unauthorised use.

Contents

EXECUTIVE SUMMARY.....	1
1 Introduction.....	4
1.1 Background to the Project.....	4
1.2 The Proponent.....	4
1.3 Project Area.....	5
1.4 Purpose of this Report.....	5
2 Site Overview.....	7
2.1 Land Ownership, Cadastre and Zoning.....	7
2.2 Project Area Description.....	7
2.3 Current and Historical Land Use.....	7
2.4 Surrounding Land Use.....	8
2.5 Conservation Areas.....	8
2.6 Lake Moodemere Environmental Watering Plan.....	8
2.7 Current Hydrological Regime and Control Features.....	9
3 Project Description.....	11
3.1 Project Scope.....	11
3.2 Alternatives Considered.....	12
4 Environmental Legislation & Policy.....	14
4.1 Commonwealth.....	14
4.2 State (Victoria).....	16
5 Environmental Values.....	21
5.1 Terrestrial Environments.....	21
5.2 Aquatic Environments.....	27
5.3 Frogs.....	30
5.4 Acid Sulphate Soils.....	30
5.5 Cultural Heritage.....	31
6 Potential Benefits and Impacts of the Project.....	33
6.1 Potential Impacts from construction activities.....	33



6.2	Benefits and Impacts from an altered hydrological regime.....	34
7	Statement of Commitments	40
7.1	Environmental Management Strategy.....	40
7.2	Summary of commitments	40
8	Project Justification and Conclusions	41
9	References	42

Tables

Table 1	Lake Moodemere cadastral details.....	7
Table 2	Surrounding land uses.....	8
Table 3	Assessment of the potential project impacts against MNES and requirement for referral	14
Table 4	Assessment of the potential project impacts against EE Act criteria and requirement for referral.....	16
Table 5	EVCs observed from site specific field mapping at Lake Moodemere (Australian Ecosystems 2011)	21
Table 6	EPBC and FFG listed threatened flora for Lake Moodemere and Sunday Creek	25
Table 7	Threatened terrestrial and wetland birds recorded or predicted to possibly occur at the site (Source EPBC Act PMST, GHD (2010) Australian Ecosystems (2011)).....	26
Table 8	Threatened Migratory birds recorded or predicted to possibly occur at the site (Source EPBC Act PMST, GHD (2010) Australian Ecosystems (2011))	26
Table 9	Aquatic vertebrate species recorded for Lake Moodemere / Sunday Creek (from Richardson and Stoffels (2011b)).....	28
Table 10	Frogs previously observed at Lake Moodemere	30
Table 11	Potential impacts to site values from construction	33
Table 12	Summary of potential Risks and benefits of restoring natural seasonality in the Lake Moodemere System	34
Table 13	Potential risks and benefits for ecosystem values for return to summer draw-down regime	36
Table 14	Project Commitments	40

FIGURES

Figure 1	Site location and features	6
Figure 2	Water balance model for Lake Moodemere and Sunday Creek	9
Figure 3	Spatial representation of EVCs at Lake Moodemere (modified from Australian Ecosystems 2011)	23

EXECUTIVE SUMMARY

The purpose of this Environmental Impact Statement (EIS) is to provide a description of the site environmental values and the potential impacts associated with the proposed development for irrigation reconfiguration at Lake Moodemere and Sunday Creek.

The proponent for the project is the Sunday Creek Irrigators Syndicate (SCIS). Goulburn Murray Water Connections Project will be undertaking the project on behalf the SCIS.

The Lake Moodemere / Sunday Creek system is a highly modified lake and wetland complex located 6 km west of Rutherglen, northern Victoria, and is situated adjacent the Murray River. The Project Site lies within the Lake Moodemere / Sunday Creek system.

Background

The current regime sees Lake Moodemere filled by the Murray River (via overland flows, or pumping) to a height that allows water to flow into Sunday Creek, which acts as a holding lagoon for irrigation water extraction. The optimum water level at which allows flows into Sunday Creek, also achieves a flooding of the wetland marshes in the northern portions of Lake Moodemere. This current arrangement has been in place since 1979 and has created an altered hydrological regime where by sustained flooding of the wetland complex occurs in the summer/autumn months, rather than the winter/spring months, which would normally occur under natural conditions. The altered hydrology has led to both positive and negative changes in vegetation composition and faunal diversity. Thirty-nine years of consistent flooding of the wetland marshes at Lake Moodemere has led to some new flora and fauna species entering the area, some threatened. The reconfiguration is set to pump river water directly into Sunday Creek for irrigation use, effectively bypassing Lake Moodemere entirely. Implementation of the proposed water delivery system will see little change within Sunday Creek in terms of water levels, however, as the Sunday Creek can now be operated independently of Lake Moodemere, the hydrological regime in the Lake can be restored to a more natural condition where by drawdown is experienced in the summer/autumn months.

Values

A review of the referral criteria for both the Environmental Biodiversity and Conservation (EPBC) Act (Commonwealth), and the Environmental Effects (EE) Act (State) has determined that this project does not trigger any criteria, therefore no referral is required. It should be noted that the full extent of potential vegetation clearing is not yet known and may still trigger a State EE Act referral should native vegetation loss exceed 10 hectares.

Lake Moodemere is considered to be a regionally significant wetland due to its species diversity and presence of threatened species. Flora and fauna surveys have been undertaken identifying numerous Commonwealth and State listed threatened species present at the site. EPBC Act listed flora: River-Swamp Wallaby Grass, and Mueller Daisy, as well as Flora and Fauna Guarantee (FFG) Act listed: Watershield, and Buloke have been observed within the Lake Moodemere system, although not within the proposed construction footprint. EPBC Act listed fauna: White-throated Needle-tail and Satin Flycatcher, both migratory have been observed at Lake Moodemere, with the Satin Flycatcher also observed within the proposed construction footprint. A further

seven bird species listed under the FFG Act were also observed close to but not within the construction footprint. No EPBC Act aquatic vertebrates were observed at the site, although the FFG Act listed Broad-shelled turtle and Flyspecked hardyhead were recorded, although not within the construction footprint. The EPBC Act listed Growling Grass Frog was predicted to occur at the site, however extensive survey carried out in late December 2017 failed to record any individuals.

Investigations for acid sulphate soils (ASS) risk factors determined a low risk for most areas of construction with the exception of Hells Gate, where Lake Moodemere connects to Sunday Creek. An Environmental management plan will be developed to detail necessary mitigation to negate ASS risks. An Aboriginal cultural heritage investigation was undertaken in 2009 which included both a standard and complex assessment. No cultural heritage was discovered at the site. All construction works will be subject to a cultural heritage management plan.

Impacts and benefits

Potential short-term impacts from construction activities will be relatively localised and mitigated by the guidance of a site-specific EMP. Avoidance of native vegetation will be incorporated into the detailed design the project, as well as efforts to minimise disturbance to inhabitants of the Lake Moodemere system. Longer-term impacts to the Lake Moodemere system, due to the altered hydrological regime are not known with any certainty. The restoration of the hydrological regime of Lake Moodemere to a more natural wetting/drying cycle will provide net benefits the system as a whole. Turtle species are expected to benefit from an increase in macrophyte diversity. Native fish are expected to benefit from increased food availability. Some risk does exist to the FFG listed Fly Specked Hardhead associated with reduced access to wetland macrophytes during breeding season. It is also possible that exotic species of fish, such as carp and gambusia, may also benefit from draw-down conditions as they are generally more tolerant of poor water quality. Aquatic fringing vegetation is expected to increase in diversity, although there is also the risk of increased dominance of *Juncus ingens*. Frog diversity is likely to benefit from the draw-down regime. Bird communities are expected to benefit from increased habitat productivity and food sources, in addition to increased shallow wetland habitat. Some temporary relocation of wetland species may occur if the lake and wetland become too shallow.

Mitigation

Construction activities will be undertaken in accordance with an approved site-specific EMP. The EMP will detail the scope of activities and outline the potential impacts and mitigative controls to be put in place to reduce the risk of environmental harm. As well as this, on-going monitoring will be undertaken to assess the ecological condition of the site.

Although outside the scope of this investigation, it is likely an operating plan will be developed which will outline scheduling and volumes of inflows to lake Moodemere, necessary to meet stakeholder needs, while focusing on ecological improvement.

Conclusions

The reconfiguration of the Lake Moodemere / Sunday Creek system is an opportunity to restore the hydrology Lake Moodemere to a near natural state, while providing added benefits of water savings to the Murray Darling

System through improved water delivery efficiencies. The degree of impact on the environment is considered to be relatively minor with net benefits in vegetation and fauna diversity expected.

1 INTRODUCTION

The Sunday Creek Irrigators Syndicate (SCIS) proposes to reconfigure the current delivery mechanism for water into Sunday Creek, from the Murray River, near Rutherglen, Victoria. The current regime involves water passing through Lake Moodemere to Sunday Creek. The proposal sees a new pipeline constructed from the Murray River direct to Sunday Creek, providing significant water saving.

This Environmental Impact Assessment (EIA) has primarily been prepared to accompany an application for planning approval to the Indigo Shire (Victoria) and Federation Shire (NSW) and an application for approval to undertake works near a waterway. This EIS describes the existing environment, current use for irrigation, the proposed reconfiguration project scope and outlines the potential for impacts during the construction phase and through an altered hydrological regime.

1.1 Background to the Project

In 2008, Goulburn Murray Water (GMW) in consultation with the SCIS commissioned Sinclair Knight Mertz (SKM) to undertake an investigation into the feasibility of implementing a more efficient means of delivering irrigation and stock & domestic water to irrigators on Sunday Creek. The investigation proposed a number of options, with diversion from the Murray River direct to Sunday Creek (effectively bypassing Lake Moodemere) being the preferred option based on cost/benefit.

The current operating practice sees an artificial water level maintained in Lake Moodemere through the use of a gravity fed regulator from the Murray River, and a pump station from the Murray River that is used in times of low flows. Once Lake Moodemere reaches an optimum level, water flows through an artificially constructed connecting channel (known as Hells Gate) into Sunday Creek. At the same time, overtopping water from the Lake moves onto the floodplain adjacent to the Lake to the north. This area consists of an extensive natural wetland marsh. The current operating practice results in sustained annual flooding, an alteration to the natural wetting a drying cycle experienced under normal conditions.

The preferred water delivery option seeks to provide a more efficient method of water delivery to Sunday Creek by pumping water from the Murray River directly into Sunday Creek (via a connecting pipeline), thus bypassing Lake Moodemere entirely. Water savings from the recommended method are achieved through reduced seepage losses and evaporation (mainly from inundation of the wetland marshes to the north).

Lake Moodemere and surrounding wetlands and riverine forest provides important habitat for numerous threatened species and vegetation communities. Construction works and alterations to the hydrological regime are likely to have some impact on the flora and fauna residing in the area.

1.2 The Proponent

The proponent for this project is the: **Sunday Creek Irrigators Syndicate (SCIS)**.

Goulburn-Murray Water Connections Project (GMW Connections Project) is undertaking this project on behalf of the SCIS.

1.3 Project Area

The Project is located at Lake Moodemere / Sunday Creek (adjacent the Murray River), approximately 6 km west of Rutherglen, Victoria (refer to Figure 1). The Project Site is situated wholly within publicly owner/managed lands, the details of which are provided in Section 2.1. The site is accessed via Distillery Road and Hyde Road at the northern end of the site, and Lake Road at the southern end of the side. The Project Site is generally bounded by the Murray River to the north and public land to the south and east.

1.4 Purpose of this Report

This EIA report has been prepared by Aquaterra Scientific Pty Ltd on behalf of GMW Connections Project to accompany the planning applications for the proposed Project.

The purpose of this EIA report is to:

- Provide a detailed description of the project and the lands affected;
- Assess the potential environmental impacts of the Project on the physical environment (having regard to both current and future land use);
- Identify general management and mitigation measures to be implemented to minimise potential impacts associated with the Project; and
- Justify the proposed Project, including suitability of the Project Site and its alignment with whether the proposed Project is in keeping with stakeholder interest.

