Meran Lakes Complex
Environmental Water Management Plan

NORTH CENTRAL
Catchment Management Authority
Connecting Rivers, Landscapes, People

Department of Environment, Land, Water & Planning

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

Front cover photo: An aerial photograph of Lake Meran from 2011 (North Central CMA 2011)

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EXECUTIVE SUMMARY

The Meran Lakes Complex Environmental Water Management Plan (EWMP) is an important part of the Victorian Environmental Water Planning Framework. It provides the ten year management goal, based on scientific information and community and stakeholder consultation, which can be used by the respective agencies; North Central Catchment Management Authority (CMA), Department of Environment, Land, Water and Planning (DELWP) and the Victorian Environmental Water Holder (VEWH); for both short and longer-term environmental water planning. The EWMP management goal is for Meran Lakes Complex, comprising six named wetlands: Lake Meran, Little Lake Meran, Tobacco Lake, Round Lake, Great Spectacle Lake and Little Spectacle Lake. However the ecological objectives and proposed water regimes are proposed for the two wetlands within the complex that the North Central CMA can deliver water to; Lake Meran and Little Lake Meran.

This EWMP is not a holistic management plan, but is focused on environmental water management so that Meran Lakes Complex can provide environmental, social, cultural and economic values for all users. Actions such as floodplain connectivity investigations and pest plant and animal works are documented as complementary to environmental water management in this EWMP.

The following components are the main sections featured in the Meran Lakes Complex EWMP. A summary of the main conclusions to facilitate appropriate environmental water management into the future are summarised below.

Catchment setting

The Meran Lakes Complex is located in the Wandella sub-catchment, of the Loddon River Basin, on the mid-Loddon River floodplain. The mid-Loddon floodplain is dominated by a large number of distributary streams and anabranches that flow northwards across a broad floodplain with a low gradient. Wandella Creek is one of the larger distributary channels on the western side of the Loddon River floodplain and is the main stream that carries natural flows to the Meran Lakes Complex. Lake Meran can also receive flood flows from further upstream via the Leaghur State Forest.

Hydrology and system operations

Prior to river regulation, the mid-Loddon floodplain would have experienced frequent flooding in late winter/early spring, with minor to moderate flooding occurring more than once in most years. Under river regulation, water is harvested in storage, reducing the frequency of minor to moderate flooding, meaning the mid-Loddon does not hold as much ponded water as it would have prior to development.

Following the connection of the Loddon River at Loddon Weir to the Waranga Western Channel, Lake Meran and Little Lake Meran received channel outfalls that ensured they maintained permanent water until the Millennium Drought. During the earlier part of last century, water levels fluctuated substantially with water levels ranging between a third and two thirds full during the droughts of the 1930s and 1940s. The latter half of last century was much wetter than the first half and both wetlands received significant outfalls and diverted flood flows that maintained very high water levels in Lake Meran and Little Lake Meran over most of that period.

The wetlands downstream of Lake Meran were inundated only during large floods, generally between every five to eight years. Great Spectacle Lake is the most downstream wetland in the complex and did not completely fill or spill in some of the years it received water.

All of the wetlands in the complex dried during the Millennium Drought, and since this time Lake Meran and Little Lake Meran have not received the large volumes of outfall water that maintained them at high levels. Lake Meran floods naturally, but Little Lake Meran is disconnected from the floodplain and only receives flood water in very extreme events, such as the 2011 floods. Other than floodwater, environmental water is currently the only other source of water for Lake Meran and Little Lake Meran. Environmental water has been delivered to Lake Meran for the last few years targeting the water level of 79.5 mAHD in accordance with the water regime specified in the Lake Meran EWP. Little Lake Meran has not received environmental water to date.

Water dependent values

The water dependent values were determined through review of previous scientific investigations and advice from the Meran Lakes Complex EWMP Community Advisory Group. The wetlands in the Meran Lakes Complex all support River Red Gum communities, with some very large old trees located on the upper banks of Lake Meran and Little Lake Meran. The complex has in the past supported a high diversity of wetland birds with well over 300 bird species recorded at the complex, although Lake Meran has recorded the lowest abundance and diversity of waterbirds across wetlands managed with environmental water in the North Central CMA region. Lake Meran, as a permanent freshwater lake, provides refuge for a Murray River Turtle population, which, unlike many populations in the region, comprises a higher proportion of juveniles, from multiple age cohorts, to adults, and therefore may be regionally significant.

Ecological condition and threats

The historic condition was informed by the Meran Lakes Complex EWMP Community Advisory Group. The condition of Lake Meran and Little Lake Meran has changed significantly through time, with the wetland condition of first half of last century being described as clear water, full of aquatic plants, teeming with fish and supporting hundreds to thousands of wetland birds. The primary threat to the condition of the wetlands has been attributed to Common Carp.

The current condition was informed by the Index of Wetland Condition (IWC) assessment completed for Lake Meran in 2014 and the other wetlands in 2015. The IWC shows that the current condition of wetlands in the Meran Lakes Complex ranges from moderate for Lake Meran and Little Lake Meran to good for the other wetlands. The hydrological condition of Lake Meran and Little Lake Meran is very poor due to hydrological modifications in the landscape. The Biotic sub-index rating of poor for vegetation at Lake Meran was attributed to lack of critical life forms for EVCs, weediness and the death of large old trees, which are indicative of the wetlands being subject to altered hydrological processes. The other wetlands were rated as moderate to good for vegetation, with the primary issue being weediness and lack of key structural components of EVCs.

Management objectives

Management objectives were established by the CMA and were informed by scientific literature and input from Meran Lakes Complex EWMP Community Advisory Group on the environmental values and condition. These were reviewed and refined by a scientific panel comprising wetland ecology and waterbird experts, and further refined with guidance from the DELWP appointed Expert Review Panel. The long-term management goal for Meran Lakes Complex is:

Meran Lakes Complex long term management goal

A hydrologically diverse wetland complex comprising permanent, intermittent and episodic freshwater wetlands that supports: healthy Aquatic Herbland, Lake bed Herbland and Intermittent Swampy Woodland vegetation classes; a high diversity and periodically high abundance of wetland birds; and regionally significant breeding populations of freshwater turtles (e.g. Murray River Turtle).

Managing risks from the delivery of environmental water and risks to achieving objectives

Risks associated with the delivery of environmental water include the potential for salt load increases increasing salinity in Lake Meran in the absence of natural flood flushing and the threat of prolonged inundation drowning River Red Gum trees if natural flooding follows a filling event.

The threats to achieving ecological objectives that are external to environmental water include Common Carp preventing the establishment of aquatic vegetation and fox predation on freshwater turtles and water extraction by diverters at key periods during the water regime.

Environmental water delivery infrastructure

Lake Meran and Little Lake Meran are connected to the Loddon Valley Irrigation System through the 8/2 and the 4A/8/2 channels respectively. The capacity of the 8/2 channel is restricted by a culvert under Pickles Canal to 100 ML/day, which is considered adequate to fill Lake Meran.

The 4/8/2 is restricted by a culvert under a road to 27 ML/day which will be upgraded to 50 ML/day. This will improve the interruptible supply risk to Little Lake Meran. The outfall to Little Lake Meran is 30 ML/day.

Demonstrating outcomes

Monitoring is required to allow the CMA to adaptively manage environmental watering events (intervention monitoring). It is also required to enable the CMA and VEWH to demonstrate the long term outcomes of the implementation of the Meran Lakes Complex EWMP. This EWMP recommends a suite of long-term and intervention monitoring activities that will meet the CMAs monitoring requirements.

Consultation

Key stakeholders, including DELWP, VEWH, Goulburn Murray Water (GMW), GMW Connections Project, Parks Victoria and Gannawarra Shire Council, were all consulted in the development of this EWMP.

The North Central CMA established a Community Advisory Group (CAG) to provide advice on the environmental values of the site, help describe the change in condition over time and to capture the community's knowledge about how the system behaves hydrologically. Additionally, the Loddon River Environmental Water Advisory Group was consulted on the Seasonal Watering Proposal (2016-17), which incorporated new and updated water regime recommendations.

The North Central CMA engaged with Traditional Owners, Barapa Barapa, through a site visit and a knowledge gathering day. The Barapa Barapa Traditional Owners present provided advice on what the site may have been used for in the past based on artefacts around the site. They also provided advice on potential contemporary cultural uses.

Knowledge gaps

The management actions in the Meran Lakes Complex EWMP are based on the best available information. Knowledge gaps identified during the development of the EWMP relate to the groundwater/surface water interactions, and the regional significance of the freshwater turtle population.

ACKNOWLEDGEMENTS

Acknowledgement of Country

The North Central Catchment Management Authority acknowledges Aboriginal Traditional Owners within the region, their rich culture and spiritual connection to Country. We also recognise and acknowledge the contribution and interest of Aboriginal people and organisations in land and natural resource management.

Contributions to the Meran Lakes Complex EWMP

The information contained in the Meran Lakes Complex Environmental Water Management Plan (EWMP) has been sourced from a variety of reports and field inspections and from individual knowledge and expertise. The North Central CMA acknowledges the assistance of the following people in preparing this EWMP:

- Carl Chamberlain, Brett Condely, Norman Condely, Peter Condely, Cameron English, Elizabeth English, Kirstie English, Stephen English, Colin Fenton, Paul Haw, Ron Kelly, John Pike, Sarah Prior, Morton Ritchie, Shelley Ritchie, Deidre Schlitz, Stuart Simms, Ron Turner (Community representatives)
- Esther Kirby and George McGee (Barapa Barapa Traditional Owners and Elders)
- Chris McCauley, Anna Lucas, Jamie Bell and Andrea Keleher, Department of Environment, Land, Water and Planning (DELWP)
- Mark Toomey, Victorian Environmental Water Holder (VEWH)
- Graeme Hannan, Dale McGraw, Chris Solum and Dean Radcliffe (Goulburn Murray Water)
- Leeza Wishart (Parks Victoria)
- Geoff Rollinson and Roger Griffiths (Gannawarra Shire)
- Damien Cook (Rakali Consulting)
- Dr Stuart Cooney (Ecolink Consulting)
- Geoff Savage and Alice Drummond (GHD)
- Dr Paul Boon (Dodo Environmental)
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- Dion Iervasi (Austral Research and Consulting)
- Ricky Spencer (Western Sydney University)
- Terry Hillman and Jane Roberts (Expert Review Panel)
- Michelle Maher, Phil Slessar, Phil Dyson, Ian Higgins, Bree Bisset, Rebecca Horsburgh and Laura Chant (North Central CMA).

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1. Introduction

Management of environmental water is planned and implemented through the Victorian Environmental Water Management Framework (Figure 1). The North Central Catchment Management Authority (CMA) has recently developed the North Central Waterway Strategy (NCWS) 2014-2022, which is an integrated strategy for managing and improving the region's waterways (rivers, streams and wetlands) (North Central CMA 2014). The NCWS is guided by the Victorian Waterway Management Strategy 2013 (VWMS) and the North Central Regional Catchment Strategy 2013 (RCS).

The Meran Lakes Complex of wetlands sits within the Lower Loddon Program Area and all identified the wetlands are priority wetlands in the Waterway Strategy. For the Meran Lakes Complex (Mid Loddon Wetlands) the long term resource condition target is to:

1. Maintain and improve the condition of the Mid-Loddon wetlands by 2050 as measured by Index of Wetland Condition
2. To increase the richness of wetland-dependent bird species across the Mid-Loddon Wetlands to 30 by 2020 and the number of individuals to an average of 1000 – as measured by monthly counts during a wet phase (North Central CMA, 2014).

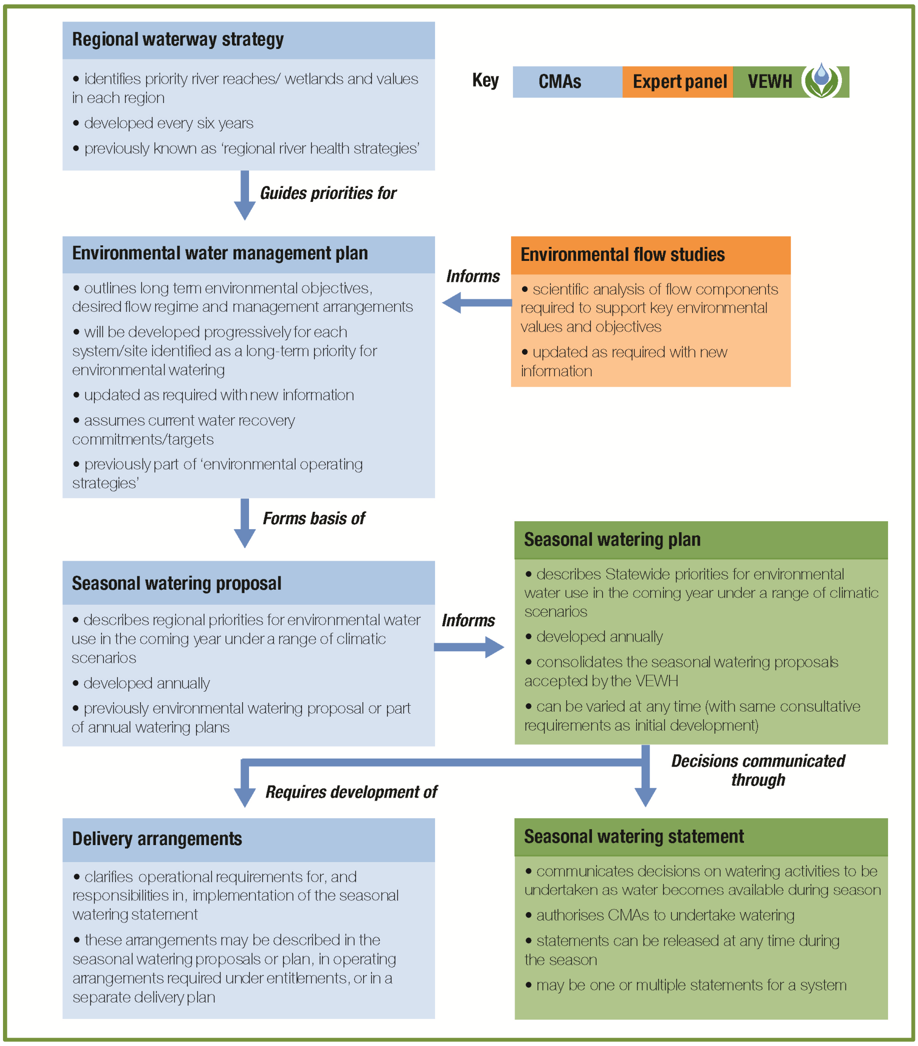

Figure 1: Planning framework for decisions about environmental water management in Victoria (VEWH 2016)

The CMA will need to implement a number of management activities, including revegetation of native vegetation, pest plant and animal control works and improved planning for environmental water management to achieve the resource condition target (North Central CMA 2014a).

1.1. Purpose and scope of the Meran Lakes Complex Environmental Water Management Plan

The Meran Lakes Complex EWMP is a ten year water management plan that describes the ecological values present, long-term goal for the wetland, priority ecological objectives and recommended water regime to achieve the objectives. It is based on scientific information and stakeholder consultation and will be used by the North Central CMA when making annual environmental watering decisions, as well as the Department of Environment, Land, Water and Planning (DELWP) and the Victorian Environmental Water Holder (VEWH) for short and long-term environmental water planning (Department of Environment and Primary Industries [DEPI] 2014a).

The purposes of the EWMP are to:

- identify the long-term objectives and water requirements for the wetland complex
- provide a vehicle for community consultation including for the long-term objectives and the watering requirements of the wetland complex
- inform the development of seasonal watering proposals and seasonal watering plans

The Meran Lakes Complex includes Lake Meran, Little Lake Meran, Tobacco Lake, Round Lake, Great Spectacle Lake and Little Spectacle Lake.

Environmental water can only be delivered to Lake Meran and Little Lake Meran directly. Tobacco Lake, Round Lake, Great Spectacle Lake or Little Spectacle Lake could be artificially watered through surcharging Lake Meran; however this is unlikely to occur and the water regimes for the wetlands downstream of Lake Meran are entirely dependent on natural floodwaters spilling from Lake Meran. Therefore this EWMP describes the hydrology and environmental values and presents a management goal for the complex; however it only recommends ecological objectives and water regimes for Lake Meran and Little Lake Meran.

1.2. Development Process

Environmental water planning for the Meran Lakes Complex first occurred during 2010, when Goulburn Murray Water (GMW) Connections Project (formerly the Northern Victoria Irrigation Renewal Project) was required to prepare wetland (ten) and waterway (two) Environmental Watering Plans (EWP) in the Goulburn Murray Irrigation District. These EWPs were the primary means to assess whether significant environmental values would be impacted by modernisation (e.g. reduction in channel outfalls) and calculate the mitigation water required to maintain environmental values. The North Central CMA, on behalf of the Connections Project, prepared an EWP for Lake Meran, but not for any other wetlands in the Meran Lakes Complex.

The North Central CMA identified the need to develop an EWMP for the whole Meran Lakes Complex in 2014 (North Central CMA, 2014). The EWMP updates and refines the objectives and targets described in the Lake Meran EWP, and includes specific objectives for Little Lake Meran (the other wetland in the complex that can receive environmental water). The EWMP has been developed in collaboration with stakeholders including VEWH, DELWP, Parks Victoria, GMW, Gannawarra Shire Council, the Meran Lakes Complex EWMP Community Advisory Group and Barapa Barapa Traditional Owners:

- **Scoping and collating information:** The Meran Lakes Complex has been the subject of many technical and scientific assessments, including some that were undertaken specifically for this EWMP (Table 1).

Table 1: History of technical work undertaken on the Meran Lakes Complex

Name of study	Author	Date	Summary
Environmental values and effects of salinity on the Flora and Fauna of the Boort – West of Loddon Salinity Management Planning Area	Lugg et al.	1991	The report assessed the conservation value of the Meran Lakes Complex wetlands in relation to key attributes (e.g. size, rarity, waterbird use). • Lake Meran identified as a good example of a permanent open freshwater lake, main values include fisheries and recreational use. • Little Lake Meran was kept full at this time with Cumbungi dominance prevailing. Recommendation was to discontinue outfall and incorporate into the floodplain. • Tobacco and Round lakes: fringed by healthy River Red Gums and Black Box. Recommended to maintain ability to flood and flush regularly. • Great and Little Spectacle Lake: Rising salinity due to surface and groundwater inputs in the absence of flooding/flushing flows.
Meran Lakes Complex Water Operational Plan – Environmental Values Assessment	Ecos Environmental Consulting	2006	The Department of Primary Industries (DPI) initiated the environmental assessment project to aid the development of the Meran Lakes Complex Water Operational Plan. The project mapped the wetlands and recommended water regimes for the wetlands: • Flood Lake Meran, Tobacco, Round, Great and Little Spectacle lakes every 6-7 years • Little Lake Meran – flood every 2-3 years with no further inflows • Complementary management actions: weed control, pest animal control (foxes and rabbits) and grazing management plans.
Meran Lakes Groundwater Study	Hekmeijer	2006	Deep aquifer groundwater salinity was in the range of 20,000 to 30,000 EC, while under Lake Meran the range was 3,000 to 6,000 EC. • Surface water infiltration established a groundwater mound under Lake Meran; the report stated that the mound had reduced significantly since 2001 due to drought and dry lake conditions. • Great Spectacle Lake was identified as the wetland most at risk from the regional groundwater system

Name of study	Author	Date	Summary
Wetland Watering requirements Technical Report (included Little Lake Meran)	North Central CMA	2009	Two management options were proposed for Little Lake Meran that were dependent on water availability and capacity to manage this wetland. • Option 1: Provide a water regime that will support the maintenance and recruitment of River Red Gum (*Eucalyptus camaldulensis*) and Black Box (*Eucalyptus largiflorens*) trees and promote the growth of a range of aquatic and amphibious plant species typical of River Red Gum Swamp. • Option 2: Actively manage wetland transition into Riverine Chenopod Woodland (a vulnerable EVC within the Victorian Riverina Bioregion) as water availability, infrastructure and disconnection from the floodplain limit the success of option 1#. This option does not require a watering regime.
Lake Meran EWP	North Central CMA	2010	Documented the approach to mitigate potential impacts of reduced channel outfalls from the irrigation system. At the time of its development Lake Meran was dry. Water management goal: To provide a water regime that supports a permanent open freshwater lake with open water and associated flora and fauna communities, which can occasionally dry out. In the intervening period until the lake is filled, maintain the emergent aquatic plant community (EVC 821: Tall Marsh) at the channel outfall within the natural inlet creek and southern basin to ensure a seed/egg source is sustained over dry periods.
Lake Meran survey and bathymetry refinement	Price Merritt Consulting	2015	The feature survey for Lake Meran was refined to provide more detail on the southern basin, and extended to incorporate Pickles Canal and potential overflow drains into the Leaghur State Park. An updated bathymetry map and rating table were supplied and are included in this report.
Vegetation survey, mapping and analysis of Lake Meran	Rakali Ecological Consulting	2015	Mapped wetland vegetation and flora and fauna values at Lake Meran (refer to Section 4.1). Recommendations included: • A healthy canopy of mature River Red Gums should be re-established in Intermittent Swampy Woodland/ Lake Bed Herbland zones (Keeping the lake level artificially high results in the temporal and spatial contraction of the habitat) • Maintaining high lake levels is likely to decrease Lake Meran's productivity for wetland birds; greater fluctuation in water levels generally leads to increased diversity and abundance of wetland birds.

Name of study	Author	Date	Summary
Meran Lakes Complex Smaller wetlands Vegetation survey, mapping and analysis	North Central CMA	2016	• Most of the Meran wetlands have fringing native vegetation that is in moderate condition according to the IWC biota sub-index score. The exception is Little Lake Meran which is in good condition. Recommendations to improve IWC scores include weed management and rehabilitation of critical life forms as per EVC benchmarks.
Lake Meran Drilling Report	North Central CMA	2016	In November 2015 four bores were established as nested piezometers at two sites immediately adjacent (to the west and to the north) to Lake Meran. The bores were constructed to capture information to improve the understanding of the local stratigraphy and will continue to inform the CMA about the interactions between surface water and groundwater.
Meran Lakes Complex Salt and Water Balance Investigation Report Study	GHD	2016	The North Central CMA engaged GHD to develop a salt and water balance model for Lake Meran and Little Lake Meran and complete a salinity risk assessment. The project also assessed the impact of the proposed water regime on the frequency of natural flooding on the wetlands downstream of Lake Meran. The salt and water balance found that in the absence of natural flooding delivery of the water regime will cause a spike in salinity over the freshwater wetland threshold of around 4,000 EC. The hydrological assessment indicated that the floods that have historically spilled to the downstream lakes are so large that they would have spilled no matter what the level in Lake Meran was.
Lake Meran Hydrogeological Study	AECOM	2016	GMW engaged AECOM to undertake a hydrogeological and salinity impact study at Lake Meran. A Monte Carlo method was adopted to run scenarios for the current and proposed watering regimes. The assessment determined that seepage from the lake to groundwater was negligible. The model showed that under a range of scenarios the greatest contribution to salt input is from surface water flows to maintain water levels. If there is sufficient natural flooding of the system (allowing salt flush to occur), the salt concentrations should not build up to detrimental levels. Rapid increases in salinity are more likely to occur during a drying phase (evaporative concentration) as observed in the past.

- **Community consultation**

  The North Central CMA established a Community Advisory Group to provide advice on the environmental values of the site, help describe the change in condition over time and to capture the community's knowledge about how the system behaves hydrologically. An Expression of Interest was sent out to the local landholders and was advertised in the media (paper and radio). Sixteen landholders (refer to Appendix A) are members of the Community

Advisory Group. Various meetings and sites visit (Table 2) and subsequent informal conversations with individual members have been undertaken to gather information from the community.

Table 2: Meetings and site visits undertaken with CAG to inform the EWMP

Meeting Date	Purpose
23 September 2015	Open discussion on issues to date; clearly defining the role of the EWMP, gathering community knowledge on the past and current environmental values and hydrology of the lake complex, and presenting the vegetation assessments. This information was critical
27 October 2015	Field visit with CAG members and ecological consultants to visit the site and discuss environmental values, changes to condition and history of flooding and water supply. The CAG, CMA and consultants visited Lake Leaghur, Leaghur State Forest, Lake Meran (Pickles Canal, outfall, southern basin to outlet on eastern side), Great Spectacle Lake, Little Spectacle Lake, Round Lake and Tobacco Lake.
Various dates	Multiple one on one visit to gain more detailed understanding of the history of Lake Meran and Little Lake Meran. This information and the information provided at the previous two meetings were critical to informing the North Central CMAs ecological and hydrological understanding of the system.
3 March 2016	Discussion of overall long-term water management goal and ecological objectives for the wetland complex. The workshop included an open forum for CAG members to comment on the accuracy of the hydrology information, environmental and social values, and change in condition over time described in the draft technical report. The North Central CMA also used the workshop to seek feedback on and acceptance of the management goal and ecological objectives. The CAG supported the draft management goal and ecological objectives.
21 April 2016	Presentation of the watering regimes and risk assessment for the wetlands within the complex to: • Inform the CAG of the hydrological regimes required to meet the agreed ecological objectives for the wetland complex • A presentation on the salt and water balance of Lake Meran and hydrological assessment of the complex (including a risk assessment of various water regime/climate scenarios for Lake Meran on the wetlands downstream). Each CAG member commented on the water regime. All recognised that the regime is significantly different to how the wetlands were managed in the past, and acknowledged that environmental water must be used to support environmental values. It was stated that the CMA will need to monitor closely to ensure the expected outcomes are achieved. The majority supported the regime and expressed gratitude that the water dependent values warranted management the delivery of environmental water to both wetlands.
4 July 2016	Presentation of the draft EWMP to the community. The community raised concerns about the GHD modelling of flood frequency and duration being greater than actually occurred, and questioned the validity of the salinity risk assessment. This concern has been addressed in the EWMP under Section 6.2.

- **Traditional Owner engagement**

  The North Central CMA invited Barapa Barapa Traditional Owners and elders on a site visit to Lake Meran to discuss the contemporary and cultural heritage values of the site. The discussion covered how the artefacts indicate what the site would have been used for in the past and what Barapa Barapa would like to see at the site going forward from a cultural use perspective.

Information from the above tasks was analysed and used to develop the following sections of the EWMP:

- Water dependent values
- Social, cultural and economic values
- Ecological condition, condition trajectory and threats
- Management objectives
- Managing risks
- Review and refine environmental water requirements for Meran Lakes Complex
- Environmental water delivery infrastructure
- Demonstrating outcomes
- Knowledge gaps and recommendations

2. Site overview

2.1. Site location

The Meran Lakes Complex comprises a series of permanent, semi-permanent, ephemeral and intermittent wetlands (Lugg et al. 1993). The complex is located about 25 kilometres north east of Boort, Victoria in the Wandella sub-catchment of the Loddon River Basin (Figure 2).

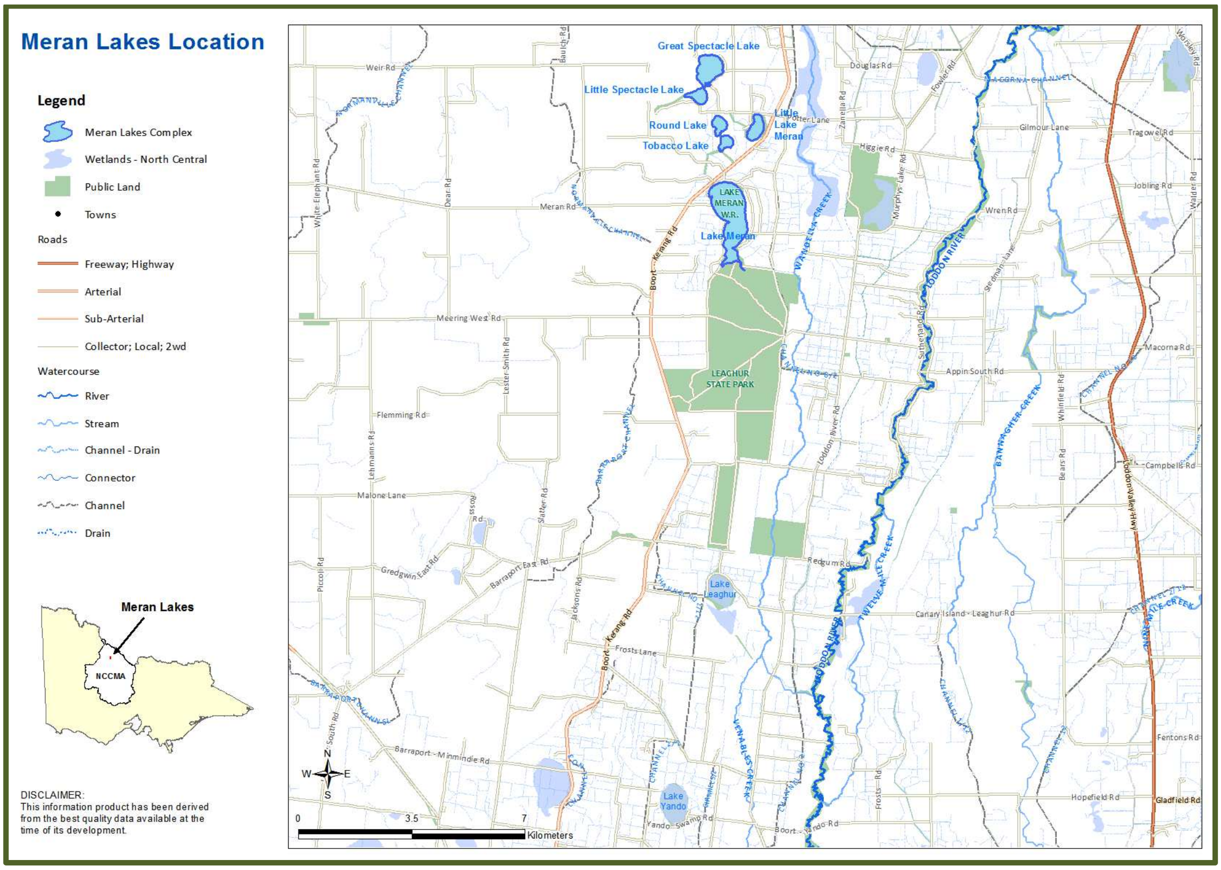

Figure 2: Location of Meran Lakes Complex

2.2. Catchment setting

Climate

Climate data (1880-2016) were obtained from the Bureau of Meteorology (BOM) for Kerang meteorological stations 080023 (Kerang) for temperature and 080024 Kerang (Meran Downs) for rainfall. Maximum average temperatures range from 31.6 °C in January to 14.1 °C in July and the minimum temperature rarely falls below zero. Rainfall averages 360 mm/year, with May to October being wetter than November to April (BOM 2015).

Geomorphological and physical characteristics

The Meran Lakes Complex is on the mid-Loddon River floodplain, which is dominated by a large number of distributary streams and anabranches that flow northwards across a broad floodplain. Wandella Creek is one of the larger distributary channels on the western side of the Loddon River floodplain and is the main stream that carries natural flows to the Meran Lakes Complex. The mid-Loddon floodplain has many wetland complexes, the main ones on the western side being the Meran Lakes Complex, the Boort wetlands to the south, and the Kerang wetlands to the north.

The Meran Lakes Complex sits within two bioregions; the Victorian Riverina Bioregion and the Murray Mallee Bioregion (refer to Appendix B).

The wetlands are bordered to the east by lunettes and they sit within a lake/lunette complex on upper floodplain Shepparton Formation alluvial sediments (Bartley, 2009). The Leaghur Fault, an ancient trough that has been filled by alluvial sediments of the Holocene Coonambidgal Formation, intersects the wetland complex in a north-south direction, and separates the natural flooding and drainage systems of the Victorian Riverina bioregion and the Murray Mallee bioregion (RWC, undated - circa mid 1990s).

The characteristics of wetlands in the Meran Lakes Complex are shown in Table 3. The bathymetry maps for Lake Meran and Little Lake Meran are shown in Appendix C.

Table 3: Wetland characteristics of Meran Lakes Complex

Characteristics	Description				
Name	**Lake Meran**	**Little Lake Meran**	**Tobacco Lake**	**Round Lake**	**Great and Little Spectacle Lakes**
Wetland ID (1994)	7626 533258	7626 541289	7626 533280	7626 - 529286	7626 – 523300 (Great), 7626-523295 (Little)
Area	222.6 ha at 82.32 mAHD 172.88 at 81.4 mAHD	31.01 ha at 79.65 mAHD	10.5 hectares	15.9 hectares	49.4 hectares (Great), 31.9 hectares (Little)
Wetland capacity	8452 ML at 82.32 mAHD 6720 ML at 81.4 mAHD	881ML at 79.65 mAHD	252 ML at 80.94 mAHD	450 ML at 80.4 mAHD	2767 ML at 82.0 mAHD (Great) 990 ML at 80.0 mAHD (Little)
Bioregion	Victorian Riverina	Victorian Riverina	Victorian Riverina	Victorian Riverina	Victorian Bioregion (east)/ Mallee Murray (west)
Conservation status	Bioregionally Important Wetland (North Central CMA, 2010)	Bio-regionally significant (NLWRA, 2002 cited in SKM, 2008)	High value – waterbirds (Lugg et al. 1993)	High value –Waterbirds (Lugg et al. 1993)	Moderate to High value (Lugg et al. 1993)
Land status	State Game Reserve (VEAC, 2008)	Natural Features Reserve (hunting), Water Supply Reserve	Natural features reserve - wildlife reserve	Natural features reserve - wildlife reserve	Wildlife Reserve (hunting) (partial)
Land manager	Lake Meran Committee of Management	Parks Victoria, Goulburn Murray Water	Parks Victoria	Parks Victoria	None (partial private land)
Surrounding land use	Dryland/irrigated cropping and grazing	Dryland/irrigated cropping	Dryland/irrigated cropping	Dryland/irrigated cropping	Dryland/irrigated cropping
Water supply	Natural: Wandella Creek Current: Channel outfalls (8/2) via the natural inlet creek Channel capacity of 100 ML/day, Outfall regulating structure capacity 80–100 ML/day (approx. 115 days to fill)	Natural: Wandella Creek Current: Channel outfall (4A/8/2) 30 ML/day	Natural: Wandella Creek Current: Flood flows from Lake Meran irrigation outfall	Natural: Floodwater from Tobacco Lake and Wandella Creek Current: Floodwater from Tobacco Lake	Natural: Floodwater from Wandella Creek, Lake Meran via Tobacco and Round or bypass flows. Little Spectacle Lake received water from Great Spectacle and has its own catchment from the Mallee Current: As per natural except that Little Spectacle was disconnected from Great Spectacle by a levee until 2011 floods.
1788 wetland category[1]	Permanent Open Freshwater	Permanent Open Freshwater	Deep Freshwater Marsh	Deep Freshwater Marsh	Deep Freshwater Marsh (Great) Shallow Freshwater Marsh (Little)
1994 wetland category	Permanent Open Freshwater	Permanent Open Freshwater	Open Water	Permanent Open Freshwater	Deep Freshwater Marsh (Great) Shallow Freshwater Marsh (Little)

[1] It is important to note that these assessments were completed as a desktop study and may not necessarily reflect the actual pre European settlement wetland type.

2.3. Land status and management

Land use

The Meran Lakes Complex is located within the Loddon Valley Irrigation Area and the surrounding land is dominated by irrigated and dryland cropping and pasture.

