WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Final Report

Lake Natimuk Weir Modification, Ecological Impact Report

Wimmera Catchment Management Authority

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1 INTRODUCTION

This report (Lake Natimuk Weir Modification, Ecological Impact Report) was undertaken as part of the *Wimmera Wetland Hydrology Investigation*. The broader project intent was to better understand the impact of climate and catchment change on water levels in Lake Natimuk, St Marys Lake (at Tooan) and Lake Wallace. This was completed by modelling the impact of these changes in calibrated or verified hydrology models. This component of the broader project builds on a calibrated model of Lake Natimuk, with the addition of desktop and on-ground ecology assessments to identify the biological values at Lake Natimuk and the connecting Natimuk Creek.

The analysis and identified biological values were used to assess the ecological impact of increasing the operating water level in Lake Natimuk by raising the outlet weir structure by 700mm. This considered:

- The potential changes to wetland ecology that may result from a raising of the outlet weir structure, which in turn will alter the hydrological regime.
- Weir operation recommendations to mitigate significant ecological risks.

It should be noted this assessment was completed on the maximum potential impact of increasing the Lake Natimuk weir height. The proposed weir is not intended to be fixed, with operational boards put in place to allow the lake to be maintained at the existing maximum water level if desired. This would enable flows to be passed through Lake Natimuk if there is a need to do so.

It should also be noted several members of the community and Lake Natimuk Foreshore Committee have noted the Lake Natimuk outlet height was previously at a level similar to the proposed level and lowered following the construction of the old weir, this is also included in documentation from Wimmera Mallee Water and the local Shire Engineer. There is some documentation that refers to a previous higher level, but no levels are provided in m AHD so no definitive comparison of current to historic levels could be made.

2 DESKTOP ASSESSMENT

The desktop assessment of biological data included the following sources:

- An Atlas of Victorian Wildlife (AVW) Database search was accessed through NatureKit (DELWP 2018) to identify fauna species that have been recorded at the lakes over a long period of time. A 2.5 km search radius from the centre of the lake was used and data sorted by most recent appearances.
- Native Vegetation Information Management maps were accessed through NatureKit (DELWP 2018) to show habitat including native vegetation type and extent information, EVC mapping for both pre-1750's and extant (2005) modelled mapping.
- Records of bird observations via Ebird.
- Environmental Protection and Biodiversity Conservation Act (EPBC Act) protected matters search.

2.1 Desktop Flora Assessment

2.1.1 Victorian Biodiversity Atlas

The Victorian Biodiversity Atlas (VBA) (DELWP 2018) was queried to identify recorded sightings of flora species within a 5km radius of Lake Natimuk.

A total of 137 flora species have been recorded within a 5km radius of the centre of Lake Natimuk. Of those 137 species, 53 are introduced and eight species are listed within Victoria as either poorly known, vulnerable or rare. It is noted that many of the species were located 30 years ago and may not have been identified since. There have only two listed species identified since the year 2000. Those listed flora species are:

- *Bromus arenarius*, Sand Brome, listed as **rare** in Victoria (i.e. rare but not considered otherwise threatened - there are relatively few known populations or the taxon is restricted to a relatively small area).
- *Malva preissiana* s.s (white-flowered coastal form), Coast hollyhock, listed as **vulnerable** in Victoria (i.e. not presently endangered but likely to become so soon due to continued depletion).

2.1.2 Mapped Vegetation - Ecological Vegetation Classes (EVC's)

Modelled EVC distribution mapping (DELWP 2018) indicates that native vegetation is substantially modified from its pre-European state, largely as a result of clearing for agriculture, and to a lesser extent the Caravan Park residential buildings. The study area, including Lake Natimuk and the connecting Natimuk Creek, is located within the Wimmera Bioregion.

Pre-European (1750) modelled EVC mapping indicates that the following EVCs were likely to be present in the vicinity of Lake Natimuk:

- EVC 66: Low rises woodland associated with the connection between Lakes Wyn Wyn and Natimuk
- EVC 96: Ridged Plains Mallee occurs on higher ground between Lakes Wyn Wyn and Natimuk
- EVC 679: Drainage-line Woodland south of the lake connecting towards Natimuk township
- EVC 717: Saline Lake Aggregate occurs to the north connecting Lake Wyn Wyn in a narrow corridor
- EVC 803: Plains Woodland surrounding most of the area around the lake on higher ground where waterways and lakes are absent
- EVC 826: Plains Savannah to the east of the lake
- EVC 882: Shallow Sands Woodland bordering the lake banks

- EVC 939: Lakebed Herbland/Red Gum Swamp Mosaic located in the bed and margins of Lake Natimuk

Online mapping shows the EVCs within and around the lake margins and associated creeks are largely dependent on the presence of water and/or soil type. The Current (2005) modelled EVC mapping in the vicinity of Lake Natimuk is presented in Figure 2-1 with the key relevant EVCs (i.e. those EVCs potentially affected by a change in hydrology) labelled.