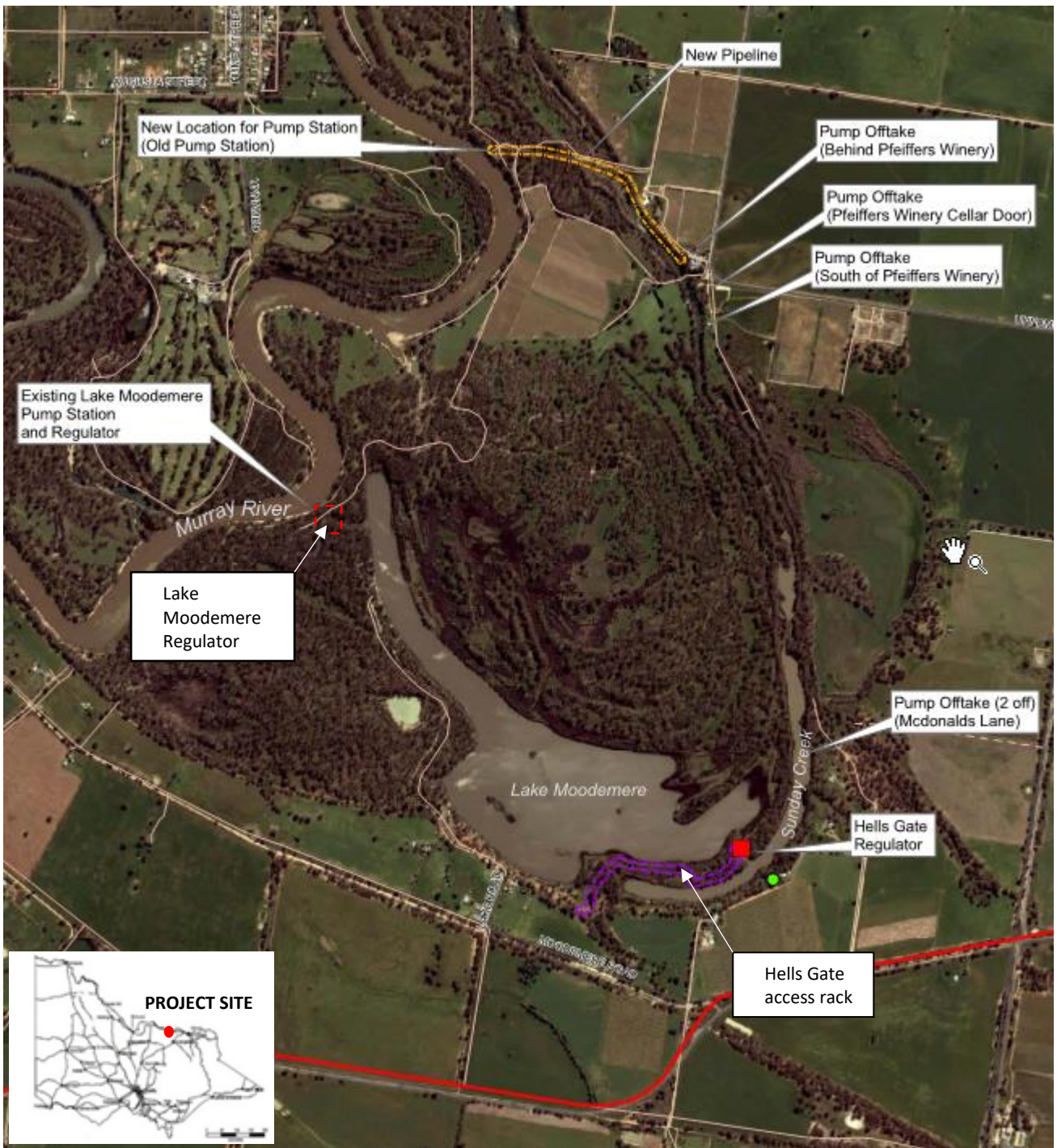


Figure 1 Site location and features

Source: Adapted from GHD (2010)

2 SITE OVERVIEW

2.1 Land Ownership, Cadastre and Zoning

The Project Site incorporates public land. Details of surrounding land parcels are provided in Table 1.

Table 1 Lake Moodemere cadastral details

Land Parcel	Land Class	LGA	Land Manager/Owner	Zone	Overlays
CA B10A	Crown land	Indigo Shire	DELWP	Farming Zone	FO, ESO2
CA 3A	Crown land	Indigo Shire	Parks Victoria	Public Conservation Recreation Zone	FO, ESO2
CA 2006	Crown land	Indigo Shire	DELWP	Public Conservation Recreation Zone	FO, ESO2
CA 6A	Crown land	Indigo Shire	Parks Victoria	Public Conservation Recreation Zone	FO, ESO2, HO546
CA 20	Crown land	Indigo Shire	Parks Victoria	Public Conservation Recreation Zone	FO, ESO2, HO546

Notes:

“CA” Crown Allotment

“DELWP” Department of Environment, Land, Water and Planning

“FO” Flood Overlay

“ESO” Environmental Significance Overlay

“HO” Heritage Overlay

2.2 Project Area Description

The Project area consists of both aquatic and terrestrial environments. Lake Moodemere is a natural flood plain lake that is topped up by the current operating arrangements for irrigation. Historically, water levels in the Lake would be highly variable, dependent heavily on overland flows from when the Murray River was in flood. However, with the inception of irrigation at the site has meant that water levels have remained at relatively constant level producing an altered ecosystem. The extensive wetland marshes to the north are routinely flooded and have altered in terms of species composition reflective of more frequent and prolonged periods of inundation. The lands surrounding the Lake and marshes are generally considered a terrestrial environment. Flooding of these portions of the site is independent of the current altered hydrological regime, although are periodically flooded by the Murray River when in flood. The forests are considered high value riverine forest containing a myriad of threatened flora and fauna species. Sunday Creek also maintains a relative constant water level for irrigation. Sunday Creek is considered to be part of the Lake Moodemere system.

2.3 Current and Historical Land Use

Lake Moodemere was originally a large swamp billabong only filling when the Murray River was in flood. The site was thought to have been an important refuge for wildlife in times of drought. The word “Moodemere” is supposedly an Aboriginal word meaning “waterhole that never dries up”. The Lake has been regulated for almost 100 years, primarily for recreational purposes. In January of each year an annual rowing regatta, touted as the oldest in Australia is held, attracting large numbers of competitors and spectators. Lake Moodemere is a public lake used for recreation purposes year-round, with past times including rowing, fishing, swimming and

skiing, as well as birdwatching and bushwalking. It was not until 1979 that Lake Moodemere was connected to Sunday Creek for irrigation purposes. Sunday Creek is essentially an elongated billabong, utilised as an irrigation water retention lagoon. Prior to this, irrigation water was delivered to Sunday Creek from a pump station located at the northern point of the site (now decommissioned).

2.4 Surrounding Land Use

The lands surrounding the Project Site generally consist of rural farming with some pockets of native vegetation and wineries. The surrounding land uses are described further in Table 2.

Table 2 Surrounding land uses

Orientation	Ownership	Local Government Area	Description
North	Private	Indigo Shire (Vic)	Mixture of state forest and privately-owned land
East	Private	Indigo Shire (Vic)	Wineries and farmland
South	Private	Indigo Shire (Vic)	Farmland
West	Crown land / Private	Federation (NSW)	The Murray River generally bounds the Project Site immediately to the west. Further to the west, in NSW, there is a mixture of land uses including public forest, farmland and a golf course

2.5 Conservation Areas

The Project Site is wholly located within crown land. Lake Moodemere Lake Reserve (CA 20) is located at the lower end of the site and mainly comprises open water with native riverine vegetation along its fringes. Moodemere Nature Conservation Reserve is located towards the northern portion of the site consisting of wetland marshes and riverine forest. Significant ecological features of threatened vegetation communities as well as recorded rare and fauna threatened species exist throughout. No works are proposed to occur through this section of the Project Site.

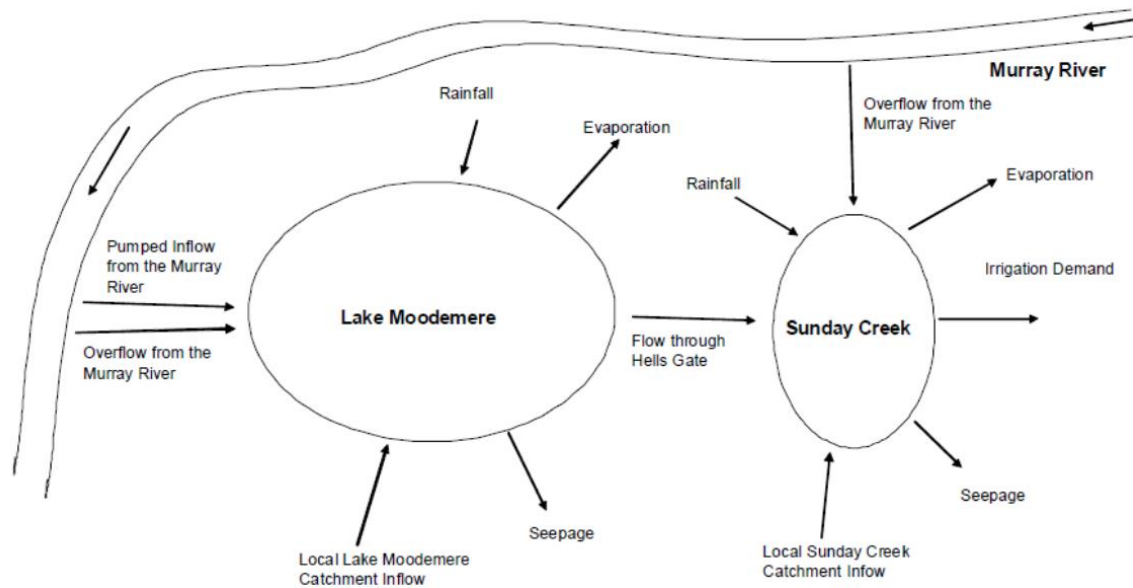
2.6 Lake Moodemere Environmental Watering Plan

The Lake Moodemere Environmental Water Plan (EWP) (Water Technology 2012) was developed for Lake Moodemere (including Sunday Creek) in 2011 to inform future hydrological management of Lake Moodemere. The purpose of the plan was to document the existing environmental values and identify critical watering regime requirements to sustain and enhance significant site values. The EWP states that the overall objective is *“To maximise the overall biodiversity of the site by reducing current hydrological constraints on the viability of native flora and fauna communities and species”*. The EWP recognizes the significant modification to the system from pre-European conditions, creating an altered ecosystem which has impacted and benefited a range of flora and fauna. The EWP is written in the context of the anticipated changes to the hydrological regime as proposed by the Project and suggests this as an opportunity to improve the ecological values of the site, although concedes the inherent risks posed to some species (including threatened species) by returning the watering regime to a some-what natural cycle.

2.7 Current Hydrological Regime and Control Features

2.7.1 Hydrological Regime and Operating Practice

The existing hydrological regime for the Lake Moodemere / Sunday Creek system is controlled by both natural and artificial features. Inputs from natural processes such as local catchment run-off and rainfall are considered to be relatively minor in comparison to anthropogenic diversion from the Murray River. Localised groundwater interaction has not specifically been investigated, although there is likely to be some minor hydraulic connection (GHD 2010). Losses from the system may occur naturally via seepage and evaporation or irrigation demand. A simplified water balance schematic is provided below in Figure 2.



Source: GHD 2010

Figure 2 Water balance model for Lake Moodemere and Sunday Creek

The current operating practice adopted during the irrigation season (September to April) maintains an artificially high-water level in the Lake by use of a gravity fed regulator from the Murray River and a pump station that is used during times of low flows. Lake Moodemere, once achieving an optimum level of 128.55m AHD, gravity flows through Hells Gate into Sunday Creek. At the same time water also pushes over the northern bank of the Lake into the wetland marshes. Up to 31.2 hectares of marshes may remain inundated for a prolonged period of time (DSE 2008).