Land tenure

Lake Meran is managed by the Lake Meran Public Purposes Committee and classified as a State Game Reserve. Little Lake Meran is classified as a Water Supply Reserve and Wildlife Reserve and is managed for these purposes by GMW and Parks Victoria respectively. Tobacco and Round lakes are currently managed by Parks Victoria as Wildlife Reserves. Great Spectacle Lake and Little Spectacle Lake have partial freehold land and are designated Wildlife Reserves (Parks Victoria management). The freehold land is cropped when the wetlands are dry.

Wildlife Reserves are managed to conserve and protect species, communities or habitats of indigenous animals and plants while permitting recreational (including hunting in season as specified by the land manager) and educational use (VEAC 2008; DSE 2009).

Environmental water management

There are several agencies directly involved in environmental water management in Victoria. Other agencies, such as public land managers, play an important role in facilitating environmental watering outcomes. Table 4 describes the key stakeholders that are involved in the management of the Meran Lakes Complex.

Table 4: Roles, responsibilities and interest in the management of Meran Lakes Complex

Agency/group	Responsibilities/involvement
Department of Environment, Land Water and Planning (DELWP Victoria)	• Manage the water allocation and entitlements framework. • Develop state policy on water resource management and waterway management approved by the Minister for Water and Minister for Environment and Climate Change. • Develop state policy for the management of environmental water in regulated and unregulated systems. • Act on behalf of the Minister for Environment and Climate Change to maintain oversight of the VEWH and waterway managers (in their role as environmental water managers). • Legislative responsibilities for the management of flora and fauna. • Approve EWMPs and endorse SWPs.
Victorian Environmental Water Holder (VEWH)	• Make decisions about the most effective use of the water holdings, including use, trade and carryover. • Authorise waterway managers to implement watering decisions. • Liaise with other water holders to ensure coordinated use of all sources of environmental water. • Publicly communicate environmental watering decisions and outcomes. • Author of the Statewide Seasonal Watering Plan. • Provides final endorsement of SWPs. • Approves delivery of environmental water (Seasonal Watering Statement), funds water delivery and some environmental water related monitoring.
Commonwealth Environmental Water Office (CEWO)	• Support the Commonwealth Environmental Water Holder to make decisions about the use of Commonwealth water holdings, including providing water to the VEWH for use in Victoria. • Liaise with the VEWH to ensure coordinated use of environmental water in Victoria. • Report on management of Commonwealth water holdings.
Murray-Darling Basin Authority (MDBA)	• Implement the Murray-Darling Basin Plan - the Basin Plan sets legal limits on the amount of surface water and groundwater that can be taken from the Basin from 1 July 2019 onwards. • Integrate Basin wide water resource management. • Manage The Living Murray water entitlements.

Agency/group	Responsibilities/involvement
North Central Catchment Authority (North Central CMA) Waterway Manager	• Waterway manager. • Identify regional priorities for environmental water management in regional Waterway Strategies • In consultation with the community assess water regime requirements of priority rivers and wetlands to identify environmental watering needs to meet agreed objectives • Identify opportunities for, and implement, environmental works to use environmental water more efficiently. • Propose annual environmental watering actions to the VEWH and implement the VEWH environmental watering decisions. • Provide critical input to management of other types of environmental water (passing flows management, above cap water). • Report on environmental water management activities undertaken.
Goulburn Murray Water (GMW)	• Water Corporation – Storage Manager and Resource Manager. • Work with the VEWH and waterway managers in planning the delivery of environmental water to maximise environmental outcomes. • Operate water supply infrastructure such as dams and irrigation distribution systems to deliver environmental water. • Ensure the provision of passing flows and compliance with diversion limits in unregulated and groundwater systems. • Endorse SWP and facilitate on-ground delivery.
Parks Victoria	• Land Manager. • Implement the relevant components of EWMPs, including (as agreed) operation and maintenance of infrastructure that is not part of the GMW irrigation delivery system. • Where agreed, participate in the periodic review of relevant EWMPs. • Endorse SWPs. • Manage and report on other relevant catchment management and risk management actions required due to the implementation of environmental water.
Input, advice and interest in environmental watering	
Traditional Owners/ Community Groups	• The delivery of environmental water is likely to provide other benefits that depend on the condition of our waterways, such as supporting social and cultural values. • The recognised Native Title Group for the Meran Lakes Complex is Barapa Barapa
Gannawarra Shire	• Local council for area that includes Meran lakes Complex. • Responsible for regulation of local development through planning schemes and on-ground works.
Loddon River Environmental Water Advisory Group (LEWAG)	• The LEWAG consists of key stakeholders and community representatives who provide advice to the North Central CMA on the best use of environmental water for the wetlands located on the Loddon River floodplain.
Local community	• Lake Meran Public Purposes Committee • Lake Meran Irrigation Diverters Group • Recreational users of the Meran Lakes Complex, including speed boating and passive recreational pursuits such as walking, bird watching and camping. • Community Advisory Group established and consulted in the development of this EWMP (refer to Section 1.2).

Agency/group	Responsibilities/involvement
Field And Game Australia	• A voluntary organisation formed by hunters to promote responsible firearm ownership and ethical hunting. • Membership on Loddon River EWAG

2.4. Environmental water sources

Environmental water available for the Meran Lakes Complex includes water sourced from unregulated flows and from water available under various environmental entitlements held by the Victorian Environmental Water Holder.

Unregulated flows

Unregulated flows usually occur during wet periods after heavy rainfall. This is water that is outside the limits of storage and consumption. The North Central CMA makes recommendations to GMW regarding the delivery of unregulated flows, for example water from unregulated flows can be diverted to floodplain wetlands such as Lake Meran.

Water entitlements

Bulk and environmental entitlements are legal rights to water which are issued with a range of conditions and obligations for taking and using water. The VEWH holds three bulk and environmental entitlements that can directly be used to provide water to the Meran Lakes Complex.

- Bulk entitlement (Loddon River – Environmental Reserve) Order 2005
- Goulburn River Environmental Entitlement 2010
- Environmental Entitlement (Goulburn System – NVIRP Stage 1) 2012

The maximum entitlement volumes are shown in Table 5. The conditions attached to water held in various accounts under these entitlements means that that there is no single source of water that is specifically available for the Meran Lakes Complex, and the VEWH must prioritise use of the available water across all wetlands and waterways eligible to receive the water, such as lakes Meran, Boort, Yando and Leahgur, and the Loddon River.

A large portion of the VEWHs water is held in the Goulburn system and is delivered to the Boort district via the Waranga Western Channel. This water is normally only available during the irrigation season, from 15 August to 15 May, while the channel is in use and when there is spare capacity. Loddon system holdings are accessible year-round, however are normally only be deliverable to Lake Meran and Little Lake Meran when the Loddon Valley Irrigation System is operational.

The VEWH also has the ability to trade water from other systems or from other entitlement holders to increase water available for use in the Loddon system.

Table 5: Environmental water sources for Lake Meran and Little Lake Meran

Water entitlement	Volume
Loddon system	
Bulk Entitlement (Loddon River Environmental Reserve) Order 2005	3,480 ML high reliability
	2,024 ML low reliability
Goulburn system	
Bulk Entitlement (Loddon River Environmental Reserve) Order 2005	7,940 ML
Goulburn River Environmental Entitlement 2010	1,434 ML high reliability
Environmental Entitlement (Goulburn System – NVIRP Stage 1) 2012	1,588 ML*

* 147 ML is attributable to an assessment of outfalls at Lake Meran during 2004-05 (ref EWP)

2.5. Related agreements, legislation, policy, plans and activities

There are a range of international treaties, conventions and initiatives, as well as National and Victorian State Acts, policies and strategies that direct management of wetlands within Northern Victoria. The agreements, policies and strategies that have particular relevance to Meran Lakes Complex and the management of its environmental and cultural values are listed below.

- *Japan Australia Migratory Birds Agreement (JAMBA) 1974* – six of the species listed under this agreement have been recorded at Meran Lakes Complex
- *China Australia Migratory Birds Agreement (CAMBA) 1986* - seven of the species listed under this agreement have been recorded at Meran Lakes Complex

Commonwealth legislation and policy:

- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Part IIA) – Meran Lakes Complex is known to support places of cultural significance. Refer to Section 4.3.1.
- *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*) – one endangered and eight migratory species listed under this Act have been recorded at Meran Lakes Complex
- *Water Act 2007* – to provide for the protection of ecological values at Meran Lakes Complex through appropriate management of Murray-Darling Basin water resources.

Victorian legislation:

- Aboriginal Heritage Act 2006 - Meran Lakes Complex is known to support places of cultural significance. Refer to Section 4.3.1.
- *Catchment and Land Protection Act 1994* - governs the management of land surrounding Meran Lakes Complex e.g. pest plant and animal control.
- *Water Act 1989* - provides a formal means for the integrated management of water in Victoria.
- *Wildlife Act 1975* - Parks Victoria manages Meran Lakes Complex in accordance with this Act.
- *Flora and Fauna Guarantee Act 1988* (*FFG Act*) – nineteen fauna species and three flora species listed under this Act have been recorded at Meran Lakes Complex.

Victorian policy and strategies:

- Victorian threatened flora and fauna species (Victorian advisory lists) – nine fauna species and seventeen flora species on the Victorian advisory lists have been recorded at Meran Lakes Complex.
- Victorian Waterway Management Strategy (2014) - provides the policy direction for managing Victoria's waterways over an eight-year period.

Regional strategies and plans:

- North Central Regional Catchment Strategy (North Central CMA 2012) –this strategy (2013-2019) sets regional priorities for the management of natural assets, sets overall direction for investment and coordination of effort by landholders, partner organisations and the wider community.
- North Central Waterway Strategy (North Central CMA 2014) – this regional strategy is an action out of the Victorian Waterway Management Strategy (VWMS) and provides the

framework for managing rivers and wetlands with the community over the next eight years. It delivers key elements of the VWMS including developing work programs to maintain or improve the environmental condition of waterways in the North Central CMA region.

- Loddon River EWMP - The North Central CMA was funded to develop an EWMP in 2015 for the Loddon River and associated waterways (the Loddon River System). The Wandella Creek, which diverts flow to the west (to the Meran Lakes Complex) is a major distributary waterway from the Loddon River downstream of the Loddon Weir.

3. Hydrology and system operations

Wetland hydrology is the most important determinant in the establishment and maintenance of wetland types and processes. It affects the chemical and physical aspects of the wetland which in turn affects the types of flora and fauna that the wetland supports (DSE 2005). A wetland's hydrology is determined by surface and groundwater inflows and outflows, precipitation and evapotranspiration (Mitsch & Gosselink 2000). Duration, frequency and seasonality (timing) are the main components of water regime for wetlands.

3.1. Natural hydrology

Modelling shows that prior to European settlement the river would have flooded in most years over winter and spring, with moderate to minor flooding often occurring multiple times each year (North Central CMA, 2015). The mid-Loddon floodplain comprises a series of distributary streams, anabranches and wetlands which would have been inundated in most years over late winter early spring. This would have held water in deep holes across the Mid Loddon Floodplain, such as the deeper lakes in the Meran Lakes Complex for much of the time. Early European settlers modified the Loddon River floodplain to divert water to wetlands to ensure water security over the lower rainfall/higher evaporation months. Farming and other human activities have consolidated those modifications. Due to these modifications and the flat landscape (the gradient between Loddon Weir and Kerang Weir is 0.16m/km) it is difficult to know exactly how water moved through the mid-Loddon River floodplain prior to European settlement so the pre-European water regime of the complex is difficult to determine.

Remnant vegetation indicates how the frequency of wetting and drying patterns has changed over time. Large River Red Gum tree stumps in the bed of Lake Meran indicate that some parts of the lake dried long enough to allow trees to become established, but also flooded frequently enough to allow the trees to thrive and grow. River Red Gum requires flooding every two to five years for optimal health and can persist fully inundated for up to three years (Roberts and Marston, 2011). The presence of dead tree stumps in the bed of Lake Meran suggests that the lake may have filled to near capacity semi regularly, and possibly only held deep water for up to three years. The River Red Gum trees around the other lakes in the complex are thought to have established after European settlement as a result of more frequent inundation as there are none of the really large tress as exhibited at Lake Meran (although some could still be well over 100 years old). The woodland fringe in these other wetlands would have likely been dominated by Black Box, which requires much less frequent flooding than River Red Gums. The optimum watering regime for Black Box is considered to be inundation once every seven to ten years (Roberts and Marston, 2011).

3.2. Historic and current hydrology

Flood flows are conveyed to Lake Meran from Wandella Creek through Pickles Canal, which was constructed in the 1880 or 1890s and runs along the northern boundary of Leaghur State Park. Floodwaters that break out of the Loddon River further upstream enter Lake Meran through Leaghur State Park. Pickles Canal allows flood waters to flow back from Lake Meran to Wandella Creek when water levels in Wandella Creek subside (Ecos Environmental Consulting 2006; North Central CMA 2010). A levee bank has been constructed on the eastern bank of Wandella Creek from Forest Lane to the Lake Meran lunette. The bank holds the water higher in the creek and facilitates diversion of floodwaters through Pickles Canal to Lake Meran (Haw P. 2016 personal communication [local community], 26 July 2016).

Irrigation outfall water historically entered Lake Meran from the 8/2 Channel via a delivery channel that runs parallel to Pickles Canal (North Central CMA 2010).

The overflow point from Lake Meran was moved about 450 m north to its current location in the late 1800s. The spillway was modified, and drop boards were added in the early 1900s to hold the lake at an artificially surcharged level (North Central CMA 2010). In flood events, water from the Lake Meran outlet now flows north to the Boort–Kerang Road, and then follows it in a north-easterly direction before passing under the road via eight box culverts and flowing along a floodway north-west to Tobacco Lake then Round Lake then Great Spectacle Lake (GHD 2006). When Great Spectacle Lake overtops, water flows northward along Little Wandella Creek, which passes through cultivated land before it joins another channel that flows northeast along the edge of a paddock before flowing north through a Black Box lined channel along Truscott Road. The channel continues east adjacent to Normanville Road before passing under the road and eventually re-joining Wandella Creek near the Wandella State Forest (Ecos Environmental Consulting, 2006).

The construction of a levee system in 1934, as well as the Boort-Kerang Road and the 8/2 channel (dates not known – but before the turn of the 19th century) disconnected Little Lake Meran from the floodplain (Lugg et al. 1993; Ecos Environmental Consulting 2006). Little Lake Meran has only flooded once in the living memory of the local community i.e. during the record floods of 2011 when water entered the lake from the Boort-Kerang Road. Under normal circumstances, Little Lake Meran only receives outfalls from the 4/8/2 Channel, which is part of the Loddon Valley Irrigation system and enters the wetland from the north-west.

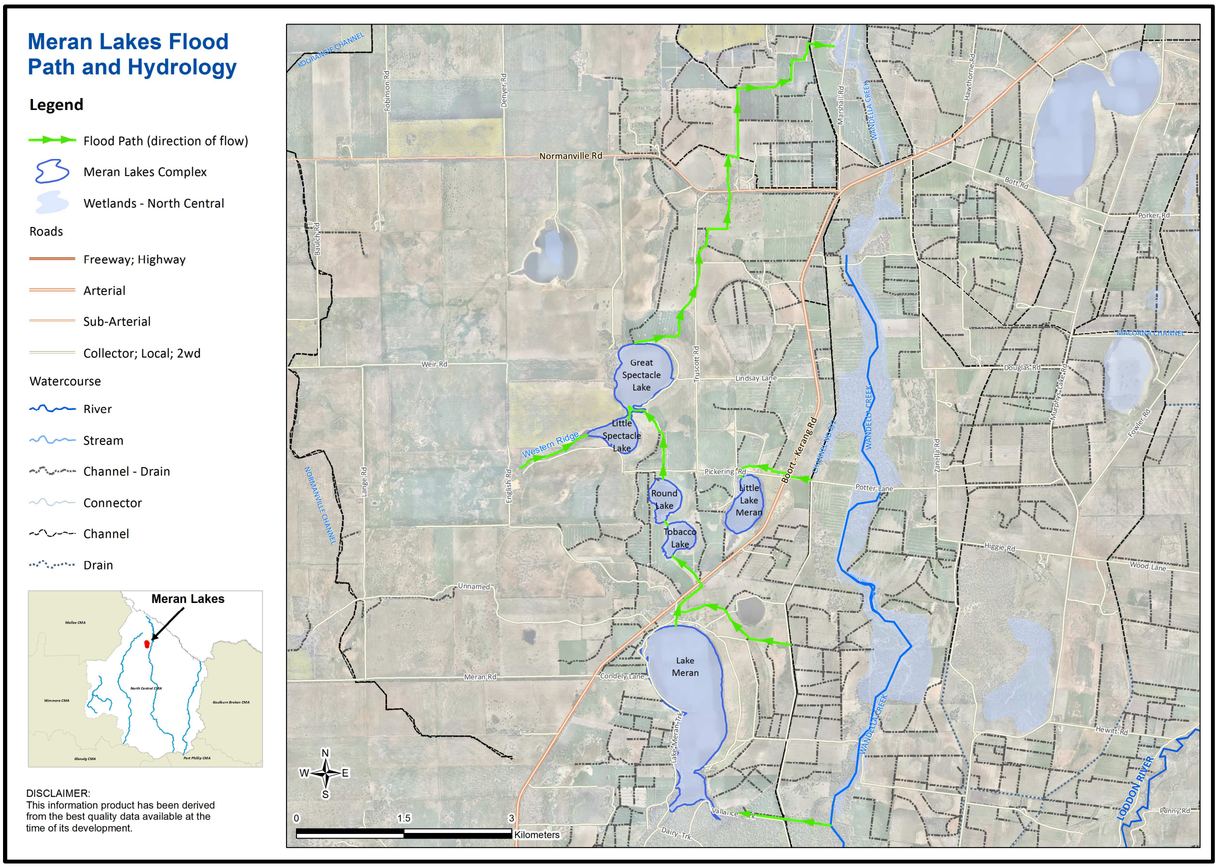

Figure 3: Meran Lakes Complex hydrological pathways

Following the connection of the Loddon River at Loddon Weir to the Waranga Western Channel, Lake Meran and Little Lake Meran received channel outfalls that ensured they maintained permanent water. During the earlier part of last century water levels fluctuated substantially. During the drought of the 1930s and 1940s the water levels in Lake Meran ranged between a third and two thirds full (Ritchie M, English B. and Turner R. personal communication [local landholders], November 2015). The latter half of the 20th century was much wetter than the first half and both wetlands received significant outfalls and diverted flood flows that maintained high water levels in Lake Meran and Little Lake Meran over most of that period.

The recent inundation history of wetlands downstream of Lake Meran has been re-constructed by drawing on the historical knowledge collected during interviews that the Victorian Department of Primary Industries conducted with the local community in 2006 and via the CAG in 2015/16. Based on this, the wetlands downstream of Lake Meran were inundated only during very large floods (Table 6). Great Spectacle Lake is the most downstream wetland and did not completely fill or spill in some of the years it received water (Table 6) (Ecos Environmental Consulting, 2006). Tobacco Lake and Round Lake draw down by evaporation and generally dry between three and four years after filling unless topped up (Ecos Environmental Consulting 2006). Tobacco Lake usually dries before Round Lake. Great Spectacle Lake draws down to dry within four to five years unless topped up. The entire Loddon floodplain was flooded in the 2010/11 floods and all the wetlands filled to capacity and spilled. The smaller wetlands in the complex took between three and five years to dry.

In October 2016 natural flooding in the Loddon catchment entered Lake Meran and the lake spilled to Tobacco and Round lakes.

Little Spectacle Lake was disconnected from the floodplain by a levee bank that was constructed between it and Great Spectacle Lake. It is not known when the levee was constructed although it was before the memory of persons interviewed. The levee bank meant that Little Spectacle Lake very rarely received water, and has filled only once in recent decades until the 2010/11 floods (E. English 2016 personal communication [local landholder], 3 March). Both of the known flood events were a result of floodwater running off the Mallee country to the west. The levee bank was destroyed by the 2011 flood and has not been replaced.

Irrigation efficiency improvements since the late 1990s significantly reduced the volume of outfall water entering Lake Meran and Little Lake Meran. Under the conditions of no or very minimal inflow to reservoirs over the Millennium Drought (1997 to 2010) these two wetlands completely dried. An assessment conducted as part of the irrigation modernisation project (formerly NVIRP, now named GMW Connections Project) concluded that outfall water contributed to maintaining significant environmental values in Lake Meran and therefore the lake should receive 147 ML as mitigation water, being 100% (the maximum allowable) of the calculated outfall volume in the baseline year (2004/05). Mitigation water was to ensure no negative impacts of irrigation modernisation on environmental values (North Central CMA, 2010). Little Lake Meran did not receive any outfall water in 2004/05 and therefore its mitigation water is zero. The volume of mitigation water allocated to Lake Meran is significantly less than the outfall volumes that these lakes received historically.

Information on environmental water deliveries to Lake Meran is summarised in Section 3.4.

Diversion licences are held by several landholders surrounding Lake Meran and Little Lake Meran. These licences permit water to be pumped from the wetland for irrigation and stock and domestic use (Ecos Environmental Consulting 2006). The licences have a collective entitlement of around 1,430 ML/year for Lake Meran and 150 ML/year for Little Lake Meran

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Table 6: Flooding/drying record for the Meran Lakes Complex. Key: ND = No data

Year	Lake Meran	Tobacco Lake	Round Lake	Great Spectacle lake	Through to downstream Wandella Creek	Little Spectacle Lake	Little Lake Meran
1851	Dried	-	-	-	-	-	-
1870 (large flood)	ND	ND	ND	ND	ND	ND	ND
1909	Spillway open	Filled	Filled	Full	Return flows	ND	ND
1917 (small flood)	ND	ND	ND	ND	ND	ND	ND
1923/24	Spillway open	Filled	Filled	Full	ND	ND	ND
1931	Spillway open	Filled	Filled	Full	ND	ND	ND
1933	Spillway open	Filled	Filled	Full	ND	ND	ND
1939	Almost dried	-	-	-	-	-	-
1955	Spillway open	Filled	Filled	Full	Return flows	ND	ND
1956	Spillway open	Filled	Filled	Full	Return flows	ND	ND
1973	Spillway open	Filled	Filled	Full	ND	ND	ND
1974	Spillway open	Filled	Filled	Full	Return flows	ND	ND
1975	Spillway open	Filled	Filled	Full	-	ND	ND
1981	Spillway open	Filled	Filled	Half full	ND	ND	ND
1983	Spillway open	Filled	Filled	~ 2 m	ND	ND	ND
1988	Spillway open	Filled	Filled	~ 1 m	ND	ND	ND
1996	Spillway open	Filled	Filled	~ 2.5 m	ND	ND	ND
2000	Low levels	-	-	-	-	-	Dried
2004	Dried	-	-	-	-	-	-
2010	Filled	-	-	-	-	-	-
2011	Spillway open	Filled	Filled	Filled	Through flows	Filled	Filled
2013/14	Environmental water delivery (1849 ML)	-	-	-	No	-	-
2014/15	Environmental water delivery (2000 ML)	Dried in 2014	-	-	No	Dried in 2014	-
2015/16	Environmental water delivery (up to 2000 ML)	-	Dried in 2016	Dried in 2015	No	-	Dried in 2016
2016/17 (May)	Environmental Water Delivery (2000 ML))						
2016/17 (October)	Filled with floodwater and spilled	Filled	Filled	-	No	-	-

3.3. Groundwater-surface water interactions

The Meran Lakes Complex occurs within the uppermost alluvial strata known geologically as the Shepparton Formation. Data from groundwater monitoring bores that have recently been drilled at Lake Meran confirm that the base of Lake Meran penetrates the underlying regional marine Parilla Sand Aquifer (North Central CMA, 2016a).

The floor of Lake Meran extends 1.2 metres below a deeply weathered surface of the Parilla Sand known as the Karoonda Surface. This horizon is capped by a ferruginous (ironstone) layer that quickly grades into a bleached kaolin rich zone. Together the two layers extend over a thickness of about ten metres. The Karoonda Surface at the base of the lake is overlain by a thin veneer of grey (hydromorphic altered) alluvial clay and together the two horizons form an aquitard that inhibits surface water migration to the underlying Parilla Sand aquifer.

When the lake level is low there is insufficient hydraulic gradient to drive appreciable volumes of water through the low hydraulic conductivity of the Karoonda clay Surface and there is very little seepage to groundwater (North Central CMA 2016a; AECOM, 2016). The seepage loss is apparent in piezometers adjacent to the lake, and groundwater levels within the regional aquifer proximal to the lake prior to the 2016 floods were falling.

For around 30 days from mid-April to 15 May, the North Central CMA delivered 2,000 ML of environmental water to Lake Meran; this appeared to register in the groundwater bore 100 m to the west of Lake Meran (Figure 4). The groundwater response was more evident in October 2016, when natural flooding filled the lake from 79.2 mAHD to around 82.3 mAHD when the groundwater rose by 1.2 metres (North Central CMA, 2016a).

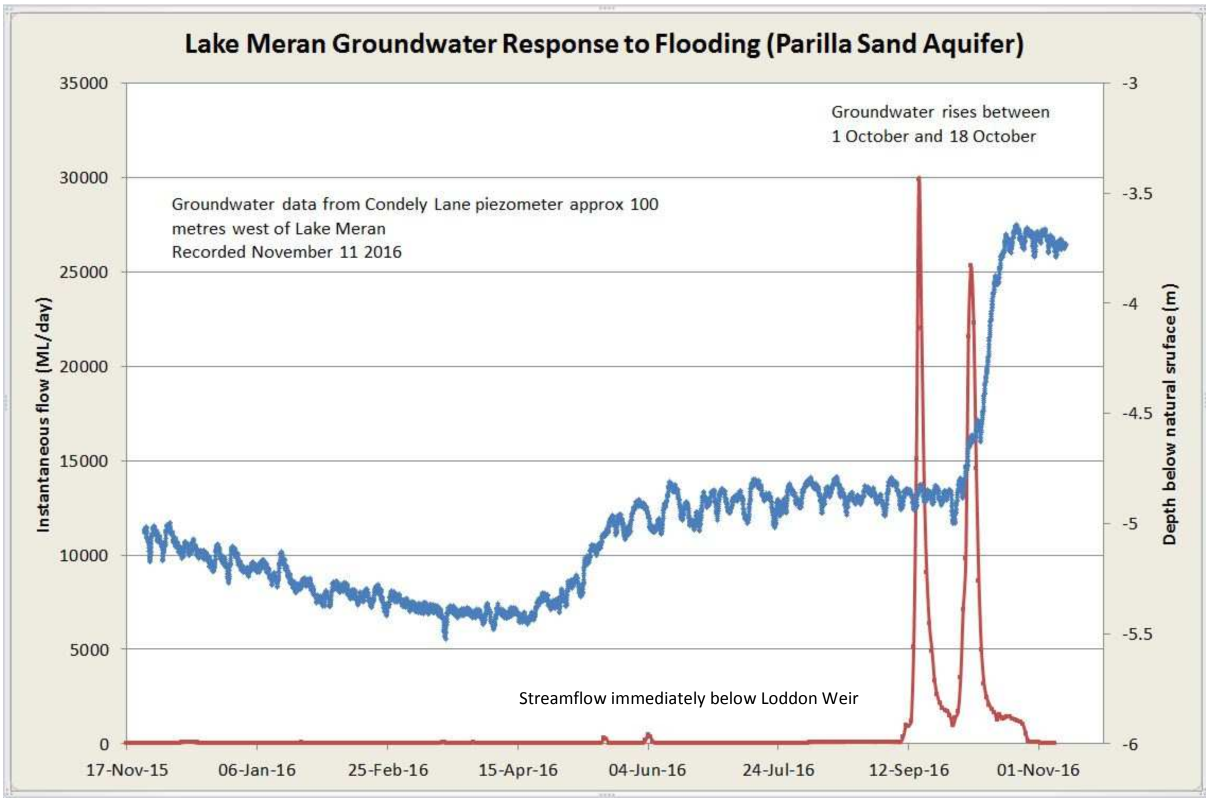

Figure 4: Groundwater response to during 2016. Aligning with filling events in Lake Meran

The post flood results of 2016 explain the enigma that is low salinity, where almost fresh groundwater (1,160 EC) in the immediate region of the lake displaces high salinity groundwater normally found within the Parilla Sand (30,000 to 50,000 EC) (North Central CMA, 2016a; GHD, 2016; AECOM, 2016). Vertical flow of lake water directly into the Parilla Sand also explains the lower salinity of the regional aquifer compared with higher salinity in the overlying Shepparton Formation (4,420 – 11,450 EC) (North Central CMA, 2016a).

It is difficult to know the extent of leakage when the lake is full and further monitoring is required to record changes in groundwater elevation as the lake fills and draws down in future.

3.4. Environmental watering

The North Central CMA has delivered environmental water to Lake Meran three times since the 2011 flood; 1,849 ML[2] in autumn 2014 (VEWH, 2014) and 2,000 ML[3] in autumn 2015 (VEWH, 2015) and 2,000 ML in autumn 2016. Those environmental water deliveries were based on the Lake Meran EWP, which recommends a permanent water level fluctuating around 79.5 mAHD.

Little Lake Meran to date has not had an EWP or EWMP and has not received any environmental water.

3.5. Water Quality

The Department of Primary Industries (DPI) measured water level and some basic water quality parameters at Lake Meran from 1990 until it dried in 2003. The sampling frequency varied for each parameter, but was usually monthly. The North Central CMA installed a continuous monitoring probe at the lake in January 2015 to measure electrical conductivity and water temperature to support the development of this EWMP.

3.5.1. Salinity

Water quality measurements taken in Lake Meran between 1990 and 2015 show that electrical conductivity remained below approximately 2,000 µS/cm (EC) for most of the time and only rose above 4,000 µS/cm, when the water level dropped below 77.0 m AHD (Figure 5). The highest conductivity measured in Lake Meran was 16,000 µS/cm (EC), and that occurred in 2002/03 just before it dried out. No data were collected while the lake was dry.

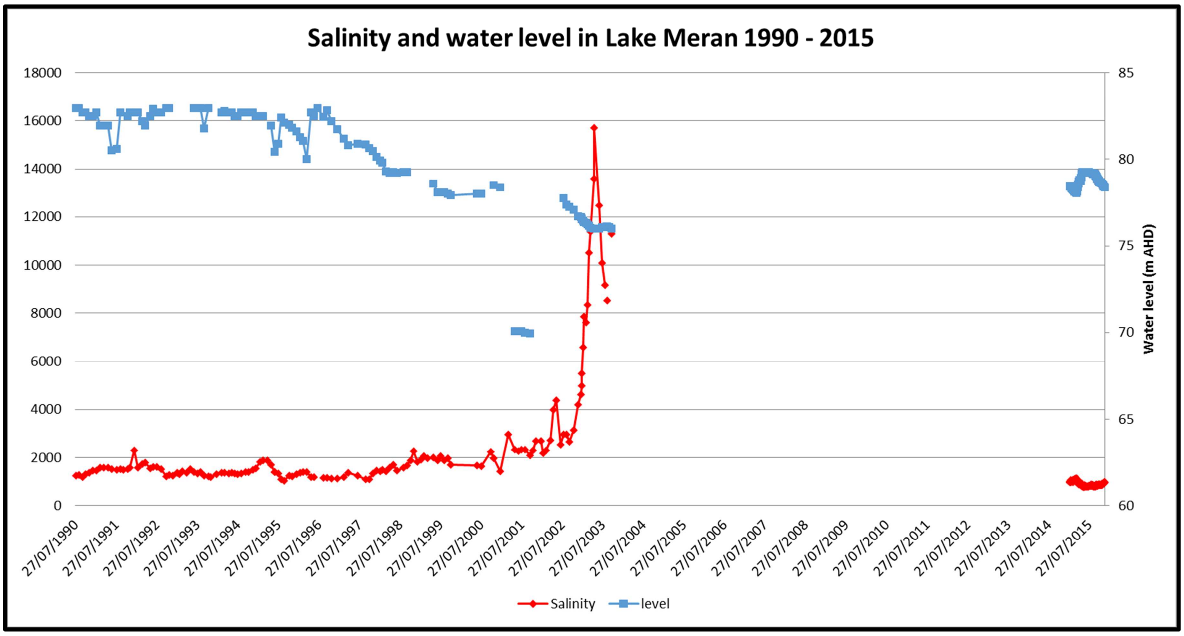

Figure 5: Plot of salinity and water level at Lake Meran from 1990 to 2015. Source: DPI and NCCMA.

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[2] The Meran Lakes Complex EWMP CAG has concerns about the accuracy of inflow volumes. GMW has provided evidence to support that the meters were working at the time that environmental water has been delivered to the lake and this is accepted by the North Central CMA and the VEWH.

[3] Ibid.

3.5.2. Dissolved oxygen

Dissolved oxygen was measured approximately monthly in Lake Meran between 1996 and 2003 (Figure 6). Dissolved oxygen concentrations in the lake have generally been within the tolerance limits for aquatic biota. The only times when dissolved oxygen concentrations have been a potential threat were between November 1998 and February 1999, when it dropped below 4 mg/L and in September and October 2003 when it was more than 15 mg/L. According to DPI data notes, these very high and very low concentrations coincided with algal blooms or large amounts of filamentous algae in the lake, rather than specific water levels. Algae photosynthesise during the day and respire at night. High concentrations of algae in standing waters often cause large daily fluctuations in dissolved oxygen with very high concentrations in the afternoon and very low concentrations first thing in the morning.

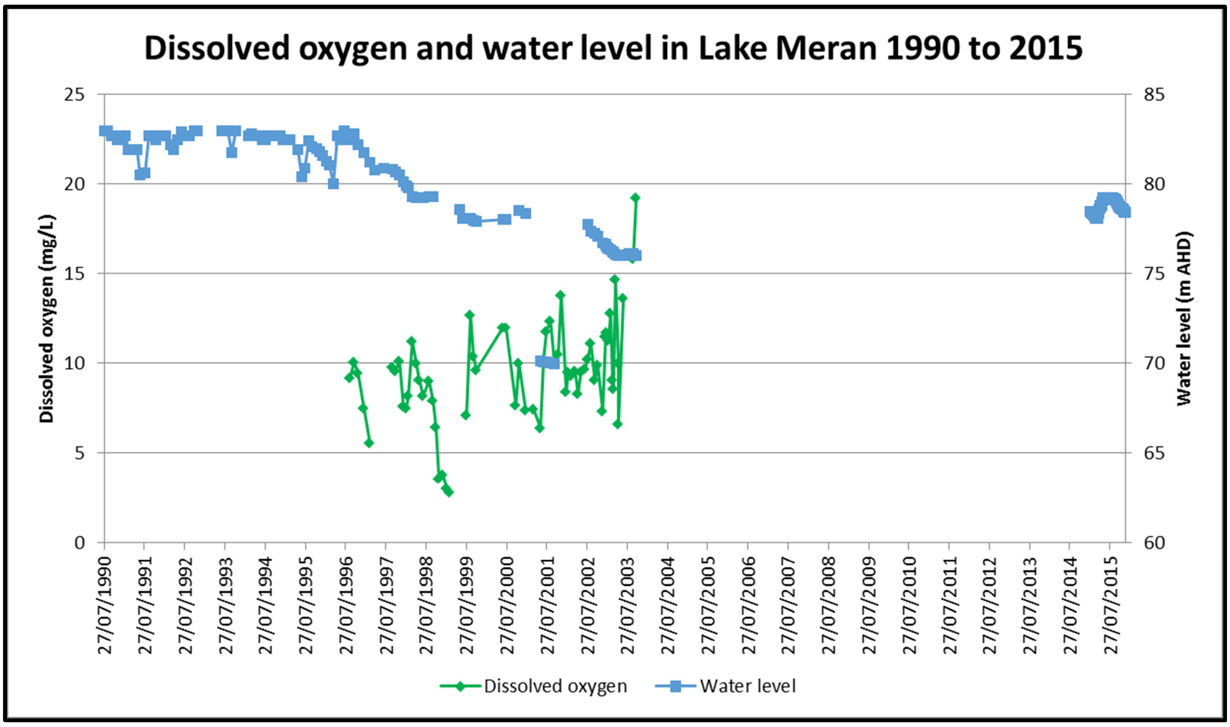


Figure 6: Plot of dissolved oxygen and water level at Lake Meran from 1990 to 2015. Source: DPI and NCCMA (water level only).