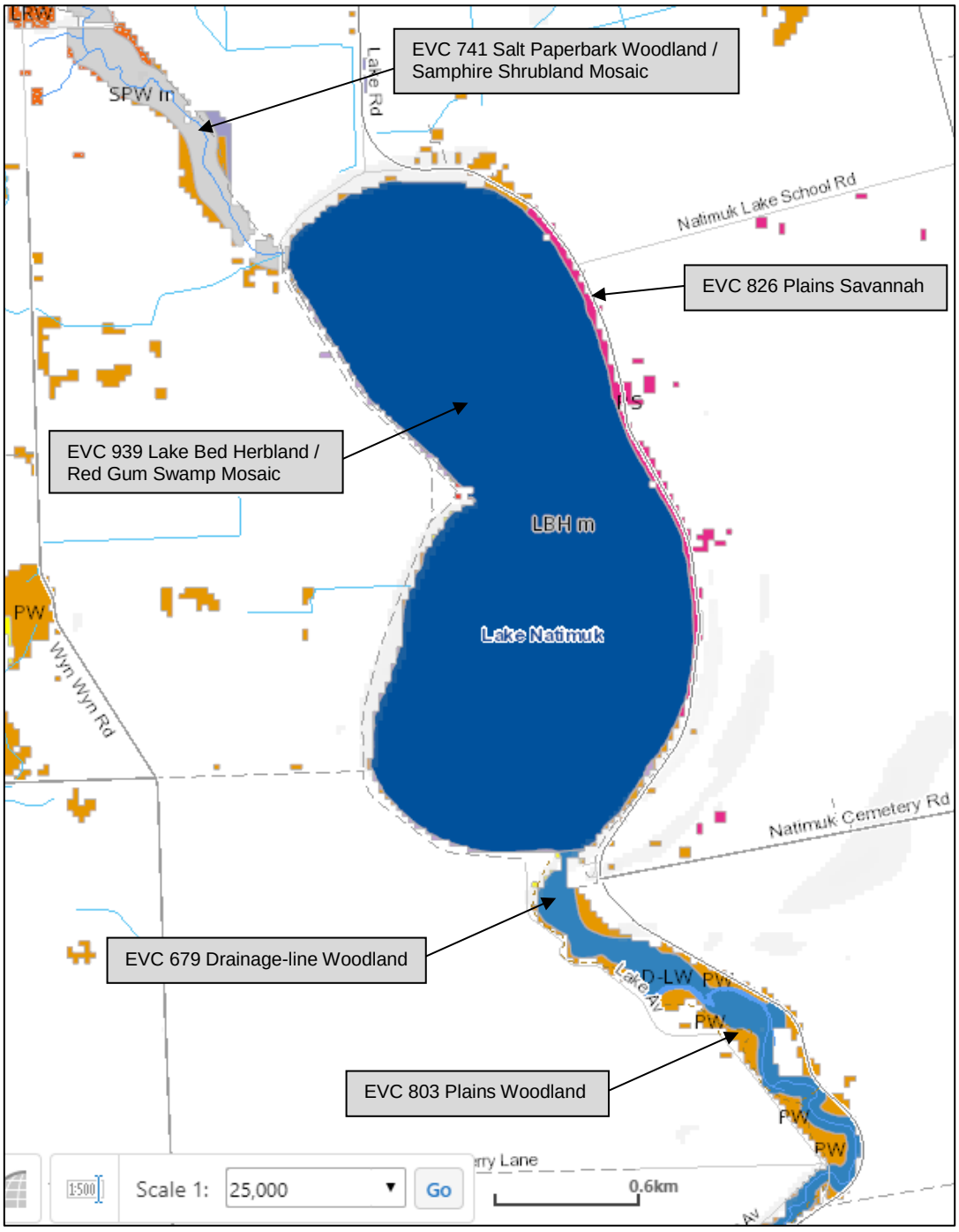

FIGURE 2-1 2005 EVC MAPPING – LAKE NATIMUK AND SURROUNDS

The current (2005) EVCs most relevant to Lake Natimuk and the connecting waterways (i.e. Natimuk Creek entering from the south and flowing out to the north towards Lake Wyn Wyn) are described further as follows:

- **EVC 939: Lakebed Herbland/Red Gum Swamp Mosaic** is mapped as occupying the entire bed of the Lake. It is inferred that the bed of the lake would be Lakebed Herbland and the margins may have affinity with Red Gum Swamp. These two EVCs are described as follows:
  - **EVC 107: Lake Bed Herbland** - Bioregional Conservation Status: not listed in the Wimmera Bioregion but identified as Depleted in most other Bioregions. Description: Herbland dominated by species adapted to drying mud within lake beds. Some evade periods of prolonged inundation as seed, others as dormant tuberous rootstocks. Present within less saline lakes of north-western areas of Victoria. Dominant species: Variously including *Glycyrrhiza acanthocarpa*, *Malva australasica* s.l., *Glossostigma* spp., *Solanum simile*, *Dysphania pumilio*; also localised species including *Mukia micrantha*, *Nicotiana goodspeedii* and *Cullen* spp.
  - **EVC 292: Red Gum Swamp** - Bioregional Conservation Status: Vulnerable (DELWP 2018a) Description: Occurs on alluvial plains in the seasonally wet depressions of shallow drainage lines or prior stream meanders, typically associated with heavy paludal soils, sometimes with gilgai development. The annual rainfall across its distribution is generally below 700 mm, and the period of inundation may range from 2 to 6 months. River Red Gum woodland to 15 m tall with sedgy or grassy-herbaceous ground-layer, comprising various balances of true aquatics and species tolerant of intermittent to seasonal inundation. Dominant species: Canopy is dominated by *Eucalyptus* spp. @ 80cm DBH and 10/Ha, 10% coverage with characteristic species River Red Gum. The understorey comprises of shrubs, herbs and graminoids (grasses, sedges, rushes), typically covering >100% (i.e. vegetation lifeforms can overlap).
- **EVC 679: Drainage-line Woodland** is mapped as occupying the Natimuk Creek channel, banks and lowest lying adjacent floodplain upstream/south of Lake Natimuk. Bioregional Conservation Status: Endangered (DELWP 2018a). Description: Sedge and rush-dominated eucalypt woodland to 15 m tall occurring along intermittent creeks in areas where annual rainfall is less than 500 mm. Dominant species: *Eucalyptus* spp. @ 80cm DBH and 15/Ha and 15% foliar coverage, character species include River Red Gum *Eucalyptus camaldulensis* and Grey Box *Eucalyptus macrocarpa* with a herb and graminoid (grasses, sedges, rushes) understorey totalling around 60% projective foliage cover.
- **EVC 803: Plains Woodland** is mapped as very sparse to patchy around the lake and on higher ground adjacent to Natimuk Creek, both upstream and downstream of the Lake. While once widespread, most of this EVC has been replaced by agricultural practices. Bioregional Conservation Status: Endangered (DELWP 2018a). Description: Grassy or sedgy woodland to 15 m tall with large inter-tussock spaces potentially supporting a range of annual or geophytic herbs adapted to low summer rainfall, with low overall biomass. Mostly occurs on terrain of low relief in areas receiving <600 mm rainfall per annum. Fertile, sometimes seasonally waterlogged, mostly silty, loamy or clay topsoils, with heavy subsoils, derived largely from former Quaternary swamp deposits. Dominant species: Buloke *Allocasuarina luehmannii* to (40cm DBH) and *Eucalyptus* spp. (to 70cm DBH) including characteristic species Yellow Gum *Eucalyptus leucoxylon*, Yellow Box *Eucalyptus melliodora* and Grey Box *Eucalyptus macrocarpa* totalling 15% cover. The understorey has diverse life forms consisting of shrubs herbs and graminoids with >100% cover.
- **EVC 826: Plains Savannah** is mapped as having remnant cover off the eastern edge of Lake Natimuk. Bioregional Conservation Status: Endangered. Description: A structurally diverse vegetation unit which includes 'grassy openings' of a few to many hundreds of hectares, with a variable tree density ranging from a very sparse savannah to woodland. The relative absence of eucalypts is particularly characteristic, with Buloke *Allocasuarina luehmannii* and perhaps Slender Cypress Pine *Callitris gracilis* subsp. *murrayensis* to 10 m tall being the dominant trees. Dominant species: Has 10% cover of Buloke and Slender Cypress Pine the dominant tree species with a sparse 10% cover. The understorey comprises shrubs (5%), herbs (35%) and grasses (50%), with the latter two lifeforms seasonally present.

- **EVC 741: Salt Paperbark Woodland/Samphire Shrubland Mosaic** is mapped as surrounding Natimuk Creek downstream/north of the Lake. These two EVCs are described as follows:
  - **EVC 676: Salt Paperbark Woodland** – Bioregional Conservation Status: Vulnerable (DELWP 2018a). Description: Low non-eucalypt woodland to 8 m tall with herbaceous ground-layer dominated by halophytic chenopods and other succulent herbs with a range of annual grasses and herbs. Occurs on heavy soils with large salt concentrations (sometimes with a shallow sand overlay on lake verges) in areas with seasonally waterlogged heavy clay soils on saline flats and lake verges. Dominant species: Salt Paperbark *Melaleuca halmaturorum* ssp. *halmaturorum* with 10% canopy cover is the dominant species. Herbs and a shrub Round-leaf Wilsonia *Wilsonia rotundifolia* dominate the understorey which generally has only 45% coverage.
  - **EVC 101: Samphire Shrubland** - Bioregional Conservation Status: Least Concern (DELWP 2018a). Description: Low open shrub layer to 0.5 m of succulent chenopods on saline clay pans. Found in association with the various halite salinas that have developed within evaporative basins or 'boinkas'. Dominant species: Salt tolerant small shrubs, herbs and graminoids comprise an understorey of approximately 30% cover.

2.2 Desktop Fauna Assessment

Atlas of Victorian Wildlife

Atlas of Victorian Wildlife database assessments identified 161 records of species that have been located within a 2km radius of Lake Natimuk.