Operating guidelines for Lake Moodemere are provided in the 'Integrated Operating Procedure' produced by the former Department of Conservation and Natural Resources (Robley 1996). It states that:

"The regulator gates should be closed in December each year, allowing the lake level to be drawn down to 1.9m through irrigation and evaporative demands. If the lake falls to a level which creates irrigation supply difficulties, the regulating structure should be operated to restore a maximum level of 1.9m. The regulator gates should be open between May 1st and August 31st each year to allow for variation in Lake level."

DSE (2006) suggests that although the maximum level was set at 1.9m this was revised down to 1.6m as the structure installed in 1996 did not function well and was removed, thus returning levels to the former height of 1.6m.

2.7.2 Control Features

Regulation of levels in Lake Moodemere and Sunday Creek is controlled through the use of the following artificial features:

- **Lake Moodemere regulator** – The regulating structure consists of two 600mm culverts through the Murray River bank and a concrete gated structure to regulate flows. The regulator is a one-way structure allowing inflow and prevents water from out falling back into the Murray River
- **Existing pump station** – Close to the existing Lake Moodemere regulator there is a pump station, which is used to divert water to Lake Moodemere during periods of low flows.
- **Lake Moodemere delivery channel** – An excavated channel of approximately 150m in length delivers water from the Lake Moodemere regulator to the Lake.
- **Hells Gate** – An artificially excavated channel between Lake Moodemere and Sunday Creek. The channel is an open channel with no regulating equipment.

3 PROJECT DESCRIPTION

3.1 Project Scope

Water delivery to Sunday Creek via direct pumping from the Murray River is considered to be a much more water efficient mechanism than the current arrangement in terms of water savings. It will involve the modification of existing structures and the installation of new pumping and delivery infrastructure. In summary, a new pipeline will be installed at the northern end of the Project Site on the Murray River bank. Water will be pumped to Sunday Creek via a new pipeline. An existing pipeline located in the vicinity proposed pipeline is in place, however it will not be utilised as a part of this project. It is believed the existing pipeline was used to deliver water to Sunday Creek, prior to the current arrangement. It is considered now to be decommissioned.

The levels in Sunday Creek will be regulated independent of the levels within Lake Moodemere. The detailed design for the new delivery method is yet to be finalised, however the concept has been agreed upon, and the broader impact footprint is confidently known.

A generalised overview of the work scope for each component of the project and the potential associated impacts is provided below:

- New pump station and power connection:** a new pump station will need to be constructed to lift and deliver water to Sunday Creek. The proposed location for the pump station is in the vicinity of a former pump station at the north end of the site near Hyde Road. The power connection will also be considered in planning. Access to the proposed pump station will be via an existing track (Hyde Road) for the most part. It is envisaged that the power connection will be underground and follow Hyde road closely, reducing the need to remove trees. The full scope of the power connection is yet to be determined. In any case, a site inspection will be carried out to assess the potential removal of vegetation, and appropriate mitigative controls, and/or offsets to be assigned. The new pump station site is already relatively cleared; therefore native vegetation removal and disturbance at that location will be low. The construction footprint for this component of the project will seek to avoid vegetation where possible and feasible.
- Pipeline and outfall:** A pipeline connecting the pump station to Sunday Creek will need to be constructed. The current outlay of the pipeline as per the SCIS proposal sees the linear footprint following Hyde Road east from the pump station, before tracking south to the outfall on Sunday Creek. Again, the majority of the construction footprint will occur along Hyde Road. Where the pipeline pathway deviates south, away from Hyde Road towards the proposed location for Sunday Creek outfall (a length of approximately 0.1km) native vegetation is likely to be encountered. The construction footprint through this section will seek to avoid as much native vegetation as possible. This portion of the site will also be assessed for vegetation once the exact alignment of the pipeline is known.
- Hells Gate:** Hells Gate is the existing excavated channel connecting Lake Moodemere to Sunday Creek. The preferred delivery option will see the need for a concrete sill to be constructed across Hells Gate. The sill will be raised to ensure that the water levels in Sunday Creek can be maintained at optimum levels independent of the water levels in Lake Moodemere. Elevated risk of acid sulphate soils in this

area have been identified and is discussed further in Section 5.4. Appropriate mitigative controls will be employed during the construction phase. Access to this site is ill-defined although it is believed that a track is present, used by SCIS to de-silt the Hells Gate channel. Vegetation clearing may be required depending on access requirements. It is noted that some portions of the site in this vicinity is of high value vegetation. In a Note to File from Peter Walsh, he writes that Malcom Campbell of Campbell Wines and SCIS, suggests that there may be access from Pfeiffer Wines; this yet to be confirmed.

- **Existing pump station and regulator:** No decommissioning works will occur at the existing pump station, as it will continue to be used. The existing Lake Moodemere regulating structure that regulates flows into the Lake will be removed and replaced. The site of the existing structure is relatively cleared; therefore it is unlikely that proposed works in this area will have any direct impact on the surrounding environment. Access to these sites is via an existing track, Lake Road. All access will remain on the existing track.

3.1.1 Anticipated new hydrological regime and operation

The proposed operating practice for Lake Moodemere and Sunday Creek is described in detail in the “Lake Moodemere Water Savings Assessment” (DEPI, 2014). A summary of the anticipated operating practice is provided below.

Irrigation water in Sunday Creek will be supplied via the new pipeline. The levels are to be maintained constantly throughout the irrigation season (September to April) to provide consistent availability to irrigators. The water levels in the Creek will be maintained independent of the levels in Lake Moodemere principally by the concrete sill installed at Hells Gate. The Hells Gate sill will be constructed to a height that is higher than the proposed operating level in Sunday Creek to prevent backflow into the Lake.

The new Lake Moodemere regulator is a critical component of this project in achieving the water savings targets, forecast in the Lake Moodemere Water Savings Assessment. Maintaining an appropriate level in the Lake is seen as an important social objective, ensuring adequate volume for the annual rowing regatta and recreational activities alike. Diversion of Murray River flows into the Lake will occur between September and the end of January, after which the regulator gates will be shut. The Lake will be maintained at a level below that required for flooding of the marshes to the north. The bulk of the water savings for this project will be achieved via this component of the operating practice via reduced evaporation and seepage. This will see a return of a more natural flooding cycle where inundation of the wetland marshes will only occur when the Murray River exceeds bank full capacity and spills onto the floodplain.

Both Lake Moodemere and Sunday Creek are still equally susceptible to overland flows when the Murray River is in major flood. Siltation of both systems would be expected to occur with no expected changes from the current arrangement (GHD 2009). It is anticipated that some additional siltation of Sunday Creek may occur under the new arrangement, although is expected to be minor.

3.2 Alternatives Considered

SKM (2008) provides a feasibility assessment for numerous options to improve the efficiency of water delivery to SCIC irrigators. Option 1 (adopted and described in Section 3.1 of this report) is the preferred option based

on water savings sales offsetting the initial capital expenditure and ongoing running costs. A second option (Option 2) was also proposed that would involve the construction of a pump station on the Murray River near Hyde Road (similar to Option 1), and implementation of an extensive network of pipeline to deliver water to the 'farm gate'. The capital expenditure of Option 2 was seven times that of Option 1, and consequently benefits generated from sale of water savings was assessed as not enough to cover the high capital costs associated with construction of the pipeline and pump station.

4 ENVIORNMENTAL LEGISLATION & POLICY

4.1 Commonwealth

4.1.1 Environmental Protection and Biodiversity Conservation (EPBC) Act, 1999

The *Environmental Protection and Biodiversity Conservation Act, 1999* (EPBC Act) establishes a Commonwealth process for the assessment of proposed actions likely to have a significant impact on matters of National Environmental Significance (MNES). Where a significant impact to MNES is potentially identified the proposed action is referred to the Australian Government Minister for the Environment (the Minister) for assessment. Establishing whether a proposed action will have a significant impact involves a detailed assessment of the ecological values at and surrounding proposed site of disturbance. There are nine MNES criteria defined in the Act. An assessment has been undertaken which assessed the relevance of each MNES component to the Project. The assessment is based on results of the targeted ecological assessments conducted for the Project Site. The results of the assessment are provided below in Table 3. The assessment determined that although numerous threatened vegetation communities, threatened flora and fauna are present or close by, the Project will have very little impact directly on these species.

Conclusion

There is the potential for three MNES (Ramsar Sites, Threatened Species and Communities, and Migratory Species) to be impacted by the project. If appropriate mitigation measures are developed and implemented as part of an EMP to protect waterbodies within the study area (including pollution by sedimentation and toxins), it is considered very unlikely that the project will impact on Ramsar sites. Appropriate mitigation measures (including appropriate timing of works) should also be developed to protect species listed as “migratory” under the EPBC Act. If this is done, the project is considered unlikely to have a significant impact on migratory species listed under the EPBC Act. Potential habitat occurs within the study area for seven EPBC Act-listed fauna species: Australian Painted Snipe, Red-tailed Black Cockatoo, Superb Parrot, Swift Parrot, Regent Honeyeater, Greater Long-eared Bat and Growling Grass Frog. If appropriate design is adopted, it is considered unlikely that the project will have a significant impact on those species.

Table 3 Assessment of the potential project impacts against MNES and requirement for referral

MNES	Assessment Outcome	Referral Triggered
World Heritage Properties	<i>No world heritage properties exist within the Project area</i>	No
National heritage places	<i>No national heritage places exist within the Project area</i>	No
Ramsar wetland of international importance	<p><i>The PMST nominates seven Ramsar sites as occurring within close proximity to the Project area:</i></p> <ol style="list-style-type: none"> 1. <i>Banrock station wetland complex</i> <i>500 - 600km upstream</i> 2. <i>Barmah forest</i> <i>50 - 100km upstream</i> 3. <i>Gunbower forest</i> <i>150 - 200km upstream</i> 	No

MNES	Assessment Outcome	Referral Triggered
	<p>4. <i>Hattah-kulkyne lakes</i> 300 - 400km upstream</p> <p>5. <i>N SW Central Murray state forests</i> 50 - 100km upstream</p> <p>6. <i>Riverland</i> 500 - 600km upstream</p> <p>7. <i>The Coorong, Lakes Alexandrina and Albert Wetland</i> 500 - 600km upstream</p> <p><i>Due to the small size of the construction footprint and the fact that construction will not occur within any of the listed Ramsar sites, it is considered unlikely that any of these sites will be impacted by the project.</i></p>	
Threatened species and communities	<p><i>Numerous EPBC listed flora has been previously observed within the Lake Moodemere wetland complex. It should be noted that flora surveys of the Project Site did not identify any EPBC listed threatened flora.</i></p> <p><i>With the exception of two migratory bird species (detailed below), no other EPBC listed species has previously been observed at the site. Although this is the case, habitat present at Lake Moodemere is consistent with that shown to support some threatened species. Habitat disturbance will be limited during construction, with disturbance mitigation to be detailed in the EMP.</i></p> <p><i>The vegetation present within the Project Site is already highly disturbed and is not characterised by any threatened ecological communities</i></p>	No
Migratory species	<p><i>Two threatened migratory species (from 10 species predicted to occur) have been recorded at Lake Moodemere. The White-throated Needletail was not recorded within the current construction footprint. The Satin Flycatcher may occur in some woodland within the construction footprint. Mitigation will be implemented to avoid this species, such as scheduling works during not-visiting times and avoidance of preferred habitat.</i></p>	No
Commonwealth marine areas	<i>Not relevant</i>	NA
The Great Barrier Reef Marine Park	<i>Not relevant</i>	NA
Nuclear actions	<i>Not relevant</i>	NA
Water resource (mining)	<i>Not relevant</i>	NA

Notes
 "NA" Not applicable

4.2 State (Victoria)

4.2.1 Environmental Effects Act 1978

The *Environmental Effects Act 1978* (EE Act) provides for the assessment of projects that are capable of having a significant effect on the environment. This enables the Minister for Planning to decide whether an Environmental Effects Statement (EES) should be prepared. This may typically occur when:

- There are likely to be significant adverse effects on the environment,
- Need for integrated assessment (social/economic/ecological), and
- Normal statutory processes would not provide a sufficiently comprehensive assessment

The Ministerial guidelines for assessment of environmental effects under the EE Act provide a range of criteria that can be used to determine whether an EES may be required for a Project. There are two types of referral criteria: (1) individual potential environmental effects; and (2) a combination of potential environmental effects.