3.5.3. Water temperature

Water temperature in Lake Meran followed a seasonal pattern (Figure 7). It ranged from approximately 7-12 °C in winter to approximately 25-27 °C in summer. Higher summer temperatures may occur when the lake level drops below approximately 77 m AHD, which may represent a threat to some aquatic biota.

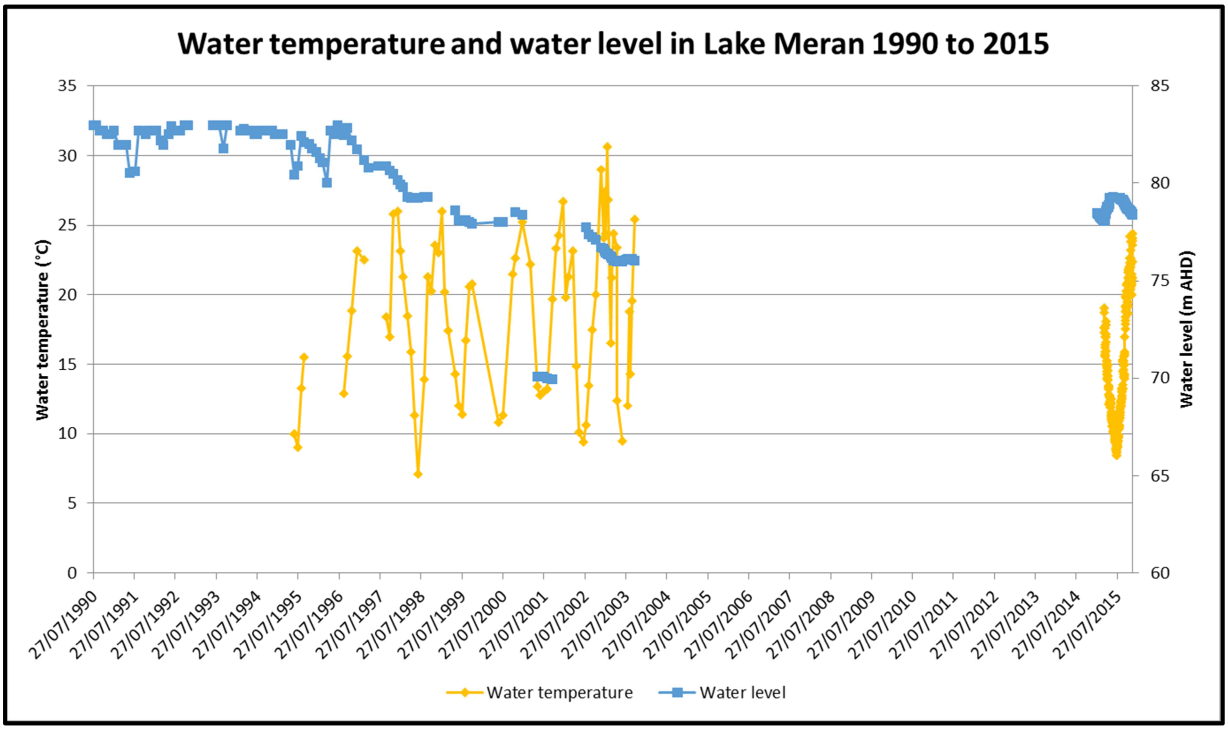


Figure 7: Plot of water temperature and water level at Lake Meran from 1990 to 2015. Source: DPI and NCCMA

3.5.4. Turbidity

Turbidity recorded from 1990 to 2003 was generally suitable for aquatic biota. However turbidity reached very high levels just before the lake dried in 2002/03 (Figure 8).

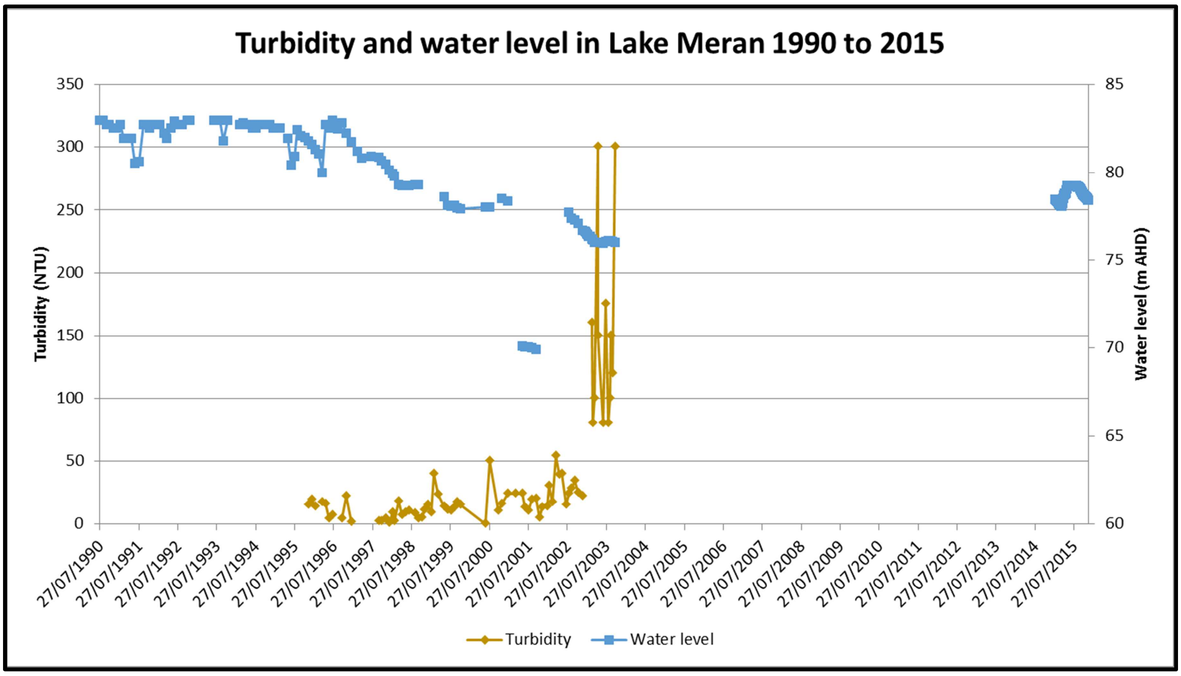


Figure 8: Plot of turbidity and water level at Lake Meran from 1990 to 2015. Source: DPI and NCCMA (water level only)

4. Water dependent values

The Meran Lakes Complex is an important asset on the mid-Loddon floodplain providing a variety of wetland habitat types that are capable of supporting a high diversity of waterbirds, frogs, mammals, reptiles and macroinvertebrates (Lugg et al. 1993; Ecos Environmental Consulting, 2006; Rakali Ecological Consulting 2015; North Central CMA 2016a). Many environmental values recorded and observed at the wetland complex are listed under legislation, agreements and conventions detailed in Table 7. The management of the wetland complex needs to comply with two international agreements as well as one national and two state legislations and agreements.

Table 7: Legislation, agreements, convention and listings relevant to the site, or species recorded at the Meran Lakes Complex

Legislation, Agreement or Convention	Jurisdiction	Listed
Japan Australia Migratory Birds Agreement (JAMBA)	International	√
China Australia Migratory Birds Agreement (CAMBA)	International	√
Environment Protection and Biodiversity Conservation Act 1999 (EPBC)	National	√
Flora and Fauna Guarantee Act 1988 (FFG)	State	√
Victorian advisory lists	State	√

4.1. Vegetation classes and flora

Nine ecological vegetation classes (EVCs) have been identified at the Meran Lakes Complex (Rakali Ecological Consulting 2015; North Central CMA 2016a; Rogers L. personal observation [North Central CMA] multiple site visits 2014-2016). The EVCs, their conservation status and the wetland where they are located are shown in Table 8, and maps are shown in Appendix D. The vegetation classes and flora for each wetland in the Meran Lakes Complex is described in sections 4.1.1. to 4.1.5. A species list is shown in Appendix E.

Table 8: Current EVCs, conservation status and relevant wetland

EVC No.	EVC	Bioregional Conservation Status (currently endorsed)	Bioregional Conservation Status (revised – awaiting endorsement)	Wetland
806	Alluvial Plains Semi-arid Grassland	-	Endangered	Little Lake Meran, Tobacco Lake, Great Spectacle, Little Spectacle Lake.
653	Aquatic Herbland	Depleted	Endangered	Lake Meran, Little Lake Meran, Round Lake
539	Brackish Lake Bed Herbland	-	Vulnerable	Little Lake Meran, Tobacco Lake, Round Lake, Great Spectacle, Little Spectacle Lake
813	Intermittent Swampy Woodland	Depleted	Endangered	All
107	Lake Bed Herbland	Vulnerable	Depleted	Lake Meran
823	Lignum Swampy Woodland	Vulnerable	Vulnerable	Lake Meran
66	Low Rises Woodland	Endangered	-	Lake Meran
103	Riverine Chenopod Woodland	Endangered	Vulnerable	Tobacco Lake, Round Lake, Great Spectacle, Little Spectacle Lake
821	Tall Marsh	Least Concern	Depleted	Lake Meran, Little Lake Meran, Round Lake

4.1.1. Lake Meran

DELWPs pre-1750 EVC mapping layer suggests that prior to European occupation the vegetation within Lake Meran was Freshwater Lake Aggregate (EVC 718) surrounded by Lignum Swampy Woodland (EVC 823). Semi-arid Woodland (EVC 97) occurred on higher elevations associated with the lunette to the east, and the land to the west of the wetland was dominated by Ridged Plains Mallee (EVC 96) interspersed with Low Rises Grassy Woodland (EVC 66) (North Central CMA 2010).

Current EVC mapping is shown in Appendix D2. The dominant vegetation is Intermittent Swampy Woodland (EVC 813), which has been mapped into three distinct zones. The upper most zone has a canopy of mature River Red Gum trees (Plate 1) with an understory of small trees such as Willow Wattle (*Acacia salicina*), sedges such as Spiny Flat-sedge (*Cyperus gymnocaulos*), wetland herbs and grasses. Below this zone Intermittent Swampy Woodland is associated with Lake Bed Herbland (EVC 107) when dry and Aquatic Herbland (EVC 653) when wet. In the mid zone all the mature trees have died and the zone is characterised by a young River Red Gum canopy (Plate 2) and Lake Bed Herbland supports threatened species including FFG listed Hoary Scurf-pea (*Cullen cinereum*) and terrestrial Downy Swainson-pea (*Swainsona swainsonioides*) (Rakali Ecological Consulting, 2015). The lowest zone, occurring in the deeper areas of the wetland, has no live trees, although there are stumps on the wetland bed. Aquatic Herbland also occurs in the lowest zone and is characterised by very small patches of aquatic herbs such Red Water-milfoil (*Myriophyllum verrucosum*).

The upper creek line that carries water through the southern basin of Lake Meran has elements of Tall Marsh (EVC 821), which is characterised by Cumbungi (*Typha spp.*) and Giant Rush (*Juncus ingens*) (Plate 3). The mid creek line that carries water through the middle basin has elements of Floodway Pond Herbland (EVC 810), which is dominated by Knotweed (*Persicaria spp.*) (Plate 4) (Rogers L. personal observation 2016 [North Central CMA], February). Large areas of Marsh Club-rush (*Bolboschoenus caldwellii*) are also located adjacent to the primary creek line in both the southern and the middle basins (Rogers L. personal observation, [North Central CMA], February 2016) (Plate 3).

Plate 1: Large old River Red Gum in Southern Basin

Plate 2: River Red Gum regeneration in the southern basin

 Plate 3: Tall Marsh and extensive stand of Club Rush in southern basin	 Plate 4: Extensive stand of Knotweed, with River Red Gum regeneration in Middle Basin

Eighteen significant flora species have been recorded at Lake Meran (Table 9). Of these 12 species are dependent on flooding for all or part of their life cycle.

Table 9: Significant flora species recorded at Lake Meran

Common Name	Scientific Name	Type	EPBC status	FFG status	VIC status
Brown Beetle-grass	*Leptochloa fusca subsp. fusca*	AM			R
Downs Nutgrass	*Cyperus bifax*	AM			V
Native Couch	*Cynodon dactylon var. pulchellus*	AM			K
Small Monkey-flower	*Mimulus prostratus*	AM			R
Smooth Minuria	*Minuria integerrima*	AM			R
Spiny Lignum	*Duma horrida subsp. horrida*	AM			R
Swamp Buttercup	*Ranunculus undosus*	AM			V
Trim Flat-sedge	*Cyperus concinnus*	AM			V
Twin-leaf Bedstraw	*Asperula gemella*	AM			R
Hoary Scurf-pea	*Cullen cinereum*	MF		L	E
Floodplain fireweed	*Senecio campylocarpus*	MF/T			R
Bluish Raspwort	*Haloragis glauca f. glauca*	T/AM			K

Type: AM-Amphibious, MF – Mudflat specialist, T - Terrestrial
EPBC status: EXtinct, CRitically endangered, ENdangered, VUlnerable, Conservation Dependent, Not Listed
FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing
Vic status: Presumed Extinct, Endangered, Vulnerable, Rare, Poorly Known

4.1.2. Little Lake Meran

DELWPs pre-1750 EVC layer mapped Little Lake Meran as a Red Gum Swamp (EVC 292) with Lignum Swampy Woodland (EVC 823) around the lake edges. Semi-arid Woodland (EVC 97) existed on the lunette east of the lake and Plains Woodland (EVC 803) to the west (DEPI 2014c).

The current dominant EVC, based on recent surveys, is Intermittent Swampy Woodland (EVC 813) characterised by a mix aged canopy of Black Box higher on the wetland margins, a mixed age canopy of River Red Gum along the lake verge and young River Red Gum trees and saplings recruiting closer to the lake bed. The upper zone comprises a diverse native understorey of forbs, grasses and shrubs.

The very outer edges of the wetland have smaller patches of Plains Woodland, Lignum Swampy Woodland and Riverine Chenopod Woodland (EVC 103). The understorey in the inner zone of Intermittent Swampy Woodland is dominated by Native Liquorice (*Glycyrrhiza acanthocarpa*) and Mallee Lovegrass (*Eragrostis dielsii*) (North Central CMA, 2016b).

The response of vegetation to the 2010/11 floods was not formally documented, however Aquatic Herbland (EVC 653), which was characterised by dense mats of Water-milfoil (*Myriophyllum* spp.), was observed in the water and on the drying mud-flats in 2014 (L. Rogers pers. obs. [North Central CMA], 22 May 2014). These mats were stranded by 2015 and the formal assessment at that time described the dry phase EVC as Brackish Lake Bed Herbland (EVC 539).

There are no records of water dependent flora species at Little Lake Meran.

4.1.3. Tobacco Lake

DELWPs pre-1750 EVC mapping suggests that prior to European settlement approximately 80% of Tobacco Lake was Red Gum Swamp (EVC 292). Lignum Swampy Woodland (EVC 823) is mapped around the western margins of the wetland (DEPI, 2014c).

Currently, Tobacco Lake is characterised by three EVCs, as shown in Table 8. Riverine Chenopod Woodland (EVC 103) is located on the highest elevation of the wetland to the north-west. This EVC is Black Box dominated vegetation. Below this EVC is Intermittent Swampy Woodland that is dominated by a Black Box canopy interspersed with River Red Gum. Some recruitment of both of these species has occurred throughout this EVC, with the densest recruitment occurring at the higher elevations (North Central CMA, 2016b).

Alluvial Plains Semi-Arid Grassland (EVC 806) is located between Intermittent Swampy Woodland and Brackish Lake Bed Herbland. This EVC is characterised by emergent macrophytes, comprising Spiny Flat-sedge (*Cyperus gymnocaulos*) and native grass Rats Tail Couch (*Sporobolus mitchellii*). Brackish Lakebed Herbland is characterised by a diversity of herbs and grasses including Mallee Lovegrass (*Eragrostis dielsii*) (North Central CMA, 2016b).

Observations since the 2011 floods indicate that Tobacco Lake does not have any obligate aquatic vegetation (water plants) (L. Rogers personal observation, [North Central CMA], 22 May 2014; North Central CMA, 2016b).

There are no records of significant water dependent flora species at Tobacco Lake.

4.1.4. Round Lake

DELWPs pre-1750 EVC mapping suggests that prior to European settlement Round Lake was characterised by Red Gum Swamp (EVC 292) with Lignum Swampy Woodland (EVC 823) around the wetland (DEPI, 2014c).

Riverine Chenopod Woodland (EVC 103) comprising a Black Box overstory and a structurally diverse native understory including shrubs, chenopods and grasses is located on the highest ground on the north west part of the lake (North Central CMA, 2016b). Intermittent Swampy Woodland (EVC 813) is characterised by Black Box in the upper margins and mature River Red Gum on the lower elevations. The understory of this EVC is dominated by Spiny Flat-sedge. Vegetation responses to the 2011 floods were not formally documented, however sparsely distributed Water-milfoil (*Myriophyllum* spp.) was observed in a narrow zone at the water's edge and on the drying mud-flats during a site visit in 2014 (L. Rogers personal observation [North Central CMA], 22 May 2014). The low elevation zone of Round Lake was classified as Brackish Lake Bed Herbland (EVC 539) in 2015; it comprised a diversity of native forbs, grasses and sedges. Very young seedlings of River Red Gum are also located in this zone (North Central CMA, 2016b).

There are no records of significant water dependent flora species at Round Lake.

4.1.5. Great Spectacle and Little Spectacle Lakes

DELWPs pre-1750 Ecological Vegetation Class mapping suggests that prior to European settlement; both wetlands comprised a Lake Bed Herbland/Lignum Swampy Woodland mosaic (EVC 942). As with the other lakes in the Meran Lakes Complex, Semi-arid Woodland (EVC 97) existed on the lunette east of the lake and Plains Woodland (EVC 803) was to the west (DEPI, 2014c).

Riverine Chenopod Woodland (EVC 103), dominated by a Black Box canopy, is currently located on the north western upper margin of Great Spectacle Lake. The vegetation is in good condition, and has all its critical life forms. Intermittent Swampy Woodland at Great Spectacle Lake is characterised by a Black Box overstory in the upper areas, mature River Red Gums in the middle, and young recently recruited River Red Gum trees on the lower areas. The understory is dominated by Spiny Flat-sedge. Below the Intermittent Swampy Woodland zone is Alluvial Plains Semi-arid Grassland. This EVC is characterised by grasses and sedges, with occasional River Red Gum saplings. Brackish Lake Bed Herbland (EVC 539) on the mudflats has all its critical life forms including forbs, grasses and sedges. Great Spectacle Lake does not have any aquatic vegetation (North Central CMA, 2016b).

Little Spectacle Lake has the same EVCs as Great Spectacle Lake, although not in such good condition, as fewer of the critical life forms are present. The Intermittent Swampy Woodland zone at Little Spectacle Lake also has many drowned Black Box trees (North Central CMA, 2016b).

4.2. Fauna

One water dependent EPBC-listed species, eight migratory species, nine FFG-listed and one FFG nominated species have been recorded at the Meran Lakes Complex (see Table 10) (Ecos Environmental Consulting 2006; Turner R 2016 personal communication [landholder] 13 November; DEPI 2014b; Rakali Ecological Consulting 2015). A species list is shown in Appendix E.

The complex supports a pair of breeding FFG listed White-bellied Sea-eagles (*Haliaeetus leucogaster*) (Plate 5). The pair have one known breeding nest at Lake Meran and have potentially reared up to three young since the floods in 2011, including one that is almost old enough to fledge (Meran Lakes Complex EWMP CAG, 2016) (Plate 6). White-bellied Sea-eagles form lifelong pairs and are described as sedentary once they take up a breeding territory (Marchant and Higgins, 1993).

When inundated, the Meran Lakes Complex supports a high diversity of waterbirds. An assessment done prior to the Millennium Drought concluded that each of the wetlands had a moderate to high waterbird carrying capacity (Lugg et al. 1993). The wetlands provide different functions for waterbirds over the different seasonal and decadal cycles and have supported a range of waterbird feeding guilds (Turner R. personal communication [Local landholder], 10 February 2016).

Plate 5: Adult White-bellied Sea-eagles. Source: L Ritchie 2016

Plate 6: Juvenile White-bellied Sea-eagle. Source: L Ritchie 2016

Plate 7: Flock of Straw-necked Ibis in River Red Gum tree. Source: L. Ritchie 2016.

Plate 8: FFG listed Broad-shelled Turtle. Source: Austral Research and Consulting

The complex also supports the three species of Murray-Darling Basin freshwater turtle species (Table 10). Each of the wetlands has a lunette and sandy foreshore that is suitable as nesting substrate for freshwater turtles.

Table 10: Significant fauna species recorded and observed at the Meran Lakes Complex

Common Name	Scientific name	Inter-national agreement	EPBC status	FFG status	Vic status
Waterbirds					
Australasian Shoveler	*Anas rhynchotis*				V
Baillon's Crake	*Porzana pusilla palustris*			L	V
Baird's Sandpiper	*Calidris bairdii*				
Caspian Tern	*Sterna caspia*			L	NT
Common Greenshank	*Tringa nebularia*	C/J/R/B			V
Eastern Great Egret	*Ardea modesta*			L	V
Freckled Duck	*Stictonetta naevosa*			L	E
Glossy Ibis	*Plegadis falcinellus*	B			NT
Gull-billed Tern	*Sterna nilotica*			L	E
Hardhead	*Aythya australis*				V
Intermediate Egret	*Ardea intermedia*			L	E
Latham's Snipe	*Gallinago hardwickii*	J/R/B		N	NT
Little Egret	*Egretta garzetta nigripes*			L	E
Musk Duck	*Biziura lobata*				V
Nankeen Night Heron	*Nycticorax caledonicus hillii*				NT
Pied Cormorant	*Phalacrocorax varius*				NT
Red-necked Stint	*Calidris ruficollis*	C/J/R/B			
Royal Spoonbill	*Platalea regia*				NT
Sharp-tailed Sandpiper	*Calidris acuminata*	C/J/R/B			
White-bellied Sea-Eagle	*Haliaeetus leucogaster*			L	V

Common Name	Scientific name	Inter-national agreement	EPBC status	FFG status	Vic status
Reptiles					
Broad-shelled Turtle	*Chelodina expansa*			L	E
Murray-River Turtle	*Emydura macquarii*				V
Eastern Long-necked Turtle	*Chelodina longicollis*				DD
Type: Invertebrate, Fish, Amphibian, Reptile, Terrestrial Bird, Waterbird, Mammal **International:** CAMBA, JAMBA, ROKAMBA, Bonn **EPBC status:** EXtinct, CRitically endangered, ENdangered, VUlnerable **FFG status:** Listed as threatened, Nominated for listing as threatened **Vic status:** presumed Extinct, Endangered, Vulnerable, Rare, Near Threatened, Poorly Known, Data Deficient,					

4.2.1. Lake Meran

Lake Meran provides open water (with fringing mudflats), reed and River Red Gum habitat components, which attract a range of fauna. In the past it has supported a high number and high diversity of waterbirds, with various species of ducks as well as swans and grebes consistently breeding at the wetland. As a permanent freshwater wetland, Lake Meran is known to have previously supported a rich diversity native fish including Murray Cod (*Maccullochella peelii),* Silver Perch (*Bidyanus bidyanus*), which are protected by national and state legislation (North Central CMA 2010).

Fish-eating colonial nesting birds, such as Australian Darter (*Anhinga novaehollandiae*), Little Black Cormorant (*Phalacrocorax sulcirostris*) and Great Cormorant (*Phalacrocorax carbo*) are frequently observed roosting on the sand bar between the middle and northern basins of Lake Meran, and in young saplings and dead trees near the water (Rakali Ecological Consulting 2015; Rogers L personal observation [North Central CMA], multiple visits 2016).

A diverse range of migratory and other wading species has been observed by local community members on the mudflats as the lake has been drawing down. Particular species of note include Red-necked Avocets (*Recurvirostra novaehollandiae*), Sharp-tailed Sandpiper (*Calidris acuminata*), and Banded Stilt (*Cladorhynchus leucocephalus*) (Henderson P. personal communication 2016 [long-term camper at Lake Meran], 28 January).

Two recent surveys found freshly hatched and juvenile freshwater turtles, predominantly Murray River Turtle (*Emydura macquarii*) (Austral Research and Consulting, 2016: Spencer and Van Dyke, unpublished data). Murray River Turtles prefer permanent well vegetated waterways and wetlands. This species is currently not listed under legislation, but is under considerable threat throughout the Murray-Darling Basin due to predation (Chessman, 2011). Foxes target turtle eggs in their nests, and will prey on hatchlings moving back to the water and females as they leave the water to lay nest. The record of a significant number of juveniles from different cohorts indicates Lake Meran may be an important recruitment site. Assessments across the Murray-Darling Basin reveal a pattern of most populations dominated by adults with a few juvenile dominated sites in the region (Spencer R.J. personal communication 2016 [University of Western Sydney] 22 February). Therefore the Murray River Turtle population at Lake Meran could be an important source of animals that can colonise other parts of the Loddon River catchment and surrounding waterways.

A recent fish survey found a single EPBC listed Murray Cod, a small number of Golden Perch, likely stocked (Hodges G. personal communication [Fisheries Victoria] 10 February 2016), and several species of small bodied native fish including Australian Smelt (*Retropinna semoni*) and Un-specked Hardyhead (*Craterocephalus stercusmuscarum fulvus*) (Austral Research and Consulting, 2016) (Appendix E). Un-specked Hardyhead is currently FFG listed, however it has recently been removed from the *Victorian Advisory List of Threatened Vertebrate Fauna in Victoria* as there are many populations across the landscape, and therefore they are no longer considered a threatened species

(Austral Research and Consulting, 2016). Threatened fish that have been recorded at Lake Meran are shown in Table 11.

Table 11: Significant fish fauna recorded at Lake Meran

Common Name	Scientific name	Types	Inter-national agreement	EPBC status	FFG status	Vic status
Golden Perch	*Macquaria ambigua*	F				vu
Murray Cod	*Maccullochella peelii*	F		VU	L	en
Silver Perch	*Bidyanus bidyanus*	F		CR	L	vu
Freshwater Catfish[4]	*Tandanus tandanus*	F			L	
Type: Invertebrate, Fish, Amphibian, Reptile, Terrestrial Bird, Waterbird, Mammal International: CAMBA, JAMBA, ROKAMBA, Bonn EPBC status: EXtinct, CRitically endangered, ENdangered, VUlnerable FFG status: Listed as threatened Vic status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known						

4.2.2. Little Lake Meran

As a permanent freshwater lake, Little Lake Meran was known to have supported Murray Cod, a species protected by federal and state legislation (Table 12). At a site visit in 2014 several Black Swans (*Cygnus atratus*) were observed nesting among aquatic vegetation at Little Lake Meran. The wetland was covered by at least 100 unidentified species of duck (likely Grey Teal and Pacific Black Ducks) (Rogers L. personal observation, 2014 [North Central CMA], 22 May). As the wetland dried it supported a number of unidentified wading birds (Rogers L. personal observation, 2015 [North Central CMA], November).

Table 12: Significant fauna species recorded at Little Lake Meran

Common Name	Scientific name	Type	International agreements	EPBC status	FFG status	DSE status
Murray Cod	*Maccullochella peelii*	F		Vu	L	EN
Type: Fish, **EPBC status:** Vulnerable; **FFG status:** Listed as threatened; **Vic status**: ENdangered,						

4.2.3. Tobacco Lake

A survey undertaken in 1990 recorded over 100 waterbirds per hectare at Tobacco Lake, which the authors noted was the highest density of waterbirds they had ever observed (Lugg et al. 1993). A flock of more than 100 ducks (unidentified species) was observed at Tobacco Lake on a site visit by the author (Rogers L personal observation [North Central CMA], 22 May 2014). Anecdotally, duck hunters shot Pink-eared Ducks (*Malacorhynchus membranaceus*) in the 2014 season at Tobacco Lake (S. English personal communication [local landholder], 22 May 2014).

4.2.4. Round Lake

Round Lake supports a very similar diversity and abundance of birds as Little Lake Meran and Tobacco Lake (Lugg et al. 1993). Round Lake is the second deepest wetland in the complex and has obligate aquatic vegetation, rushes and reeds. Round Lake possibly supports waterbirds that forage in deep water (i.e. diving birds) or on wetland vegetation. As this lake is the third biggest in the complex, it provides wetland habitat for waterbirds for a number of years after flooding.

[4] This species has not been known at the lake for many decades.

4.2.5. Great and Little Spectacle Lakes

There is limited information on the waterbirds supported by Great Spectacle and Little Spectacle lakes. However, it is likely that the wetland supports a range of feeding guilds when it is full and as it draws down to expose mudflat habitat.

4.3. Terrestrial fauna that depend on water dependent vegetation communities

While not specifically dependent on wetland habitats for critical life cycle processes, a number of terrestrial fauna are dependent on the River Red Gum and Black Box vegetation communities located within the complex wetlands. Some of these terrestrial species are described below.

There is substantial evidence that the endangered Lace Monitor (*Varanus varius*) (aka Goanna) is reasonably abundant around the wetland complex with several tracks observed at multiple sites at Lake Meran and Little Lake Meran during recent site visits (Meran Lakes Complex EWMP CAG, 2016; Rogers L. personal observation 2016 [North Central CMA] multiple visits). There is anecdotal evidence that Carpet Python (*Morelia spilota metcalfei*) are present at the complex (Meran Lakes Complex EWMP CAG, 2016), and multiple species of micro bats are known to use the vegetation around the wetlands within the complex (P Haw personal communication 2016 [local wetland expert] 10 February). Black Wallaby (*Wallabia bicolor*) also use the complex with sightings and scats recently observed in the marsh vegetation in the southern and middle basins (Rogers L. personal observation 2016 [North Central CMA] multiple visits).

Resident populations of FFG listed Grey Crowned Babbler (*Pomatostomus temporalis*) inhabit the woodland habitat throughout the complex (Turner R. personal communication 2015 [local landholder] 13 November). Other FFG listed terrestrial bird species observed in and around the wetland complex include Grey Goshawk (*Accipiter novaehollandiae*), Hooded Robin (*Melanodryas cucullata*) and the Diamond Firetail (*Stagonopleura guttata*) (Turner R. personal communication [local landholder] 13 November 2015).

4.4. Wetland depletion and rarity

Lake Meran is classified as a permanent freshwater lake, and other wetlands in the Complex, including Little Lake Meran, are classified as temporary freshwater lakes (Butcher R. 2016 personal communication [Water's Edge Consulting], 4 May). Under the current classifications, Lake Meran is 0.25% of the total permanent freshwater lake area in Victoria and the other wetlands in the complex is 0.23% of the temporary freshwater lake area throughout Victoria (see Table 13).

Table 13: Contribution of wetlands within the Meran Lakes Complex to Victoria's wetland coverage

Classification	Victoria	Lake Meran (222.6 ha)	Little Lake Meran (31 ha)	Tobacco Lake (10.5 ha)	Round Lake (15.9 ha)	Great Spectacle Lake (49.4ha)	Little Spectacle Lake (31.9 ha)	Complex
Permanent freshwater lake	95596 ha	0.25%						0.25%
Temporary freshwater lake	58314 ha		0.05%	0.02%	0.03%	0.08%	0.05%	0.23%

4.5. Ecosystem function

Ecosystem function means the biological, geochemical and physical processes and components that in an ecosystem. These functions relate to the structural components of an ecosystem (e.g. vegetation, water, soil, atmosphere and biota) and how they interact with each other, both at a local (i.e. site specific) and regional (i.e. within the landscape) scale. Ecosystem function includes processes that are essential for maintaining life such as nutrient and carbon storage, transport and cycling as well as the provision of resources that support biodiversity such as habitat, food and shelter.

The mid-Loddon floodplain was once characterised by many wetlands and many wetland types. Land clearing, farming activities and hydrological changes to the rivers and natural flow paths have significantly reduced the diversity and abundance of wetlands across the region. The Meran Lakes Complex has high value because provides a variety of wetland habitats including River Red Gum and Black Box woodland, marshes, aquatic vegetation and open water and associated mudflats. Lake Meran, with its three basin depressions, is also one of the most geomorphologically diverse wetlands on the mid-Loddon floodplain.

Further, while a number of permanent water wetlands persist in the landscape; these are primarily managed as water storages, which have limited variation in water levels from year to year resulting in low productivity. With greater variation in water level over a number of years, creating wetting and drying of a large area of its sediments, Lake Meran has the potential to be a highly productive permanent freshwater wetland.

With the exception of Little Lake Meran, the Meran Lakes Complex is connected hydraulically to the Loddon River System via the Wandella Creek and a mix of smaller natural and artificial floodways. Floods transport nutrients, carbon, fish and macroinvertebrate eggs, seeds and other propagules from the river to the wetlands and from the wetlands back to the rivers. The complex also has nutrient, carbon and biological exchange with and small area within the Leaghur State Park, and is critical for many terrestrial fauna that use the forest. A corridor of remnant riparian vegetation along the Wandella Creek links the wetlands and Leaghur State Park with the Wandella Forest. The wetland complex also provides a habitat link between the Boort and Kerang wetlands.

The Meran Lakes Complex is an important water source for biota that live on the Mallee country to the west. The importance of this has increased since the Normanville channel system was upgraded to a pipeline, which removed open water channels and reduced the number of farm dams in the Mallee country landscape (Meran Lakes Complex EWMP CAG, 2016).

Table 14 broadly shows the ecosystem functions provided by Meran Lakes Complex from a local and landscape perspective.