- Four fish, all of which are introduced species and were recorded in the 1980's. The lake and creek has had a regular occurrence of wetting and complete drying making it unsuitable for long term fish residence.
- 142 bird species, of these six are introduced, 22 are listed as significant on State level many of which are aquatic species and two, the Curlew Sandpiper and Australian Painted Snipe listed under the Commonwealth *EPBC Act*. Many of these listed species were last observed in the late 1990's to mid-2000's. Species such as the EPBC Critically endangered Australian Painted Snipe was last recorded in 1979. These species are likely to be vagrant species which visit the lake when it is full of water and food sources.
- Six species of reptiles have been observed around the lake, none of which are listed or exotic species. They include: three skinks, Olive legless Lizard, Stump Tailed Lizard and Eastern Brown Snake.
- Five species of frog have been recorded around and/or in the lake of which one, the Growling Grass Frog is endangered on a State level and vulnerable on a National level of conservation listings.
- One species of butterfly, the Yellow Sedge-skipper Butterfly is listed as vulnerable within Victoria. This was last recorded in 1985.
- Two mammals have been previously recorded but they were a significant time ago. They are the Eastern Ring-tailed possum (recorded in 1945) and the Yellow footed Antechinus which was observed in 1970.

Other lists provided by the Wimmera CMA included an excerpt printout from Ebird, including a comprehensive documentation of aquatic birds present in the vicinity of the lake. As recently as February 2018 many aquatic birds were observed by local bird enthusiasts, these included Black Swan, various duck species dominated by Grey Teals, Egrets, Herons, Avocets, Stilts, Plovers, Sandpipers, Swamphens and Spoonbills. In addition, a Freckled Duck was observed on February 1st, 2018 and White-bellied Sea-Eagle was reportedly observed in August 2014 (Ebird printout March 2018).

Natimuk-Douglas Saline Wetland System

Birds Australia (2002) prepared a management Plan for the Natimuk-Douglas Saline Wetland System. The main points cited and reported on in the management plan are summarised below:

- The wetland system provides a spectacular annual migration of thousands of Banded Stilts to these salt pans. In the spring time of most years, the salt pans support large numbers of Banded Stilt with annual peaks of between 14,000 to 60,000 birds, representing between 7 and 30% of the Australian population. These and Red-necked Avocets make the wetland system important sites for both species. However, in wetter years many of the birds go to the larger salt pans of central and Southern Australia. A main food source of Banded Stilts is the Brine shrimp, which they fatten on before heading to the coast. It should be noted that, unlike Lake Wyn Wyn which is a salt lake, Lake Natimuk is a freshwater lake and therefore utilisation by Stilts and Avocets might be limited.
- At least 81 species of bird have been recorded around the Natimuk-Douglas wetlands. This figure includes twenty species listed under one or more of the Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA) and Bonn Convention (CMS); ten species listed as threatened in Victoria under the Flora and Fauna Guarantee Act 1998; and one species (Red-tailed Black-Cockatoo) listed as nationally threatened under the Environment Protection and Biodiversity Conservation Act 1999 (Birds Australia 2002). Species recorded in moderate but sub-threshold numbers are Musk Duck (maximum 91 birds), Black Swan (maximum 3,902 birds), Grey Teal (maximum 10,074 birds), Hoary-headed Grebe (maximum 3,334 birds) and Sharp-tailed Sandpiper (maximum 488 birds). The saltmarshes that surround the wetlands provide foraging habitat for Blue-winged Parrots (maximum 61 birds) (Birds Australia 2002).
- The report states in the system some 24 threatened bird species have been recorded in the system, six of which were recorded between 1980 and 2001, prior to the report being published.
- Non-bird biodiversity: More than 360 species of plant have been recorded around the Natimuk-Douglas wetlands. This figure includes five species (Buloke, Bead Glasswort, Salt Paperbark, Hairy Tails and Dwarf Yellowheads) listed as threatened in Victoria under the Flora and Fauna Guarantee Act 1988 and three species (Bead Glasswort, Dwarf Yellowheads and Western Water-starwort) listed as nationally threatened under the Environment Protection and Biodiversity Conservation Act 1999.
- Nine species of reptile and six species of mammal (including the introduced House Mouse and European Rabbit) have been recorded around the wetlands (Birds Australia 2002).
- It was stated that the Fat-tailed Dunnart possibly uses the woodlands surrounding the wetland system but has not been proven. Further studies are required to support this theory.

- The listed key threats to the lakes are:
  - Altered surface water flows and input;
  - Rising groundwater and salinity;
  - Pollution;
  - Pest plants and animals;
  - Fire; and
  - Recreation.
- At the time the management plan was written the concept of climate change was more theory than fact and the effect of drought as a result of this can be categorised in altered surface water flows and input.

Directory of Important Wetlands (DIW)

Natimuk Lake, Natimuk Creek and Lake Wyn Wyn are listed in the Directory of Important Wetlands. Six species listed by Japan-Australia Migratory Bird Agreement (JAMBA) and China-Australia Migratory Bird Agreement (CAMBA) have been recorded at Natimuk Lake and Natimuk Creek. These are the Great Egret, Greenshank, Marsh Sandpiper, Sharp-tailed Sandpiper, Red-necked Stint, Curlew Sandpiper and one species only listed by CAMBA (Glossy Ibis).

2.3 EPBC Protected Matters Search

The online EPBC Protected Matters Search Tool (PMST) was accessed to undertake a search within a 2.5km radius of the centre of Lake Natimuk. The search results are summarised as follows:

- One wetland of International importance, Lake Albacutya some 50-100km north
- Four Listed threatened ecological communities, two endangered and two critically endangered, they are:
  - Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions, Endangered Community may occur within area.
  - Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia, Endangered Community likely to occur within area.
  - Natural Grasslands of the Murray Valley Plains, Critically Endangered Community likely to occur within area.
  - White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland Critically Endangered Community likely to occur within area
- 22 Listed Threatened species, of which eight are birds, one fish, one frog and one reptile, the remainder are plants.
- 11 Listed Migratory species

The full Protected Matters Search report is provided in Appendix A.

3 FIELD ASSESSMENT OF LAKE NATIMUK

3.1 Flora Assessment

The field flora assessment was undertaken concurrently with the fauna assessment on the day of 31 March 2018. The assessment concentrated on the areas likely to be affected by a modification to Lake Natimuk's outlet weir structure. The areas of particular interest were:

- The Lake Natimuk margin above the existing high water mark.
- The potentially backwatered reach of Natimuk Creek, upstream of the Lake.
- Natimuk Creek downstream from Lake Natimuk to Lake Wyn Wyn.

Each of these areas of interest are described in Section 4 Impact Assessment.

3.1.1 Field Validation of EVC mapping

The 2005 EVC mapping, as shown in Figure 2-1, was reviewed and related to vegetation observed in the field. A review of the vegetation of key areas potentially affected by a change in hydrology follows.

Lake Natimuk - EVC review

The 2005 EVC mapping suggested that the bed of Lake Natimuk was a mosaic of two EVCs; Lake Bed Herbland and Red Gum Swamp.

The bed of the lake was completely dry at the time of assessment so validation of the Lake Bed Herbland is difficult, however, is likely that once lake receives water, a herbland will present itself within the shallower extents of the Lake. The left image in Figure 3-1 is taken from the middle of Lake Natimuk showing *Crassula* sp. (red) and *Chenopodium* spp. (green) growing across the dry lake bed.

Despite being mapped as a mosaic, there were no mature patches of Red Gum Swamp within the bed of the lake. However the lake is fringed with large old and less mature River Red Gums around most of the perimeter. As with the Lake Bed Herbland, it is difficult to identify the herbaceous understorey associated with a Red Gum Swamp until the area receives water. The right image in Figure 3-1 is looking down the eastern lake margin showing the line of River Red Gums which may have affinities with Red Gum Swamp under wetter conditions. It should also be noted the mass of seedlings growing on the inside of the mature parents. These trees would be drowned out under a 'normal' hydrological regime and are a sign of the lake not filling in recent years.