A referral under the EE Act would be warranted if this Project were to result in any individual potential environmental effects that might be of regional or state significance (DSE 2006a). Similarly, a referral under the EE Act would be warranted if this project were to result in the combination of two or more listed types of potential effects on the environment that might be of regional or state significance (DSE 2006a). The criteria for assessing the need for a referral under the EE Act is assessed against the potential impacts for the Project and is present in Table 4.

Table 4 Assessment of the potential project impacts against EE Act criteria and requirement for referral

Criteria	Assessment outcome	Triggered
<i>Individual potential environmental effects</i>		
Potential clearing of >10 hectares of native vegetation that is from and endangered ecological vegetation class (EVC) or has high conservation significance.	<i>Impacts to native vegetation will be minimised through detailed alignment planning and environmentally sensitive design. At this point in time the extent of native vegetation removal is not known with any certainty as the detailed design has not been finalised. A key design criterion will be the avoidance of native vegetation where possible, especially large trees.</i>	To be confirmed when detailed design is known
Potential long-term loss of a significant proportion of habitat or population of a threatened species	<i>The reconfiguration of the watering regime at Lake Moodemere is not expected to cause a significant loss of habitat of any threatened species. The wetland ecosystem is likely to transition back to a somewhat natural system consistent with pre-irrigation conditions.</i>	No
Potential long-term change to the ecological character of wetland listed under the Ramsar Convention	<i>Numerous Ramsar listed wetland occur downstream of the site the closest of which is approximately 100km downstream. Due to the small size of the construction footprint and the fact that construction will not occur within any of the listed Ramsar sites,</i>	No

Criteria	Assessment outcome	Triggered
	<i>it is considered unlikely that any of these sites will be impacted by the project.</i>	
Potential extensive or major effect on the health or biodiversity of an aquatic ecosystem on the long term.	<i>The altered hydrological regime proposed as a part of this project will be beneficial to the wetland system of Lake Moodemere. Although there will be an effect, it is considered to be largely positive (especially long-term) by returning the ecosystem dynamics to a more natural cycle (wet/dry cycle, as opposed to prolonged consistent inundation).</i>	No
Potential extensive or major effects on the health or biodiversity of aquatic, estuarine or marine ecosystems, over the long term	<i>Not applicable to this project as the environment is neither estuarine or marine.</i>	NA
<i>A combination of potential environmental effects</i>		
Potential clearing of 10 ha or more of native vegetation, unless authorised under an approved Forest Management Plan or Fire Protection Plan	<i>Impacts to native vegetation will be minimised through detailed alignment planning and environmentally sensitive design. At this point in time the extent of native vegetation removal is not known with any certainty as the detailed design has not been finalised. A key design criterion will be the avoidance of native vegetation where possible, especially large trees.</i>	To be confirmed when detailed design is known
Matters listed under the Flora and Fauna Guarantee Act 1988: – Potential loss of a significant area of a listed ecological community; or – Potential loss of a genetically important population of an endangered or threatened species (listed or nominated for listing), including as a result of loss or fragmentation of habitats; or – Potential loss of critical habitat.	<i>The reconfiguration of the watering regime at Lake Moodemere is not expected to cause a significant loss of habitat of any threatened species. The wetland ecosystem is likely to transition back to a somewhat natural system consistent with pre-irrigation conditions. Although there may be some modification to habitat, there is not expected to be a loss of any critical habitat.</i>	No
Potential extensive or major effects on land stability, acid sulphate soils or highly erodible soils over the short or long term	<i>The construction phase of the project will be conducted in accordance with a project specific approved environmental management plan (EMP). Acid sulphate soil risks at the site have already been assessed and appropriate measure will be incorporated to protect environmental values and structure integrity from potential effects. Short and long-term effects of erosion and sedimentation will be mitigated through appropriate design controls and careful implementation in accordance with the EMP during the construction phase.</i>	No

Criteria	Assessment outcome	Triggered
Potential extensive or major effects on beneficial uses of waterbodies over the long term due to changes in water quality, stream-flows or regional groundwater levels	<i>The proposed development will result in an improvement in water quality both in Lake Moodemere and Sunday Creek. Stream flows and groundwater will not be impacted.</i>	No
Potential extensive or major effects on Aboriginal cultural heritage	<i>A standard and complex aboriginal cultural heritage assessment was undertaken at the site in 2010. No cultural heritage was identified. An approved registered CHMP will be developed specifically for the project and be in place for the construction phase of the project.</i>	Not anticipated given results thus far
Potential extensive or major effects on cultural heritage places listed on the Heritage Register or the Archaeological Inventory under the Heritage Act 1995.	<i>No aboriginal places were identified within the construction footprint for the Project. Twenty-four Aboriginal places (including 23 scarred trees, and 1 artefact scatter) have been identified within 20km of the Project site. These sites will not be impacted by the Project. A contingency plan (as a part of the CHMP) will be implemented in the case of unexpected finds.</i>	No

4.2.2 Flora and Fauna Guarantee Act 1988

Proponents are required to apply for an FFG Permit to “take” protected flora species, vegetation communities and fish species in areas of public land. Numerous threatened flora and fauna species are confirmed to exist at the project site. No threatened flora or fauna are required to be removed or destroyed as a part of this project. If in the event that the situation does arise where this is required, GMW Connections Project has an FFG Act Permit to Take/Keep Protected Flora (Permit no. 10008646), Additionally, threatened fish such as Murray Cod may require translocation to an area close by where works are not being carried out. In this instance, GMW Connections Project has an FFG Act Permit to Take Fish (permit no. 10008645) in place that is relevant to this project.

4.2.3 Planning and Environment Act 1987

The Planning and Environment Act 1987 (P&E Act) provides control over the removal of native vegetation. The Indigo Shire planning scheme contains the native vegetation planning provisions in Clause 52.17. A planning permit to remove or lop native vegetation or disturb the tree protection zone (TPZ) of native trees is required at the pipeline, and Hells Gate track and regulator sites, as native vegetation may require removal as a result of the construction, and there is unlikely to be an exemption under the Act.

4.2.4 **Wildlife Act 1975 and Wildlife Regulations 2013**

The *Wildlife Act 1975* (and associated Wildlife Regulations 2013) is the primary legislative instrument in Victoria providing for the protection and management of wildlife. Any persons engaged in the removal, salvage or relocation of native fauna during the project must hold a current Management Authorisation under the *Wildlife Act 1975* issued by DELWP. GMW Connections Project has a Management Authorisation Permit No. 10008647.

4.2.5 **Fisheries Act 1995**

The *Fisheries Act 1995* provides a framework for the regulation, management, development and conservation of Victorian fishes, aquatic habitats and ecosystems and associated aquatic biological resources. FFG listed fish are also protected under the *Fisheries Act 1995* and may not be taken without authorisation.

Construction works may require the dewatering of some sections of the system to allow adequate access. A Fish Liberation permit issued by Fisheries is required to remove and relocate fish. GMW Connections Project currently hold relevant permit (permit No. FL134).

4.2.6 **Environment Protection Act 1970**

The *Environment Protection Act 1970* is the principal Victorian statute dealing with the protection of the environment from pollution and the management of wastes. It provides a framework for developing, implementing and enforcing State Environmental Protection policies (SEPPs). No approvals are specifically required although mitigation measures for environmental protection should be implemented through an environmental management plan (EMP) for the project.

4.2.7 **Catchment and Land Protection Act 1994**

The *Catchment and Land Protection Act 1994* (CLP Act) contains provisions relating to catchment management planning, land management, noxious weeds and pest animals.

No approvals are specifically required although mitigation measures for land protections, particularly weed management, should be implemented through an environmental management plan (EMP) for the project.

4.2.8 **Aboriginal Cultural Heritage Act 2006 and Aboriginal Heritage Regulations 2007**

An approved Cultural Heritage Management Plan (CHMP) will be required for this project

Under the *Aboriginal Heritage Act 2006* (the Act), a CHMP is required if the proposed activity is specified in the *Aboriginal Heritage Regulations 2007* (the Regulations) as a high impact activity, and the activity area (or part thereof) is specified as an area of cultural heritage sensitivity.

Under the Regulations, a utility installation where the works are a linear project with a length exceeding 100m (r.43(1)(b)(xxiii)(C)), and the works affect an area exceeding 25 square meters (r.43(1)(b)(xxiii)(D)) are identified as high impact activities. The scope of works planned for this project will include works that constitutes “high impact”. The project site is located in an area of cultural heritage sensitivity pursuant to the Regulations, as it is located within 200m of a waterway (Murray River) and within 200m of a prior waterway (r.23 and r.24 respectively). Therefore, a CHMP is mandatory under s.76 of the Act.

A CHMP has largely been completed for the project site in 2011, although it is not approved, detailed further in Section 5.5. A new updated CHMP is required to be submitted to Aboriginal Victoria.

5 ENVIRONMENTAL VALUES

5.1 Terrestrial Environments

A detailed terrestrial ecological assessment of the Project site was undertaken by GHD (2009) to describe the flora and fauna features present within the Project area and the potential ecological impacts due to the project. Flora and fauna surveys were undertaken in July 2009.

In addition to the GHD (2009) report, a flora and fauna values assessment for Lake Moodemere (Australian Ecosystems 2011) has also been undertaken. This report was commissioned by the North East Catchment Management Authority to inform the Lake Moodemere Environmental Watering Plan implementation. This report was undertaken independently of the GHD report and is not specific to the proposed project impact footprint. The survey area generally encompasses the wider Lake Moodemere/Sunday Creek wetland complex. The survey area is not inclusive of the portion of the impact footprint for the pipeline and pump station. This report does provide very useful information for Lake Moodemere and surrounding areas that may be indirectly impacted by the project. A review of the two key reports has also been undertaken with the key information relevant to the context of this impact assessment presented below.

5.1.1 Ecological Vegetation Classes

Ecological Vegetation Classes (EVCs) mapping is derived from the grouping of vegetation communities based on their floristic, structural and ecological functions. Mapping the communities provides for an overview of the vegetation composition of a particular portion of the landscape, with additional benefits of understanding the conservational status of vegetation communities. EVCs have been mapped across Victoria by DELWP and are derived mainly through interpretation of aerial photos and modeled data. For Lake Moodemere and Sunday Creek, Australian Ecosystems (2011) has undertaken site specific field-based mapping of the vegetation and provides a revised EVC map. The revised EVC map differs significantly from the EVC mapping provided by DELWP's Nature Kit (DELWP 2017). EVCs observed by Australian Ecosystems (2011) are presented in Table 9. EVCs are spatially presented in Figure 3. It should be noted that the EVC map produced by Australian Ecosystems does not cover the entire construction footprint proposed as a part of this project. EVC interpretation undertaken by GHD for the construction footprint confirms that it is unlikely that any additional EVCs are present in the unmapped areas along the northern end of Sunday Creek and along Hyde Road, north to the Murray River.