Table 14: Ecosystem function of Meran Lakes Complex at a local and landscape scale

Local ecosystem functions	Landscape ecosystem functions
• **Convert matter to energy for uptake by biota**- this requires suitable substrate surfaces (i.e. rocks, woody debris, and gravel) and water conditions for biofilms and plant matter to grow on and interactions between primary producers and consumers such as the breakdown of carbon and nutrients by zooplankton and macroinvertebrates for higher order consumers. • **Provide shade and shelter for biota**- this includes amelioration of extremes in temperature, sunlight exposure and wind as well as protection from predators. The relationships between tree, shrub, forb and grass species exhibited at each wetland and compatible geology, soil type, slope aspect, elevation, moisture availability and temperature range characteristics are the main ecosystem components supporting this function. • **Provide water for consumption**- retention and storage of water for use by biota to enhance growth and development and to ensure survival and reproduction. • **Reproduction**- recruitment of new individuals requires sufficient shelter from predators, food for growth, resources for nest building and cues for breeding (i.e. water level changes, temperature, rainfall etc.). Adequate resources to support newly recruited juveniles are also required, including shelter, food and provision of water for consumption. Plants also require specific germination and growth conditions (including flood cues, follow up flooding, drying etc.) to ensure successful recruitment.	• **Provide refugia –** local refuges are important for many aquatic biota on the mid-Loddon floodplain, and also for the Mallee Murray Bioregion to the west. Refuges in this context predominantly relate to wet areas that persist when the surrounding landscape dries. They allow populations to persist through periods of environmental stress and provide a source of biota that can disperse to recolonise other parts of the landscape when the stress is over (e.g. when floods break a prolonged drought). • **Population persistence**- a number of species require specific habitat conditions to breed. With the significant reduction in suitable wetland habitat on the mid-Loddon floodplain, the populations of the three Murray-Darling freshwater turtle species, and other significant frog, bird and fish species are declining. • **Movement/ dispersal**- Some species need to be able to move across the landscape (i.e. migrate) to complete critical stages of their life cycle. Movement and dispersal of individuals also helps to maintain diversity within the landscape and reduces the risk of local species extinction. The movement of mobile species such as birds supports the dispersal of seeds/propagules in the landscape providing a source for colonisation. • **Biological diversity**- the provision of a sufficient number and range of habitat types in the landscape supports a high diversity of native species. This in turn assists to safe guard populations from the impacts of catastrophic events (i.e. loss of habitat through fire and clearing) that may deplete a particular habitat type at one site. Having populations in multiple habitat locations across the region helps to maintain genetic and species diversity.

4.6. Social values

4.6.1. Cultural heritage

Prior to European occupation, Aboriginal people were the custodians of the Meran Lakes Complex, relying on its resources and living by the banks of the wetlands for tens of thousands of years. Although the traditional boundaries are thought to be somewhat fluid, the people who are believed to have most extensively occupied and used the Meran Lakes Complex are the Barapa Barapa Nation (Lovell Chen et al. 2013; VACL 2016). Barapa Barapa country extends from within NSW down to the lower Loddon districts (Lovell Chen et al. 2013).

Local residents believe that the Barapa Barapa lived on Country until approximately 1875 (Morton Ritchie pers. comm. [local landholder], 18 February 2016). By the early 1900s, very few Aboriginal people remained in the area due to disease (particularly smallpox), and to being driven off Country by pastoralists, violence, and food scarcity (Lovell Chen et al. 2013).

All Aboriginal sites, places and objects are protected under the *Archaeological and Aboriginal Relics Preservation Act 1972* and the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*. In Lake Meran, nine sites of Aboriginal archaeological significance have been recorded and registered with Aboriginal Affairs Victoria (AAV). All of these sites are Aboriginal scar trees (North Central CMA 2010).

The North Central CMA organised a site visit to Lake Meran with Elders and other members of the Barapa Barapa to support the development of the EWMP. The participants noted that the wetlands in the Complex would have provided reliable sources of water as well as a rich and diverse supply of mineral, plant and animal resources for food, fibre, medicines, shelter, clothing and tools. Evidence of the previous use of the Complex by the Barapa Barapa remains, and participants noted that there are many more culturally significant sites at the Complex than currently recorded on the Victorian Aboriginal Affairs Victoria (AAV) register.

Evidence of Aboriginal use of the area, in the form of multiple oven mounds and middens indicate that the complex was very productive when water was in the landscape (Kirby E and McGee G personal communication [Barapa Barapa Traditional Owners and Elders], 18 February 2016). Leaghur Forest immediately to the south of Lake Meran has oven mounds approximately every 200 metres; there are also many oven mounds around and within Lake Meran as testament to its value as a regular food source (Haw P. personal communication (local community), 18 February 2016). Oven mounds, which were used to cook food, were only built in areas where there was a good supply of wood and are usually found near waterways. The mounds often contain charcoal, burnt clay or stone heat retainers, as well as animal bones, shells and stone tools.

4.6.2. Recreation

The Meran Lakes Complex supports a variety of recreational pursuits; most notably Lake Meran is a popular place over summer for camping, swimming, water skiing and enjoying the natural environment (including sandy beaches and River Red Gums). The community place high value on Lake Meran as a deep permanent waterbody, enabling the use of the diving platform and boating activities. When sufficiently full, it is considered a safe, deep lake for swimming and water skiing with a gradual shore incline and therefore great for families.

After the 2010/11 floods, the Public Purposes Committee received funds from Rotary to upgrade Camp Slade. The upgrades included constructing a new shelter and BBQ area, tennis courts, playground and erecting relevant signage.

New Year's Day family sport celebrations have been held at Lake Meran for at least 100 years. Old-fashioned competitions such as sheath throwing, athletics and sack races continue to be held. In more recent times family ski races were added to the New Year's Day events.

A petition to "Save Lake Meran" was launched by the community in 2015 in an attempt to secure water for the lake. The community see the benefits of having visitors to the area as a real boost to the local economy (refer to Section 4.7).

Recreational values at downstream lakes in the complex primarily relate to pursuits such as wildlife observation (i.e. Field Naturalist Club and bird watchers) and picnicking when water is present.

Under the status as a Wildlife Reserve, the complex is available for in season duck hunting as sanctioned by the land manager. Annual fox hunting drives occur within the complex and in the surrounding area in an effort to control fox numbers.

4.7. Economic

The Meran Lakes Complex sits within a productive agricultural landscape of mixed farming with cropping of cereals, grains, sheep and cattle grazing. The Meran Lakes Complex provides the following economic benefits to the local community:

- Tourism: visitors bring money to the community
- Irrigation licenses: several land owners have licences that enable them to divert water from Lake Meran and Little Lake Meran to support the production of food and fibre.
- Grazing licenses on frontage: in fencing off parts of the Complex to contain livestock, the landowners may help protect areas from illegal wood harvesting and damage associated

with camping. The current license holders rarely graze the frontage, which is primarily used for moving stock between paddocks.

4.8. Ecological condition and threats

4.8.1. Historic condition

Historical anecdotes about Lake Meran and Little Lake Meran in the first half of the 20th Century describe the wetlands with such thick beds of aquatic vegetation that people using the lake had to cut their way through or swim over (Meran Lakes Complex EWMP CAG, 2016). Native fish populations were so abundant that at times small fishing boats would almost capsize when the net was being retrieved (Ritchie M personal communication 2015 [local landholder] November). Thousands of ducks and other waterbirds would use the site and when they took to the air the sky would darken (Meran Lakes Complex EWMP CAG, 2015). During the Great Depression of the late 1930s early 1940s, homeless families camped at the two lakes and lived off food they caught or gathered (Ritchie M, English B and Turner R 2015 personal communication [local landholders], November).

The decline of the condition of Lake Meran observed during the lifetime of the local community, in particular the reduction in condition and abundance of wetland vegetation, was observed to have started with the introduction of speed boating in the 1950s. The original speedboats used old car motors, and were known to leak oil and churn up the water and vegetation, with cut up vegetation often observed floating on the lake once the boats had left (Ritchie M personal communication 2015 [local landholders] November).

The introduction of Common Carp (*Cyprinus carpio*) in the 1970s caused more significant degradation. Carp foraging behaviour made the water more turbid and contributed to the substantial loss of wetland vegetation at all of the wetlands within the complex (Meran Lakes Complex EWMP CAG, 2016). The negative impact of Common Carp on wetland vegetation is common across the North Central CMA region and much of the Murray Darling Basin.

The Millennium Drought had a devastating impact on aquatic biota across the entire Loddon River System. Anecdotes from local landowners describe hundreds of freshwater turtles leaving the Meran Lakes Complex wetlands as Lake Meran and Little Lake Meran dried (Meran Lakes Complex EWMP CAG, 2016). Some of the turtles were rescued and placed in house dams (Plate 9), however it is likely that many perished as the entire landscape was dry. Fisheries Victoria removed numerous very large EPBC listed Murray cod from Lake Meran before it dried during the Millennium Drought (Ritchie M. personal communication 2015 [local landholder] 13 November). At the time that the Lake Meran EWP was developed the lake was already dry, as were many sites around the region, and the primary aquatic values had already been lost.

Plate 9: Turtles being rescued and placed in house dam. Source: L. Ritchie, 2016.

4.8.1. Current condition

Based on the Index of Wetland Condition (IWC) assessments completed in 2014 for Lake Meran and 2015 for the other wetlands, the wetlands within the Meran Lakes Complex are currently in moderate to good condition (see Table 15).

Table 15: Overall Index of Wetland Condition (IWC) scores for each wetland in the complex

Sub-index	Lake Meran	Little Lake Meran	Tobacco Lake	Round Lake	Great Spectacle Lake	Little Spectacle Lake
Catchment	very poor	poor	poor	poor	poor	moderate
Physical form	excellent	excellent	excellent	excellent	excellent	excellent
Hydrology	very poor	very poor	moderate	moderate	moderate	moderate
Water properties	moderate	good	moderate	good	good	good
Soil	excellent	excellent	excellent	excellent	excellent	moderate
Vegetation	poor	moderate	moderate	moderate	good	moderate
IWC scaled raw score (out of 10)	**5**	**6.07**	**6.25**	**6.99**	**7.25**	**6.69**
IWC condition category	**moderate**	**moderate**	**moderate**	**good**	**good**	**good**

Little Lake Meran has the lowest hydrology score in the complex because it is completely disconnected from the floodplain and natural flow paths by levees and roads (North Central CMA, 2016b). The artificial water management of Lake Meran and Little Lake Meran has altered the timing and frequency of inflows to both lakes and disrupted natural filling and draw down phases. This has contributed to the very poor rating for the hydrology sub-index for both of these wetlands (Rakali Ecological Consulting, 2015; North Central CMA, 2016b).

The other wetlands in the complex were rated moderate for the hydrology sub-index. The primary impact on the hydrology score for the smaller wetlands was localised modifications to natural flow paths, including construction of drains and levees. The seasonality of the flooding regime is not likely to have changed as these wetlands only receive water during natural floods (North Central CMA 2016a).

Permanent very high water levels at Lake Meran have drowned many large River Red Gum trees and reduced the extent of the oldest trees to a narrow zone around the outer edge. Lake Meran has the poorest quality vegetation within the complex due to the loss of large old trees, a low abundance and low diversity of woodland understorey, and a lack of obligate aquatic vegetation (Rakali Ecological Consulting, 2015). Greater fluctuations in water levels during the late 1990s and since the 2011 flood have triggered the recruitment of several cohorts of River Red Gum trees through the southern and mid basins of Lake Meran, and at lower elevations in the northern basin of Lake Meran (Rakali Ecological Consulting, 2015; North Central CMA, 2016b).

The vegetation condition at Little Lake Meran was assessed as moderate. The mixed age class of the canopy species and diverse woodland understorey are the main reasons why vegetation at Little Lake Meran is in better condition than at Lake Meran (Rakali Ecological Consulting, 2015; North Central CMA, 2016b).

Vegetation condition at Tobacco Lake, Round Lake and Little Spectacle Lake is moderate, largely due to the high abundance of terrestrial weeds. Great Spectacle Lake has a high diversity of vegetation structural components and large areas with very little weed cover; as a result it has a good vegetation sub-index score (North Central CMA, 2016b).

Little Lake Meran and Round Lake supported dense beds of Water-milfoil after the floods (Rogers L. personal observation 2014 [North Central CMA] 22 May). Both Little Lake Meran and Round Lake had substantial numbers of dead Common Carp on the wetland beds as the lakes dried, but aquatic vegetation was still present in the wetlands when they held water (Rogers L. personal observation 2014 [North Central CMA] 22 May).

The low abundance or lack of aquatic vegetation, and other structural habitat, such as small and large woody debris and associated leaf packs, is significantly limiting the productivity of Lake Meran. This is evident in the results of an acoustic monitoring survey undertaken in late November 2015 to assess frog species diversity and abundance. Acoustic recorders were placed near some aquatic vegetation to the west of Lake Meran and near a stand of dead timber to the north of Lake Meran in November 2015, and were left in place for a week. During that time they detected many sounds including splashing Carp, but no frog calls. During the same period, local landholders reported hearing frogs in dams near their homes, and acoustic recorders in other wetlands in the North Central CMA region recorded high frog abundance.

A macroinvertebrate survey completed at Lake Meran in 2016 caught very few macroinvertebrate families and the results did not pass the EPA guidelines for a healthy ecosystem for shallow (<5m deep) inland lakes. The low abundance and low diversity of macroinvertebrates was attributed to a lack of leaf packs, large submerged wood, submerged tree roots or different structural forms of macrophytes (e.g. submerged, floating, emergent) (North Central CMA 2016c). These habitat forms are critical to biological productivity because they provide a substrate on which biofilms and aquatic plants can grow, which in turn provide food and habitat for macroinvertebrates (North Central CMA, 2016c).

A recent survey of Lake Meran found that the wetland fish population was dominated by Common Carp in both biomass and abundance. While a small number of native fish were present, including one EPBC listed Murray Cod; the native fish population is currently in poor condition (Austral Research and Consulting 2016).

4.8.2. Current trajectory – do nothing

This section refers only to Lake Meran and Little Lake Meran, as these wetlands can receive environmental water.

Without environmental water, Lake Meran will be entirely dependent on natural flooding, and Little Lake Meran will not receive any water. The Loddon River, which is the source of floodwater for Lake Meran, will continue to be operated to provide for consumptive needs, which means high inflows will be harvested in storages in winter and spring and released at a controlled rate during the irrigation season (i.e. mid-August to mid-May). This operating regime reduces the frequency of floods throughout the Loddon River system and therefore reduces the frequency of natural inflows to Lake Meran. Climate change is likely to exacerbate the problem with best case scenario models predicting a 16% reduction in average annual runoff, an 18% reduction in average surface water availability and a 27% reduction in end of system flows for the Loddon River system by 2030 (CSIRO 2008). Not delivering environmental flows may result in the following ecological consequences:

- Loss of permanent water habitat for Murray River Turtle at Lake Meran
- Decline in the condition of very large adult River Red Gum trees (with potential death at Little Lake Meran)
- Loss of breeding habitat for colonial nesting waterbirds
- Loss of feeding habitat (i.e. fish) for breeding pair of White-bellied Sea-eagle
- Loss of FFG listed mud-flat flora species (e.g. Hoary Scurf-pea)
- Inability to recover key structural components of the wetlands, including aquatic vegetation, macroinvertebrate and frog communities.

4.9. Conceptualisation of Lake Meran and Little Lake Meran

The EWMP conceptualises the values and ecological functions for Lake Meran and Little Lake Meran (Figure 9 and Figure 10 respectively) as these are the two wetlands that the CMA can deliver environmental water to. The numbers in the figures are described on the page following each figure.

4.9.1. Lake Meran

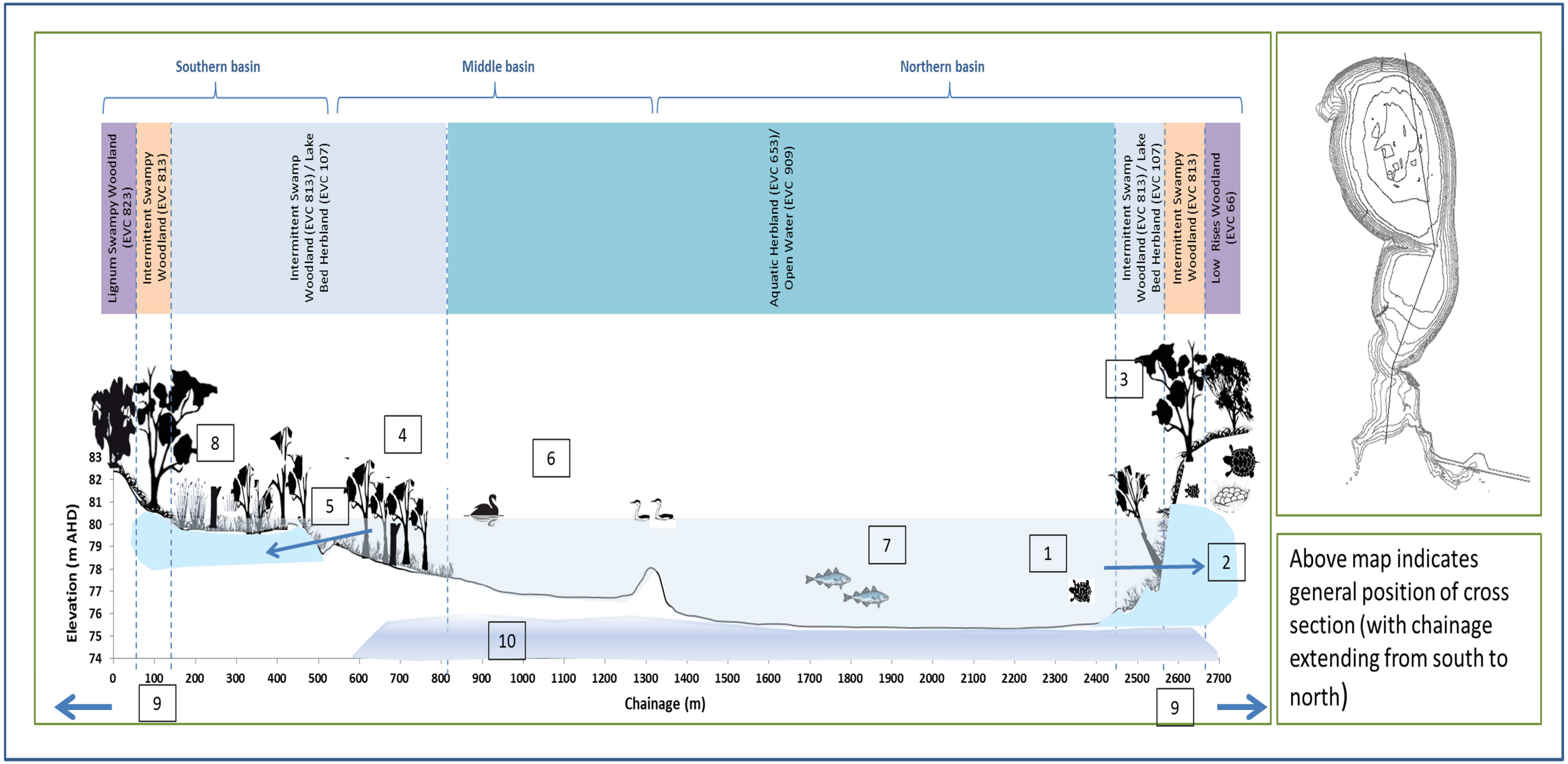


Figure 9: Cross section indicating conceptual understanding of Lake Meran ecology

Description of ecological concepts of Lake Meran:

1. Lake Meran supports a mixed age class of Murray River Turtles with more juveniles than adults. Currently, research has found most freshwater turtle populations are dominated by adults, with very few juveniles being recorded. All of the wetlands have a lunette to the east, which provides suitable nesting substrate.
2. Pore space in the sandy foreshore increases the total capacity of Lake Meran and fills via lateral seepage during filling events. This increases the volume of water required to reach target levels.
3. Very large old River Red Gum trees persist in a narrow band higher on the wetland profile. The location of these trees reflects the high water levels that Lake Meran has been managed at for many years. These trees would access soil pore water when the wetland holds water (see point 10) and the fresh groundwater lens underneath the lake (see point 11) during the dry periods of the 1930s and the Millennium Drought.
4. Multiple age cohorts of recently recruited River Red Gum trees are present further down the wetland profile. The oldest is thought to be from the 1996 flood, with the younger cohorts occurring after the 2011 floods (two are related to environmental watering events). The youngest cohort stands at about 1.2 metres and is located in the southern basin. These multiple age cohorts will naturally thin out, as some of the stands are quite dense. Some of these younger trees are producing seed. These tree will provide an increase in available habitat for many of the wetland birds recorded at the complex, including breeding habitat for colonial nesting waterbirds, such as Australian Darter and various cormorant species (see point 6) that breed in River Red Gum trees when flooded.
5. Lake Bed Herbland grows on the bed of wetlands when the water recedes. The plants that make up this EVC have seeds that can tolerate inundation for many years (varies per species) and germinate when the substrates are exposed to air. These species require dry period that is long enough to allow plants reach maturity and set seed. This EVC supports FFG listed Hoary Scurf-pea.
6. The lake provides a variety of habitats, such as open water, mudflats, marsh vegetation and woodland vegetation that are used by wetland birds. Wetland birds will use the entire complex when inundated and many species will rely on Lake Meran when the rest of the complex is dry. A breeding pair of White-bellied Sea-eagles uses Lake Meran, and the other wetlands when wet, as well as surrounding land to feed on fish, frogs, small mammals, lizards and other fauna.
7. Historically Lake Meran supported a diverse and abundant native fish population. The current population is dominated by Common Carp, which has impacted on the condition of the wetland through restricting aquatic vegetation growth and increasing turbidity.
8. The natural drainage line that carries water from the GMW channel, Pickles Canal and Leaghur Forest into the wetland supports Tall Marsh vegetation, including Cumbungi and Giant Rush. This vegetation supports many native bird species and also acts as a filter of floodwaters (until it is completely inundated).
9. Lake Meran is hydraulically connected to Wandella Creek via Pickles Canal to the south and via various flood ways and the smaller wetlands (except Little Lake Meran), to the north. At times of natural flooding and when the floods recede this creates opportunities for exchange of carbon, nutrients, eggs, seeds, propagules and aquatic fauna between the complex, Wandella Creek and the Loddon River.
10. A freshwater lens is located under Lake Meran indicating groundwater seepage has occurred over time. The current seepage rate is negligible (see Section 3.3 and two bores adjacent to the wetland will be monitored on an ongoing basis to assess changes to groundwater/ surface water interactions going forward.

4.9.2. Little Lake Meran

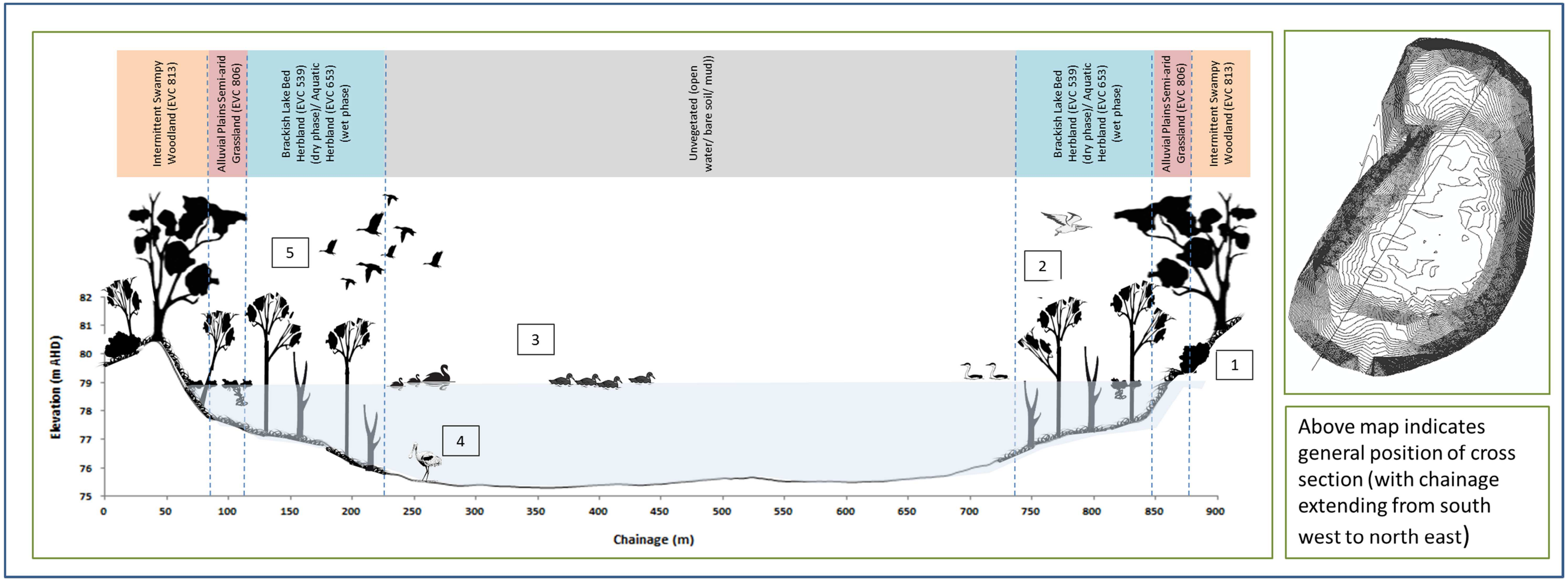


Figure 10: Cross section indicating conceptual understanding of Little Lake Meran ecology

1. Little lake has large old River Red Gum trees persisting in a narrow band higher on the wetland profile, their location evidence of the high water levels that Lake Meran has been managed at for many years.
2. Younger cohorts of River Red Gum trees are located further down the profile indicative of the drier conditions of the last 15 20 years.
3. The wetland provides open water habitat during its wet phase which supports deep water foraging waterbirds.
4. As the wetland dries (as has occurred recently since the 2011 floods), the deepest sections of the wetland bed provides mudflat habitat for wading birds, including many threatened and migratory species.
5. The shallower wetland areas support Aquatic Herbland during the wet phase. This EVC is present as dense stands of Water Milfoil, which provides breeding and feeding habitat for wetland birds, such as Black Swans. As the wetland draws down to dry Aquatic Herbland is replaced by this area supports Brackish Lake Bed Herbland when drying. The salt tolerant flora typical of this EVC also requires an inter-drying phase to ensure the plants mature and set seed.

4.10. Significance

While the current condition of the complex, and in particular Lake Meran and Little Lake Meran, is moderate and productivity is low, the complex supports a number of threatened species including a breeding pair of FFG listed White-Bellied Sea-Eagles. Recent surveys have shown that Lake Meran supports a significant number of juvenile Murray River Turtles and the Western Sydney University has proposed that the Meran Lakes Complex (in particular Lake Meran) may be a regionally important recruitment area for freshwater turtles (Spencer R. personal communication 2016 [Western Sydney University], 14 April).

Lake Meran also supports Lake Bed Herbland which includes two FFG listed flora species (Hoary Scurf-pea and Downy Swainson-pea) and is considered depleted across the Victorian Riverina.

The rehabilitation of key structural components of the wetlands, particularly Lake Meran and Little Lake Meran will improve the current productivity of the complex and provide substantial benefit at a landscape scale to water dependent and terrestrial values.

Further, while a number of permanent water wetlands persist in the Loddon Basin, these are primarily managed as water storages and due to constant almost bank full water levels, have very low productivity. The management of Lake Meran with greater levels of fluctuation will contribute to a more productive and higher value wetland.

5. Management objectives

5.1. Management goal

The long term management goal for Meran Lakes Complex has been derived from technical reports, the VWMS, North Central Waterway Strategy, environmental values documented in Section 4 and scientific expert input. It seeks to address and respond to the current condition and condition trajectory discussed in Section 4.8.

Meran Lakes Complex long term water management goal

A hydrologically diverse wetland complex comprising permanent, intermittent and episodic freshwater wetlands that support: healthy Aquatic Herbland, Lake Bed Herbland and Intermittent Swampy Woodland vegetation classes; a high diversity and periodically high abundance of wetland birds; and regionally significant breeding populations of freshwater turtles (e.g. Murray River Turtle).

The hydrological diversity described in the long term water management goal is defined in Table 16.

Table 16: Wetland regime type and definition of the wetlands at the Meran Lakes Complex (Source: DELWP, 2016)

Wetland	Water regime type	Definition
Lake Meran	Permanent	Never dries or dries rarely (i.e. holds water at least 8 years in every 10), but levels may fluctuate within or between years.
Little Lake Meran	Intermittent	Infrequently inundated, on average 3 to less than 8 years in every 10.
Tobacco Lake	Intermittent	Infrequently inundated, on average 3 to less than 8 years in every 10.
Round Lake	Intermittent	Infrequently inundated, on average 3 to less than 8 years in every 10.
Great Spectacle Lake	Episodic	Infrequently inundated, on average less than 3 years in 10
Little Spectacle Lake	Episodic	Infrequently inundated, on average less than 3 years in 10

5.2. Ecological objectives

Ecological objectives have been established for Lake Meran and Little Lake Meran as these are the two wetlands that the CMA can deliver water to. They describe the intended outcomes of environmental water delivery, contribute towards achieving the long term water management goal and are based on the key values of the site. Where appropriate, the ecological objectives are expressed as the target condition or functionality for each key value, using one of the following trajectories:

- restore – recover a value that has been damaged, degraded or destroyed and return it to its original condition.
- rehabilitate – repair a value that has been damaged, degraded or destroyed but not to the extent of its original condition.
- maintain – maintain the current condition of a value
- increase the extent – facilitate recruitment to increase the area covered by the value

Table 17: Ecological objectives and their justifications Lake Meran

Objective	Justification
1. Fauna objectives	
Primary fauna objectives	
1.1 Maintain refuge for and successful recruitment and survival of freshwater turtles, in particular Murray River Turtles	▪ All of Victoria's three turtle species have recently been recorded at Lake Meran (all other lakes in the complex are dry) ▪ Proportionally a high number of Murray-River Turtle hatchlings and juveniles were recently captured under two separate surveys, indicating successful recruitment over a number of years (Austral Research and Consulting, 2016; Spencer and Van Dyke, unpublished data). The site could be a regionally significant source population (Spencer R. personal communication 2016 [Western Sydney University], 14 April). ▪ Long-necked Turtles are a totem for the Barapa Barapa people.
1.2 Rehabilitate feeding and breeding opportunities for a high diversity of wetland birds (e.g. White-bellied Sea-eagles, Cormorants and Australian Darter, Black Swans and Grebes)	▪ Lake Meran provides a wide range of habitat types over its three basins and over wetting and drying cycles that can support a high diversity and abundance of waterbirds and terrestrial birds that use wetland habitats (but do not require flooding for life cycle processes), with around 330 species recorded at the wetland complex (Birds Australia, DELWP (2015), North Central CMA (2015); Rakali Ecological Consulting (2015), Turner R. personal communication [local landholder] 13 November 2015). ▪ A breeding pair of White-bellied Sea-eagle has successfully fledged at least two since the wetland complex filled in 2011. Protection of known White-bellied Sea-Eagle nests is a primary action for the conservation of this species under the FFG Action Statement (Clunie, 2003). ▪ Colonial nesting birds used both lakes to breed in the past (in the large trees around the fringes when water levels were high). ▪ Colonial nesting birds are frequently observed at Lake Meran, although breeding rates at the lake are low. ▪ Many waterbirds are a food source for the Barapa Barapa people.

Objective	Justification
Secondary fauna objectives	
1.3 Rehabilitate the diversity and abundance of native frog populations to support at least common species in the region such as Pobblebonks, Marsh Frogs, Perons Tree Frog	▪ Frogs, including eggs and tadpoles, are an important component of the food web and are prey at all life stages for a diversity of fauna including fish, reptiles and birds. ▪ Frogs are known to be present in surrounding farm dams and are present in the Southern Basin of Lake Meran. ▪ This ecological objective is long term (i.e. it may not be achieved in the life of this plan) and dependent on achieving other objectives e.g. restoration of aquatic vegetation and complementary measures, such as Common Carp Control.
1.4 Rehabilitate the abundance of large-bodied fish species known to have historically occurred at the site and small-bodied fish species common to the region.	▪ Lake Meran has historically supported diverse and abundant native fish populations including Murray Cod, Freshwater Catfish and numerous small-bodied species ▪ If Lake Meran is maintained as a permanent wetland then the aim should ultimately be to rehabilitate native fish populations however, this ecological objective is long term (i.e. it may not be achieved in the life of this plan) and dependent on achieving other objectives e.g. restoration of aquatic vegetation and complementary measures, such as Common Carp control. ▪ Fish provide an important food source for piscivorous wetland birds such as cormorants and White-bellied Sea-eagles.
2. Vegetation objectives	
2.1 Rehabilitate and increase the extent of Aquatic Herbland EVC 653 vegetation toward benchmark condition (e.g. *Myriophyllum spp.*, *Vallisneria spp. Triglochin spp.*, *Potamogeton* spp.)	▪ Aquatic Herbland is an endangered EVC in the Victorian Riverina Bioregion. ▪ A high coverage of aquatic vegetation has been shown to strongly correlate with high productivity ▪ Aquatic Herbland supports a high abundance of common frog species, which are important food source for dabbling ducks, egrets and other fish-eating waterbirds. ▪ Swans and grebes use aquatic vegetation as nesting substrate
2.2 Rehabilitate and increase the extent of Lake Bed Herbland EVC 107 vegetation towards benchmark condition (e.g. FFG listed Hoary Scurf-pea and Downy Swainson-pea) on exposed wetland bed.	▪ Lake Bed Herbland is a depleted EVC in the Victorian Riverina Bioregion. ▪ This EVC supports FFG listed species Hoary Scurf-pea and Downy Swainson-pea ▪ Herbland species provide food and habitat for terrestrial animals including Black Wallaby ▪ Many Lake Bed herbland species are used by Barapa Barapa for cultural uses such as medicine (i.e. Sneezeweed (*Centipeda cunninghamii*)).

Objective	Justification
2.3 Maintain the extent of emergent aquatic vegetation associated with Tall Marsh EVC 821 (including Typha spp., Juncus spp. and Eleocharis spp.), in the southern basin and higher levels of the mid basin of Lake Meran	▪ Tall Marsh is a depleted EVC in the Victorian Riverina Bioregion ▪ Tall Marsh vegetation provides foraging and nesting habitat for waterbirds such as crakes and rails ▪ Rushes and reeds provide tubers for food and fibre for weaving for the Barapa Barapa people.
2.4 Rehabilitate the condition of Intermittent Swampy Woodland towards EVC benchmark condition by: 2.4.1 maintain the health of adult and recently recruited River Red Gum and Black Box trees (within the wetted area) and 2.4.2 increase the extent of River Red Gum Trees 2.4.3 rehabilitate the associated understorey species such as River Coobah (*Acacia stenophylla*), Tangled Lignum (*Duma florulenta*) and various herbs and graminoids.	▪ Intermittent Swampy Woodland is an endangered EVC in the Victorian Riverina Bioregion ▪ River Red Gum communities provide habitat for a many waterbird species when inundated, including roosting and breeding habitat for colonial nesting birds such as Australian Darters and various cormorant species ▪ Old River Red Gum trees provide hollows for various waterbirds, terrestrial birds and native mammals. ▪ Woodland trees provide important habitat for terrestrial species such as FFG listed Grey Crowned Babbler, Carpet Python and bats. ▪ Understorey shrubs and groundcovers are critical life forms in the Intermittent Swampy Woodland EVC which is endangered in the Victorian Riverina Bioregion ▪ Understorey structural components provide critical habitat for fauna including frogs and birds
3. Process objective	
3.1 Rehabilitate macroinvertebrate communities to ensure that all expected functional groups (e.g. grazers, shredders, filter feeders etc.) are present and have sufficient biomass to support ecological processes and food webs.	▪ Macroinvertebrates and zooplankton are critical components of wetland food webs. Productive macroinvertebrate and zooplankton communities will provide food that will support large numbers of fish, frogs, waterbirds and turtles. ▪ Need to support multiple functional groups because they use different habitats and serve different ecological processes.