FIGURE 3-1 MIDDLE AND MARGIN OF LAKE NATIMUK

Natimuk Creek upstream of Lake Natimuk - EVC review

The 2005 EVC mapping suggested that EVC 679 Drainage-line Woodland occupies the creek bank and floodplain. Drought and/or salinity appears to have killed off the scarce River Red Gums. Salt tolerant Samphires dominate much of the channel while grasses dominate the floodplain with Tangled Lignum *Muehlenbeckia florulenta* abundant on the higher floodplain (Figure 3-2). There is currently little affinity with Drainage-line Woodland, particularly with the loss of trees. The drainage line and lower floodplain appears to be disturbed by clearing, grazing and salinisation, however the upper floodplain retains attributes of EVC 808 Lignum Scrub.

FIGURE 3-2 VIEWS UP NATIMUK CREEK, UPSTREAM OF LAKE NATIMUK

Natimuk Creek downstream of Lake Natimuk - EVC review

The 2005 EVC mapping suggested that EVC 741 Salt Paperbark Woodland / Samphire Shrubland Mosaic surrounds Natimuk Creek in this reach. This EVC is valid for the downstream half of the reach (see Figure 3-3 right photo), however the upstream half of the reach is more an open woodland and more synonymous with EVC 803 Plains Woodland (see Figure 3-3 left photo).

FIGURE 3-3 NATIMUK CREEK DOWNSTREAM OF LAKE NATIMUK

3.2 Fauna Assessment

The surrounds of the lake were assessed throughout the day and evening of 31st March 2018. Due to the phase of the lake being dry at the time of assessment, the fauna that currently utilise the lake were limited to terrestrial and arboreal species. The lake is surrounded by a narrow band of River Red Gums of varying ages. In some locations where erosion is occurring at tree bases, particularly on the eastern side of the lake, there has been rock placement to reduce wave action erosion and protect the roots and stability of the trees. Large River Red Gums provide a food and shelter source for birds, arboreal mammals and reptiles. Several examples of old and dead trees occur adjacent to the camping ground. The understorey is dominated by grasses and juvenile River Red gums near the mature trees. The west side of the lake has been planted out with a mix of native species. The lake bed consists mainly of opportunistic terrestrial species that will be drowned out when the lake next fills. As the lake fills, this drowned vegetation will provide valuable habitat and carbon/energy to the lake environment.

3.2.1 Birds

Lake Natimuk has a considerable bird population using the surrounds of the lake. Birds utilise the remnant narrow edge of the lake which consists of mature and juvenile River Red Gum trees and several opportunities for hollow nesting species in large dead trees. Dominant bird species included Eastern Rosellas, Magpie larks, Galahs and Red-rumped Parrots utilising the higher canopy of fringing Eucalypts while ground dwelling birds such as Australian Magpie and feeding Red-rumped Parrots, Willie Wagtails and Superb Fairy-wrens were common within the understorey species dominated by young Eucalypts and occasional shrubs. Birds of prey Whistling Kite and Black Shouldered Kite were observed while Kookaburras, Little Ravens, Corellas and Cockatoos were heard in the distance. Non-native species utilise dead hollow bearing trees, these include House Sparrows and Starlings.

Aquatic birds were absent at the time of assessment as lake was dry. However, utilising both the historic photograph records, the eBird database and prior knowledge of Lake Natimuk and their inhabitants, it can be presumed that when habitat (water) conditions are present these species will utilise the lake in large numbers.

3.2.2 Mammals

Large macropods are likely to use the lake and its surrounding vegetation particularly the Natimuk Creek Reserve woodland corridor. A large mob of Eastern Grey Kangaroos was observed close to the margins of Lake Wyn Wyn.

Remains of a large rat were located within the treed area of the lake margin, this is believed to be an introduced rat such as Brown Rat *Rattus norvegicus*. There is also likely to be domesticated animals hunting in the area given the close proximity to houses and farms. These include pet dogs and cats.

Terrestrial pest species occurring at the site include rabbits and foxes. Parts of the lake banks have long grass and rabbit holes were observed frequently in the sandy soil. The assortment of large trees bearing hollows and some spotlighting indicated the presence of Brushtail Possums. It is also probable that Ring-tailed Possums utilise the area surrounding the lake in optimal conditions and scats of this species were found. Yellow footed-Antechinus was located in the saline lakes system in the 1970's and, although habitat is depleted and there is likely to be predators, this species may still be present. There were sufficient hollows near the bases of large trees to suggest habitat providing trees were adequate. The Natimuk Creek Reserve downstream of Lake Natimuk provided broader, connected habitats for more species. Small arboreal mammals are likely to utilise tree hollows, indicated by Brushtail Possum scats.

A White-striped Freetail Bat *Tadarida australis* was heard emitting calls that are audible to the ecologists present. These were located on the fringes of the lake adjacent to River Red Gums. It is highly probable that

this and other species would be present year-round but are more likely to occur when water is within the lake and a food source is more readily available.

Spotlighting was undertaken on the evening of 31st March 2018. Large hollow bearing River Red Gums were the focus of the survey along the south-western and southern margins of the lake. Two Brushtail Possums were observed in large River Red Gum trees immediately west of the Natimuk Creek entry point on the southern margin of the Lake.

3.2.3 Reptiles

Skink holes in the sand were frequently observed. These are likely to be from the Large-striped Skink, a species previously recorded in the area. Indication of use by some species that succumbed to the lake drying out were evident. An Eastern Long-necked Turtle shell was observed on the western bank of the lake at the base of a large River Red Gum (Figure 3-4), possibly predated by a fox upon leaving the drying lake bed.

FIGURE 3-4 EASTERN LONG-NECKED TURTLE SHELL ON THE WESTERN BANK OF LAKE NATIMUK

It could be expected that other reptiles including skinks, snakes and goannas would utilise the site when there is a food source.

3.2.4 Fish and other aquatic species

Other fauna observed were discarded exoskeletons of the Common Yabby *Cherax destructor* on the bank of the lake. There was no habitat to support fish at the time of assessment and no pools were observed within Natimuk Creek.

4 IMPACT ASSESSMENT

4.1 Overview

As detailed in the Model Calibration Report (July 2018), a Source model was developed as part of this project. The model was calibrated to historic observed water levels in Lake Natimuk. The model was used in this component of the project to determine the predicted water level changes which could occur as a result of increasing the height of the outlet structure. This was completed by modelling the full period of available historic rainfall data (1906-2017) with the current catchment conditions in both scenarios; the current outlet weir height, 114.7 m AHD and the proposed outlet height, 115.4 m AHD. A range of statistics was then extracted from each scenario demonstrating the potential change in in hydrologic regime and biological impacts associated with raising the outlet weir structure by 700mm. The margins of Lake Natimuk were viewed at several locations to assess the potential impacts of creating a higher water operating level. A concrete weir structure has already been constructed but currently stands on the lake side of the existing weir and has not been commissioned (Figure 4-1). There is evidence (Wimmera Mallee Water correspondence provided by the Lake Natimuk Foreshore Committee) that Lake Natimuk was operated at a height 15 inches (38.1 cm) above its current level but it is not definitive.