Table 5 EVCs observed from site specific field mapping at Lake Moodemere (Australian Ecosystems 2011)

EVC no.	EVC name	Bioregional conservation status	DELWP (2005 data)	Australian Ecosystems 2011	Overlaps with construction footprint
56	Floodplain riparian woodland	Vulnerable	✓	✓	✓
804	Rushy riverine swamp	Depleted		✓	
168	Drainage-line Aggregate		✓		
172	Floodplain Wetland Aggregate		✓		

EVC no.	EVC name	Bioregional conservation status	DELWP (2005 data)	Australian Ecosystems 2011	Overlaps with construction footprint
945	Floodway pond herbland / Riverine swamp forest complex	Depleted		✓	
821	Tall marsh	Depleted		✓	
814	Riverine Swamp Forest	Vulnerable	✓		
815	Riverine swampy woodland	Vulnerable	✓	✓	
653	Aquatic herbland	Depleted		✓	
106	Grassy riverine forest	Depleted		✓	
816	Sedgy riverine forest	Vulnerable	✓	✓	
810	Floodway pond herbland	Vulnerable		✓	
803	Plains woodland	Endangered	✓	✓	✓
295	Riverine grassy woodland	Vulnerable	✓	✓	✓
1087	Tall Marsh / Aquatic Herbland Mosaic	Vulnerable	✓		

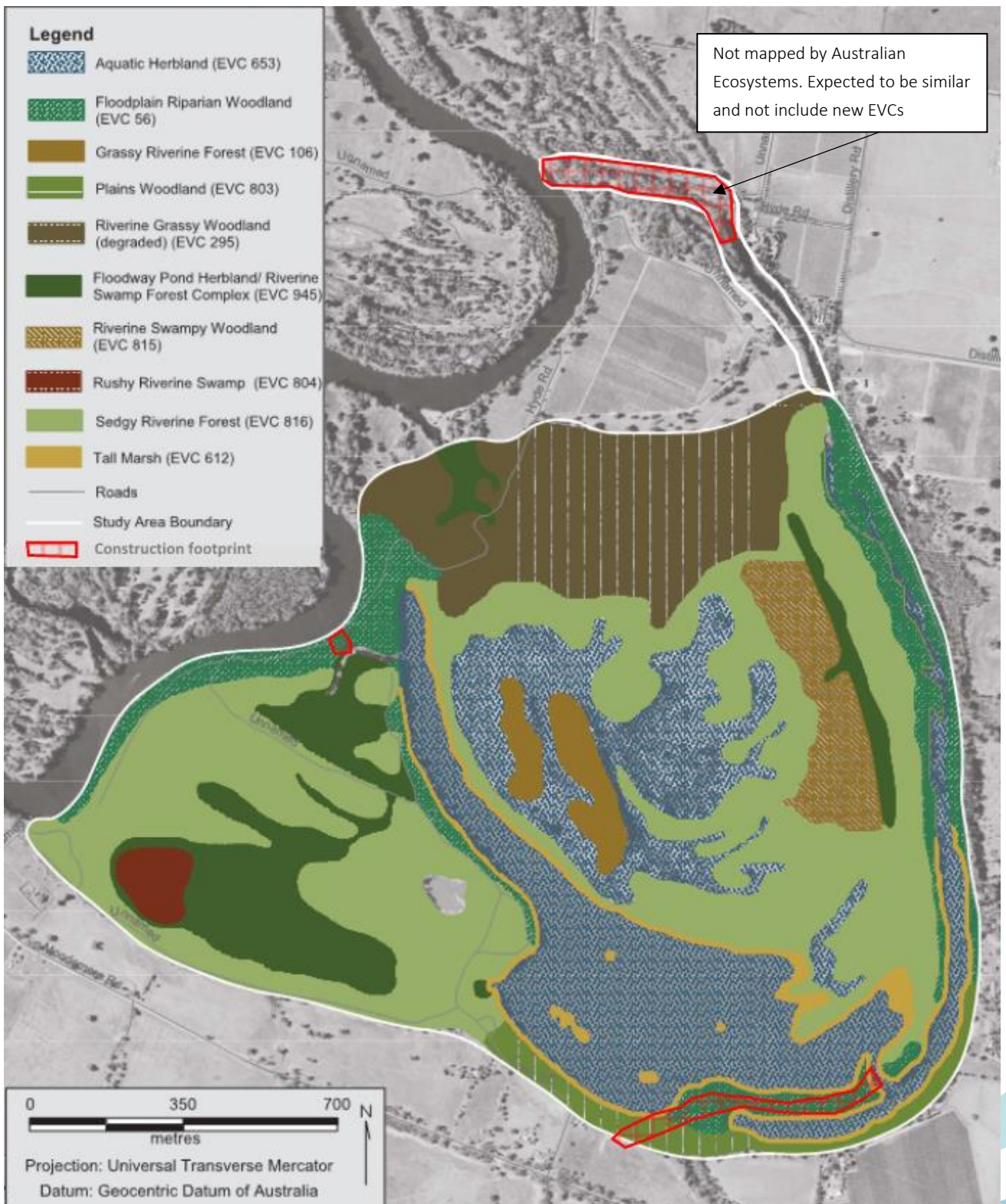


Figure 3 Spatial representation of EVCs at Lake Moodemere (modified from Australian Ecosystems 2011)

5.1.2 Vegetation communities of conservation significance

The EPBC Act Protected Matters Search Tool (PMST) identified five nationally threatened ecological communities as likely to occur within 10km of the site. These are:

- Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions (listed as Endangered, and considered possible to occur in the study area),
- Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasses of South-eastern Australia (listed as Endangered and likely to occur within the area)
- Weeping Myall Woodlands (listed as Endangered, and considered possible to occur in the study area),
- Natural Grasslands of the Murray Valley Plains (listed as Critically Endangered, and considered possible to occur in the study area), and
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (listed as Critically Endangered and considered likely to occur in the study area).

Field surveys undertaken by GHD 2010 did not identify ecological communities: Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions, Weeping Myall Woodlands and White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native. At the time of their assessment EPBC threatened ecological communities: Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasses of South-eastern Australia, and Natural Grasslands of the Murray Valley Plains were not listed during the PMST search. Therefore, at this stage it is unconfirmed as to whether these communities exist at the site. EVC 803 Plains Woodland is dominated by Grey Box trees and highly indicative of threatened ecological community Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasses of South-eastern Australia and is mapped extensively towards the southern end of Lake Moodemere, in the vicinity of the construction footprint (access track to Hells Gate). Therefore, it is possible that EPBC listed ecological community Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasses of South-eastern Australia may be present at the site.

EVC mapping provided by Australian Ecosystems (2011) does not identify any grassland EVCs. EPBC listed "Natural Grasslands of the Murray Valley" is characterised by a dominance of perennial tussocks grasses with a lack of woody plants. Trees and shrubs are generally sparse, amounting less than 10% of projected foliage cover (TSSC 2012). The portion of the site located to the north of Lake Moodemere has not been surveyed, however it does not appear to have open grasslands (based on aerial imagery interpretation and DELWP EVC mapping). It is therefore considered that it is unlikely that EPBC threatened ecological community Natural Grasslands of the Murray Valley is present at the site.

5.1.3 Flora species of conservation significance

The flora survey undertaken for the Lake Moodemere / Sunday Creek wetland complex by Australian Ecosystems (2011) identified 278 vascular plant species with 169 indigenous species.

The EPBC Act PMST and the Victorian Biodiversity Atlas (VBA) provides a list of threatened species either confirmed, or as potentially present at the site. Table 6 provides a summary of the likelihood of encountering

threatened species within the construction footprint. The likelihood of occurrence is based on the survey works of GHD (2010) and Australian Ecosystems (2011).

Table 6 EPBC and FFG listed threatened flora for Lake Moodemere and Sunday Creek

Common name	Scientific name	Status	Likelihood of occurrence within construction footprint
River Swamp Wallaby-grass	<i>Amphibromus fluitans</i>	EPBC- vulnerable	Possible. Not observed within the construction footprint. It was observed by Australian Ecosystems and is associated with EVC 653 and EVC 945. Australian Ecosystems maps Sunday Creek as EVC 653. The GHD survey reports that the significant degraded nature of Sunday Creek is unlikely to support this species.
Mueller Daisy	<i>Brachyscome muelleroides</i>	EPBC- vulnerable FFG listed	Unlikely. Considered extremely rare. Has not been observed at the site.
Tricolour Diuris	<i>Diuris sheaffiana</i>	EPBC- vulnerable	Unlikely. Never been observed at the site. Extremely rare, only one plant ever recorded in Victoria. Unlikely to occur
Greencomb Spider-orchid	<i>Caladenia tensa</i>	EPBC - Endangered	Unlikely. Not observed at site. Unlikely to occur, not suitable habitat.
Turnip Copperburr	<i>Sclerolaena napiformis</i>	EPBC - Endangered	Unlikely. Not observed at the site. Unlikely to be present at the site
Small Purple-Pea	<i>Swainsona recta</i>	EPBC - Endangered	Unlikely. Not observed at the site. Unlikely to be present at the site, non-suitable habitat
Watershield	<i>Brasenia schreberi</i>	FFG listed	Possible. Present in Lake Moodemere. Not observed within the construction footprint. Species prefers permanent submersion.
Buloke	<i>Allocasuarina luehmannii</i>	FFG listed	Possible. Not observed within the construction footprint. May occur elsewhere around Lake Moodemere in association with Grey Box (<i>Eucalyptus macrocarpa</i>). Was observed by Australian Ecosystems around Lake Moodemere.

5.1.4 Threatened fauna

5.1.4.1 Birds

The Victorian Fauna Database (VFD) (as cited in Australian Ecosystems 2011) lists 133 bird species recorded at Lake Moodemere, 33 of which are considered wetland species. In the field survey undertaken by Australian Ecosystems (2011), 73 bird species were confirmed. It should be noted that the survey was undertaken in late July, and thus some bird species (particularly migratory species) may not have been recorded due to seasonal limitations. A total of 32 bird species are listed under the FFG Act or threatened under the EPBC Act as either predicted to occur at the site or have previously been recorded. Of these, 13 are considered to be migratory species. Some threatened bird species have been recorded at the site previously. Likelihood of occurrence at the site is detailed in Table 7 and

Table 8. Likelihood of occurrence should be considered when developing the environmental management plan.

Table 7 Threatened terrestrial and wetland birds recorded or predicted to possibly occur at the site (Source EPBC Act PMST, GHD (2010) Australian Ecosystems (2011))

Common name	Scientific name	Status	Likelihood of occurrence
Australian Painted Snipe	<i>Rostratula australis</i>	EPBC – Vulnerable FFG Act – Listed	Not recorded at the site. Unlikely, although possible
Australian Bittern	<i>Botaurus poiciloptilus</i>	EPBC – Endangered	Not recorded at the site. Possible
Curlew Sandpiper	<i>Calidris ferruginea</i>	EPBC – Critically Endangered	Not recorded at the site. Possible
Painted Honeyeater	<i>Grantiella picta</i>	EPBC – Vulnerable	Not recorded at the site. Unlikely unsuitable habitat, prefers Myall, Brigalow and Box-gum woodlands
Plains Wanderer	<i>Pedionomus torquatus</i>	EPBC – Critically Endangered	Not recorded at the site. Unlikely, unsuitable habitat
Brolga	<i>Grus rubicunda</i>	FFG Act – Listed	Not recorded at the site. Possible
Intermediate Egret	<i>Ardea intermedia</i>	FFG Act – Listed	Not recorded at the site.
Eastern Great Egret	<i>Ardea modesta</i>	FFG Act – Listed	Possible - Recorded at site
Freckled Duck	<i>Stictonetta naevosa</i>	FFG Act – Listed	Possible - Recorded at site
Blue-billed Duck	<i>Oxyura australis</i>	FFG Act – Listed	Possible - Recorded at site
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	FFG Act – Listed	Possible - Recorded at site
Barking Owl	<i>Ninox connivens</i>	FFG Act – Listed	Possible - Recorded at site
Red-tailed Black-Cockatoo	<i>Calyptorhynchus banksi graptogyne</i>	EPBC – Endangered FFG Act – Listed	Not recorded at the site. Possible
Superb Parrot	<i>Polytelis swainsonii</i>	EPBC – Vulnerable FFG Act – Listed	Not recorded at the site. Possible
Turquoise Parrot	<i>Neophema pulchella</i>	FFG Act – Listed	Not recorded at the site. Possible
Swift Parrot	<i>Lathamus discolor</i>	EPBC – Vulnerable FFG Act – Listed	Not recorded at the site. Unlikely, unsuitable habitat
Hooded Robin	<i>Melanodryas cucullata</i>	FFG Act – Listed	Possible - Recorded at site
Grey-crowned Babbler	<i>Pomatostomus temporalis</i>	FFG Act – Listed	Not recorded at the site. Unlikely
Speckled Warbler	<i>Pyrrholaemus saggitatus</i>	FFG Act – Listed	Not recorded at the site. Unlikely, unsuitable habitat
Regent Honeyeater	<i>Anthochaera phrygia</i>	EPBC – Vulnerable FFG Act – Listed	Not recorded at the site. Unlikely
Diamond Firetail	<i>Stagonopleura guttata</i>	FFG Act – Listed	Possible - Recorded at site

Table 8 Threatened Migratory birds recorded or predicted to possibly occur at the site (Source EPBC Act PMST, GHD (2010) Australian Ecosystems (2011))

Common name	Scientific name	Status	Likelihood of occurrence
Fork-tailed Swift	<i>Apus pacificus</i>	EPBC – Threatened	Not recorded at the site.