Table 18: Ecological objectives and their justifications for Little Lake Meran

Objective	Justification
4. Fauna objectives	
4.1 Rehabilitate feeding and breeding opportunities for a high diversity of wetland birds of various feeding guilds, (e.g. ducks, fish eating birds, deep water foragers, and migratory wading waterbirds)	▪ The wetland complex provides a wide range of habitat types over their wetting and drying cycles that can support a high diversity and abundance of waterbirds and terrestrial birds that use wetland habitats (but do not require flooding for life cycle processes), with around 330 species recorded at the wetland complex (Birds Australia, DELWP (2015), North Central CMA (2015); Rakali Ecological Consulting (2015), Turner R. personal communication [local landholder] 13 November 2015). ▪ Many waterbirds are a food source for the Barapa Barapa people.
5. Vegetation	
5.1 Rehabilitate Aquatic Herbland EVC 653) vegetation toward benchmark condition (e.g. *Myriophyllum* spp., Triglochin spp., *Potamogeton* spp.)	▪ Aquatic Herbland is an endangered EVC in the Victorian Riverina Bioregion. ▪ A high coverage of aquatic vegetation has been shown to strongly correlate with high productivity ▪ Aquatic Herbland supports a high abundance of common frog species, which are important food source for dabbling ducks, egrets and other fish-eating waterbirds. ▪ Swans and grebes use aquatic vegetation as nesting substrate
5.2 Rehabilitate the condition of Intermittent Swampy Woodland (EVC 821) towards benchmark condition by: 5.2.1 maintaining the health of adult and recently recruited River Red Gum and Black Box trees 5.2.2 increasing the extent of River Red Gum 5.2.3 rehabilitating the associated understorey species such as River Coobah (*Acacia stenophylla*), Tangled Lignum (*Duma florulenta*) and various herbs and graminoids.	▪ Intermittent Swampy Woodland is an endangered EVC in the Victorian Riverina Bioregion ▪ River Red Gum communities provide habitat for a many waterbird species when inundated, including roosting and breeding habitat for colonial nesting birds such as Australian Darters and various cormorant species ▪ Old River Red Gum trees provide hollows for various waterbirds, terrestrial birds and native mammals. ▪ Woodland trees provide important habitat for terrestrial species such as FFG listed Grey Crowned Babbler, Carpet Python and bats. ▪ Understorey shrubs and groundcovers are critical life forms in the Intermittent Swampy Woodland EVC which is endangered in the Victorian Riverina Bioregion ▪ Understorey structural components provide critical habitat for fauna including frogs and birds
6. Habitat objective	
6.1 Maintain open water and associated mud-flat habitats for sufficient periods during flooding and drying cycles to drive aquatic food webs and support wetland bird feeding and breeding.	▪ A high diversity and abundance of waterbirds use the open water (e.g. White-bellied Sea-eagle, multiple duck species and fish eating birds), and mudflat habitat (Latham's Snipe, spoonbills and other wading migratory birds) when they are present in the wetland complex ▪ Some birds e.g. dotterels breed on mudflats

5.3. Hydrological requirements of ecological objectives

The hydrological requirements for the values that the ecological objectives detailed in Section 5.2 have been developed for Little Lake Meran and Lake Meran. To meet the hydrological requirements of the Meran Lakes Complex EWMP, environmental water requirements have been set considering the following factors:

- the preferred timing of watering events
- the recommended duration for watering events
- the tolerable intervals between events (condition tolerances)

The hydrological requirements to achieve the ecological objectives have been described in Table 20 for Little Lake Meran and Table 19 for Lake Meran. These have been derived from Roberts and Marston, 2011; Rogers and Ralph, 2011; Rakali Ecological Consulting, 2015; and Marchant and Higgins, 1993.

Table 19: Hydrological requirements of ecological objectives for Lake Meran

Ecological objectives	Water management area	Hydrological Requirements: Recommended number of events in 10 years – Min	Opt	Max	Inter-drying period duration (months) – Min	Opt	Max	Duration of ponding (months) – Min	Opt	Max	Preferred timing of inflows	Approximate target volume (ML) and depth (m AHD)[5]	Depth (m)
1. Fauna objectives													
1.1 Maintain refuge and successful recruitment and survival of freshwater turtles, in particular Murray River Turtles	Fringe	MRT prefer permanent well vegetated wetlands and prefer not to travel overland to other waterways.									NA	77.3 mAHD – 77.8 mAHD 1244 ML – 1750 ML	>1.5 m
1.2 Rehabilitate feeding and breeding opportunities for a high diversity of wetland birds, including White-bellied Sea-eagles, cormorants and Australian Darter, Black Swans and grebes	Fringe and bed	2	3	10	Not known	24	48	7	10	-	Spring-autumn	77.3 mAHD to 81.4 mAHD 1244 ML – 6720 ML	<3.5m #
2. Vegetation objectives													
2.1 a Rehabilitate and increase the extent of Aquatic Herbland EVC 653 vegetation toward benchmark condition (e.g. *Myriophyllum* spp., *Vallisneria* spp. *Triglochin* spp., *Potamogeton* spp.)	Bed verges	2	7	9	12	36	60	4	8	11	Autumn/ Spring	77.3 mAHD to 81.4 mAHD 1244 ML – 6720 ML	>10cm

[5] Volume is based on the Lake Meran capacity table (Appendix C) and does not take into consideration losses associated with delivery, evaporation and seepage

Ecological objectives	Water management area	Hydrological Requirements: Recommended number of events in 10 years			Inter-drying period duration (months)			Duration of ponding (months)			Preferred timing of inflows	Approximate target volume (ML) and depth (m AHD)[5]	Depth (m)
		Min	Opt	Max	Min	Opt	Max	Min	Opt	Max			
2.1b Rehabilitate and increase the extent of Lake Bed Herbland EVC 107 vegetation towards benchmark condition (e.g. FFG listed Hoary Scurf-pea and Downy Swainson-pea) on exposed wetland bed.	Dry bed	1	2	3	24^	48^	60^	These species require the inter drying period			N/A	77.8 mAHD 1750 ML	N/A
2.2 Maintain the extent of emergent aquatic vegetation associated with Tall Marsh EVC 821 (including *Typha* spp., *Juncus* spp. and *Eleocharis* spp.), in the southern basin and higher levels of the mid basin of Lake Meran	Fringe and Lake Meran drainage line	2	8	9	12	24	60	4	8	12	Spring/ Summer	Maintained through water moving through drainage line into the wetland	0.3 – 1.5m
2.3 a (i) Maintain the health of adult and recently recruited River Red Gum trees in Intermittent Swampy Woodland.	High/ Moderate elevations of fringe and southern basin bed	1	2	3	12	24-36	60	2	4	12	Spring/ Summer	81.4 mAHD 6720 ML	<1.4m
2.3 a (ii) Maintain the health of adult Black Box trees in Intermittent Swampy Woodland.	Higher elevations of fringe	1	2	2	36	60	120	0	3	6	As per natural	81.4 mAHD 6720 ML	Not critical

Ecological objectives	Water management area	Hydrological Requirements											
		Recommended number of events in 10 years			Inter-drying period duration (months)			Duration of ponding (months)			Preferred timing of inflows	Approximate target volume (ML) and depth (m AHD)[5]	Depth (m)
		Min	Opt	Max	Min	Opt	Max	Min	Opt	Max			
2.3 b Increase the extent of River Red Gum Trees	Southern basin	1*	2*	3*	Shallow follow up flooding required then as per adult			1	2	12	Late Spring – Early Summer	81.4 mAHD 6720 ML	Do not overtop seedlings
2.3 c Rehabilitate the associated understorey species such as River Coobah (*Acacia stenophylla*), Tangled Lignum (*Duma florulenta*) and various herbs and graminoids.	High/ Moderate elevations of fringe and southern basin bed	As per overstory species											
3 Process objectives													
3.1 Rehabilitate macroinvertebrate communities to ensure that all expected functional groups (e.g. grazers, shredders, filter feeders etc.) are present and have sufficient biomass to support ecological processes and food webs.	Wetted areas	2	7	9	12	36	60	4	8	11	Autumn/ Spring	77.3 mAHD to 81.4 mAHD 1244 ML – 6720 ML	N/A

depth under colonial nesting waterbird nests

^ This is a dry phase EVC, the inter-drying period timing relates to the period of time this EVC requires no flooding.

*number of desired recruitment events, follow up flooding required

Table 20: Hydrological requirements of ecological objectives for Little Lake Meran

Ecological objectives	Water management area	Hydrological Requirements											
		Recommended number of events in 10 years			Inter-drying period duration (months)			Duration of ponding (months)			Preferred timing of inflows	Approximate target volume (ML) and depth (m AHD)[6]	Depth (m)
		Min	Opt	Max	Min	Opt	Max	Min	Opt	Max			
4. Fauna objectives													
4.1. Rehabilitate feeding and breeding opportunities for a high diversity of wetland birds of various feeding guilds, (e.g. ducks, fish eating birds, deep water foragers, and migratory wading waterbirds)	Whole wetland	The waterbirds known to use the Meran Lakes Complex have a myriad of hydrological requirements. It is anticipated that at various phases of the complex watering regimes will provide suitable conditions for a high diversity of waterbirds, particularly once aquatic and amphibious wetland vegetation improve the productivity of the complex. Most migratory waterbirds arrive in late winter (Aug-Sept) and depart in early autumn (Apr-May)											
5. Vegetation objectives													
5.1 Rehabilitate Aquatic Herbland EVC 653) vegetation toward benchmark condition (e.g. *Myriophyllum* spp., Triglochin spp., *Potamogeton* spp.)	Wetland bed	2	7	9	12	36	60	4	8	11	Autumn/ Spring	79.65 mAHD 880 ML	N/A
5.2 a (i) Maintain the health of adult and recently recruited River Red Gum trees in Intermittent Swampy Woodland.	Fringe	1	2	3	12	24-36	60	2	4	12	Spring/ Summer	79.65 mAHD 880 ML	<1.4m ^
5.2 a (ii) Maintain the health of adult and recently recruited Black Box trees in Intermittent Swampy Woodland.	Higher elevations of fringe	1	2	2	36	60	120	0	3	6	As per natural	79.65 mAHD 880 ML	Not critical

[6] Volume is based on the Little Lake Meran capacity table (Appendix C) and does not take into consideration losses associated with delivery, evaporation and seepage

<table>
<tr><th rowspan="3">Ecological objectives</th><th rowspan="3">Water management area</th><th colspan="13">Hydrological Requirements</th></tr>
<tr><th colspan="3">Recommended number of events in 10 years</th><th colspan="3">Inter-drying period duration (months)</th><th colspan="3">Duration of ponding (months)</th><th rowspan="2">Preferred timing of inflows</th><th rowspan="2">Approximate target volume (ML) and depth (m AHD)[6]</th><th rowspan="2">Depth (m)</th></tr>
<tr><th>Min</th><th>Opt</th><th>Max</th><th>Min</th><th>Opt</th><th>Max</th><th>Min</th><th>Opt</th><th>Max</th></tr>
<tr><td>5.2 b Increase the extent of River Red Gum in Intermittent Swampy Woodland</td><td>Moderate to low Fringe bed</td><td>1*</td><td>2*</td><td>3*</td><td colspan="3">Shallow follow up flooding required then as per adult</td><td>1</td><td>2</td><td>12</td><td>Late Spring – Early Summer</td><td>This relates to drawing down the wetland and allowing the lake bed to dry</td><td>Do not overtop seedlings</td></tr>
<tr><td>5.2 c Rehabilitate the associated understorey of Intermittent Swampy Woodland species such as River Coobah (Acacia stenophylla), Tangled Lignum (Duma florulenta) and various herbs and graminoids.</td><td>Fringe</td><td colspan="13">As per overstory species</td></tr>
<tr><td colspan="15">6. Habitat objectives</td></tr>
<tr><td>6.1. Maintain open water and associated mud-flat habitats for sufficient periods during flooding and drying cycles to drive aquatic food webs and support wetland bird feeding and breeding.</td><td>Whole wetland</td><td colspan="11">Open water and associated mud-flat habitats are a product of wetting and drying of wetlands. The flooding frequency and inter-drying period is dependent on achieving other objectives</td><td>Full wetting and drying cycle</td><td>varied</td></tr>
</table>

^ depth near trees

5.4. Watering regime

Water regimes for Lake Meran and Little Lake Meran are based on the ecological objectives in Section 5.2 and hydrological requirements outlined in Section 5.3.

To allow for adaptive and integrated management, the watering regime is framed using a seasonally adaptive approach. This means that the watering regime is given for optimal conditions, as well as the maximum and minimum tolerable watering scenarios. The minimum watering regime is for drought or years with low water allocations, the optimum watering regime in dry - average conditions with adequate water availability and the maximum is for wet or flood years. These are described in Sections 5.4.1 to 5.4.3.

5.4.1. Lake Meran watering regime

Minimum watering regime

Fill to 81.4 mAHD one in every seven years. Filling will commonly occur during late winter or early spring, but may commence in autumn on some occasions to provide variability. Maintain depth between 80.0 mAHD and 81.0 mAHD for eight to ten months which will provide at least 0.5 to 1.5 metres depth under most trees in the southern basin (depth and duration adaptive and dependent on bird breeding events); allow to draw down from late summer and over the subsequent years to a minimum level between 77.3 mAHD to 77.8 mAHD[7]. Allow fluctuations between 77.3 mAHD and 77.8 mAHD until the next filling event.

Dry period: Allow exposed lake bed above 77.8 mAHD to dry completely for up to four years.

Optimum watering regime (see Figure 11)

Fill to between 80.5 - 81.4 m AHD one in every five years. Filling will commonly occur during late winter or early spring, but may commence in autumn on some occasions to provide variability. Maintain depth between 80.0 mAHD and 81.0 mAHD for eight to ten months which will provide at least 0.5 to 1.5 metres depth under most trees (depth and duration adaptive and dependent on bird breeding events); allow to draw down from late summer and over the subsequent years to a minimum level between 77.3 mAHD to 77.8 mAHD. Allow fluctuations between 77.3 mAHD and 77.8 mAHD until the next filling event.

Dry period: Allow exposed lake bed above 77.8 mAHD to dry completely for up to two years.

Maximum watering regime

Fill to 80.5 mAHD one in every three years. Filling will commonly occur during late winter or early spring, but may commence in autumn on some occasions to provide variability. Maintain depth between 80.0 mAHD and 80.5 mAHD for eight to ten months which will provide at least 0.5 to 1.0 metres depth under most trees (depth and duration adaptive and dependent on bird breeding events); allow to draw down from late summer and over the subsequent years to a minimum level between 77.3 mAHD to 77.8 mAHD. Allow fluctuations between 77.3 mAHD and 77.8 mAHD until the next filling event.

Dry period: Allow exposed lake bed above 77.8 mAHD to dry completely for up to one year.

[7] The Lake Meran Diverters Group has indicated that they would like to source an additional volume of water above the minimum level established in this EWMP. The North Central CMA would not object to this as long as the increase in water level does not impact the environmental benefit of the proposed regime. The water level of around 78.3 mAHD would see a loss of approximately nine hectares (13%) of the total wetting and drying lake bed available for Lake Bed Herbland and Intermittent Swampy Woodland. A water level of 78.8 mAHD would see a loss of approximately 18 hectares (27%) of the total wetting and drying lake bed available for Lake Bed Herbland and Intermittent Swampy Woodland. As such the North Central CMA would prefer any water level increase to be under 78.8 mAHD.

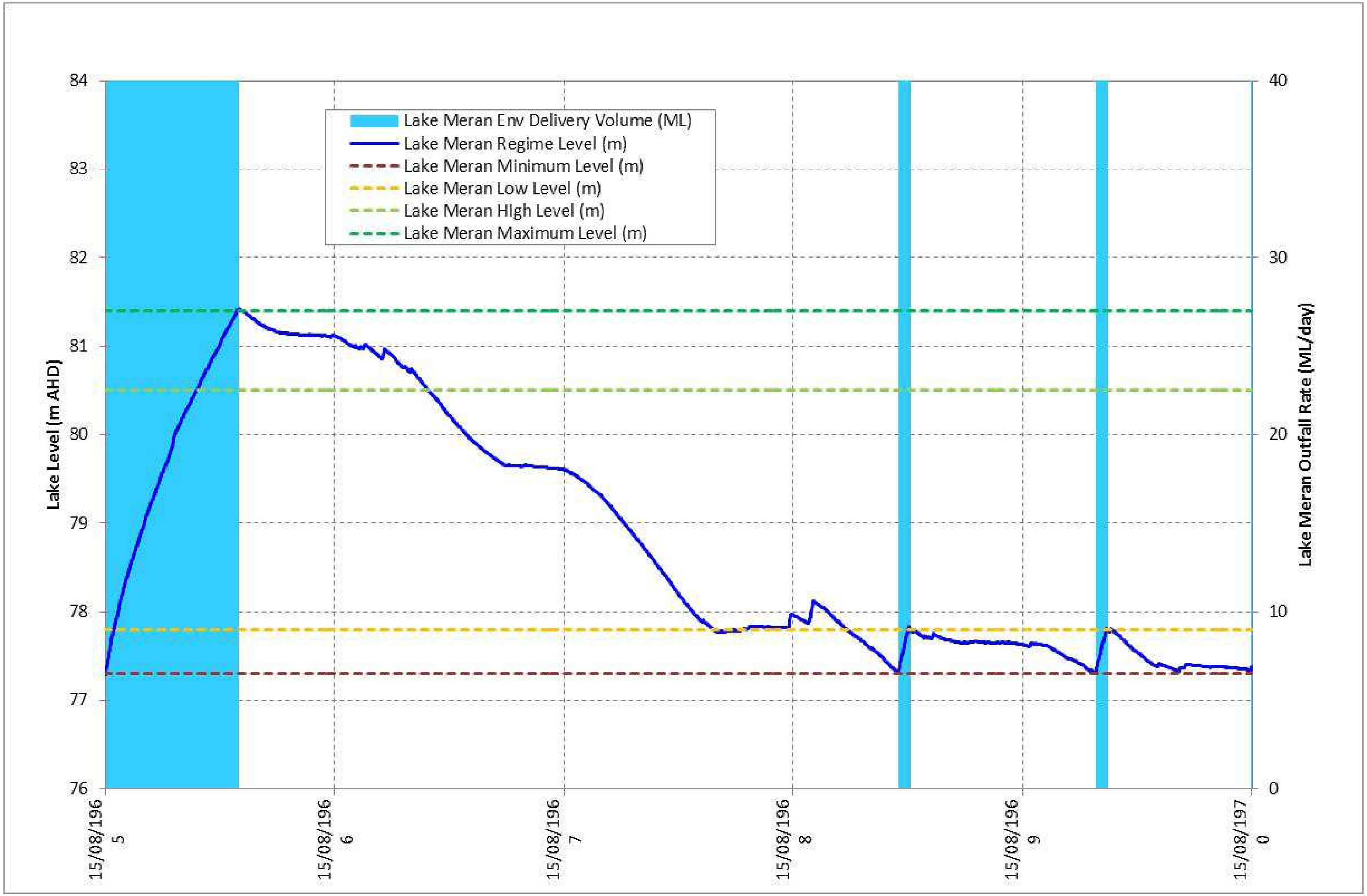
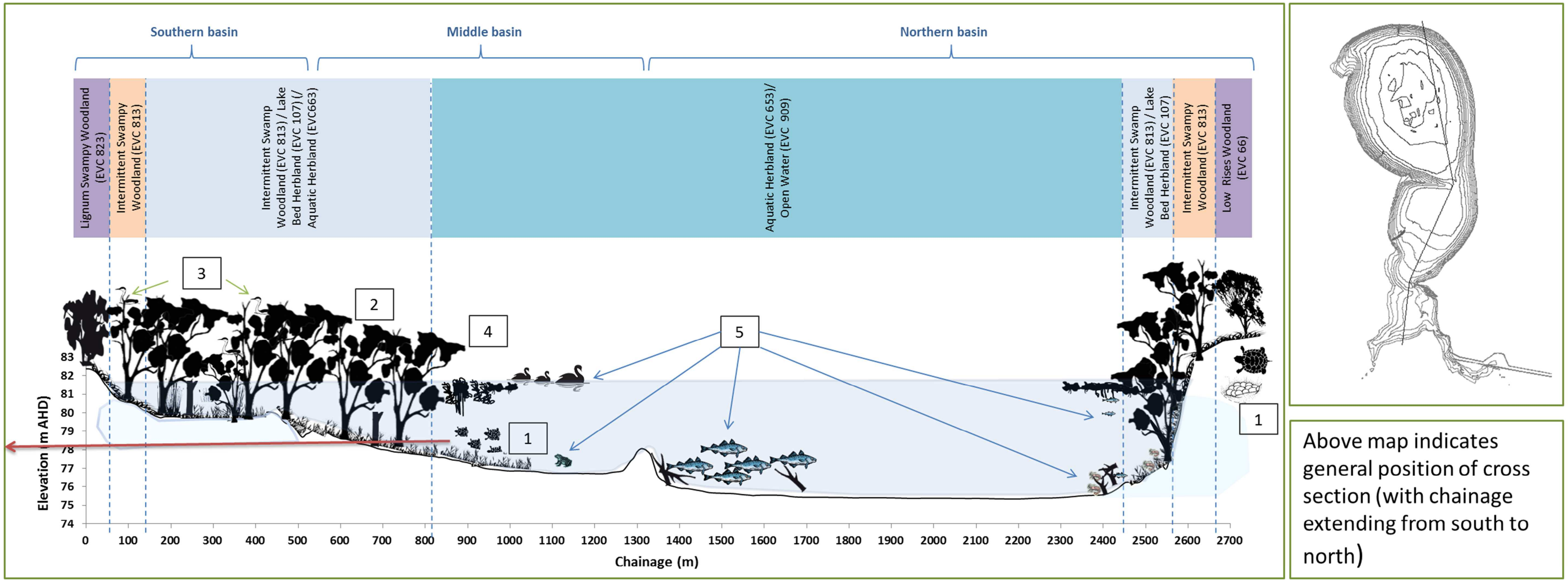


Figure 11: Lake Meran Optimum Environmental Water Regime hydrograph for one five year cycle

5.4.2. Conceptual vision for Lake Meran

Figure 12 and Figure 13 pictorially represents the vision of Lake Meran after the implementation of the water regime described above achieves the ecological objectives, subject to the implementation of complementary actions outlined in Section 8.



Above map indicates general position of cross section (with chainage extending from south to north)

Figure 12: The conceptual vision for Lake Meran when at the maximum level that will be achieved by the proposed water regime

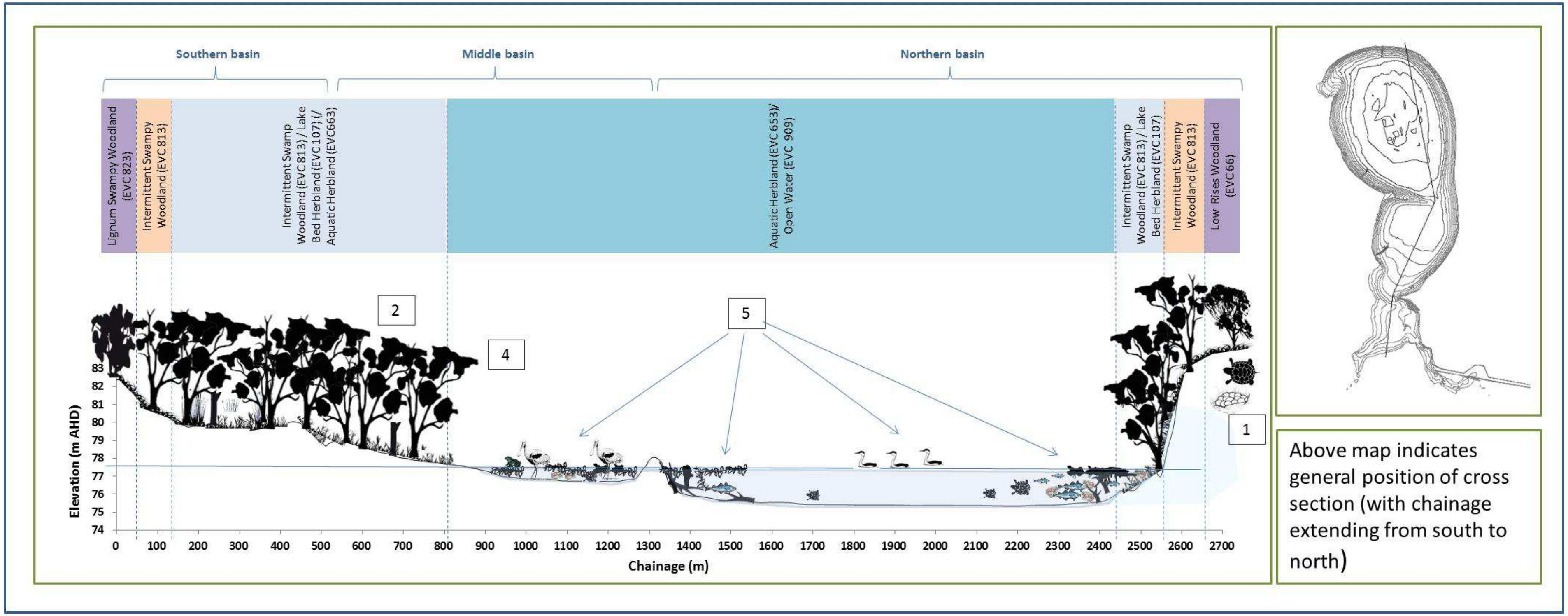


Figure 13: The conceptual vision for Lake Meran when at the minimum level that will be achieved by the proposed water regime

1. Successful recruitment of Murray River Turtles continues and Lake Meran is possibly a source population for the Loddon River Basin when the system is in flood (connectivity via Pickles Canal and Wandella Creek).
2. Intermittent Swampy Woodland vegetation such as River Red Gum extends throughout the southern basin, trees along the wetland verges mature. The extension of this EVC will provide structure, feeding and breeding habitat, shading and carbon to the wetland.
3. Breeding of colonial nesting waterbirds, such as Australian Darters and various cormorant species occurs when trees are inundated.
4. Rehabilitation of flora species associated with Aquatic Herbland which will provide breeding and feed habitat for waterbirds such as Black Swans and Grebes. It is anticipated that this vegetation will be permanently associated with the edge of the water regardless of level.
5. Rehabilitation of a high diversity and abundance of macroinvertebrate, frog, native fish and wetland birds, indicative of a productive and healthy wetland.

5.4.3. Little Lake Meran watering regime

The aim of the water regime for Little Lake Meran is to support open water and aquatic vegetation (Aquatic Herbland), associated mudflats (Brackish Lake Bed Herbland), during wet phases and to rehabilitate Intermittent Swampy Woodland, which will in turn support a range of water dependent and aquatic species. The wetland will be managed as a Temporary Freshwater Swamp to provide habitat for wetland birds.

Minimum watering regime

Fill to 79.7 mAHD one in every seven years. Filling will commonly occur during late winter or early spring, but may commence in autumn on some occasions to provide variability. Maintain depth between 78.7 mAHD and 79.7 mAHD for eight to ten months which is an average depth of one to two metres under many mature trees on the outer wetland verge (depth and duration adaptive and dependent on bird breeding events); allow to draw down from late summer and over the subsequent years to dry (between two and three years depending on diversions).

Dry period: Allow to dry completely to cracking clays for up to four years.

Optimum watering regime

Fill to 79.7 mAHD one in every five years. Filling will commonly occur during late winter or early spring, but may commence in autumn on some occasions to provide variability. Maintain depth between 78.7 mAHD and 79.7 mAHD for eight to ten months which is an average depth of one to two metres under many mature trees on the outer wetland verge (depth and duration adaptive and dependent on bird breeding events); allow to draw down from late summer and over the subsequent years to dry (between two and three years depending on diversions).

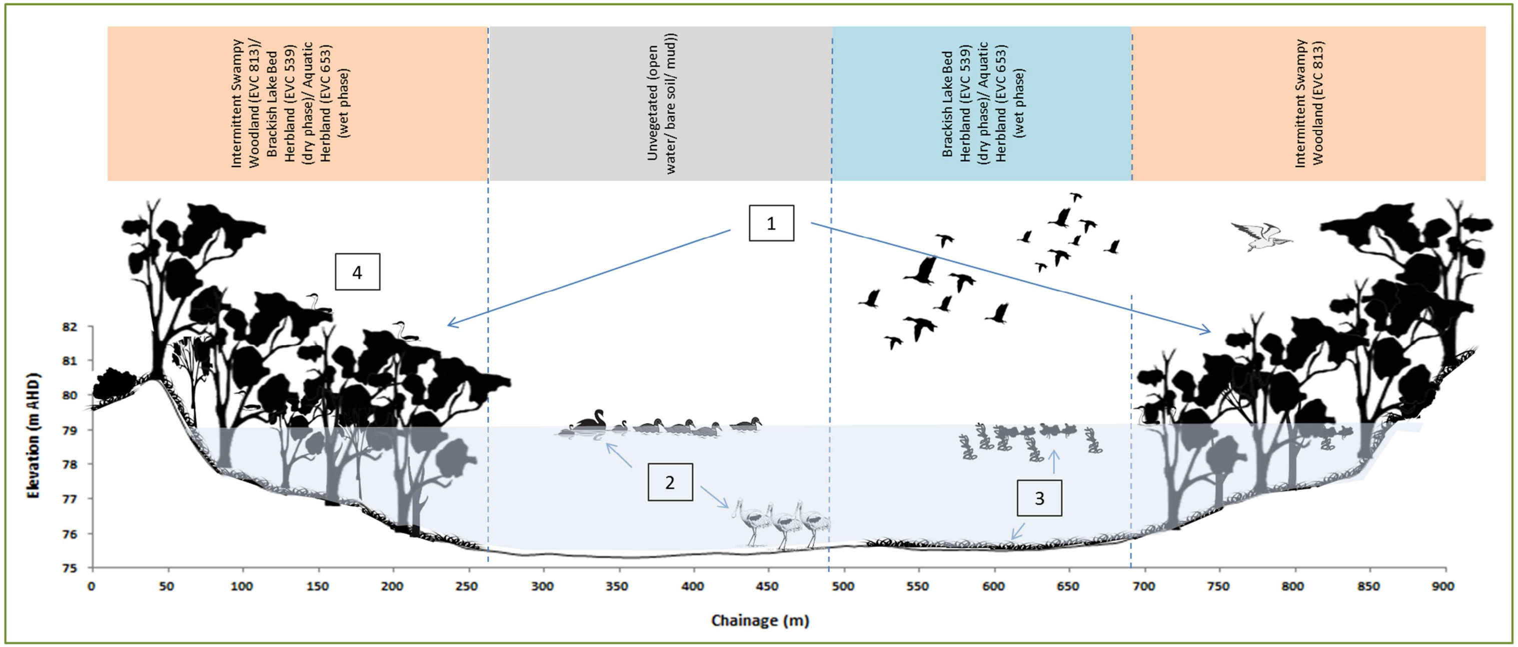
Dry period: Allow to dry completely to cracking clays for up to two years.

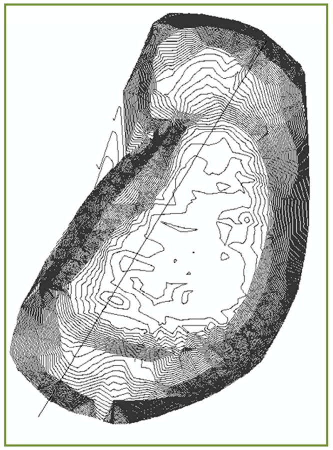
Maximum watering regime

Fill to 79.2 mAHD one in every four years (between optimum regime events). Filling will commonly occur during late winter or early spring, but may commence in autumn on some occasions to provide variability. Maintain depth between 78.7 mAHD and 79.2 mAHD for eight to ten months which is an average depth of 0.5 to 1.0 metre under many mature trees on the outer wetland verge (depth and duration adaptive and dependent on bird breeding events); allow to draw down from late summer and over the subsequent years to dry.

Dry period: Allow to dry completely to cracking clays for up to one year.

Figure 14 pictorially represents the vision of Little Lake Meran after the implementation of the water regime described above achieves the ecological objectives, subject to the implementation of complementary actions outlined in Section 8.





Above map indicates general position of cross section (with chainage extending from south west to north east)

Figure 14: The conceptual vision for Little Lake Meran that will be achieved by the proposed water regime

1. Intermittent Swampy Woodland extends down the wetland profile where maximum inundation level is around 2.5 to three metres. The extension of this EVC will provide structure, feeding and breeding habitat, shading and carbon to the wetland.
2. The deeper section of the wetland will provide open water, supporting deep water forging waterbird species when wet and mudflat habitat, supporting threatened and migratory waders when drying.
3. Aquatic Herbland and Brackish Lake Bed Herbland will extend further into the wetland during wet and dry phases respectively. Aquatic Herbland will provide feeding and breeding habitat for waterbirds such as Black Swans and Grebes, as well as lower trophic animals such as macroinvertebrates and frogs. Brackish Lake Bed Herbland protects the soil and provides habitat for many wetland birds, as well as reptiles and small mammals.
4. Breeding of colonial nesting waterbirds, such as Australian Darters and various cormorant species occurs when trees are inundated.

6. Risk assessment

6.1. Risk framework

A qualitative risk assessment has been undertaken to assign the level of risk of threats to achieving the objectives as well as risks related to the delivery of environmental water through the implementation of this EWMP. The relationship between likelihood (probability of occurrence) and the severity (severity of the impact) provide the basis for evaluating the level of risk (Table 21).

Table 21: Risk Matrix

		Severity		
		Major	Moderate	Minor
Likelihood	Probable	High	High	Moderate
	Possible	High	Moderate	Low
	Improbable	Moderate	Low	Low

The results from the Meran Lakes Complex EWMP risk assessment are presented in Table 22. Management measures relevant for the moderate to high level risks are recommended and the residual risk is then calculated using the same risk matrix. Please note that short-term operational risks (e.g. environmental releases causes flooding of private land) are assessed as part of the development of the Loddon River System Seasonal Watering Proposal which includes the Meran Lakes Complex.

6.2. Salinity risk assessment

The risk of increased salinity within Lake Meran was not identified in the Lake Meran EWP (North Central CMA 2010). The Lake Meran Diversions Licence Holders Group brought this to the CMAs attention in 2012, and subsequently engaged Price Merrett Consulting in 2013 to assess the salinity impact from implementation of the EWP. Price Merrett obtained a simple salt and water balance model that was developed by the North Central CMA for Lake Meran to assess the impact. The model results under four scenarios highlighted that that delivering environmental water increased salinity concentrations over time through evapoconcentration (Price Merrett Consulting 2013). Further work was required as the simple model treated Lake Meran as a closed system and did not consider groundwater interactions or through flow flooding.

The salinity risk assessment undertaken during the development of this EWMP was informed by a number of sources. The CMA installed a water level and salinity probe in Lake Meran for 12 months (calibration period), and drilled two nested piezometer bores to the west and to the north of Lake Meran to gain an understanding of groundwater-surface water interactions (see Section 3.3). GHD (2016) completed permeameter testing to understand infiltration rates and completed a modelling project that conceptualised and developed a salt and water balance model for Lake Meran and Little Lake Meran. GMW engaged AECOM (2016) to assess the impact of the EWP on the salinity in Lake Meran. The data collected form the bores, water level probe and permeameter testings was used to inform the infiltration and seepage rates selected to be used in the model.