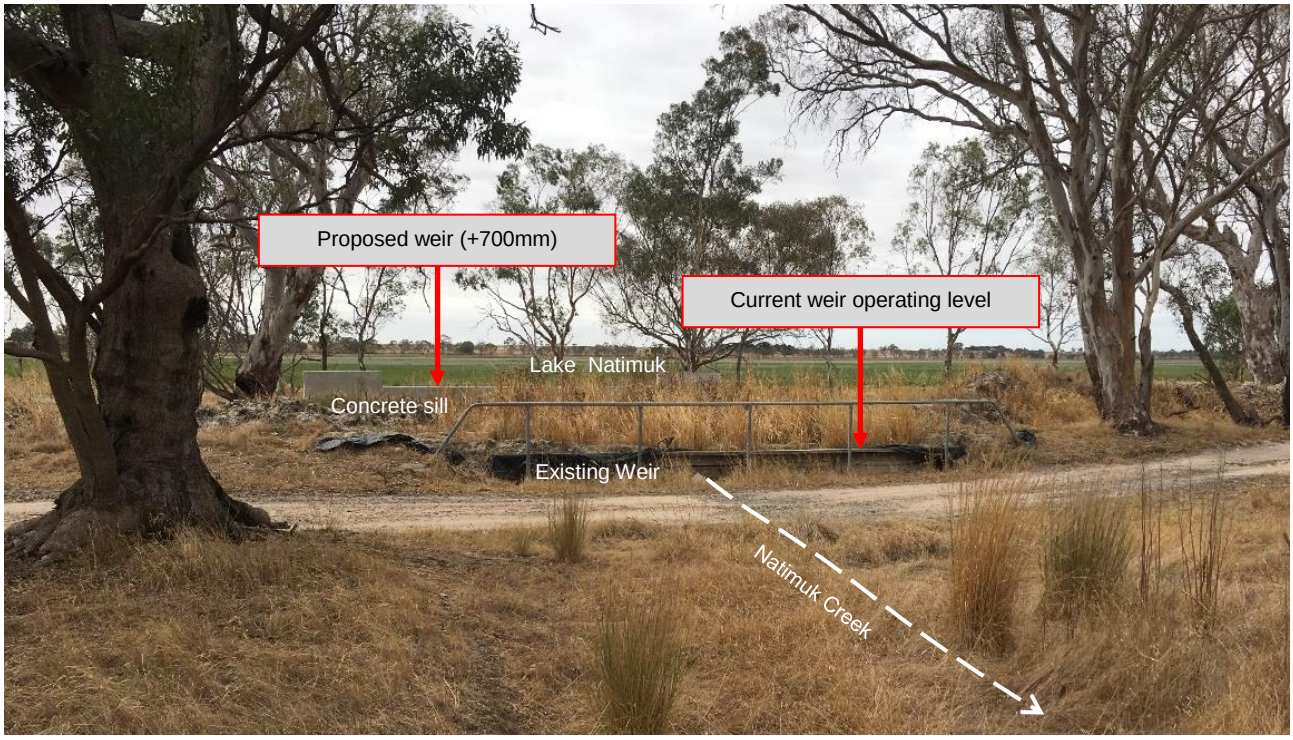

FIGURE 4-1 VIEW TOWARDS LAKE NATIMUK FROM THE OUTLET SHOWING EXISTING WEIR AND NEWLY CONSTUCTED WEIR SILL

4.2 Changes to Hydrologic Regime

4.2.1 Analysis

The maximum standing water level in existing and proposed conditions was mapped in plan view to show the extent of inundation around Lake Natimuk and upstream into Natimuk Creek. Figure 4-2 shows the extent of

inundation under existing conditions (yellow line) and the inundation extent should the 700mm higher weir were in operation (blue line). The 700mm higher weir is hereafter referred to as 'the proposed weir'.

The maximum increase in inundation area is generally relatively minor with the existing lake banks containing the inundation. The existing wet area of the lake is around 310 Ha, this would increase to 317 Ha in with the elevated weir height. No increase in water levels will occur downstream of the outlet weir.

FIGURE 4-2 INUNDATION MAPPING WITH DISCUSSION SITE LOCATIONS

The modelled water levels over the entire period of record are also shown in Figure 4-3 with the change in depth as a result of the proposed weir shown in Figure 4-4.