White-throated Needletail	<i>Hirundapus caudacutus</i>	EPBC – Threatened	Possible - Recorded at site
Yellow Wagtail	<i>Motacilla flava</i>	EPBC – Threatened	Not recorded at the site.
Satin Flycatcher	<i>Myiagra cyanoleuca</i>	EPBC – Threatened	Possible - Recorded at site
Common Sandpiper	<i>Actitis hypoleucos</i>	EPBC – Threatened	Not recorded at the site.
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	EPBC – Threatened	Not recorded at the site.
Pectoral Sandpiper	<i>Calidris melanotos</i>	EPBC – Threatened	Not recorded at the site.
Latham’s Snipe	<i>Gallinago hardwickii</i>	EPBC – Threatened	Not recorded at the site.
Eastern Curlew	<i>Numenius madagascariensis</i>	EPBC – Critically Endangered	Not recorded at the site.
Common Greenshank	<i>Tringa nebularia</i>	EPBC – Threatened	Not recorded at the site.

5.2 Aquatic Environments

5.2.1 Description

Previous works undertaken to characterise the aquatic environment is limited, however Richardson and Stoffels (2011a; 2011b) investigated the biodiversity of vertebrate species for the preparation of the Lake Moodemere Environmental Watering Plan. Their investigation included surveys conducted across the summer months of 2010, and the winter months of 2011.

The aquatic environments as assessed in this report represent permanent bodies of water: Lake Moodemere and Sunday Creek. The wetland marshes to the north-east of the Lake are considered terrestrial as generally this environment remains not inundated. This portion of the study is very important in an ecological context and is captured in Section 5.1.

Lake Moodemere

Lake Moodemere is a permanent water body covering an approximate area of 62 hectares. The body of water has a long narrow “finger” extending to the north where inflows are generally received from the Murray River, and a small protrusion at the eastern end where Hells Gate connects with Sunday Creek. When in flood or with raised water levels for irrigation purposes, the Lake extends to the east into the wetland marshes inundating a further 25 to 30 hectares. The southern side of the Lake is characterised by tall fringing rushes overarched by large River Red Gums. On the northern side of the Lake, banks are also lined with tall rushes, with a small section of sedgy forest separating the Lake from the aquatic herb land marshes. Maximum depth in the Lake is approximately 2.2m (Water Technology 2012). Substrate is variable, consisting of silt in some sections to areas of concentrated organic matter. Water quality is considered to be very good.

Sunday Creek

Sunday Creek is a narrow waterbody approximately 3.5km long. Towards the southern end, the creek is widest between 20 – 80m, with depths to 2m, which extends approximately 1.5km to the north. Immediately past this point the creek narrows to 5m and less than 1m in depth. Beyond this relatively short section, Sunday Creek

again opens up to form a channel of 10-20m in width to its termination point just south of Hyde Road. Sunday Creek is characterised by a high variability of in-stream woody debris, and littoral macrophytes. Large river red gums line both banks and provide significant shading in many sections. Water quality in the Creek is poorer than in Lake Moodemere with higher temperature and low dissolved oxygen (especially in the northern portions of the reach where anoxic conditions have been reported).

5.2.2 Values

Richardson and Stoffels (2011a) surmise from the results of their investigations compared to other investigations undertaken regionally (Balcombe and Closs 2004 and Beesley *et al* 2011), that although information is relatively limited for wetland complexes between Lake Hume and Mulwala, aquatic vertebrate biodiversity observed in the Lake Moodemere-Sunday Creek wetland complex is likely to be equally, if not more diverse than other surrounding wetlands.

The PMST search (conducted 10 December 2017) predicts the occurrence of three species of threatened fish: Flathead Galaxias (*Galaxias rostratus*), Murray Cod (*Maccullochella peelii*) and Macquarie Perch (*Macquaria australasica*). Aquatic vertebrate surveys undertaken by Richardson and Stoffels did not observe these species. Surveys did however identify numerous FFG Act species. Table 9 presents the aquatic vertebrate fauna species observed during their investigations.

Previously, Freshwater Catfish (*Tandanus tandanus*), a FFG Act listed fish had been reported to exist in the system based on anecdotal evidence. No Freshwater Catfish were observed during the aquatic surveys. Eight native species of vertebrate fauna were observed during the investigation including:

- Three turtles;
- One large body fish (Golden Perch); and
- Four small bodied fish.

Of the eight species recorded, Broad shelled turtle, and the Flyspecked hardy head are listed as threatened under the FFG Act.

Table 9 Aquatic vertebrate species recorded for Lake Moodemere / Sunday Creek (from Richardson and Stoffels (2011b))

Species		Threatened Status	Lake Moodemere	Sunday Creek
Turtles				
Broad shelled Turtle	<i>Chelodina expansa</i>	FFG Act listed	✓	✓
Eastern long-necked Turtle	<i>Chelodina longicollis</i>	-	✓	
Murray River Turtle	<i>Emydura macquarii</i>	-	✓	
Native Fish				
Golden Perch	<i>Macquarie ambigua</i>	-	✓	✓
Australian Smelt	<i>Retropinna semoni</i>	-	✓	✓
Flyspecked Hardyhead	<i>Craterocephalus stercusmuscarum fulvus</i>	FFG Act listed	✓	✓

Species		Threatened Status	Lake Moodemere	Sunday Creek
Flathead Gudgeon	<i>Philypnodon grandiceps</i>	-	✓	
Carp Gudgeon	<i>Hypseleotris</i> spp.	-	✓	✓
Nom-native fish				
Goldfish	<i>Carassius auratus</i>	-	✓	✓
Common carp	<i>Cyprinus carpio</i>	-	✓	✓
Redfin	<i>Perca fluviatilis</i>	-	✓	✓
Oriental Weatherloach	<i>Misgurnus anguillicaudatus</i>	-	✓	
Eastern Gambusia	<i>Gambusia holbrooki</i>	-	✓	✓

Richardson and Stoffels reported a much higher catch per unit effort of non-native fish in Sunday Creek, inferring that the poor quality water was likely to be benefiting species like carp and gold fish, inhibiting colonisation of native species.

Due the limited availability of scientific data for these types of wetland systems along the upper Murray, the impacts risks and benefits of an alteration to the Lake Moodemere hydrology are largely speculative. Richardson and Stoffels suggest that the risks and benefits can be viewed separately as the new arrangement will see independence between the Lake Moodemere and Sunday Creek.

The proposed alteration in Lake Moodemere which will generally see a gradual decrease in lake levels following the initial fill at the beginning of summer. The greater ephemerality may be at the detriment of the regionally-rare Broad Shell turtle (also FFG Act listed), and the Murray River turtle which are associated with more permeant wetlands. Additionally, the giant Juncus (*Juncus ingens*) beds present around the lake, particularly along the northern margins may be an important breeding habitat for the threatened Flyspecked Hardyhead. A loss of decline in the Juncus could be detrimental to the species. A positive effect on exotic species currently in Lake Moodemere should also be viewed as an impact risk. Ideal condition produced during the summer as a result of retreating water levels and water quality reduces, is likely to benefit species such as carp, gold fish and eastern gambusia.

Conversely, as alluded to earlier in this report, some significant benefit may also be achieved, by returning the wetland to a more natural wet/dry cycle. The long-necked turtle is generally associated with ephemeral wetlands, and so will benefit from increased ephemerality. Richardson and Stoffels (2011b) indicate that with the exception to the Murray River turtle, all other vertebrate species recorded are likely to have some degree of benefit of a return to a more natural cycle. Further to this, it is also likely to increase the diversity of submerged and floating macrophytes which may encourage the colonisation of other important fish species such as Southern pygmy perch and Flat-headed galaxias not currently found in the complex. This will, however, only occur if these species are found in other wetlands close by.

The primary risks associated with a change in local hydrology of Sunday Creek includes fragmentation of the wetland complex (via construction of the concrete sill at Hells Gate) which may result in a decline in fish diversity, by hampering population recovery effort following local disturbances, additionally, given the adapted

nature of Sunday creek to slight warmer water temperatures, direct pumping of water into the creek at the northern end, may increase the threat of cold-water pollution during summer impacting fish and turtles. However, this is also likely to have a positive effect too, where the introduction of better quality water is likely to have the ability to improve and restore the overall water quality of Sunday Creek. In turn this may reduce the abundance of noxious pest fish that can tolerate poorer conditions, while increasing the abundance of native species. Furthermore, this will create a more stable habitat, suitable for the re-introduction of rare species such as the freshwater catfish.

5.3 Frogs

A review of the Atlas of Victorian Wildlife (undertaken by GHD 2010) indicated that eight species of frog have been observed within a 10km radius of the site. Field surveys conducted by GHD in spring of 2009, Australian Ecosystems in winter 2010, and Jacobs in summer 2017 confirmed the presence of six frog species, presented below in Table 10.

Table 10 Frogs previously observed at Lake Moodemere

Common name	Scientific name
Common Froglet	<i>Crinia signifera</i>
Plains Froglet	<i>Crinia parinsignifera</i>
Peron’s Tree Frog	<i>Litoria peronii</i>
Sloans Froglet	<i>Crinia sloanii</i>
Spotted Marsh Frog	<i>Limnodynastes tasmaniensis</i>
Pobblebonk	<i>Limnodynastes dumerilii</i>

The EPBC Act PMST predicts that the Growling Grass Frog may occur at Lake Moodemere. Extensive surveys undertaken by Jacobs in December 2017 did not find this species present at the site. It is therefore concluded that it is not present at the Project Site.

5.4 Acid Sulphate Soils

The Project site is located within a mapped area of elevated acid sulphate soils (ASS) risk. ASS is the name given to soils material affected by iron sulfide minerals. The soils may contain either sulphuric acid or have the potential to form sulfuric acid under certain exposure conditions. Although ASS is commonly associated with the coastal/marine environment, elevated risk of ASS is recognised for many inland situations. ASS can occur in a wide range of waterlogged/anaerobic and/or drained environments including rivers and streams, lakes, wetlands, floodplains, billabongs and marshes (Fitzpatrick and Shand 2008). For construction projects such the subject of this report, the primary concern is when soils with elevated risk of ASS are excavated and become exposed to oxygen. Whilst *in situ*, ASS may have little to no effect on the surrounding environment if left undisturbed (Fitzpatrick and Shand 2008). Exposure of ASS to the open environment or reducing the water table below the affected soil zone (via dewatering or draining) allows oxygen to mix with the soil material. Oxygen in the soil profile will oxidise sulfide minerals (particularly pyrite, which is typical of these environments) producing sulphates and iron oxyhydroxide minerals. In the presence of water this may convert to sulphuric acid, compounded also by the release of hydrogen (from iron oxide), which causes further acidification. ASS has the

potential to pollute agricultural land and water sources, with flow-on effects of released heavy metals, and increased soil and water acidity. Potential impacts of ASS pollution at the site is discussed further in Section 7.