The data collected from the bores shows there is a lens of groundwater under Lake Meran that is substantially fresher than the surrounding regional groundwater aquifer. Salinity in the lens ranges between 1,100 and 11,000 EC (North Central CMA, 2016a), whereas the regional aquifer is between 20,000 and 30,000EC (GHD, 2016). Further, as is documented in Section 3.3, the groundwater levels in the bores respond when water is entering Lake Meran (North Central CMA, 2016a). While this is indicative of surface water discharge to the groundwater system, the groundwater response indicates that the discharge occurs rapidly during a filling event but then reaches equilibrium once the filling event has ceased (North Central CMA, 2016). Therefore a conservative seepage rate of 0 mm/d was adopted for the Lake Meran model (GHD 2016), which calibrated most closely with the shape of the hydrograph collected from the surface water probe (GHD, 2016). Further, the surface water probe indicated the water level over winter (when diversions and evaporation were negligible) remained relatively stable. AECOM (2016) determined that seepage to the groundwater table was negligible and that surface water inputs of salt would likely exceed the salt mobilised to the groundwater table.

Based on the findings of the permeameter testing the initial infiltration rates were modelled at 5 ML/d as losses during the filling period are lost to the unsaturated soil profile in the lake bed on filling (GHD, 2016; North Central CMA, 2016a).

The CMA also referred to multiple sources that describe the salinity tolerances of biota that ecological objectives have been established for (Roberts and Marston 2011; Rogers and Ralph 2011; Frood and Papas, 2016) and sought advice from the scientific panel engaged to test the scientific robustness of key components of the EWMP. The salinity threshold for biota selected for the salinity risk assessment is based on best available science. The North Central CMA selected 4,000 EC as a conservative threshold for biota, which all have salinity tolerances greater than 4,000 EC. However it was determined that sub-lethal effects of higher levels of salinity to ensure that the current values are maintained and rehabilitation of expected values is not compromised.

The model outputs[8] from the model scenario; optimum regime without diversions; indicated that, if water extraction was not occurring, salinity spiked during extended periods without through-flow floods. Historically, if the optimum regime was delivered over the Millennium Drought salinity would have reached between 6,000 and 10,000 EC when the lake was at the minimum level (Figure 15). This output informed the likelihood and severity of the risk as shown in Table 22.

[8] The CMA acknowledges that the modelled flooding frequency and magnitude of flooding does not align with the local community's knowledge, as documented in Section 3.2 of the Meran Lakes Complex EWMP, or the physical capacity of the outlet infrastructure. However, the salinity risk assessment and management strategies documented in the EWMP are not informed by the modelled flooding frequency or magnitude but rather by the modelled salinity response during extended dry periods. The modelling difference is due to the way flow data from the Loddon River were modelled through the State approved Wandella Creek REALM model and is not due to issues with the data itself.

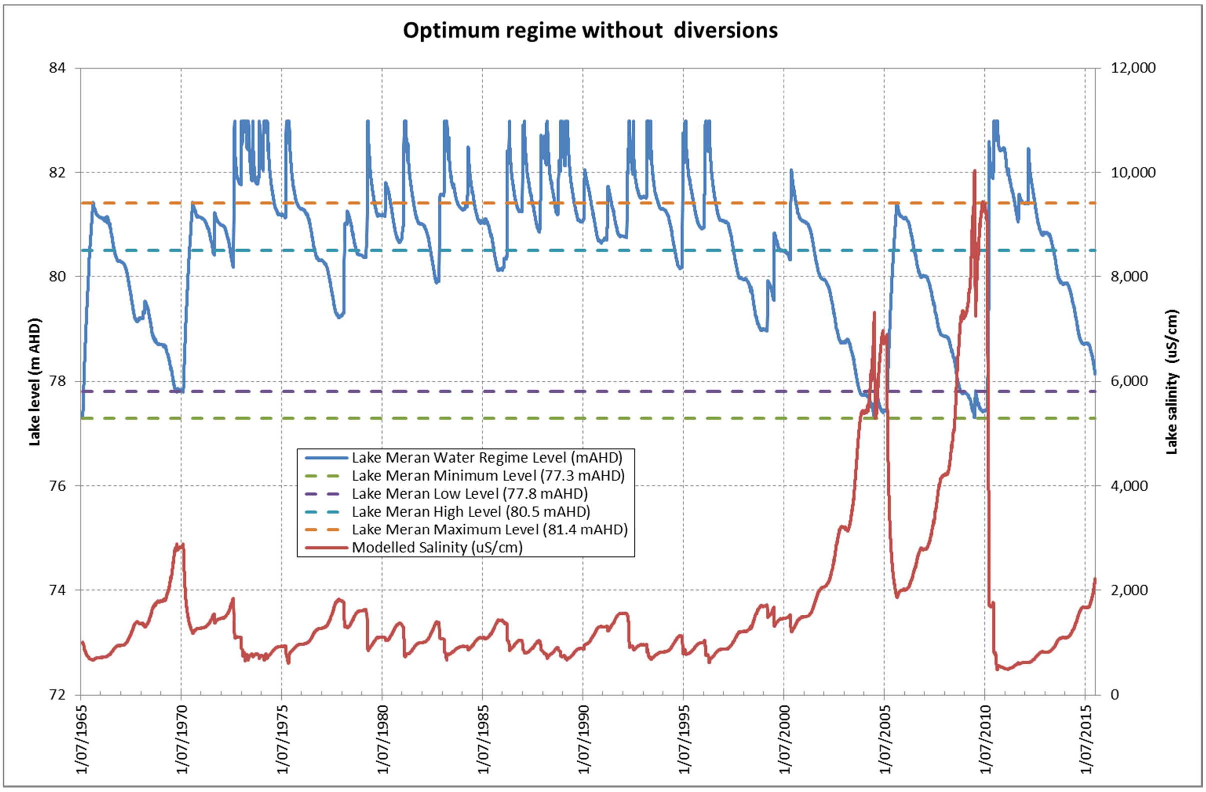


Figure 15: Optimum regime without diversions delivered over historic climate showing salinity peaks if water regime had been delivered over the Millennium Drought.

Water extraction when the wetlands are drawing down from the maximum to the minimum levels was confirmed as the appropriate mitigation option to retain salinity under the selected salinity threshold for a freshwater ecosystem. The CMA requested a scenario that modelled a hypothetical (extremely unlikely) period of 50 years with no floods for Lake Meran (Figure 16). The model output from this scenario demonstrated the water quality remained well within the threshold for the entire period (Figure 16).

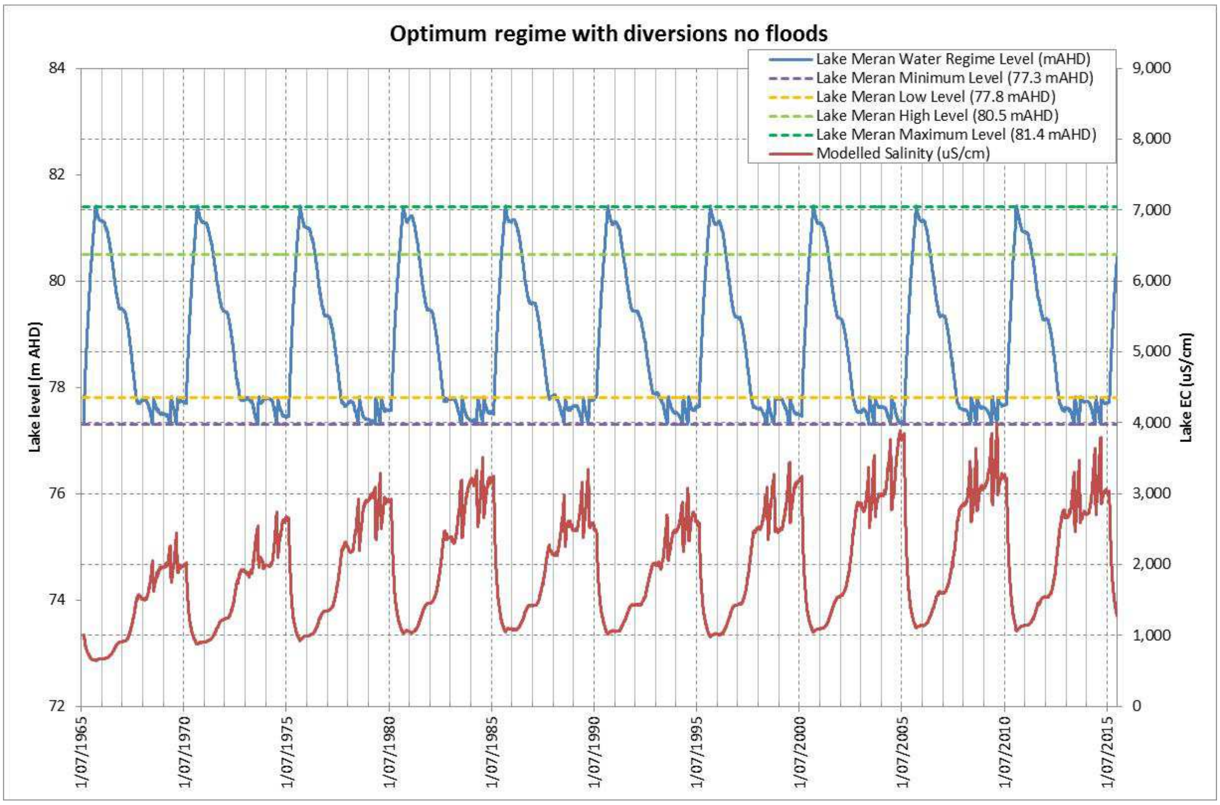


Figure 16: Optimum regime with water extraction delivered over the historic climate assuming no floods

The CMA identified that water extraction during the draw down period was a benefit to Lake Meran and Little Lake Meran, however extracting water when the wetland is being maintained at the minimum level (Lake Meran only) and while both wetlands are being filled to maximum level presents an ecological risk. The salinity risk assessment looks at these two situations separately. These are described in more detail in Table 22.

Table 22: Risk assessment and management measures

NB: R = Risk, RR = residual risk

	Threat	Impacts	Relevant objective	Likelihood	Severity	R	Mitigation Options	RR
Threats from environmental water								
1	Salinity	Modelling has indicated that with no flooding over two or more cycles of the optimum regime, lake salinity will exceed 4,000 EC when the lake is at minimum level (GHD, 2016). While the adults of the current and expected biota would tolerate higher levels of salinity, the sub-lethal effects, such as reduced vigour and loss of reproductive success, start to operate at salinities less than the maximum tolerated by the adults of a given species (GHD, 2016). The modelled salinity over the historic climate record (1965 to 2016) indicates that the frequency of exceedence is less than 10% of the time and therefore GHD suggested that the risk was insignificant (GHD, 2016). However given the uncertainty of frequency of natural flooding going forward, particularly under climate change, the North Central CMA assessed the risk against the period of time that the lake would be at the minimum level under the three (maximum, optimum and minimum) water regimes (between one and four years). Therefore if salinities passed the threshold of 4,000 EC and persisted for long enough, recruitment of freshwater species may fail which would represent a major risk.	1.2, 2.1, 2.3, 3.1, 5.1	Probable (over time)	Major		*Water extraction to manage salinity* The salinity risk assessment determined that pumping around 2,300 ML (over three years) when the wetland is drawing down from the maximum level to the minimum level reduces the salt load and salinity concentration under the proposed regime for Lake Meran and Little Lake Meran. Currently this can be achieved through licenced irrigation diversions, and diversions could exceed 2,300 ML during the draw down period as entitlement on Lake Meran is 1430 ML/year. If diversion licenses ceased to exist on the lake this mitigation option could be achieved through other pumping strategies. The cessation of salt import (i.e. not delivering environmental water) when water levels are low may be a management measure under drought conditions, and may be influenced by the availability of environmental water. It is important to note the assumption that water extraction of around 2,300 ML during the drawdown period manages salinity concentrations within an acceptable range is based modelling, which has an inherent level of uncertainty. The CMA will need to monitor conditions over each cycle to confirm that salinity levels match these estimates and to implement appropriate mitigation if conditions get worse than expected. Residual risk is calculated with a likelihood reduced to possible and severity to minor.	

	Threat	Impacts	Relevant objective	Likelihood	Severity	R	Mitigation Options	RR
2	Minimum water level in Lake Meran creating too much air space in the lake and preventing natural flooding reaching the downstream lakes.	The water dependent values at the downstream wetlands, in particular the River Red Gum vegetation classes, are stressed or lost. GHD (2016) modelled flooding frequency and magnitude of flooding has been determined as overestimated, however recent experience from 2010/2011 (filled from dry spilled to all wetlands) and 2016 (spilled from 79.2 mAHD filled Tobacco and Round lakes) flooding indicates that large floods in wet years will spill regardless of Lake Meran's water levels. It is important to note that flooding frequency and magnitude may be different under climate change.	No specific objectives set for the downstream wetlands	Possible	Moderate		If natural flooding occurs in the region, but does not spill to the downstream lakes, the CMA will review management of the water regime to determine whether it is necessary to maintain high water levels in Lake Meran during wet periods to ensure spilling. If natural flooding of wetlands does not occur in the next five to eight years the CMA could investigate direct environmental watering options. Both of these options are subject to engagement with the local community. Residual risk is calculated assuming the management measures are implemented reducing the likelihood to improbable.	
3	Natural flooding on the back of an environmental water event	Natural flooding in years 2-3 of the optimum cycle could inundate some values beyond their duration tolerance e.g. River Red Gum trees, and Lake Bed Herbland seeds could become unviable if under water for too long. It is possible that back to back natural flooding will occur causing this impact even in the absence of environmental water delivery.	2.2, 6.2, 6.4	Possible	Moderate		Pumping of floodwater could expedite drawdown of water levels and allow vegetation to be exposed more quickly. This can currently be achieved through diversions. Residual risk is calculated on reducing the severity to minor.	

	Threat	Impacts	Relevant objective	Likelihood	Severity	R	Mitigation Options	RR
Threats to achieving ecological objectives								
4	Foxes	Fox predation on freshwater turtle nests has significantly reduced Murray River turtle recruitment throughout much of the Murray Darling Basin (Chessman, 2011). There is evidence of fox predation on turtle nests at Lake Meran, but there is also evidence of recent turtle recruitment and therefore it is important to limit the impact of fox predation in the future. Fox baiting is currently occurring on some of the private land near Lake Meran. No fox control measures are occurring on public land near the lake.	1.1	Probable (without private land baiting)	Major		Fox control measures, such as baiting or shooting on public and private land surrounding the wetland complex, particularly at key nesting and hatching times. If fox control measures are successful at reducing fox numbers then less turtle nests will be disturbed and turtle recruitment rates should increase. It will not be possible to eliminate all fox predation, but the control measures are expected to reduce the likelihood of an impact to possible and the severity to moderate. Therefore the residual risk associated with this threat will be Moderate.	
5	Rabbits	Rabbits graze on native vegetation and significantly impact recruitment of trees and shrubs and prevent the establishment of groundcovers. Rabbit warrens and grazing by rabbits can lead to increased areas of bare ground and subsequent erosion by wind and water.	2.4.2, 5.2.2	Possible	Moderate		Rabbit control measures, such as warren fumigation, baiting, and shooting and the erection of fences or other measures to exclude rabbits from selected areas will help riparian vegetation to recruit and become established in response to environmental watering events. These mitigation measures are expected to reduce the risk to native vegetation objectives from high to moderate.	

	Threat	Impacts	Relevant objective	Likelihood	Severity	R	Mitigation Options	RR
6	Common Carp	Common Carp are 'ecosystem engineers' and have contributed to the degradation of Lake Meran changing from a clear water macrophyte (water plant) dominated system to a turbid phytoplankton dominated system. The rehabilitation of structure (namely water plants) is critically important to drive the food web and meet objectives for wetland fauna. It is probable that Carp will reduce the likelihood of rehabilitation of the macrophytes in Lake Meran.	Primary 2.1, 5.1 Secondary 1.3, 1.4	Probable	Major		Common Carp control measures, such as removal programs (netting or electrofishing), or introduction of Carp Virus. Screening of the inlet channel will also stop large Common Carp from entering the wetland during environmental water delivery flows. However, natural flooding will still facilitate Carp movement into Lake Meran. Once Carp are at a level that instream habitat is recovering, the introduction of large-bodied, predatory native fish may help to keep the numbers down. It is not clear how effective individual Carp control measures will be and it will probably be necessary to implement several methods concurrently. If Carp control measures reduce Carp to very low numbers in Lake Meran then the residual risk to environmental objectives will be low. If the mitigation measures are less effective than the residual risk will be moderate or remain high. Over time the North Central CMA will assess of the impact of this risk on achievement of objectives and environmental outcomes of environmental water at Lake Meran.	

	Threat	Impacts	Relevant objective	Likelihood	Severity	R	Mitigation Options	RR
7	Removal of saplings and trees.	Tree removal directly impacts the achievement of ecological objectives, which is to increase the extent of woodland vegetation for both Lake Meran and Little Lake Meran. The removal of trees reduces available habitat for wetland biota, and impacts ecological functions such as providing leaf litter that drives food webs and shading for wetland plants and biota. There is evidence of recently removed trees and saplings on the exposed shores and the land surrounding Lake Meran. It is recognised that at the Camp Slade Foreshore this is a safety risk, however, there is evidence surrounding the wetland, including in the southern and middle basins.	2.4, 5.2	Probable	Moderate		Ensure local landholders and recreation visitors to the wetlands are aware of the potentially damaging environmental effects of removing native vegetation from the wetlands and are aware of the legislation that prohibits unauthorised removal of native vegetation. Increased policing of the relevant legislation may also be required, if improved education is not sufficient. Residual risk reduced to improbable once community understand legislative restriction on the removal of native vegetation.	
8	No seedbank or propagules for the establishment of currently missing vegetation (e.g. Intermittent Swampy Woodland understorey or Aquatic Herbland species).	Without a viable seedbank or source of propagules, environmental water will not facilitate the natural regeneration of the target EVCs	2.1, 2.2, 2.4, 5.1, 5.2	Possible	Major		Direct seeding and revegetation programs at appropriate times of the wetting and drying cycle. Residual risk is calculated on reducing severity to moderate as direct seeding and revegetation will not cover all of Lake Meran or Little Lake Meran.	

	Threat	Impacts	Relevant objective	Likelihood	Severity	R	Mitigation Options	RR
9	Groundwater	Groundwater discharge to Little Lake Meran due to high water levels in Lake Meran and no water in Little Lake Meran. This has the potential to have a similar impact to those that have been experienced at other wetlands in the region, such as Wandella Lake and Lake Elizabeth, which are now saline wetlands due to the discharge of regional groundwater into the wetland beds.	-	Improbable	Major		If evidence that discharge to the bed of Little Lake Meran occurs, ensure filling regimes are implemented at the same time to facilitate downward pressure from both wetlands. Residual risk is calculated on reducing the severity to minor.	
10	Interruptible supply during the irrigation season.	During the irrigation season the water delivery for the environment is an interruptible supply. This is because GMW primarily operates its network to service its consumptive customers who own delivery share in the channel network and at times there is high irrigation demand. The modelling that was undertaken to inform the salinity risk assessment for Lake Meran used a nominal inflow of 40 ML/day, which was based on the average inflow for the previous two years of environmental water delivery. Under this scenario without diversion it takes approximately six months to fill Lake Meran from the minimum water level from August to February. This includes about 1.3 GL of evaporation losses which are primarily lost in the hot summer months (average evaporation from November to Feb > 150 mm per month). The ecological impact to the wetland vegetation on the higher elevations is due to the water level reaching the plants during, or at the end of summer, reducing the optimum time for growth and/or germination.	'	Probable	Moderate		There are two mitigating actions proposed: • The water required to meet the target level could be significantly reduced if the North Central CMA and VEWH negotiate with GMW to access the irrigation network outside the irrigation season to enable full access to the 8/2 channel (up to 100 ML/day) or the 4A/8/2 channel (up to 30 ML/day). This could save > 1 GL of water. • In the absence of negotiated channel access, commence deliveries in late autumn of the previous year to prime the lake for surcharge in winter-spring the following year, at the commencement of the irrigation season There are years when the CMA will not be able to implement either of these mitigation strategies, so the residual risk likelihood remains the same, however, as there will be years when the CMA will be able to implement them the severity is reduced to minor.	

	Threat	Impacts	Relevant objective	Likelihood	Severity	R	Mitigation Options	RR

11a	Water extraction from Lake Meran by licenced diverters when Lake Meran is at it minimum level	Currently the diverters are not able to extract below 77.8 mAHD without extending pumping lines or dredging sump pits. To extend, diverters would need to apply and obtain approval to alter their works under Section 67 of the *Water Act 1989.* Likelihood is possible.
		
		Extracting water when Lake Meran is being maintained at the minimum water level (77.3 mAHD to 77.8 mAHD) presents a significant ecological risk to the permanent water biota at Lake Meran.
		
		The minimum level has been selected to provide a depth of 1.5 metres for approximately 50 to 65 hectares of water, which is required to maintain an appropriate water temperature for aquatic biota.
		
		At 77.3 mAHD the lake holds 1244 ML of water. If pumping occurred (entitlement is 1430 ML) it could significantly reduce the available area of water for aquatic biota.
			1.1 and 1.4	Possible	Major		In the case that practices change, i.e. diverters apply for and are approved to extend their lines, there are four potential mitigation options to compensate for extraction by licenced diverters reduce the risk during the minimum level phase (Lake Meran only):
							
							• Deliver more water (demand + losses) to the lakes
							• Provide diverters an alternative supply outside the lakes.
							• If alternative water sources cannot be secured:
							  • GMW review and implement license conditions with consideration of the environmental needs of the wetland; or
							  • The Minister applies conditions under Section 56 of the *Water Act 1989* with consideration of the environmental needs of the wetland.
							
							Implementation of one these strategies should reduce the risk to low.
							
							If mitigation options are not implemented the impact of this risk is likely to outweigh the benefits of implementing the EWMP, particularly for the ecological objectives dependent on permanent water. Therefore if this risk cannot be managed the CMA will carefully consider the benefit of implementing the EWMP at Lake Meran.	

	Threat	Impacts	Relevant objective	Likelihood	Severity	R	Mitigation Options	RR
11b	Water extraction from Lake Meran by licenced diverters when filling wetlands to target level	Water extraction by diverters while environmental water is being delivered to target the maximum level and in the two to four months after the maximum level is reached presents an ecological risk to the environmental values at the upper limit of the maximum water, such as Intermittent Swampy Woodland vegetation (such as River Red Gum trees and Eumong) which require flooding inundation and ponded water for between two and four months (Roberts and Marston, 2011). The impact of extraction would depend on the volume of extraction, as well as the timing of the delivery of water. The preferred timing of filling is late winter/early spring, which aligns with what would historically occur in an unmodified system. According to modelling information, under a fill from the beginning of the irrigation season (15 August), with an interruptible supply (i.e. average inflow 40 ML/day at Lake Meran), diversions plus associated losses could reduce the water delivered to Lake Meran by up to 1 GL, which depending on the target level could reduce the depth by around 60 cm. The area reduced if the target level was 81.4 mAHD would be around 13 hectares. Given the size of the area impacted the severity has been assessed as minor. NB: While the EWMP proposes an objective for the breeding of waterbirds, which would require water to be held at a stable level for up to ten months to ensure parents do not abandon the nests, it is recognised that the trees that will be recruited throughout the southern basin of Lake Meran and the bed of Little Lake Meran will need to reach maturity before any large scale events will occur. And at this point the impact of this threat on waterbird breeding is considered to have a minor severity.	2.4	Probable	Minor		At this point in time there no mitigation measures recommended to limit the impacts of water extraction on bird breeding. Mitigation options the same as risk 11a This risk could further be reduced by implementing mitigation options under risk 10. If the likelihood of this risk cannot be reduced, the benefits of watering Lake Meran will be carefully considered and may result in the Lake not receiving environmental water, particularly in years of low water allocations.	

	Threat	Impacts	Relevant objective	Likelihood	Severity	R	Mitigation Options	RR
12	Smaller scale floods that do not spill bring salt into Lake Meran	This risk was raised by the CAG and requires further monitoring (if the incident occurs).		Unknown	Major		Management measures as per those in salinity risk 1.	

7. Environmental water delivery infrastructure

7.1. Infrastructure constraints

Lake Meran receives outfalls from the 8/2 Channel via a delivery channel that runs parallel to Pickles Canal. The reported capacity of the 8/2 Channel is 110 ML/day; however a siphon that passes water beneath Pickles Canal has a reported capacity of 100 ML/day. The outfall structure is fully automated and has a capacity of 80–100 ML/day (Hillemacher and Ivezich, 2008 cited in North Central CMA, 2010).

The capacity of inlet to Little Lake Meran from the 4A/8/2 Channel that supplies Little Lake Meran is 30 ML/day. There is no capacity to deliver flood flows from Lake Meran to Little Lake Meran.

There are no structures available to directly water Tobacco Lake, Round Lake, Great Spectacle Lake or Little Spectacle Lake from the channel system and these wetlands are therefore dependent on flood flows from Lake Meran.

7.2. Operation constraints

The delivery of environmental water to Lake Meran and Little Lake Meran is an interruptible supply. This means that inflows can be reduced to almost zero ML/day during a filling event, which may result in greater losses during the delivery phase. Given the channel capacity constraints and potential for an interruptible supply, it could take up to five months to fill Lake Meran from 77.3 m AHD to the maximum target level range. If the CMA has access to full capacity in the 4A/8/2 it will take a little over a month to fill Little Lake Meran.

8. Complementary actions

The condition of the Meran Lakes Complex is not entirely related to hydrology; as such a number of complementary actions will be required to ensure the ecological objectives are achieved. Table 23 documents the recommended actions for the Meran Lakes Complex.

Table 23: Complementary actions to enhance the outcomes of environmental water

Activity	Risk (R) or Objective (EO)	Wetland	Rationale	Recommendation	Priority
Prevention and control measures for Common Carp	R 5	Lake Meran, Little Lake Meran	Common Carp feeding behaviour impacts the establishment of aquatic vegetation	Carp screens to the channel offtake for Little Lake Meran. Control measures to remove Carp already at Lake Meran such as congregating the Carp prior to netting and electrofishing (Austral Research and Consulting, 2016). Look to release the *Cyprinid herpesvirus 3* virus once it has passed the Australian Government approvals process.	High
Fox control	R 3	Complex	Foxes are commonly observed at Meran Lakes Complex. Nest predation has been observed around the shoreline of Lake Meran and Little Lake Meran.	Undertake fox control measures such as baiting, fox drives and education activities to encourage control measures on surrounding land by landholders.	High
Woody habitat reinstatement	EO 1.1 to 1.4 and 3.1	Lake Meran	Woody habitat provides structure for biofilms that will increase the diversity and abundance of macroinvertebrates, which in turn drive the food web and undertake critical ecosystem processes.	Strategically place woody debris or structures (e.g. fish havens) in the northern basin. This needs to occur in consultation with Gannawarra Shire as the waterway manager under the *Marine Safety Act 2010* and the local community.	High

Activity	Risk (R) or Objective (EO)	Wetland	Rationale	Recommendation	Priority
Revegetation and exclusion plots of aquatic vegetation	R 5 EO 2.1 and 5.1	Lake Meran	Even with control measures for Common Carp in place, the seed bank of the previous diversity of aquatic plants is unknown. Exclusion plots would allow vegetation to establish without feeding pressure from Common Carp and also waterbirds. Recent trials at exclusion of Common Carp from wetlands, such as Reedy Lagoon in the Gunbower Forest, and Lake Yando, south of the Meran Lakes Complex, have resulted in good vegetation responses when compared to sites without carp exclusion.	Establish a yet to be determined number of revegetation exclusion plots around Lake Meran with a diversity of Aquatic Species such as Water Ribbons (*Triglochin spp.*), Eel Grass (*Vallisneria australis*) and Pondweed (*Potamogeton spp to* assist the CMA in understanding if it required revegetation works are required. If the seedbank is depleted then revegetation works could occur.	High
Revegetation of surrounding wetland buffer	All	Complex	Buffer vegetation with all structural components (i.e. groundcover, understorey and overstory species) will protect wetlands from surrounding land use activities, and provide habitat for many terrestrial species that use the complex.	Revegetating the public land surrounding the wetlands and protecting existing native vegetation on freehold land through land management agreements (North Central CMA 2015).	Medium
Protection of freshwater turtle nests	EO 1.1	Complex (predominantly Lake Meran and Little Lake Meran)	Freshwater turtles are naturally predated on by a number of native species, including Lace Monitors. The impacts of lack of recruitment of juvenile turtles, largely due to fox predation, across the Murray-Darling Basin is currently not well understood, however, there are concerns that as freshwater turtles are long-lived species, many years of reduced recruitment may lead to a population crash in the future when aged turtles start to die.	Work with Turtles Australia and local community to identify viable nests and cover with netting that allows hatchings through but prevents foxes and other biota digging them up.	Medium

Activity	Risk (R) or Objective (EO)	Wetland	Rationale	Recommendation	Priority
Rabbit/Hare control		Complex	Impact of rabbits/hares is evident at Meran Lakes Complex with the presence of warrens, scatters and grazed vegetation.	Undertake rabbit/hare control measures such as warren fumigation, baiting to encourage control measures on surrounding land by landholders.	Moderate

9. Demonstrating outcomes

Monitoring is required to enable the North Central CMA and VEWH to justify the application of environmental water by demonstrating that watering is achieving the planned ecological outcomes.

Two types of monitoring are recommended to assess the effectiveness of the proposed water regime on objectives and to facilitate adaptive management:

- Long-term condition monitoring
- Intervention monitoring

DELWP is currently developing WetMAP (Wetlands Monitoring and Assessment Program), which will be a long-term monitoring program aimed at assessing the effect of environmental water on Victorian wetlands. As WetMAP is in its early stages of development monitoring this EWMP proposes monitoring activities in Section 9.1 and Section 9.2 that will demonstrate the achievement of the short and long-term objectives documented in this EWMP.

9.1. Long-term condition monitoring

Long-term condition monitoring aims to establish whether the watering regime (and other factors) is causing a change in, or maintaining, the overall condition of the wetland, by examining trends over time. Table 24 details the monitoring required for the Meran Lakes Complex EWMP.

Table 24: Required long-term condition monitoring for Lake Meran and Little Lake Meran

Ecological Objective No.	Ecological Objective	Method	When
Primary fauna objectives			
1.1	Maintain refuge for and successful recruitment and survival of freshwater turtles, in particular Murray River Turtles	Comprehensive turtle surveys, using fyke nets and cathedral traps.	Ideally annually with no more than two years between surveys
1.2	Rehabilitate feeding and breeding opportunities for a high diversity of wetland birds (e.g. White-bellied Sea-eagles, Cormorants and Australian Darter, Black Swans and Grebes)	Comprehensive waterbird monitoring including abundance, diversity and breeding.	Ideally annually with no more than two years between surveys – over breeding periods and during watering events
Secondary fauna objectives			
1.3	Rehabilitate the diversity and abundance of native frog populations to support at least common species in the region such as Pobblebonks, Marsh Frogs, Perons Tree Frog	Frog survey's using acoustic recorders and spotlighting methods.	Ideally every two years with no more than five years between surveys – during warmer months.
1.4	Rehabilitate the abundance of large-bodied fish species known to have historically occurred at the site and small-bodied fish species common to the region.	Comprehensive fish surveys that describe the relative abundance (CPUE) and size classes using a combination of electrofishing (large-bodied) and small mesh gauge fyke nets (small-bodied)	Ideally every two years with no more than five years between surveys

Ecological Objective No.	Ecological Objective	Method	When
Vegetation objectives			
2.1, 5.1	Rehabilitate and increase the extent of Aquatic Herbland EVC 653 vegetation toward benchmark condition (e.g. Myriophyllum spp., Vallisneria spp. Triglochin spp., Potamogeton spp.)	Baseline survey required – quadrats and transects that are stratified to record data from different wetland zones. Surveys to include tree health, EVC mapping, IWC as well as species presence and abundance.	Baseline (Year 0), Year 3, 6 and 9 in late Spring an early Summer – preferably November/Summer
2.2	Rehabilitate and increase the extent of Lake Bed Herbland EVC 107 vegetation towards benchmark condition (e.g. FFG listed Hoary Scurf-pea and Downy Swainson-pea) on exposed wetland bed.		
2.3	Maintain the extent of emergent aquatic vegetation associated with Tall Marsh EVC (including *Typha* spp., *Juncus* spp. and *Eleocharis* spp.), in the southern basin and higher levels of the mid basin of Lake Meran		
2.4, 5.2	Rehabilitate the condition of Intermittent Swampy Woodland towards EVC benchmark condition by: • maintain the health of adult and recently recruited River Red Gum and Black Box trees (within the wetted area) and • increase the extent of River Red Gum Trees • rehabilitate the associated understorey species such as River Coobah (Acacia *stenophylla*), Tangled Lignum (*Duma florulenta*) and various herbs and graminoids.		
Process objectives			
3.1	Rehabilitate macroinvertebrate communities to ensure that all expected functional groups (e.g. grazers, shredders, filter feeders etc.) are present and have sufficient biomass to support ecological processes and food webs.	Quantitative macroinvertebrate surveys using artificial substrates or Hess samplers. Samples only need to be identified to family level to allow functional group assessment, but animals need to be counted and dry weighed.	Yearly, during filling and draw down, and every second year when Lake at low levels.

9.2. Intervention monitoring

Intervention monitoring aims to assess responses to the changes in the water regime (intervention) and whether ecological objectives are being achieved, such as breeding of freshwater turtles.

An ongoing environmental watering resource planning program for wetlands in the North Central CMA currently has a monitoring program that focuses on basic habitat condition (using a rapid condition assessment and photopoint monitoring), and water depth and inundation extent data. Additional intervention monitoring of the response to a watering event will be important to provide feedback on how the system is responding and whether any amendments need to be made to the operational management or determine if any risk management actions need to be enacted. Intervention monitoring for Lake Meran and Little Lake Meran is described in Table 25.

Table 25: Required intervention monitoring for the implementation of the Meran Lakes Complex

Ecological Objective No.	Ecological objective	Monitoring question	When	Method
1.1	Maintain refuge for freshwater turtles	Are freshwater turtles surviving between events?	Between events	Trapping as per above
1.1	Maintain successful recruitment of freshwater turtles?	Are freshwater turtles breeding and are hatchlings surviving?	During and between events?	Monitoring of nesting events (e.g. after rainfall in breeding seasons (e.g. March-April for Murray River Turtles), using local volunteers and TurtleSat). Trapping as per above noting age classes.
1.2, 4.1	Support breeding events for waterbirds	Are waterbirds breeding at Lake Meran and Little Lake Meran?	Through-out watering and flood events	Visual monitoring as well as the use of monitoring cameras in key areas of the wetlands (i.e. in trees over water)
2.1, 5.1	Rehabilitate Aquatic Herbland EVC 653) toward benchmark condition (e.g. *Myriophyllum* spp., *Vallisneria* spp. *Triglochin* spp., *Potamogeton* spp.)	Do the wetlands have sufficient cover (as determined by the EVC benchmark) of aquatic flora species?	During watering events, as required, wait at least one month, and at least two more times as required.	Photopoint and rapid condition assessment monitoring
2.2	Rehabilitate and increase extent of Lake Bed Herbland (EVC 107) vegetation towards benchmark condition (e.g. FFG listed Hoary-Scurf-pea) on exposed wetland bed	Do the wetlands have sufficient cover (as determined by the EVC benchmark) of Lake Bed Herbland species?	Between watering events up two months post drying, and then up to three times within inter-drying period.	Photopoint and rapid condition assessment monitoring
2.3	Maintain the extent of emergent aquatic vegetation associated with Tall Marsh EVC (including *Typha* spp., *Juncus* spp. and *Eleocharis* spp.), in the southern basin and higher levels of the mid basin of Lake Meran	Do the wetlands have sufficient cover (as determined by the EVC benchmark) for Tall Marsh?	During watering events	Photopoint and rapid condition assessment monitoring

Ecological Objective No.	Ecological objective	Monitoring question	When	Method
2.4, 5.2	Rehabilitate the condition of Intermittent Swampy Woodland towards EVC benchmark condition by: • maintain the health of adult and recently recruited River Red Gum and Black Box trees (within the wetted area) and • increase the extent of River Red Gum Trees • rehabilitate the associated understorey species such as River Coobah (*Acacia stenophylla*), Tangled Lignum (*Duma florulenta*) and various herbs and graminoids.	Is the condition of Intermittent Swampy Woodland progressing toward benchmark condition?	Between watering events	Photopoint and rapid condition assessment monitoring of the same trees selected during baseline monitoring.