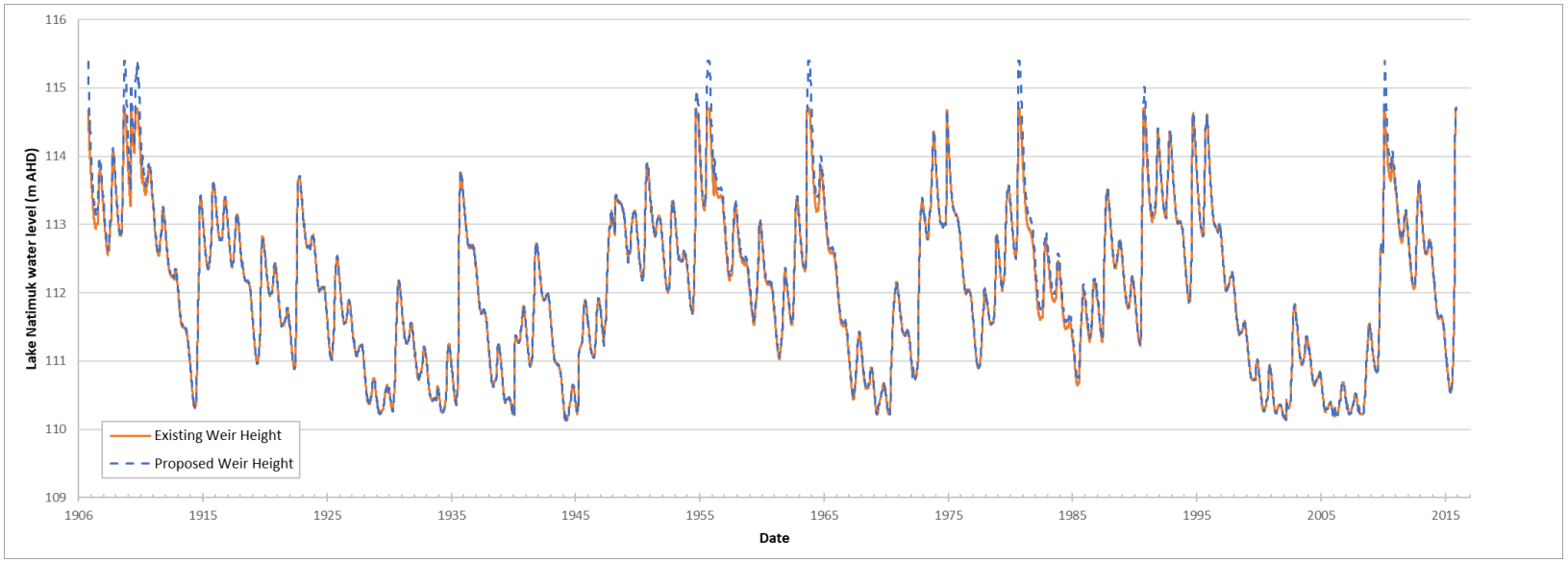

FIGURE 4-3 LAKE NATIMUK WATER LEVEL TIME SERIES IN EXISTING AND PROPOSED CONDITIONS

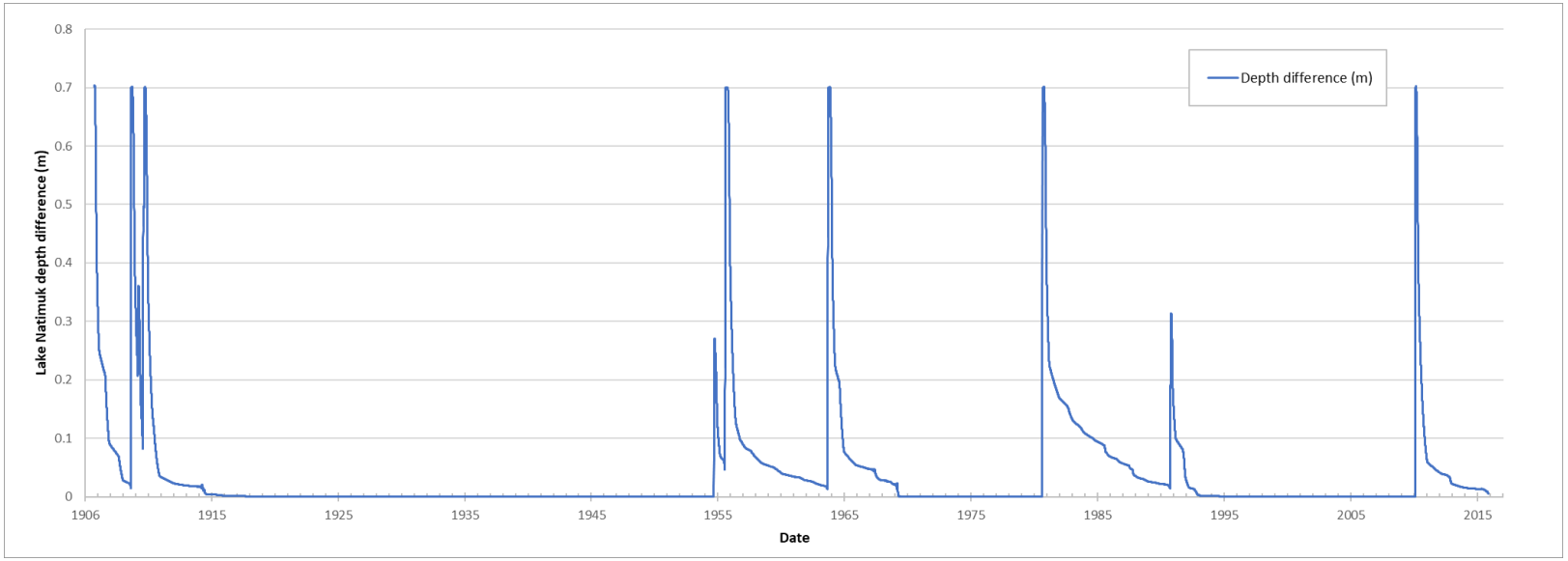

FIGURE 4-4 DEPTH INCREASE TIMESERIES

Over the 111 years of available rainfall data, Lake Natimuk spilled in nine years in existing conditions and seven years in the proposed outlet scenario. In general, with an increase to the weir height, the lake water level is higher during and post large events and remains higher for several months/years post the event before levels get low enough to come into alignment. An example of this over the 1980-1990 period is shown in Figure 4-5, where a large flow occurred September 1981, the lake spilled in both scenarios but remained at a higher level in the proposed scenario till around mid-985. The maximum increase in depth was 0.7m (the difference between the existing and proposed weir heights) but within six months this had reduced to around 0.2m.

The late 2010 and early 2011 period is also shown in Figure 4-6, there was a moderate flow event in December 2010 followed by a larger event in January 2011. Water levels are the same during and immediately post December 2010, because the existing weir height wasn't reached. In January 2011 the existing weir height was exceeded, resulting in higher water levels in the elevated weir height modelling.

In the proposed weir height scenario, water levels in Lake Natimuk exceeded 114.7 m AHD on 887 days (in 111 years), these are days where the water level would be between the yellow and blue contours in Figure 4-2. In the 1981 example water is within this area for around four months. The difference in water level reached a maximum of 0.7m (the point at which the proposed maximum weir height is exceeded) and is reduced to 0.25m after around 4-5 months. Water levels sat in the height between the existing and proposed weir heights for around 3 months.

Across the modelled events, after the lake has reached the proposed maximum level it can take between 3-4 months to 3-4 years for the impact of proposed weir to be reduced to less than 0.1m.