5.4.1 Works completed to date

An acid sulphate soils (ASS) investigation has been undertaken for the Project site by GHD (GHD 2010). The investigation focused on assessing the key areas of the project where ground excavation will occur. This included the impact areas around the pipeline and Hells Gate. A review of the impact footprint assessed as a part of the ASS investigation identifies a potential gap in information as the full extent of the pipeline alignment has not been assessed (mainly the section from where the alignment leaves Hyde Road and diverts south towards Sunday Creek).

The results of the ASS assessment for the site determined the following:

- Analytical testing of the chemical properties of the soils located in the vicinity of the proposed pipeline indicated a moderate risk for acid generation potential. This risk was downgraded to low on the basis that the water table in the area was well below the proposed excavation depth.
- Analytical testing of the chemical properties of the soils located in the vicinity of Hells Gate indicated a high risk for acid generation potential. This high-risk level was considered to be an actual risk considering the saturated soil conditions encountered at the site at the time of sampling.
- It was recommended that ASS will need to be appropriately managed through adoption of suitable environmental management controls and ASS management principles incorporation of into the design of the Hells Gate structure

5.5 Cultural Heritage

A cultural heritage assessment for the Project area was undertaken in 2010 by Terraculture (commissioned through GHD) (Terraculture 2010). The assessment undertaken was a part of the development of a Cultural Heritage Management Plan (CHMP) for the proposed Lake Moodemere reconfiguration. Unfortunately, as the project never progressed past the early planning stage, the CHMP, although completed to the point of final review, was not submitted for department approval. As such, the CHMP Notice of Intent to Prepare a CHMP (NOI) registration ID (#11001) was discontinued effectively cancelling the NOI. Nevertheless, the cultural heritage assessment provides valuable information for the planning context for this Project. It should be noted that the scope of works detailed in the previously completed cultural heritage assessment is insufficient for the full proposed scope, as characterised in this report. TerraCulture’s assessment focuses on the new pump station site, a partial footprint of the pipeline alignment (does not include the full proposed length and outfall area at Sunday Creek, and Hells Gate regulator and the access track into Hells Gate. The site-specific construction footprint detailed in the cultural assessment will need to be checked against the project concept design currently adopted to ensure that the full impact footprint is captured. This is also relevant where additional components of the project scope have been subsequently added since 2010 (such as the Lake Moodemere regulator removal/replacement). The results of the assessment a summarised below:

- No Aboriginal places are recorded within the project.

- Twenty-four Aboriginal sites are located within a 20km radius of the Project site, including 23 scarred trees and one stone artefact scatter. This is considered to be a low density of sites and is likely reflective of the limited works that has been undertaken in the area.
- A standard assessment was undertaken and heavily restricted by poor ground surface visibility. No Aboriginal cultural heritage was identified. The assessment concluded that no further works need occur in the vicinity of Hells Gate or the Hells Gate access track. A complex assessment was warranted for the Pump station/pipeline impact area.
- The complex assessment targeted discrete landforms within the work area. Test pits were excavated and were found to be either sterile or containing materials not relevant to Aboriginal cultural heritage.
- The assessment concluded that no Aboriginal cultural heritage was identified at the site and no areas of potential sensitivity were identified.

5.5.1 Further works required

As a part of the environmental planning due diligence for this project, the unapproved CHMP previously developed for the project will formulate the basis for a new CHMP required for a planning application. The 2010 TerraCulture CHMP is likely to be out of date in terms of recent legislative amendments, and desktop review information (as well as scope and impact footprint detail). The revised CHMP will capture the updated information.

6 POTENTIAL BENEFITS AND IMPACTS OF THE PROJECT

This section seeks to outline the potential impacts of the construction phase of the project and also qualify the potential impacts and benefits of an altered hydrological regime of the system, resultant of the reconfiguration.

The Lake Moodemere system is a regionally significant wetland complex in a highly regulated stretch of the Murray River. The hydrological regime of the Lake and surrounding features is modified from natural conditions due to the regulation of flows from the Murray River into the Lake for irrigation use. This project provides an opportunity to return the Lake and surrounding floodplain to a more natural wet/dry cycle, typical of conditions experienced prior to modification. The proposal to operate Sunday Creek independently of Lake Moodemere provides an opportunity to manage the watering requirements of the Lake with a more tailored focus on enhancing environmental values. The project proposes a number of man-made infrastructure components that need to be constructed to permit the reconfiguration plan to effectively operate. Potential impacts to the environment from the construction phase of the project needs to be appropriately managed to reduce the risks of harm to the environment. Additionally, post construction, management of both Lake Moodemere and Sunday creek, as effectively independent systems needs also to be managed effectively in terms of water requirements to achieve net benefits to all stake holders with minimal negative effects.

6.1 Potential Impacts from construction activities

An Environmental Management Plan (EMP) will need to be developed for the Project. The EMP will outline the types of construction activities and qualify the potential impacts to the surrounding environment associated with the construction activities. The EMP will detail necessary mitigation to eliminate or reduce the risk for environmental harm. In the absence of such mitigation measures, the proposed development may have a range of impacts to environmental values at the Project site. The extent to which the impact may have to site values is dependent on construction techniques, appropriate detailed design (e.g. avoidance of trees) and the application of mitigative measures. A summary of impacts potentially occurring due to construction activities is provided below in Table 11.

Table 11 Potential impacts to site values from construction

Potential Impact	Relevant infrastructure			
	Pipeline	Hells Gate Regulator	Hells Gate Track	Lake Moodemere Regulator
Loss of native vegetation	✓	✓	✓	✓
Loss of habitat for threatened species	✓	✓	✓	✓
Loss of hollow-bearing trees	✓		✓	✓
Damage to trees from branch lopping	✓	✓	✓	✓
Damage to tree root zones from pipeline trenching	✓	✓	✓	✓
Prevention of fish passage between Lake Moodemere and Sunday Creek		✓		
Habitat fragmentation	✓	✓	✓	✓

Potential Impact	Relevant infrastructure			
	Pipeline	Hells Gate Regulator	Hells Gate Track	Lake Moodemere Regulator
Compaction of ground beneath trees	✓	✓	✓	✓
Loss of aquatic woody debris	✓			
Disturbance to native wildlife	✓	✓	✓	✓
Direct mortality of native wild life	✓	✓	✓	✓
Erosion and Sediment run-off	✓	✓	✓	✓
Introduction of aquatic weeds	✓	✓		✓
Introduction terrestrial weeds	✓	✓	✓	✓
Loss of coarse woody debris through ground clearing	✓		✓	✓
Harm to cultural heritage	✓	✓	✓	✓
Input of toxic substances to waterways and ground (oils, fuels, etc)	✓	✓	✓	✓
Interception of acid sulphate soils			✓	

Source: adapted from GHD (2010)

6.2 Benefits and Impacts from an altered hydrological regime

The key departures from a natural regime are a reduction in winter/spring overbank flooding of the higher portions of the floodplain, and the retention of high water levels through the summer/autumn period, when water levels would naturally draw-down. Although restoration of winter/spring flooding closer to the natural regime would be of benefit, this is and will continue to be rarely achieved (at least under natural conditions) due to the regulated flow regime of the Murray River. As mentioned earlier, the proposed implantation of new regulating structure, as a part of the reconfiguration, will distinguish a separation of Lake Moodemere from Sunday Creek. While little to no draw-down will be experienced in Sunday Creek, subject to social and economic factors, draw-down in Lake Moodemere will take place.

Table 12 Summary of potential Risks and benefits of restoring natural seasonality in the Lake Moodemere System

System Component	Benefits	Risks
Lake Moodemere	<ul style="list-style-type: none"> An increase in diversity of vegetation communities around the fringes of Lake Moodemere specifically in the northern marshes, contributing to: <ul style="list-style-type: none"> opportunities for regeneration of threatened and uncommon vegetation types currently present but not prevalent, Greater diversity of vegetation lifeforms, favouring fauna currently absent (i.e. Southern Pygmy Perch because of their association with wetlands with diverse lifeform), 	<ul style="list-style-type: none"> There may be a reduction in the extent of emergent aquatic vegetation, depending on response times for regeneration of vegetation within the ephemerally wetted zone. There may be an increase in the extent and quantity of <i>Juncus ingens</i> beds at the expense of other habitats. There is potential for localised reduction in the quantity of suitable habitat for certain threatened vertebrates (Fly Specked Hardyhead and Broad Shelled Turtle) contributing to a decline in numbers.

System Component	Benefits	Risks
	<ul style="list-style-type: none"> – greater availability of frog habitat due to variability in lifeforms and niches, – an increase in the width of the fringe of Tall Marsh, – an increase in the availability of feeding habitat for wading waterbird species as the wetland fringe becomes broader and more diverse, – restoration of a diverse seedbank (currently compromised by long term history of regulation), – restoration of soil carbon and nutrient cycling. • Providing a niche comprising infrequently exposed muddy sediment (below typical current water level available for colonisation) by Floodway Pond Herbland EVC which: <ul style="list-style-type: none"> – includes a range of specialist mud flat plant species, which germinate on drying mud, – is currently locally uncommon and would be utilised by wading and mud-probing bird species (i.e. Painted Snipe, Dotterels, Plovers). 	<ul style="list-style-type: none"> • There is potential for increased colonisation by invasive plant species within areas of wetting and drying habitats. • Loss of drought refuge for a range of flora and fauna species (although the drying regime is unlikely to require drying every year and therefore may not need to dry in droughts)
<i>Sunday Creek</i>	<ul style="list-style-type: none"> • Potential for reduced hypoxia events, and overall improved water quality. In-turn this is likely to increase native diversity of fish and other aquatic vertebrates, and decrease populations of noxious fish species such as carp. • Provide opportunities for re-introduction of native fish species 	<ul style="list-style-type: none"> • Potential loss of thermal refuge, assuming that Sunday Creek offers some protection from cold water present in the Murray River. • Disconnection of Sunday Creek via the concrete sill at Hells Gate, increases fragmentation of the wetland complex.

(Source: adapted from Water Technology (2012))

Developing an appropriate procedure for watering in Lake Moodemere will be an important factor in the success of impact mitigation from the reconfiguration works. While the development of a specific operating procedure is outside the scope of this project, the key ecosystem components and existing environmental values affected by the Project need to be considered. Table 13 provides a summary of the risks and benefits to environmental values identified earlier by an alteration of existing conditions in Lake Moodemere to a more natural summer draw-down regime nominally experienced at the site, pre-irrigation.

Table 13 Potential risks and benefits for ecosystem values for return to summer draw-down regime

Ecosystem value	Restoration of natural hydrological regime – Summer/Autumn draw-down of Lake Moodemere	
	Benefits	Risks
Vegetation Communities		
EVC804– Rushy Riverine Swamp	Increased regeneration of indigenous under storey species, increase health and regeneration of River Red Gums.	Too much regeneration of River Red Gums, causing thick stands of saplings to develop.
EVC821 – Tall Marsh	Increase in indigenous plant species diversity and creation of a greater area of habitat for certain birds such as Crakes and Rails.	Invasion of Giant Rush into other EVCs including Aquatic Herbland.
EVC653 – Aquatic Herbland	Increased likelihood of regeneration of native aquatic herbs. Decreased likelihood of invasion by exotic aquatic species which require permanent inundation.	Invasion of Giant Rush.
EVC810 – Floodway Pond Herbland	Increased likelihood of regeneration of native mudflat species.	Invasion of Giant Rush.
EVC56 – Floodplain Riparian Woodland	None (would benefit from more wetting during winter and spring).	Decrease in health of River Red Gums. Lack of recruitment of indigenous understorey species. Increased weed invasion. (This comment relates to a reduction in winter / spring flood frequency. As these EVCs are located on higher ground they will not be impacted by the summer / autumn drawdown).
EVC945 – Floodway Pond Herbland / Riverine Swamp Forest Complex		
EVC815 – Riverine Swampy Woodland		
EVC106 – Grassy Riverine Forest		
EVC816 – Sedgy Riverine Forest		
Birds		
Blue-billed Duck	Potential increase in habitat productivity and therefore food sources.	This species will not remain in the area if the lake and wetlands become too shallow. However, it is a highly mobile species which will come and go from the area according to whether or not suitable habitat is available.