10.Knowledge gaps and recommendations

The Meran Lakes Complex EWMP has been developed using the best available information. However, a number of information and knowledge gaps exist that impact on the effectiveness of the water regime proposed in the EWMP. The priority status of these are summarised in Table 26.

Table 26: Knowledge gaps and recommendations

Knowledge Gap	Objective/ Risk	Recommendation	Who	Priority
Conceptual understanding				
The volume of pore space in the sand that surrounds Lake Meran – and the subsequent volume required to reach target water levels.	-	Record observations over the next filling events and revise modelling if needed.	North Central CMA and GMW	Medium
Objectives				
The regional significance of the freshwater turtle population	1.1	Undertake genetic sampling of population and molecular assessment to understand contribution of Meran population to the broader region population	Western Sydney University	High
The existence and viability of seed bank for critical life forms of multiple EVCs	2.2, 6.1, 6.2	Establish exclusion plots to determine the recruitment response to watering events	North Central CMA	High
Risks				
The effectiveness of multiple carp control measures	5	Fish surveys after trialling different management measures	North Central CMA	Medium/High
The response of groundwater levels and salinity to changed water regimes in Lake Meran and Little Lake Meran	9	Continue to monitor groundwater bores near Lake Meran and the wetland bed of Little Lake Meran under the filling event of Lake Meran	North Central CMA	High

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Abbreviations and acronyms

AAV	Aboriginal Affairs Victoria
ACF	Australian Conservation Foundation
AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment Conservation Council
BE	Bulk Entitlement
BOM	Bureau of Meteorology
Bonn	The Convention on the Conservation of Migratory Species of Wild Animals (also known as the Bonn Convention or CMS)
CAG	Community Advisory Group
CAMBA	China-Australia Migratory Bird Agreement
CEWH	Commonwealth Environmental Water Holder
CEWO	Commonwealth Environmental Water Office
CMA	Catchment Management Authority
CoM	Committee of Management
DELWP	Department of Environment, Land, Water and Planning
DEPI	Department of Environment and Primary Industries (separated into two departments: DELWP Victoria and DELWP Victoria in 2015)
DPI	Department of Primary Industries (Now Department of Economic Development, Jobs, Transport and Resources)
DSE	Department of Sustainability and Environment (Now DELWP Victoria in 2015)
EC	Electrical conductivity
EPA	Environment Protection Authority
EPBC	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
EVC	Ecological Vegetation Class
EWMP	Environmental Water Management Plan
EWP	Environmental Watering Plan
FFG	*Flora and Fauna Guarantee Act 1988* (Vic)
GL	Gigalitre (one billion litres)
GMW	Goulburn Murray Water
HRWS	High Reliability Water Share
IWC	Index of Wetland Condition
JAMBA	Japan-Australia Migratory Bird Agreement
LEWAG	Loddon River Environmental Water Advisory Group
LRWS	Low Reliability Water Share
MDBA	Murray-Darling Basin Authority
ML	Megalitre (one million litres)
ML/d	Megalitres per day
NCWS	North Central Waterway Strategy
RCS	Regional Catchment Strategy
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
RWC	Rural Water Corporation
SWP	Seasonal Watering Proposal

UWS	University of Western Sydney
VACL	Victorian Aboriginal Corporation of Languages
VBA	Victorian Biodiversity Atlas
VEAC	Victorian Environmental Assessment Council
VEWH	Victorian Environmental Water Holder
VWMS	Victorian Waterway Management Strategy

Appendix A: Committee membership

Table A 1: Members of the Community Advisory Group

Name	Name
Rob Loats (Chair)	Paul Haw
Carl Chamberlain	Ronald Kelly
Brett Condely	Alan Pickering
Norman Condely	John Pike
Peter Condely	Lorraine Ritchie
Cameron English	Morton Ritchie
Stephen English	Deirdre Schlitz
Colin Fenton	Ron Turner

Table A 2: Members of the Project Steering Committee

Name	Organisation
Anna Lucas/Chris McAuley	Department of Environment, Land, Water and Planning
Andrea Keleher	Department of Environment, Land, Water and Planning
Geoff Rollinson	Gannawarra Shire Council
Dale McGraw/ Graeme Hannon	Goulburn Murray Water
Chris Solum	Goulburn Murray Water Connections Project
Leeza Wishart	Parks Victoria
Mark Toomey	Victorian Environmental Water Holder
Andrew Sharpe	North Central Catchment Management Authority
Philip Slessar	North Central Catchment Management Authority

Table A 3: Scientific advisors

Name	Organisation	Expertise
Damien Cook	Rakali Ecological Consulting	Wetland ecologist/ botanist
Stuart Cooney	Ecolink Consulting	Ornithologist
Ricky Spencer	University of Western Sydney	Herpetologist

Appendix B: Average outfall calculations from 1996 to 2003

Table B 1: CAG water balance calculation (1996 to 2003) to determine the shortfall (outfall water requirement)

Water balance component description	
Lake Meran inputs	
End of 1996 - Lake volume @ 81.38 mAHD (ML)	6,852
End of 2003 - Lake empty (ML)	0
Average Volume per metre (depth of lake = 6 metres) (ML)	1,142
7 years of rainfall @ .35 metres/year	2.45
Total input to lake from rainfall (2.45 m x 1142 ML)	2,798
Known lake inputs (volume at start + rainfall inputs)	**9,650**
Lake Meran outputs	
Yearly evaporation rate (metres/year)*	1.15
Evaporation over 7 years (metres)	8.05
Evaporation losses (ML)	9,193
6 years of diversions @ 1435 ML/year**	8,610
7 years of seepage @ 1 ML/day***	2,555
Total losses from the lake (evaporation, diversions, seepage)	**20,358**
Lake input shortfall over 7 year period (ML)	**10,708**
Annual average outfall (10780 ML/7 years) (ML/year)	1,530

*Evaporation rate based on Price Merritt Consulting report (2013)

**There were only six years of diversions, in 2003 diverters were not able to pump from the lake

***Seepage rate adapted from GHD hydrological study (2006)

Appendix C1: Lake Meran bathymetry

Appendix C2: Little Lake Meran bathymetry

Appendix D: Bioregions and EVC distribution at the Meran Lakes Complex

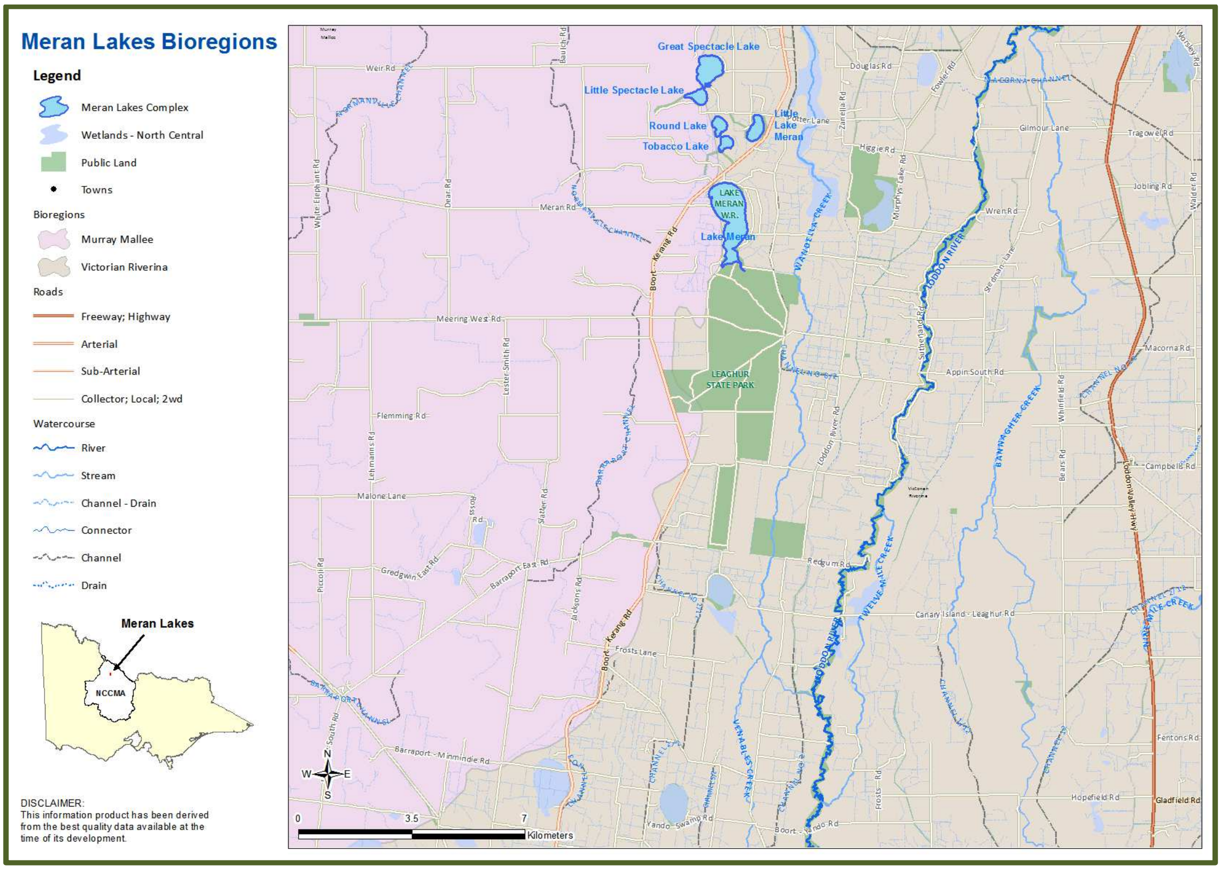

Figure D 1: Bioregions for the Meran Lakes Complex

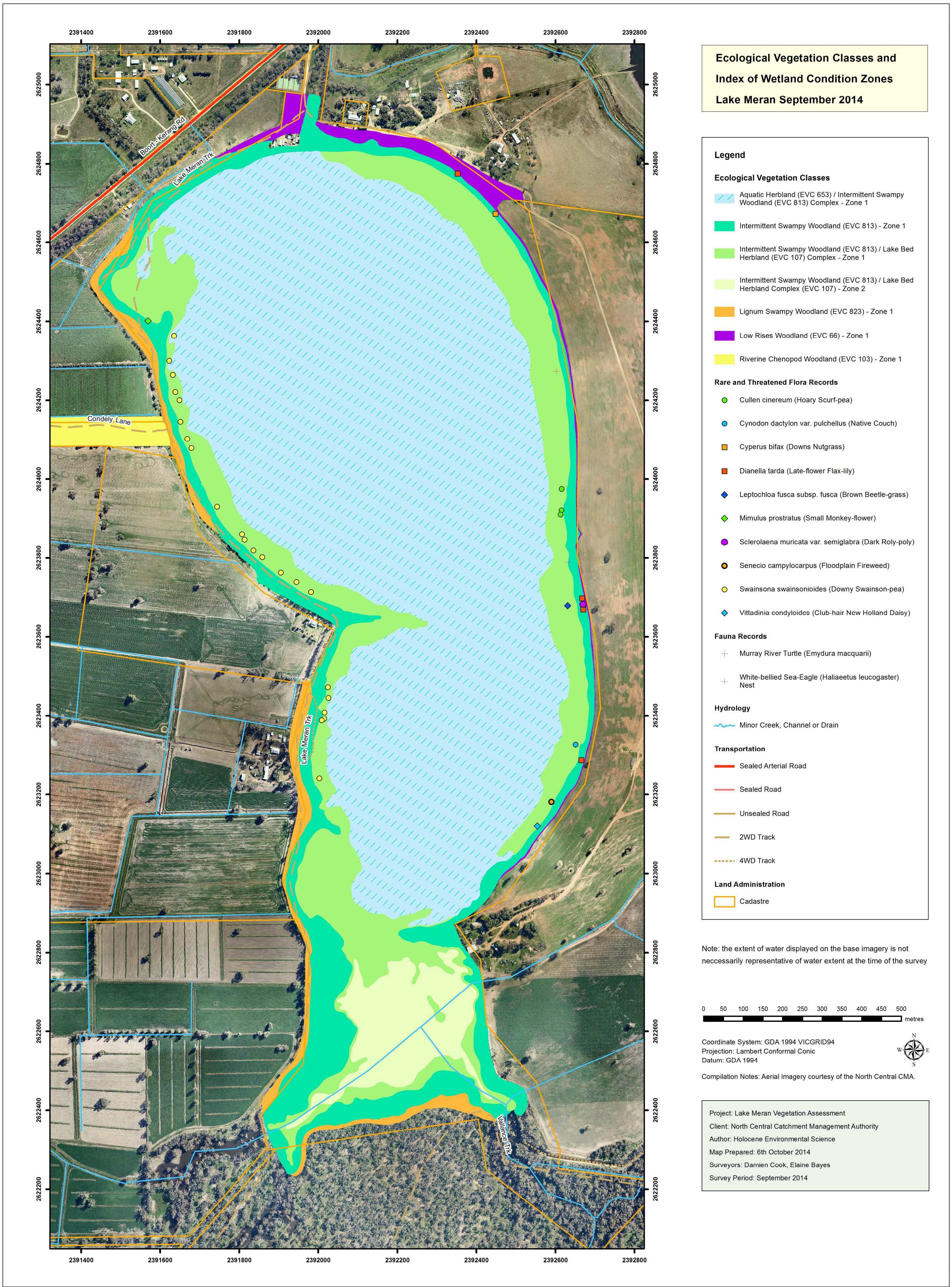

Figure D 2: Current distribution of EVCs at Lake Meran

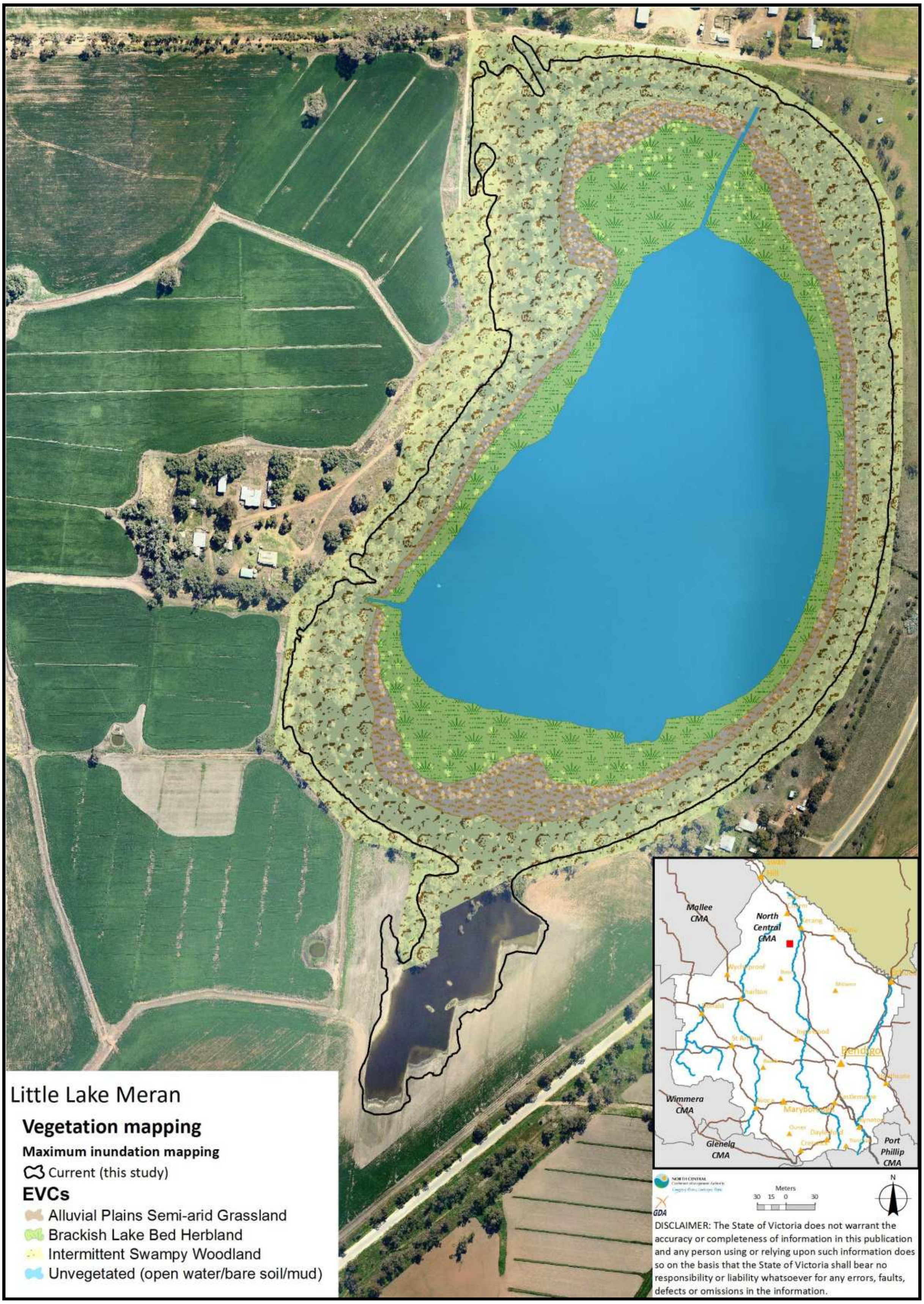

Figure **D 3: Current distribution of EVCs at Little Lake Meran.**

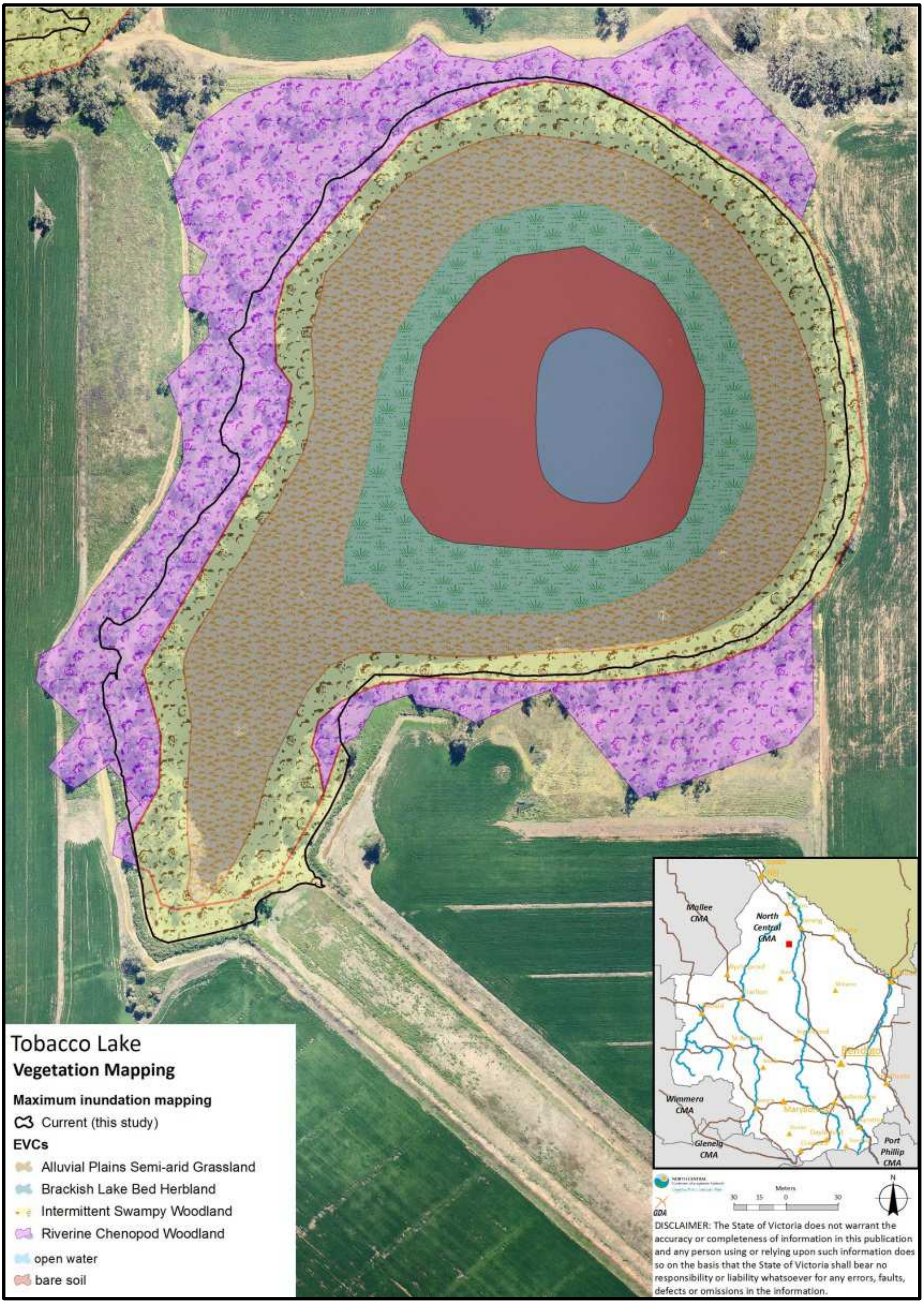

Figure **D 4: Current distribution of EVCs at Tobacco Lake.**

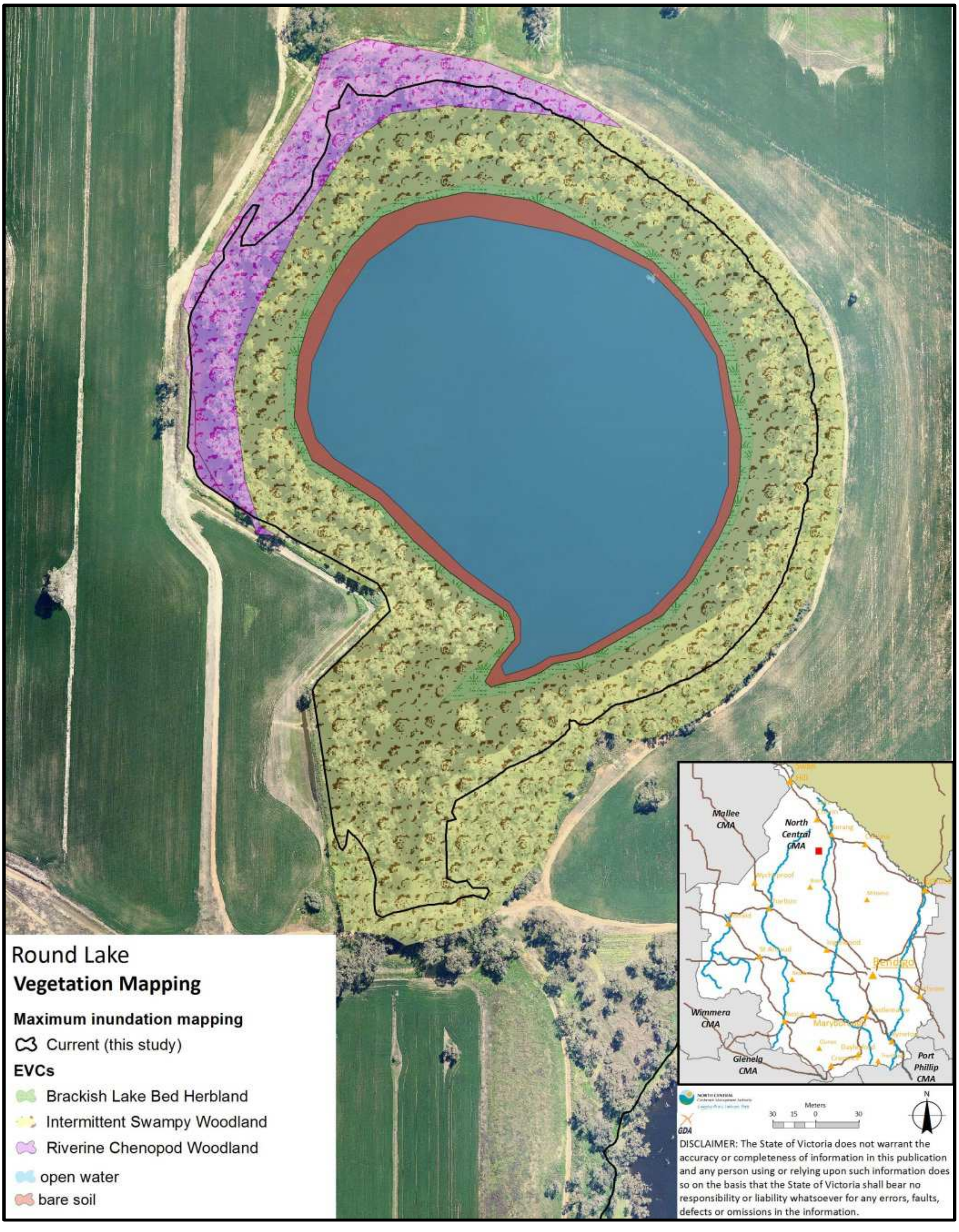

Figure **D 5: Current distribution of EVCs at Round Lake.**

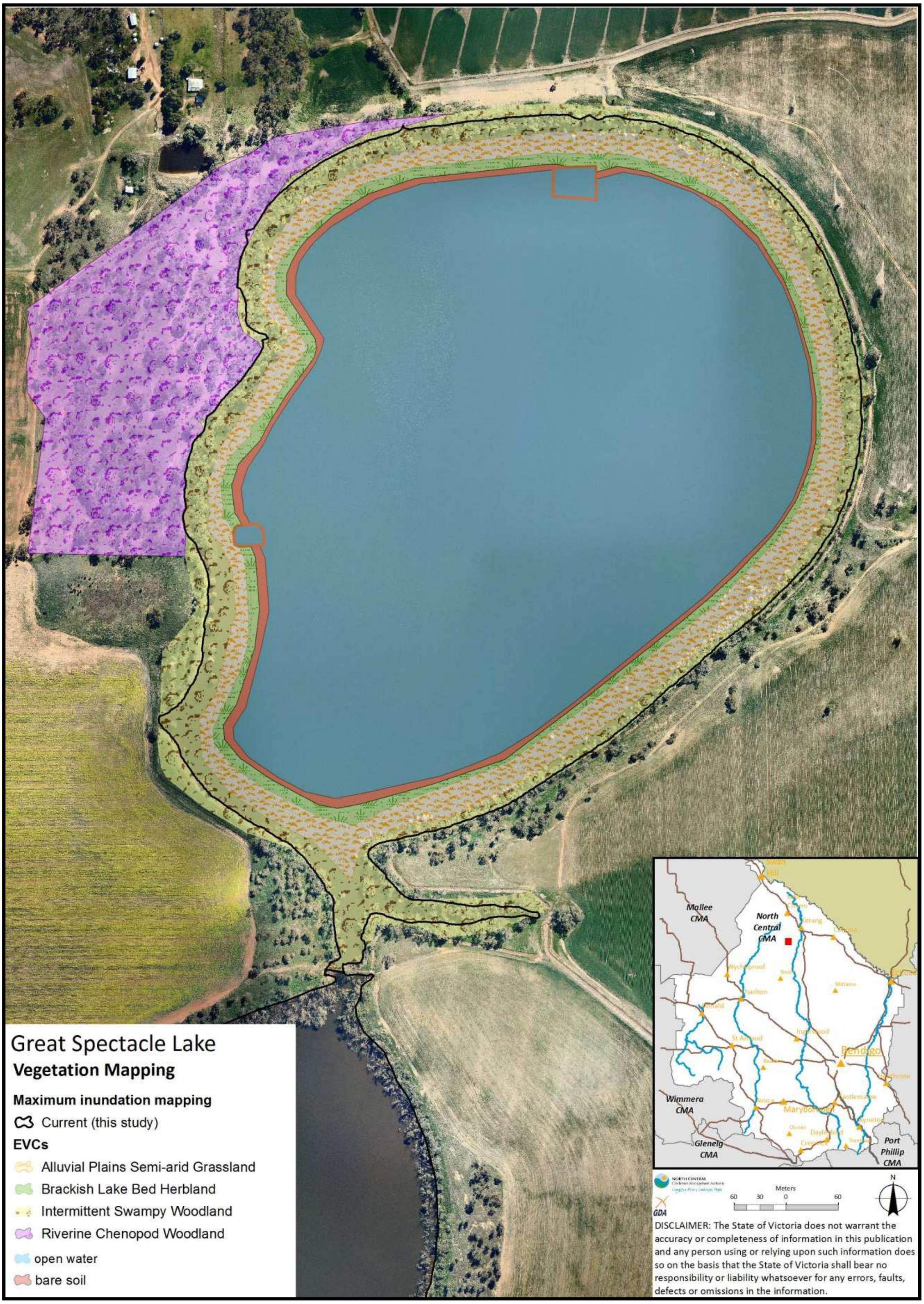

Figure **D 6: Current distribution of EVCs at Great Spectacle Lake.**

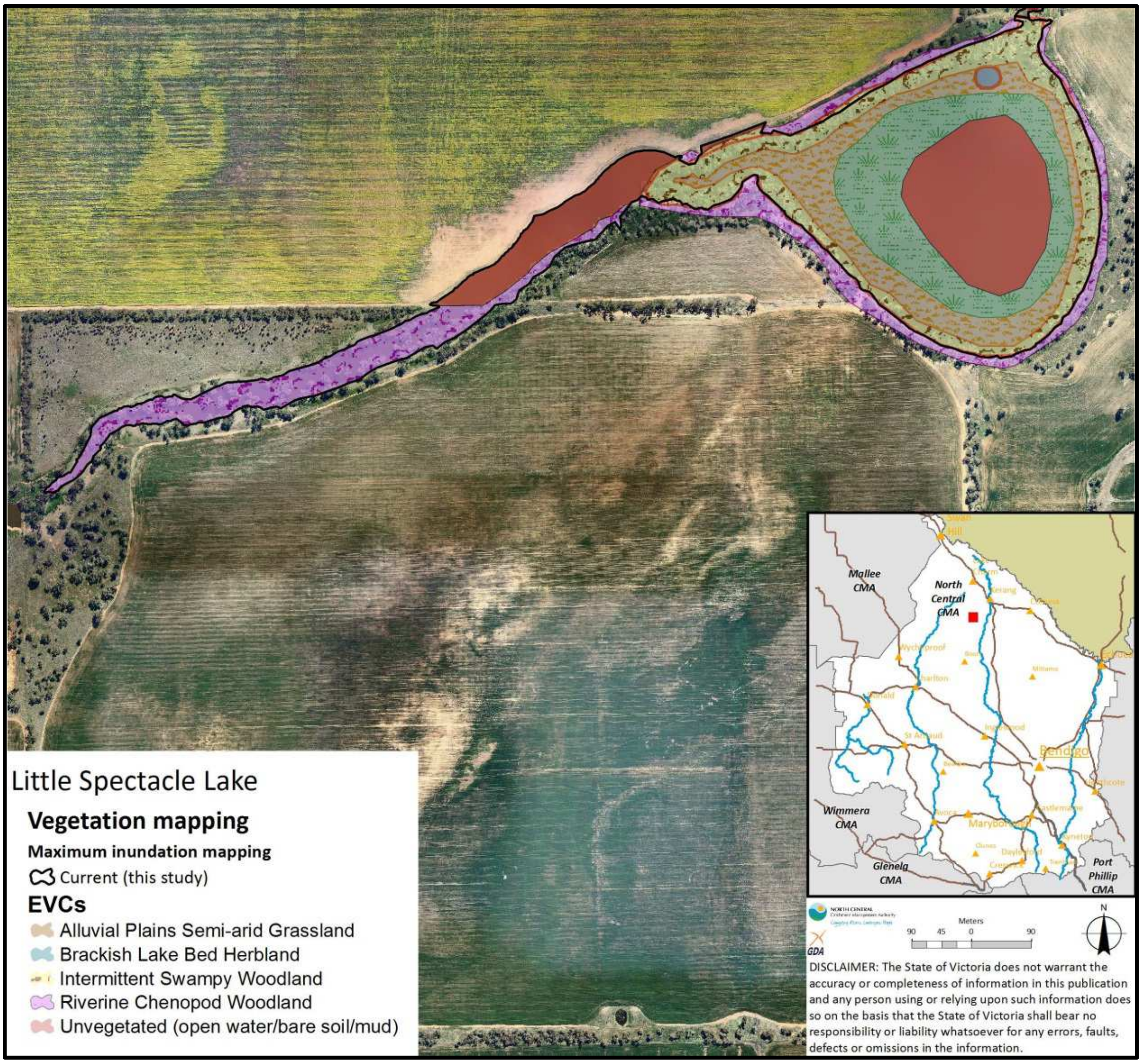

Figure **D 7: Current distribution of EVCs at Little Spectacle Lake.**

Appendix E: Species list

Table E1: Fauna Species List

Sources: Austral Research and Consulting (2016), Birds Australia, DELWP (2015), North Central CMA (2015); Rakali Ecological Consulting (2015), Turner R. personal communication [local landholder] 13 November 2015.

Common Name	Scientific Name	Last record[9]	Wetland
Amphibians			
Plains Froglet	*Crinia parinsignifera*	1995	Little Lake Meran
Southern Bullfrog	*Limnodynastes dumerilii*	1989	Little Lake Meran, Round Lake, Tobacco Lake
Fish			
Australian Smelt	*Retropinna semoni*	2016	Lake Meran, Round Lake, Tobacco Lake
Bony Herring	*Nematalosa erebi*	1991	Lake Meran
Carp Gudgeon	*Hypseleotris klunzingeri*	2016	Lake Meran
Flathead Gudgeon	*Philypnodon grandiceps*	2016	Lake Meran, Little Lake Meran, Round Lake, Tobacco Lake
Golden Perch	***Macquaria ambigua***	**2016**	**Lake Meran**
Murray Cod	***Maccullochella peelii***	**2016**	**Lake Meran, Little Lake Meran**
River Blackfish	***Gadopsis marmoratus***	**1950**	**Lake Meran**
Silver Perch	*Syn.fam. Terapontidae gen. Bidyanus*	1988	Lake Meran
Un-specked Hardyhead	*Craterocephalus stercusmuscarum fulvus*	2016	Lake Meran
Mammals			
Black Wallaby	*Wallabia bicolor*	2014	Tobacco Lake
Common Brushtail Possum	*Trichosurus vulpecula*	1995	Lake Meran
Lesser Long-eared Bat	*Nyctophilus geoffroyi*	1962	Lake Meran

[9] This denotes the year the record was provided to the CMA for many of the birds.