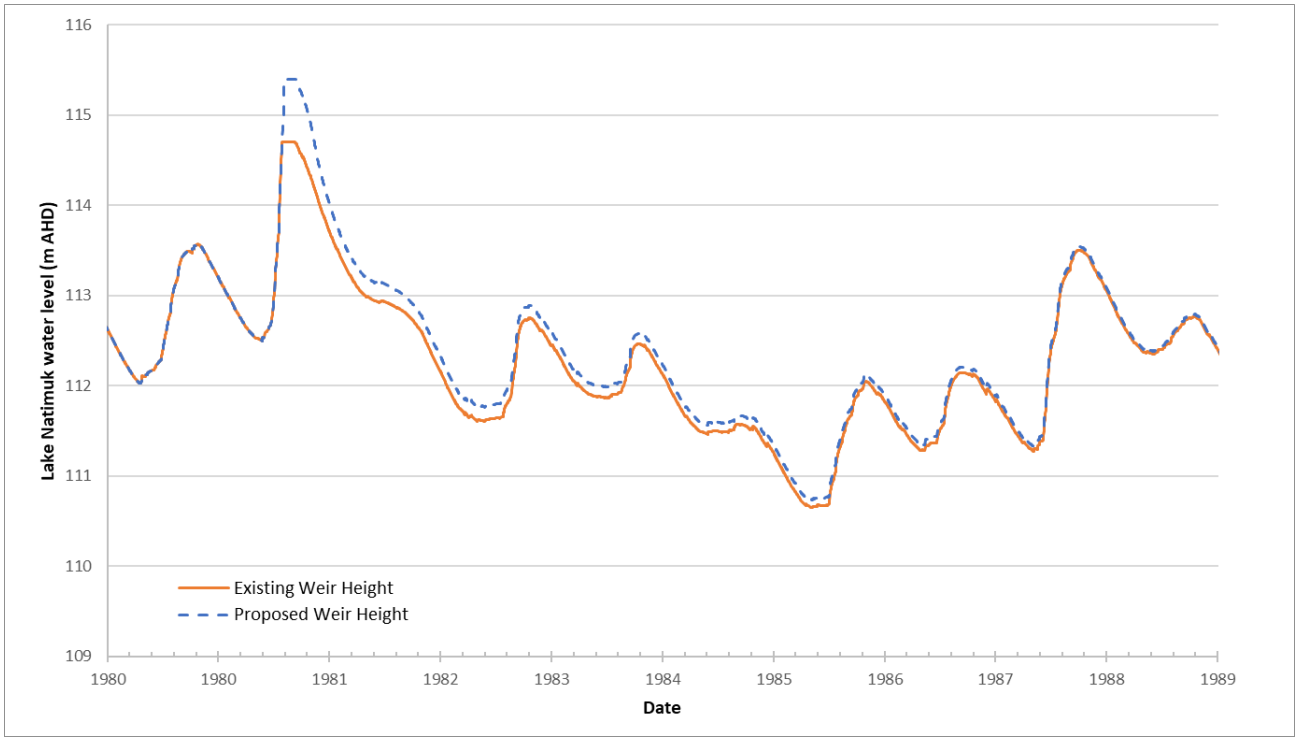

FIGURE 4-5 WATER LEVEL COMPARISON – 1980-1990

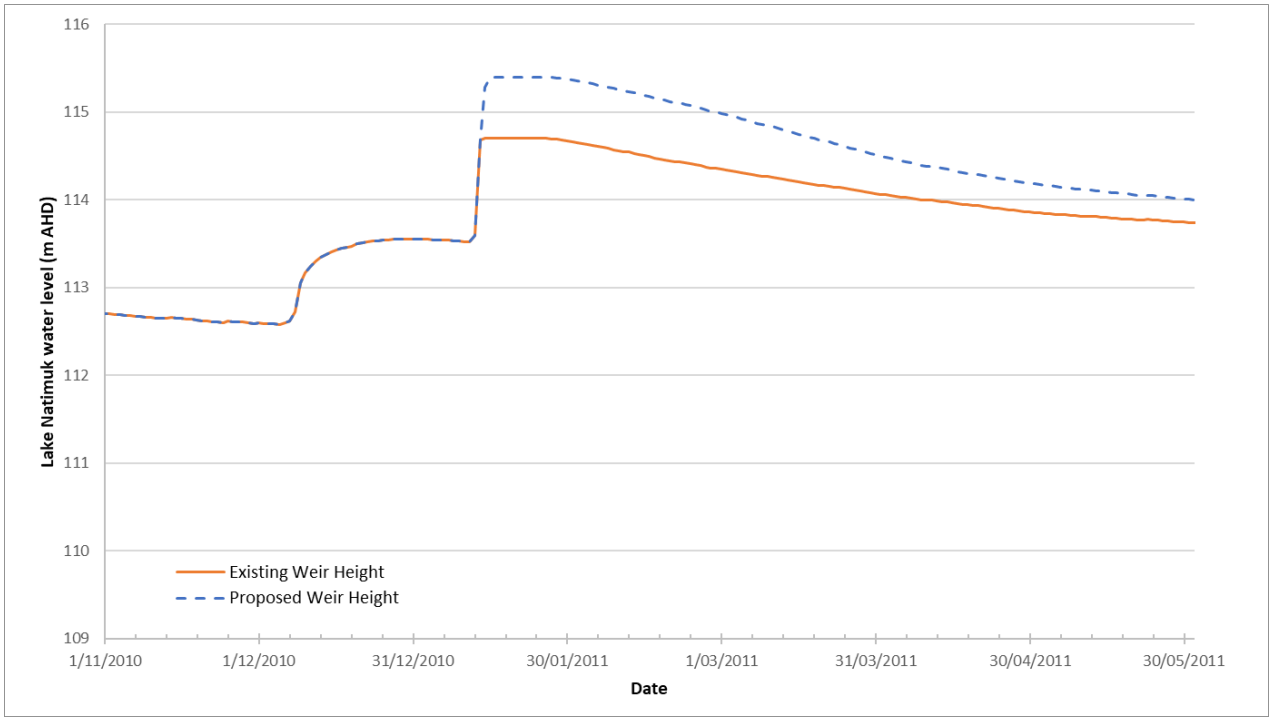

FIGURE 4-6 WATER LEVEL COMPARISON – 2010/2011

The number of days water levels exceeded depth thresholds of 4m, 3m, 2m, and 1m for both the existing and proposed scenarios were calculated, as shown in Table 4-1. The results show there is a much larger disparity at higher depths. This is also what is indicated by the graphs shown in Figure 4-3 and Figure 4-4. However climate and land use change are expected to lead to reduced flows into the lake which will offset any proportional increase in water levels due to the proposed weir.

TABLE 4-1 NUMBER OF DAYS EXCEEDING DEPTHS OF 4M, 3M, 2M AND 1M

Depth threshold	Number of days exceeding depth threshold (111 year record)	
	Existing conditions	Proposed conditions
4 m	355 (0.9%)	2,312 (5.7%)
3 m	9,646 (23.9%)	9,990 (24.7%)
2 m	21,104 (52.2%)	21,384 (52.9%)
1 m	31,939 (79.0%)	31,982 (79.1%)

4.2.2 Summary

Increasing the Lake Natimuk outlet weir height causes several key hydrologic changes, these include:

- A relatively minor increase in maximum inundation extent – 310 Ha to 317 Ha.
- Based on historical conditions, water will sit within the extra area of inundation for significant periods of time, several months as the lake level reduces from the modified maximum water level to its current operating height.
- Due to the increases weir height, elevated water levels in Lake Natimuk remain for longer after it reaches maximum capacity. The timing of these increases can be greater than 0.1m for between 3 months and up to 4 years depending on additional rainfall events and evapotranspiration.

- Lake Natimuk is expected to spill into the outlet channel less frequently with an increase to the weir height, reducing the number of instances from around eight every hundred years to six based on historic conditions.
- Increasing the outlet weir height impacts water levels most when the lake is full, with no relative decrease in the time the lake is empty or close to empty.
- Climate and land use changes will reduce the frequency of time the lake will be above the existing conditions level compared to historical conditions.

4.3 Impacts on Lake Natimuk and upstream Natimuk Creek

A number of sites around the Natimuk Lake and up the Natimuk Creek were visited (identified by green letters on Figure 4-2) to gain an appreciation of the potential increase in inundation and to view the vegetation and habitats within that increased extent. Each of these locations and potential impacts of a raised water level are discussed below.

Location A – Northern shore of Lake Natimuk

Figure 4-7 shows an aerial image of Location A on the northern shore of Lake Natimuk. This and subsequent aerial images of locations around and upstream of Lake Natimuk show a yellow line depicting the inundation level when the existing weir starts to spill, and the blue line models the extent of inundation when the proposed weir begins to spill. The area between the lines is the additional area that is expected to be inundated if the proposed weir is commissioned. The green dots in the following figures represent photograph locations, while the green arrows indicate the direction of photographs within this report.

FIGURE 4-7 LOCATION A INUDATION MAPPING AND PHOTO LOCATION

Figure 4-8 is a photo showing an approximation of the inundation extent of the existing weir (yellow dashed line) and the 700mm higher weir (blue dashed line). The following comments and potential impacts can be drawn from both images:

- The existing weir's level of inundation is closely aligned with the trunks of the large River Red Gums that surround the lake in this vicinity. If the proposed weir is commissioned, the large River Red Gums will be inundated to a depth approximating 700m at the time of spilling. The inundation is expected to be infrequent (i.e. many years apart) and the duration of inundation is expected to be relatively long (i.e. a number of months). River Red Gums can tolerate inundation for extended periods and are unlikely to be adversely affected by this higher water level. However, the higher water level may lead to increased erosion around the trunk and roots (see Location B notes on erosion).
- The additional area of inundation varies in width from about 5 – 15m.
- The area being inundated is covered mostly in grasses, both exotic and native. Some of these grasses may be temporarily or permanently lost or disturbed during inundation events, however, substantial change in ground cover composition is not anticipated as the duration of inundation is not expected to be long.

FIGURE 4-8 LOCATION A PHOTO WITH APPROXIMATE INUNDATION EXTENTS

Location B – Eastern shore of Lake Natimuk

Figure 4-9 show an aerial image with the inundation lines and Figure 4-10 photo locations (green arrows). The bank/margin of the lake is relatively steep in this vicinity, hence the inundation lines are close together. This relative steepness is presumably due to there being a lunette on the eastern side of the lake.

FIGURE 4-9 LOCATION B INUDATION MAPPING AND PHOTO LOCATIONS

The following comments and potential impacts can be drawn from both Figures:

- As with Location A, the existing weir's level of inundation is closely aligned with the trunks of a line of River Red Gums. However, there are also some larger River Red Gums located with trunks located well within the existing weir's inundation extent.
- Figure 4-10 shows how rock has been used to protect the bank and River Red Gums along the existing weir high water mark.
- It is presumed that erosion is more prevalent on the eastern side of the lake due the dominant south-westerly winds causing wave action erosion. This prevailing wind is likely exacerbating boat wash to the eastern shore. Rock has been used to protect both banks and the soil around trees.
- The higher water level associated with the proposed weir may extend above the existing bank rockwork. This may necessitate the extension of rockwork up the bank to protect it from erosion. More detailed survey may be required to identify the exact location of the proposed weir inundation level and consider the potential costs of additional rockwork prior to commissioning.
- Trees on the eastern side of the lake within the current high water mark have been rocked to protect the soil around root systems. Assuming trees within the proposed weir high water mark may require a similar treatment, and since most of the existing trees are located close to the current weir high water mark, a substantial amount of rock may be required.

FIGURE 4-10 LOCATION B PHOTO WITH APPROXINMATE INUNDATION EXTENTS, AND ROCKED BASE OF RIVER RED GUM

Location C – Western shore of Lake Natimuk

Location C on the western shore has a gentle consistent slope where the difference between the existing and proposed weir levels is consistently around 4 - 5m. As with the Locations A and B, the existing weir high water mark correlates with around or just above the trunkline of the existing large River Red Gums.