Ecosystem value	Restoration of natural hydrological regime – Summer/Autumn draw-down of Lake Moodemere	
	Benefits	Risks
Eastern Great Egret	Increased area for foraging as a greater area of shallow wetland fringe would be created as the wetland and lake draw down. Potential increase in habitat productivity and therefore food sources.	This species will not remain in the area if the lake and wetlands become too shallow. However, it is a highly mobile species which will come and go from the area according to whether or not suitable habitat is available.
White-Bellied Sea Eagle	Potential increase in habitat productivity and therefore food sources.	If drying caused a decrease in fish prey items, the resident Sea Eagles would be forced to forage elsewhere, such as along the river or further afield. However, it is likely they would return to the lake when suitable conditions returned.
Australian Painted Snipe	Increased area for foraging as a greater area of shallow wetland fringe would be created as the wetland and lake draw down. Potential increase in habitat productivity and therefore food sources.	No obvious risk.
Freckled Duck	Potential increase in habitat productivity and therefore food sources.	This species will not remain in the area if the lake and wetlands become completely dry. However, it is a highly mobile species which will come and go from the area according to whether or not suitable habitat is available.
Turtles		
Broad shelled Turtle (Threatened, FFG)	This species is a carnivorous ambush predator, so it may benefit from increased abundance of prey (e.g. small fish and crustaceans) associated with a (potentially) more diverse macrophyte assemblage.	May be at risk of a reduction in numbers as it prefers permanent waterbodies (Cann 1998) although it should be noted that a significant pool volume would remain under a drawdown scenario. Preferred diet consists of live aquatic prey (yabbies, prawns, small fish etc.) and this species' relative success in the lake may be linked to the large beds of emergent macrophytes and the high abundance of small fish therein (Chessman 1993).
Eastern Long-necked Turtle	May benefit from increased zooplankton productivity. It is generally associated with ephemeral wetlands, so it may benefit from increased ephemerality.	Currently occurs in low numbers but may be advantaged (see 'Benefits'). Increased numbers of this common turtle may impact on the two other rarer species.
Murray River Turtle	No obvious benefit.	May be at risk of a reduction in numbers as preferred habitat tends toward large permanent waterbodies although it should be noted that a significant pool volume would remain under a drawdown scenario. Diet consists mostly of plant-based material such as filamentous algae

Ecosystem value	Restoration of natural hydrological regime – Summer/Autumn draw-down of Lake Moodemere	
	Benefits	Risks
		(Chessman 1986) and this species' success in the lake may be linked to the extensive emergent macrophyte beds.
<i>Fish-Native</i>		
Golden Perch	May benefit from increased abundance of small fish and crustaceans.	No obvious risk.
Australian Smelt	May benefit from increased zooplankton productivity.	No obvious risk.
Flyspecked Hardyhead (threatened, FFG)	May benefit from increased zooplankton productivity.	Reduced access to wetland macrophytes during breeding period (shrinking wetland) as well as the loss of an important spawning habitat (giant juncus beds). This species lays eggs with adhesive strands that attach to vegetation, and survival of eggs in vegetated areas is higher (Llewellyn 1979; Milton & Arthington 1983a).
Flathead Gudgeon	May benefit from increased zooplankton productivity.	No obvious risk.
Carp Gudgeon	May benefit from increased zooplankton productivity.	No obvious risk.
<i>Fish-Non-native</i>		
Goldfish	May benefit from summer conditions if lake retreats and is not connected to river (low DO, high temp, hypoxic)	
European carp	May benefit from summer conditions if lake retreats and is not connected to river (low DO, high temp, hypoxic). Shallow and warm waters are ideal habitat for carp spawning.	
Redfin	No obvious benefit.	
Oriental Weatherloach	May benefit from ephemeral conditions given ability to tolerate poor water quality and aestivate during dry periods. Particularly prevalent in rice fields in native range (see Keller & Lake 2007).	
Eastern Gambusia	May benefit as reproductive activity linked to higher water temperatures (Milton & Arthington 1983b).	
<i>Frogs</i>		

Ecosystem value	Restoration of natural hydrological regime – Summer/Autumn draw-down of Lake Moodemere	
	Benefits	Risks
Common Froglet, Plains Froglet, Sloan’s Froglet, and Spotted Marsh Frog.	Frogs are often most abundant in wetlands that have regular drying periods and aquatic vegetation made up of a diversity of lifeforms, including emergent, floating-leaved and submerged species. It is therefore likely that frog diversity and abundance at Lake Moodemere could be increased by returning a more natural hydrological regime to the lake and its associated wetlands.	No known risks.

(Source: taken from Water Technology (2012), based on the works of Richardson and Stoffels (2011a; 2011b), Australian Ecosystems (2011) & GHD (2010))

7 STATEMENT OF COMMITMENTS

This chapter summarises the commitments made by SCIS in this EIS to manage potential environmental impacts resulting from the proposed reconfiguration project. These commitments include management, mitigation, measures and monitoring to be implemented during and after the construction phase.

7.1 Environmental Management Strategy

GMW Connections Project will be undertaking this project on behalf of the SCIS. As such GMW Connections Project has a wide range of environmental management programs for its existing modernisation projects. These are undertaken in accordance with an Environmental Management System (EMS), which was approved by the DELWP in May 2013. A new project specific environmental management plan (EMP) will be developed in accordance with the EMS.

7.2 Summary of commitments

A summary of the environmental management and mitigation measure described for aspects of the project are provided in Table 14.

Table 14 Project Commitments

Aspect	Commitment
Ecological values and biodiversity	<ul style="list-style-type: none"> • Incorporation of native vegetation avoidance into the design process. • The EMP will detail biosecurity for site. • Construction works to be scheduled appropriately to minimise the impacts to migratory birds and other sites users. • Offset management plan for cleared vegetation. Offsets are not yet known and will be determined once the detailed design is known. • On-going environmental values monitoring plan to assess ecosystem condition.
Water Quality	<ul style="list-style-type: none"> • EMP to detail mitigations for erosion and sediment controls as well as spill containment. • On-going water quality monitoring as a part of the environmental values monitoring plan.
Acid Sulphate soils	<ul style="list-style-type: none"> • Design will incorporate provisions for ASS management in accordance with Australian standards. • EMP to outline a detailed plan to avoid or minimise risk of unexpected unearthing of ASS, and where ASS is encountered, provide a contingency plan to minimise impacts to the surrounding environment.
Aboriginal cultural heritage	<ul style="list-style-type: none"> • Construction works will be undertaken in accordance with an approved CHMP, detailing a dedicated contingency plan for unexpected unearthing of cultural material.
Social / land managers	<ul style="list-style-type: none"> • Proponent to work closely with land managers/owners to ensure the needs and requirements are adequately met in an equitable way for all. • Proponent to work closely with social organisations that utilise the Lake and its surrounds to ensure that their requirements are considered in the future management of the Lake.

8 PROJECT JUSTIFICATION AND CONCLUSIONS

The EIS has considered all potential impacts to the environmental values present at the Project site and considered alternative development options to achieve feasible water savings. All options inherently attain an outcome that would see an altered hydrological regime in the Lake Moodemere System. The proposed option of reconfiguration is by far the most economically feasible approach both in terms of capital expenditure and sales on water savings. Whilst the implementation of the reconfigured system is likely cause noticeable changes to some site characteristics, the evidence presented in this report prepared by industry professionals indicates that a return of the system to a pre-irrigation condition of summer/autumn draw-down will generally have net benefits to most ecosystem values.

9 REFERENCES

- Australian Ecosystems, 2011. Identification of Vegetation, Bird and Frog Values and their Hydrological Requirements for input into the Lake Moodemere Environmental Watering Plan. Draft report to the NCCMA
- Balcombe, S. R and Closs G. P 2004. Spatial relationships and temporal variability in a littoral macrophyte fish assemblage. *Marine and Freshwater Research* 55:609-617.
- Beesley L, Price A, King A, Gawne B, Nielsen D, Koehn J, Meredith S, Vilizzi L, Ning N, Hladyz S, 2011. *Watering floodplain wetlands in the Murray-Darling Basin for native fish*, Waterlines Report, National Water Commission, Canberra.
- Cann, J. 1998. *Australian Freshwater Turtles*, Beaumont Publishing, Singapore.
- Chessman, B.C. 1993. Observations on the diet of the broad-shelled turtle, *Chelodina expansa* Gray (Testudines: Chelidae), *Australian Wildlife Research*, **10**, 169–172.
- Chessman, B.C. 1986. Diet of the Murray Turtle, *Emydura macquarii* (Gray) (Testudines: Chelidae), *Australian Wildlife Research*, **13**, 65–69.
- DSE 2006a. *Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1978*. (Ed. 7) Department of Sustainability and Environment.
- DELWP 2017. *Nature Kit*. Accessed online 17 December 2017 at: <http://maps.biodiversity.vic.gov.au/viewer/?viewer=NatureKit>
- DEPI 2014. *Lake Moodemere Water Savings Assessment*. Internal report for DEPI Water Resources Division.
- Fitzpatrick R, and Shand P, 2008. *Inland Acid Sulphate Soils: Overview and conceptual models*. In *Inland Acid Sulfate Soil Systems Across Australia* (Eds. Rob Fitzpatrick and Paul Shand). pp 6-74. CRC LEME Open File Report No. 249 (Thematic Volume) CRC LEME, Perth, Australia.
- GHD 2009. *Report for Lake Moodemere – Flora, Fauna and Net Gain Assessment*. Report prepared for Goulburn Murray Water, Tatura.
- GHD 2010. *Report for Lake Moodemere Water Savings Project: Phase 2 – Water Resources Report*. Report prepared for Goulburn Murray Water, Tatura.
- Llewellyn, L.C. 1979. Some observations on the spawning and development of the Mitchellian freshwater hardyhead *Craterocephalus fluviatilis* McCulloch from inland waters in New South Wales, *Australian Zoologist*, **20**, 269–288.
- Milton, D.A. & Arthington, A.H. (1983a) Reproduction and growth of *Craterocephalus marjorie* and *C. stercusmuscarum* (Pisces: Atherinidae) in south-eastern Queensland, Australia, *Freshwater Biology*, **13**, 589–597.
- Milton, D.A. & Arthington, A.H. (1983b) Reproductive biology of *Gambusia affinis holbrooki* Baird and Girard, *Xiphophorus helleri* (Gunther) and *X. maculatus* (Heckel) (Pisces; Poeciliidae) in Queensland, Australia, *Journal of Fish Biology*, **23**, 23–41.

Richardson A and Stoffels R.J 2011a. *Investigation of the aquatic vertebrate fauna (fish and turtles) in Lake Moodemere*. Final Report prepared for the North-East Catchment Management Authority by The Murray-Darling Freshwater Research Centre, MDFRC Publication 07/2011, February.

Richardson A and Stoffels R 2011b. *Identification of the aquatic vertebrate values and their hydrological requirements for input into the Environmental Watering Plan for the Lake Moodemere-Sunday Creek wetland complex*. Final Report prepared for the North-East Catchment Management Authority by The Murray-Darling Freshwater Research Centre, MDFRC Publication 32/2011, August

Robley 1996. *Lake Moodemere Water Management Plan*. Shepparton: Department of Conservation and Natural Resources.

SKM 2008. *Lake Moodemere water Savings Feasibility Assessment*. Tatura: SKM.

Threatened Species Scientific Committee (TSSC) 2012. *Commonwealth Listing Advice on Natural Grasslands of the Murray Valley Plains*. Department of Sustainability, Environment, Water, Population and Communities. Canberra

Water Technology. (2012). *Lake Moodemere Environmental Watering Plan*. NECMA, Wangaratta.