Common Name	Scientific Name	Last record[9]	Wetland
Little Forest Bat	*Vespadelus vulturnus*	1995	Lake Meran
Southern Forest Bat	*Vespadelus regulus*	1995	Lake Meran
Reptiles			
Broad-shelled turtle	***Chelodina expansa***	**2016**	**Lake Meran**
Eastern long-necked turtle	***Chelodina longicollis***	**2016**	**Lake Meran, Little Lake Meran, Round Lake, Tobacco Lake**
Murray River Turtle	***Emydura macquarii***	**2016**	**Lake Meran**
Terrestrial birds			
Australian Hobby	*Falco longipennis*	2016	Meran Lakes Complex
Australian Magpie	*Cracticus tibicen*	2016	Meran Lakes Complex
Australasian Pipit	*Anthus novaeseelandiae*	2016	Meran Lakes Complex
Australian Raven	*Corvus coronoides*	2016	Meran Lakes Complex
Black Falcon	***Falco subniger***	**2016**	**Meran Lakes Complex**
Black Kite	*Milvus migrans*	2001	Lake Meran
Black-chinned Honeyeater	***Melithripterus gularis***	**2016**	**Meran Lakes Complex**
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	2016	Meran Lakes Complex
Black-faced Woodswallow	*Artamus cinereus*	2016	Meran Lakes Complex
Black-shouldered Kite	*Elanus axillaris*	2016	Meran Lakes Complex
Blue Bonnet	*Northiella haematogaster*	2016	Meran Lakes Complex
Blue-faced Honeyeater	*Entomyzon cyanotis*	2016	Meran Lakes Complex
Blue-winged Parrot	*Neophema chrysostoma*	2016	Meran Lakes Complex
Brown Falcon	*Falco berigora*	2016	Meran Lakes Complex
Brown Goshawk	*Accipiter fasciatus*	2016	Meran Lakes Complex
Brown-headed Honeyeater	*Melithreptus brevirostris*	2001	Lake Meran

Common Name	**Scientific Name**	**Last record[9]**	**Wetland**
Brown Songlark	*Cincloramphus cruralis*	2016	Meran Lakes Complex
Brown Treecreeper (south-eastern ssp.)	***Climacteris picumnus victoriae***	**2016**	**Meran Lakes Complex**
Buff-banded Rail	*Gallirallus philippensis*	2016	Meran Lakes Complex
Buff-rumped Thornbill	*Acanthiza reguloides*	2016	Meran Lakes Complex
Chestnut-rumped Thornbill	*Acanthiza uropygialis*	2001	Lake Meran
Clamorous Reed Warbler	*Acrocephalus australis*	2016	Meran Lakes Complex
Cockatiel	*Nymphicus hollandicus*	2016	Meran Lakes Complex
Collared Sparrowhawk	*Accipiter cirrhocephalus*	2016	Meran Lakes Complex
Common Bronzewing	*Phaps chalcoptera*	2016	Meran Lakes Complex
Crested Pigeon	*Ocyphaps lophotes*	2002	Lake Meran, Little Lake Meran, Little Spectacle Lake, Round Lake
Crested Shrike-tit	*Falcunculus frontatus*	2000	Lake Meran
Crimson Chat	*Epthianura tricolor*	2016	Meran Lakes Complex
Diamond Firetail	***Stagonopleura guttata***	**2016**	**Meran Lakes Complex**
Dusky Woodswallow	*Artamus cyanopterus*	2016	Meran Lakes Complex
Eastern Rosella	*Platycercus eximius*	2016	Meran Lakes Complex
European Goldfinch	*Carduelis carduelis*	2016	Meran Lakes Complex
European Skylark	*Alauda arvensis*	2016	Meran Lakes Complex
Fairy Martin	*Petrochelidon ariel*	2016	Meran Lakes Complex
Galah	*Eolophus roseicapilla*	2016	Meran Lakes Complex
Grey Butcherbird	*Cracticus torquatus*	2016	Meran Lakes Complex
Grey Fantail	*Rhipidura albiscapa*	2016	Meran Lakes Complex
Grey Goshawk	***Accipiter novaehollandiae novaehollandiae***	**2016**	**Meran Lakes Complex**
Grey Shrike-thrush	*Colluricincla harmonica*	2016	Meran Lakes Complex

Common Name	Scientific Name	Last record[9]	Wetland
Grey-crowned Babbler	***Pomatostomus temporalis temporalis***	**2016**	**Meran Lakes Complex**
Hooded Robin	***Melanodryas cucullata cucullata***	**2016**	**Meran Lakes Complex**
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*	2016	Meran Lakes Complex
Horsfield's Bushlark	*Mirafra javanica*	2016	Meran Lakes Complex
Inland Thornbill	*Acanthiza apicalis*	2016	Meran Lakes Complex
Jacky Winter	*Microeca fascinans*	2016	Meran Lakes Complex
Laughing Kookaburra	*Dacelo novaeguineae*	2016	Meran Lakes Complex
Leaden Flycatcher	*Myiagra rubecula*	2016	Meran Lakes Complex
Letter-winged Kite	*Elanus scriptus*	2016	Meran Lakes Complex
Little Button-quail	***Turnix velox***	**2016**	**Meran Lakes Complex**
Little Corella	*Cacatua sanguinea*	2016	Meran Lakes Complex
Little Eagle	*Hieraaetus morphnoides*	2016	Meran Lakes Complex
Little Grassbird	*Megalurus gramineus*	2016	Meran Lakes Complex
Little Lorikeet	*Glossopsitta pusilla*	2016	Meran Lakes Complex
Little Raven	*Corvus mellori*	2002	Little Lake Meran, Little Spectacle Lake, Round Lake
Little Wattlebird	*Anthochaera chrysoptera*	2016	Meran Lakes Complex
Long-billed Corella	*Cacatua tenuirostris*	2016	Meran Lakes Complex
Magpie-lark	*Grallina cyanoleuca*	2016	Meran Lakes Complex
Masked Woodswallow	*Artamus personatus*	1985	Lake Meran
Mistletoebird	*Dicaeum hirundinaceum*	2016	Meran Lakes Complex
Musk Lorikeet	*Glossopsitta concinna*	2016	Meran Lakes Complex
Nankeen Kestrel	*Falco cenchroides*	2016	Meran Lakes Complex
Noisy Friarbird	*Philemon corniculatus*	2016	Meran Lakes Complex

Common Name	**Scientific Name**	**Last record**[9]	**Wetland**
Noisy Miner	*Manorina melanocephala*	2016	Meran Lakes Complex
Olive-backed Oriole	*Oriolus sagittatus*	2016	Meran Lakes Complex
Pallid Cuckoo	*Cuculus pallidus*	2016	Meran Lakes Complex
Peaceful Dove	*Geopelia striata*	2016	Meran Lakes Complex
Peregrine Falcon	*Falco peregrinus*	2016	Meran Lakes Complex
Pied Butcherbird	*Cracticus nigrogularis*	2016	Meran Lakes Complex
Plains-wanderer	***Pedionomus torquatus***	**2016**	**Meran Lakes Complex**
Rainbow Bee-eater	***Merops ornatus***	**2016**	**Meran Lakes Complex**
Rainbow Lorikeet	*Trichoglossus haematodus*	2016	Meran Lakes Complex
Red Wattlebird	*Anthochaera carunculata*	2016	Meran Lakes Complex
Red-capped Robin	*Petroica goodenovii*	2016	Meran Lakes Complex
Red-rumped Parrot	*Psephotus haematonotus*	2016	Meran Lakes Complex
Restless Flycatcher	*Myiagra inquieta*	2016	Meran Lakes Complex
Rufous Whistler	*Pachycephala rufiventris*	2016	Meran Lakes Complex
Sacred Kingfisher	*Todiramphus sanctus*	2016	Meran Lakes Complex
Satin Flycatcher	*Myiagra cyanoleuca*	2016	Meran Lakes Complex
Scarlet Robin	*Petroica boodang*	2016	Meran Lakes Complex
Silvereye	*Zosterops lateralis*	2016	Meran Lakes Complex
Singing Honeyeater	*Lichenostomus virescens*	2016	Meran Lakes Complex
Southern Boobook	*Ninox novaeseelandiae*	2016	Meran Lakes Complex
Southern Whiteface	*Aphelocephala leucopsis*	2016	Meran Lakes Complex
Spotted Harrier	***Circus assimilis***	**2016**	**Meran Lakes Complex**
Spotted Pardalote	*Pardalotus punctatus*	2016	Meran Lakes Complex

Common Name	Scientific Name	Last record[9]	Wetland
Striated Pardalote	*Pardalotus striatus*	2016	Meran Lakes Complex
Stubble Quail	*Coturnix pectoralis*	2016	Meran Lakes Complex
Sulphur-crested Cockatoo	*Cacatua galerita*	2016	Meran Lakes Complex
Superb Fairy-wren	*Malurus cyaneus*	2016	Meran Lakes Complex
Swamp Harrier	*Circus approximans*	2016	Meran Lakes Complex
Tawny Frogmouth	*Podargus strigoides*	2016	Meran Lakes Complex
Tree Martin	*Petrochelidon nigricans*	2016	Meran Lakes Complex
Variegated Fairy-wren	*Malurus lamberti*	2016	Meran Lakes Complex
Wedge-tailed Eagle	*Aquila audax*	2016	Meran Lakes Complex
Welcome Swallow	*Hirundo neoxena*	2016	Meran Lakes Complex
Whistling Kite	*Haliastur sphenurus*	2016	Meran Lakes Complex
White-breasted Woodswallow	*Artamus leucorynchus*	2016	Meran Lakes Complex
White-browed Scrubwren	*Sericornis frontalis*	2016	Meran Lakes Complex
White-browed Woodswallow	*Artamus superciliosus*	2016	Meran Lakes Complex
White-fronted Chat	*Epthianura albifrons*	2016	Meran Lakes Complex
White-plumed Honeyeater	*Lichenostomus penicillatus*	2016	Meran Lakes Complex
White-winged Chough	*Corcorax melanorhamphos*	2016	Meran Lakes Complex
White-winged Fairy-wren	*Malurus leucopterus*	2016	Meran Lakes Complex
White-winged Triller	*Lalage tricolor*	2016	Meran Lakes Complex
Willie Wagtail	*Rhipidura leucophrys*	2016	Meran Lakes Complex
Yellow Thornbill	*Acanthiza nana*	2001	Lake Meran
Yellow-plumed Honeyeater	*Lichenostomus ornatus*	2016	Meran Lakes Complex
Yellow-rumped Pardalote	*Pardalotus xanthopygus punctatus*	2016	Meran Lakes Complex

Common Name	**Scientific Name**	**Last record**[9]	**Wetland**
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	2016	Meran Lakes Complex
Zebra Finch	*Taeniopygia guttata*	2016	Meran Lakes Complex
Waterbirds			
Australasian Grebe	*Tachybaptus novaehollandiae*	2016	Meran Lakes Complex
Australian Pelican	*Pelecanus conspicillatus*	2016	Meran Lakes Complex
Australian Shelduck	*Tadorna tadornoides*	2016	Meran Lakes Complex
Australasian Shoveler	***Anas rhynchotis***	**2016**	**Meran Lakes Complex**
Australian White Ibis	*Threskiornis molucca*	2016	Meran Lakes Complex
Australian Wood Duck	*Chenonetta jubata*	2016	Meran Lakes Complex
Baillon's Crake	***Porzana pusilla palustris***	**2016**	**Meran Lakes Complex**
Baird's Sandpiper	***Calidris bairdii***	**2016**	**Meran Lakes Complex**
Banded Lapwing	*Vanellus tricolor*	2016	Meran Lakes Complex
Banded Stilt	*Cladorhynchus leucocephalus*	2003	Lake Meran, Little Lake Meran
Black Swan	*Cygnus atratus*	2016	Meran Lakes Complex
Black-fronted Dotterel	*Elseyornis melanops*	2016	Meran Lakes Complex
Black-tailed Native-hen	*Tribonyx ventralis*	2016	Meran Lakes Complex
Black-winged Stilt	*Himantopus himantopus*	2016	Meran Lakes Complex
Blue-billed Duck	***Oxyura australis***	**2016**	**Meran Lakes Complex**
Brolga	***Grus rubicunda***	**2016**	**Meran Lakes Complex**
Caspian Tern	***Hydroprogne caspia***	**2016**	**Meran Lakes Complex**
Chestnut Teal	*Anas castanea*	1997	Lake Meran, Little Lake Meran, Round Lake, Tobacco Lake
Common Greenshank	***Tringa nebularia***	**2016**	**Meran Lakes Complex**
Darter	*Anhinga novaehollandiae*	2016	Meran Lakes Complex

Common Name	Scientific Name	Last record[9]	Wetland
Dusky Moorhen	*Gallinula tenebrosa*	2016	Meran Lakes Complex
Eastern Great Egret	***Ardea modesta***	**2016**	**Meran Lakes Complex**
Eurasian Coot	*Fulica atra*	2016	Meran Lakes Complex
Freckled Duck	***Stictonetta naevosa***	**2016**	**Meran Lakes Complex**
Glossy Ibis	***Plegadis falcinellus***	**2016**	**Meran Lakes Complex**
Great Cormorant	*Phalacrocorax carbo*	2016	Meran Lakes Complex
Great Crested Grebe	*Podiceps cristatus*	2016	Meran Lakes Complex
Grey Teal	*Anas gracilis*	2016	Meran Lakes Complex
Gull-billed Tern	***Gelochelidon nilotica macrotarsa***	**2016**	**Meran Lakes Complex**
Hardhead	***Aythya australis***	**2016**	**Meran Lakes Complex**
Hoary-headed Grebe	*Poliocephalus poliocephalus*	2016	Meran Lakes Complex
Intermediate Egret	***Ardea intermedia***	**2016**	**Meran Lakes Complex**
Latham's Snipe	***Gallinago hardwickii***	**2016**	**Meran Lakes Complex**
Little Black Cormorant	*Phalacrocorax sulcirostris*	2016	Meran Lakes Complex
Little Egret	***Egretta garzetta nigripes***	**2016**	**Meran Lakes Complex**
Little Pied Cormorant	*Microcarbo melanoleucos*	2016	Meran Lakes Complex
Masked Lapwing	*Vanellus miles*	2016	Meran Lakes Complex
Musk Duck	***Biziura lobata***	**2016**	**Meran Lakes Complex**
Nankeen Night Heron	***Nycticorax caledonicus australasiae***	**2016**	**Meran Lakes Complex**
Pacific Black Duck	*Anas superciliosa*	2016	Meran Lakes Complex
Pied Cormorant	***Phalacrocorax varius***	**2016**	**Meran Lakes Complex**
Pink-eared Duck	*Malacorhynchus membranaceus*	2016	Meran Lakes Complex
Purple Swamphen	*Porphyrio porphyrio*	2002	Lake Meran, Little Lake Meran, Little Spectacle Lake, Round Lake

Common Name	Scientific Name	Last record[9]	Wetland
Red-capped Plover	*Charadrius ruficapillus*	2016	Meran Lakes Complex
Red-kneed Dotterel	*Erythrogonys cinctus*	2016	Meran Lakes Complex
Red-necked Avocet	*Recurvirostra novaehollandiae*	2016	Meran Lakes Complex
Red-necked Stint	***Calidris ruficollis***	**2016**	**Meran Lakes Complex**
Royal Spoonbill	***Platalea regia***	**2016**	**Meran Lakes Complex**
Sharp-tailed Sandpiper	***Calidris acuminata***	**2016**	**Meran Lakes Complex**
Silver Gull	*Chroicocephalus novaehollandiae*	2016	Meran Lakes Complex
Straw-necked Ibis	*Threskiornis spinicollis*	2016	Meran Lakes Complex
White-bellied Sea-Eagle	***Haliaeetus leucogaster***	**2016**	**Meran Lakes Complex**
White-faced Heron	*Egretta novaehollandiae*	2002	Meran Lakes Complex
White-necked Heron	*Ardea pacifica*	2016	Meran Lakes Complex
Yellow-billed Spoonbill	*Platalea flavipes*	2016	Meran Lakes Complex
Introduced species			
Carp-Goldfish (hybrid)	*Cyprinus carpio-Carassius auratus*	2016	Lake Meran
Common Blackbird	*Turdus merula*	2016	Meran Lakes Complex
Common Carp	*Cyprinus carpio*	2016	Great Spectacle Lake, Lake Meran, Little Lake Meran, Little Spectacle Lake, Tobacco Lake
Common Myna	*Acridotheres tristis*	2016	Meran Lakes Complex
Common Starling	*Sturnus vulgaris*	2016	Meran Lakes Complex
Eastern Gambusia	*Gambusia holbrooki*	2016	Lake Meran
Eurasian Tree Sparrow	*Passer montanus*	2016	Meran Lakes Complex
European Rabbit	*Oryctolagus cuniculus*	1995	Lake Meran, Little Lake Meran, Round Lake, Tobacco Lake
Goldfish	*Carassius auratus*	2016	Lake Meran, Little Lake Meran
House Sparrow	*Passer domesticus*	2016	Meran Lakes Complex

Common Name	Scientific Name	Last record[9]	Wetland
Red Fox	*Vulpes vulpes*	1990	Little Lake Meran, Round Lake, Tobacco Lake
Redfin Perch	*Perca fluviatilis*	2016	Lake Meran, Little Lake Meran, Round Lake, Tobacco Lake
Tench	*Syn.fam. Cyprinidae gen. Tinca*	1984	Lake Meran, Little Lake Meran
Key: Bold= significant species			

Table E2: Flora Species Lists – Meran Lakes Complex

Sources: DELWP (2015), North Central CMA (2015), Rakali Ecological Consulting (2015).

Common Name	Scientific Name	Last record	Wetland
Native flora			
Annual New Holland Daisy	*Vittadinia cervicularis*	2014	Round Lake
Australian Lilaeopsis	*Lilaeopsis polyantha*	1990	Lake Meran
Australian Saltmarsh-grass	*Puccinellia stricta s.s. (Syn.Puccinellia stricta var. stricta)*	2014	Great Spectacle Lake, Little Spectacle Lake
Berry Saltbush	*Atriplex semibaccata*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Tobacco Lake
Black Box	*Eucalyptus largiflorens*	2014	Meran Lakes Complex
Black Cotton-bush	*Maireana decalvans s.l. (Syn.Maireana decalvans)*	2014	Great Spectacle Lake, Round Lake, Tobacco Lake
Black Roly-poly	***Sclerolaena muricata var. muricata***	**2014**	**Little Spectacle Lake**
Blue Heron's-bill	*Erodium crinitum*	2014	Little Lake Meran
Blue Rod	*Stemodia florulenta*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake, Tobacco Lake
Bluebush	*Maireana spp.*	2014	Tobacco Lake
Bristly Wallaby-grass	*Rytidosperma setaceum (Syn.Austrodanthonia setacea)*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake, Tobacco Lake

Common Name	Scientific Name	Last record	Wetland
Brome	*Bromus spp.*	1990	Lake Meran
Brown Beetle-grass	***Leptochloa fusca subsp. fusca***	**2014**	**Lake Meran**
Clammy Goosefoot	*Dysphania pumilio (Syn.Chenopodium pumilio)*	2014	Little Lake Meran
Clove-strip	*Ludwigia peploides subsp. montevidensis*	1990	Lake Meran
Club-hair New Holland Daisy	***Vittadinia condyloides***	**2014**	**Lake Meran**
Common Blown-grass	*Lachnagrostis filiformis s.l.*	2014	Meran Lakes Complex
Common Boobialla	*Myoporum insulare*	2014	Little Spectacle Lake
Common Nardoo	*Marsilea drummondii*	2014	Tobacco Lake
Common Reed	*Phragmites australis*	2014	Great Spectacle Lake
Common Spike-sedge	*Eleocharis acuta*	2014	Great Spectacle Lake, Lake Meran
Common Swamp Wallaby-grass	*Amphibromus nervosus*	2014	Little Spectacle Lake
Common Verbena	*Verbena officinalis s.l.*	2014	Great Spectacle Lake, Little Lake Meran, Round Lake, Tobacco Lake
Cotton Fireweed	*Senecio quadridentatus*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake, Tobacco Lake
Couch	*Cynodon dactylon*	2014	Great Spectacle Lake, Lake Meran, Little Spectacle Lake, Round Lake
Dark Roly-poly	***Sclerolaena muricata var. semiglabra***	**2014**	**Lake Meran**
Desert Spear-grass	*Austrostipa eremophila*	2014	Little Spectacle Lake, Round Lake, Tobacco Lake
Dock	*Rumex spp.*	2014	Round Lake
Downs Nutgrass	***Cyperus bifax***	**2014**	**Lake Meran**
Downy Swainson-pea	***Swainsona swainsonioides***	**2014**	**Lake Meran**
Drooping Cassinia	*Cassinia arcuata*	2014	Round Lake, Tobacco Lake
Flat Spurge	*Euphorbia drummondii (Syn.Chamaesyce drummondii)*	2014	Great Spectacle Lake
Flat-top Saltbush	***Atriplex lindleyi subsp. lindleyi***	**2014**	**Great Spectacle Lake**
Floodplain Fireweed	***Senecio campylocarpus***	**2014**	**Lake Meran**

Common Name	**Scientific Name**	**Last record**	**Wetland**
Frosted Goosefoot	*Chenopodium desertorum*	2014	Great Spectacle Lake, Little Lake Meran
Galvanized Burr	***Sclerolaena birchii***	**2014**	**Tobacco Lake**
Gold Rush	*Juncus flavidus*	2014	Little Spectacle Lake
Goodenia	*Goodenia spp.*	2014	Great Spectacle Lake
Grass Bindweed	*Convolvulus remotus*	2014	Great Spectacle Lake
Grassland Wood-sorrel	*Oxalis perennans*	2014	Great Spectacle Lake
Grey Germander	*Teucrium racemosum s.l.*	2014	Great Spectacle Lake, Little Spectacle Lake
Grey Roly-poly	*Sclerolaena muricata var. villosa*	2014	Great Spectacle Lake, Little Spectacle Lake, Round Lake, Tobacco Lake
Hedge Saltbush	*Rhagodia spinescens*	2014	Little Spectacle Lake, Tobacco Lake
Hoary Scurf-pea	***Cullen cinereum***	**2014**	**Lake Meran**
Inland Club-sedge	***Isolepis australiensis***	**2012**	**Lake Meran**
Jersey Cudweed	*Helichrysum luteoalbum (Syn.Pseudognaphalium luteoalbum)*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake
Kidney-weed	*Dichondra repens*	2014	Great Spectacle Lake
Knob Sedge	*Carex inversa*	2014	Great Spectacle Lake, Little Spectacle Lake, Tobacco Lake
Large-fruit Tassel	*Ruppia megacarpa*	1989	Little Spectacle Lake, Round Lake
Late-flower Flax-lily	***Dianella tarda***	**2014**	**Lake Meran**
Leafy Fireweed	*Senecio squarrosus s.l.*	2014	Great Spectacle Lake
Marsh Club Rush	*Bolboschoenus caldwellii*	2014	Lake Meran, Great Spectacle Lake, Round Lake
Mallee Love-grass	*Eragrostis dielsii*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake, Tobacco Lake
Moonah	*Melaleuca lanceolata (Syn.Melaleuca lanceolata subsp. lanceolata)*	2014	Little Lake Meran, Round Lake, Tobacco Lake
Myoporum	*Myoporum spp.*	2014	Little Spectacle Lake
Narrow-leaf Cumbungi	*Typha domingensis*	1990	Lake Meran

Common Name	Scientific Name	Last record	Wetland
Narrow-leaf Dock	*Rumex tenax*	2014	Great Spectacle Lake, Little Spectacle Lake
Native Liquorice	*Glycyrrhiza acanthocarpa*	2014	Little Lake Meran
Native Couch	***Cynodon dactylon var. pulchellus***	**2014**	**Lake Meran**
Nodding Saltbush	*Einadia nutans subsp. nutans*	2014	Great Spectacle Lake, Little Lake Meran, Round Lake, Tobacco Lake
Oondoroo	*Solanum simile*	2014	Little Spectacle Lake
Pale Knotweed	*Persicaria lapathifolia*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake, Tobacco Lake
Paper Sunray	*Rhodanthe corymbiflora*	2014	Little Spectacle Lake
Pondweed	*Potamogeton spp.*	1990	Lake Meran
Prickly Saltwort	*Salsola tragus*	2014	Great Spectacle Lake, Little Spectacle Lake, Round Lake, Tobacco Lake
Raspwort	*Haloragis spp.*	2014	Great Spectacle Lake
Rat-tail Couch	*Sporobolus mitchellii*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Tobacco Lake
Red Bird's-foot Trefoil	*Lotus cruentus*	2014	Lake Meran
Red Water-milfoil	*Myriophyllum verrucosum*	2014	Lake Meran, Little Lake Meran, Great Spectacle Lake, Little Lake Meran, Round Lake
Rigid Panic	*Walwhalleya proluta*	2014	Great Spectacle Lake, Little Spectacle Lake
River Club-sedge	*Schoenoplectus tabernaemontani*	1990	Lake Meran
River Red-gum	*Eucalyptus camaldulensis*	2014	Meran Lakes Complex
Rosinweed	*Cressa australis*	2014	Great Spectacle Lake
Rough Spear-grass	*Austrostipa scabra*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake, Tobacco Lake
Ruby Saltbush	*Enchylaena tomentosa var. tomentosa*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake, Tobacco Lake
Salt Sea-spurrey	*Spergularia brevifolia (Syn.Spergularia sp. 3)*	2014	Great Spectacle Lake
Small Knotweed	*Polygonum plebeium*	2014	Little Lake Meran, Round Lake, Tobacco Lake

Common Name	Scientific Name	Last record	Wetland
Small Loosestrife	*Lythrum hyssopifolia*	2014	Great Spectacle Lake, Lake Meran, Little Spectacle Lake, Round Lake
Small Monkey-flower	***Mimulus prostratus***	**2014**	**Lake Meran**
Small Spike-sedge	*Eleocharis pusilla*	1990	Lake Meran
Smooth Heliotrope	*Heliotropium curassavicum*	2014	Meran Lakes Complex
Southern Cane-grass	*Eragrostis infecunda*	1990	Lake Meran
Sow Thistle	*Sonchus spp.*	2014	Great Spectacle Lake, Little Lake Meran, Tobacco Lake
Spider Grass	*Enteropogon acicularis*	2014	Great Spectacle Lake, Little Spectacle Lake, Tobacco Lake
Spiny Flat-sedge	*Cyperus gymnocaulos*	2014	Meran Lakes Complex
Sprawling Saltbush	*Atriplex suberecta*	2014	Little Lake Meran, Round Lake, Tobacco Lake
Stalked Plover-daisy	*Leiocarpa websteri*	2014	Little Spectacle Lake
Sticky Hop-bush	*Dodonaea viscosa*	2014	Great Spectacle Lake
Tall Fireweed	*Senecio runcinifolius*	2014	Great Spectacle Lake, Little Spectacle Lake, Tobacco Lake
Tangled Lignum	*Duma florulenta (Syn.Muehlenbeckia florulenta)*	2014	Great Spectacle Lake, Little Lake Meran
Toad Rush	*Juncus bufonius*	2014	Great Spectacle Lake, Little Spectacle Lake
Tobacco	*Nicotiana spp.*	2014	Little Lake Meran
Variable Sida	*Sida corrugata*	2014	Great Spectacle Lake, Little Lake Meran
Victorian Club-sedge	*Isolepis victoriensis*	2014	Great Spectacle Lake, Round Lake
Willow Herb	*Epilobium spp.*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake, Tobacco Lake
Windmill Grass	*Chloris truncata*	2014	Great Spectacle Lake
Woolly New Holland Daisy	*Vittadinia gracilis*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake, Tobacco Lake
Yellow Twin-heads	*Eclipta platyglossa subsp. platyglossa (Syn.Eclipta platyglossa)*	2014	Great Spectacle Lake
Introduced flora			

Common Name	Scientific Name	Last record	Wetland
African Box-thorn	*Lycium ferocissimum*	2014	Meran Lakes Complex
Annual Beard-grass	*Polypogon monspeliensis*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake, Tobacco Lake
Annual Seablite	*Suaeda maritima subsp. maritima*	2014	Little Spectacle Lake, Tobacco Lake
Annual Veldt-grass	*Ehrharta longiflora*	2014	Little Spectacle Lake, Round Lake
Artichoke Thistle	*Cynara cardunculus subsp. flavescens (Syn.Cynara cardunculus)*	2001	Little Lake Meran
Aster-weed	*Aster subulatus*	2014	Meran Lakes Complex
Barley Grass	*Hordeum spp.*	2014	Great Spectacle Lake, Little Spectacle Lake, Tobacco Lake
Black Nightshade	*Solanum nigrum s.l. (Syn.Solanum nigrum sensu Willis (1972))*	2014	Little Lake Meran, Little Spectacle Lake, Tobacco Lake
Bridal Creeper	*Asparagus asparagoides*	2014	Lake Meran
Buck's-horn Plantain	*Plantago coronopus*	2014	Great Spectacle Lake
Buffalo Grass	*Stenotaphrum secundatum*	2014	Lake Meran
Burr Medic	*Medicago polymorpha*	2014	Tobacco Lake
Camel Thorn	*Alhagi maurorum*	2004	Lake Meran
Canary Grass	*Phalaris spp.*	2014	Little Spectacle Lake, Tobacco Lake
Cape Wattle	*Paraserianthes lophantha subsp. lophantha*	2014	Lake Meran
Celery Buttercup	*Ranunculus sceleratus subsp. sceleratus*	2014	Great Spectacle Lake, Little Lake Meran, Round Lake
Chicory	*Cichorium intybus*	2014	Little Lake Meran
Clover	*Trifolium spp.*	2014	Little Spectacle Lake, Round Lake
Cluster Clover	*Trifolium glomeratum*	2014	Little Spectacle Lake
Clustered Dock	*Rumex conglomeratus*	2014	Little Lake Meran
Common Heliotrope	*Heliotropium europaeum*	2014	Great Spectacle Lake, Little Spectacle Lake
Common Peppercress	*Lepidium africanum*	2014	Great Spectacle Lake, Little Spectacle Lake
Common Prickly-pear	*Opuntia stricta*	2001	Little Lake Meran

Common Name	Scientific Name	Last record	Wetland
Common Sow-thistle	*Sonchus oleraceus*	2014	Great Spectacle Lake, Lake Meran, Little Lake Meran, Little Spectacle Lake, Round Lake
Creeping Knapweed	*Rhaponticum repens*	2014	Great Spectacle Lake
Curled Dock	*Rumex crispus*	2014	Great Spectacle Lake, Lake Meran, Little Lake Meran, Little Spectacle Lake
Desert Ash	*Fraxinus angustifolia*	2014	Lake Meran
Drain Flat-sedge	*Cyperus eragrostis*	2014	Little Lake Meran, Little Spectacle Lake
False Sow-thistle	*Reichardia tingitana*	2014	Great Spectacle Lake
Fennel	*Foeniculum vulgare*	2001	Round Lake, Tobacco Lake
Fescue	*Vulpia spp.*	2014	Little Spectacle Lake
Fleabane	*Conyza spp.*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake
Honey Locust	*Gleditsia triacanthos*	2014	Lake Meran
Hop Clover	*Trifolium campestre var. campestre*	2014	Round Lake
Horehound	*Marrubium vulgare*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake, Tobacco Lake
Jointed Rush	*Juncus articulatus subsp. articulatus (Syn.Juncus articulatus)*	2014	Great Spectacle Lake
London Rocket	*Sisymbrium irio*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake, Tobacco Lake
Mallow of Nice	*Malva nicaeensis*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake, Tobacco Lake
Medic	*Medicago spp.*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake, Tobacco Lake
Musky Heron's-bill	*Erodium moschatum*	2014	Little Spectacle Lake
Mustard	*Sisymbrium spp.*	2014	Little Spectacle Lake
Oat	*Avena spp.*	2014	Great Spectacle Lake, Little Spectacle Lake, Round Lake, Tobacco Lake

Common Name	Scientific Name	Last record	Wetland
Olive	*Olea europaea*	2014	Lake Meran
Osage Orange	*Maclura pomifera*	2014	Lake Meran
Ox-tongue	*Helminthotheca echioides*	2014	Meran Lakes Complex
Paddy Melon	*Cucumis myriocarpus subsp. leptodermis*	2014	Tobacco Lake
Paspalum	*Paspalum dilatatum*	2014	Lake Meran
Paterson's Curse	*Echium plantagineum*	2014	Great Spectacle Lake, Lake Meran, Little Spectacle Lake, Round Lake, Tobacco Lake
Pepper Tree	*Schinus molle*	2014	Great Spectacle Lake, Tobacco Lake
Prairie Grass	*Bromus catharticus*	2014	Little Spectacle Lake
Prickly Lettuce	*Lactuca serriola*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake, Tobacco Lake
Prostrate Knotweed	*Polygonum aviculare s.l.*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake, Tobacco Lake
Red Brome	*Bromus rubens*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Tobacco Lake
River Oak	*Casuarina cunninghamiana subsp. cunninghamiana*	2014	Lake Meran
Rough Sow-thistle	*Sonchus asper s.l.*	2014	Great Spectacle Lake, Little Lake Meran, Round Lake, Tobacco Lake
Rye Grass	*Lolium spp.*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake, Tobacco Lake
Skeleton Weed	*Chondrilla juncea*	2014	Great Spectacle Lake
Soursob	*Oxalis pes-caprae*	2001	Round Lake, Tobacco Lake
Spear Orache	*Atriplex patula*	1990	Lake Meran
Spear Thistle	*Cirsium vulgare*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake, Tobacco Lake
Spiny Rush	*Juncus acutus subsp. acutus*	2014	Great Spectacle Lake, Little Spectacle Lake, Round Lake, Tobacco Lake
Stemless Thistle	*Onopordum acaulon*	2014	Tobacco Lake

Common Name	Scientific Name	Last record	Wetland
Strawberry Clover	*Trifolium fragiferum var. fragiferum*	2014	Little Lake Meran
Sugar Gum	*Eucalyptus cladocalyx*	2014	Lake Meran
Summer Grass	*Digitaria sanguinalis*	2014	Little Lake Meran
Sweet Melilot	*Melilotus indicus*	2014	Great Spectacle Lake, Little Lake Meran, Little Spectacle Lake, Round Lake, Tobacco Lake
Toowoomba Canary-grass	*Phalaris aquatica*	2014	Great Spectacle Lake, Round Lake, Tobacco Lake
Tree Tobacco	*Nicotiana glauca*	2014	Little Spectacle Lake, Round Lake
Variegated Thistle	*Silybum marianum*	2014	Little Spectacle Lake, Tobacco Lake
Water Couch	*Paspalum distichum*	1990	Lake Meran
Wild Radish	*Raphanus raphanistrum*	2014	Great Spectacle Lake, Little Spectacle Lake
Wild Sage	*Salvia verbenaca*	2014	Great Spectacle Lake
Willow-leaf Lettuce	*Lactuca saligna*	2014	Great Spectacle Lake
Woolly Clover	*Trifolium tomentosum var. tomentosum*	2014	Little Spectacle Lake

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