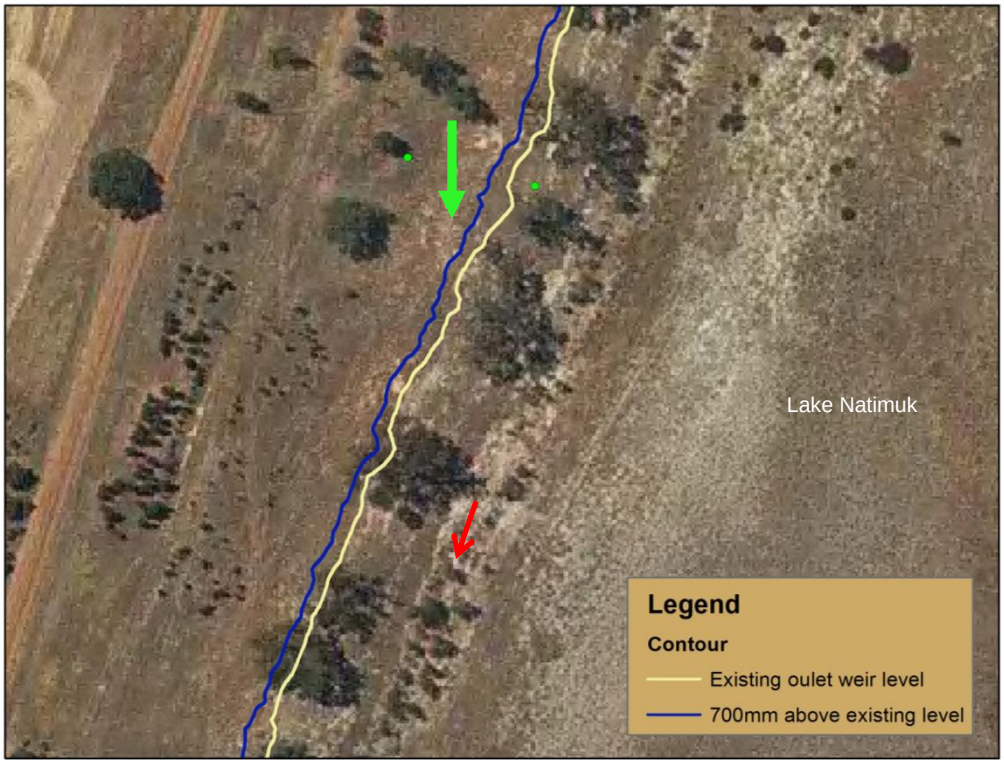

FIGURE 4-11 LOCATION C INUDATION MAPPING AND PHOTO LOCATION

The following comments and potential impacts can be drawn from both figures:

- The increased area of inundation is covered mostly with exotic grasses and therefore there is no significant impact to terrestrial native species.
- Under the proposed weir scenario, the existing large River Red Gums may be inundated around the trunks for a few weeks. This inundation will not adversely affect the trees unless there is soil washed from around the trunk and root system.
- Inundation around the trees has the potential to strand arboreal animals if present, however most animals have some swimming ability and the duration of inundation is expected to be short. Therefore, inundation around these trees is not expected to pose a high risk to fauna.
- Repeated years of dry conditions have led to terrestrialisation of the wetland, as evidenced by trees and shrubs growing on the lower edge of the lake margin (see red arrows in Figure 4-11 and Figure 4-12). This woody vegetation is likely to have germinated from seed near the wetted margin of the lake and subsequent years have not filled the lake to sufficient depth to drown this vegetation. Now that this vegetation has established and is tall enough to extend well above any high water level, the trees may persist into the future. The River Red Gums are likely to persist, however the shrub species are expected to drown if there are a few consecutive wet years.

FIGURE 4-12 LOCATION C PHOTO WITH APPROXIMATE INUNDATION EXTENTS

Location D – Natimuk Creek upstream of Lake Natimuk

Location D is situated on the left bank of the Natimuk Creek, approximately 250m upstream from the lake. The creekline in this location has a relatively broad floodplain off the right bank. The current weir level is high on the relatively steep bank and almost mimics the edge of a continuous line of Tangled Lignum, *Muehlenbeckia florulenta*.

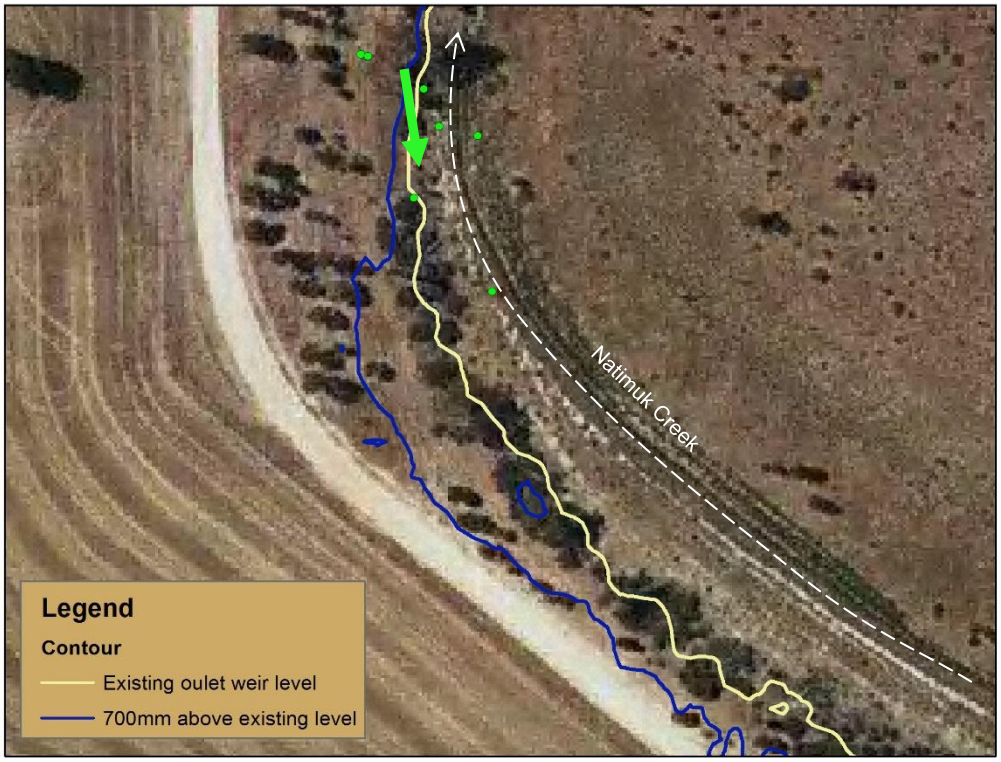

FIGURE 4-13 LOCATION D INUDATION MAPPING AND PHOTO LOCATION

The following comments and potential impacts can be drawn from the field assessment and Figure 4-13 and Figure 4-14:

- Figure 4-13 shows that an increase in weir height is likely to cause the inundation of the lignum and other shrubs and ground covers persisting above the current weir height. There are numerous saltbush and grass species that may be displaced to higher margins should inundation occur regularly or for a prolonged period.
- The established Lignum is not expected to be adversely affected by deeper inundation and may expand its distribution back to the limit of the proposed weir inundation extent.
- Trees further offstream behind the Lignum are closer aligned to the proposed weir inundation extent and should not be adversely affected.
- There has been a considerable amount of revegetation around and downstream of Location D. Some of the planted shrub species may be susceptible to waterlogging if within the proposed weir inundation extent.

FIGURE 4-14 LOCATION D PHOTO WITH APPROXIMATE INUNDATION EXTENTS

Location E – Natimuk Creek upstream of Lake Natimuk

Location E is situated on the left bank floodplain of the Natimuk Creek, approximately 1.2km upstream of the lake and 2.5km downstream of Natimuk Township. The creekline in this location has a relatively broad floodplain (Figure 4-15) with Lignum growing on the lower floodplain closer to the creek and Moonah, *Melaleuca lanceolata*, growing in in patches further offstream (Figure 4-16). The Moonah is growing both within and above the current weir inundation extent.

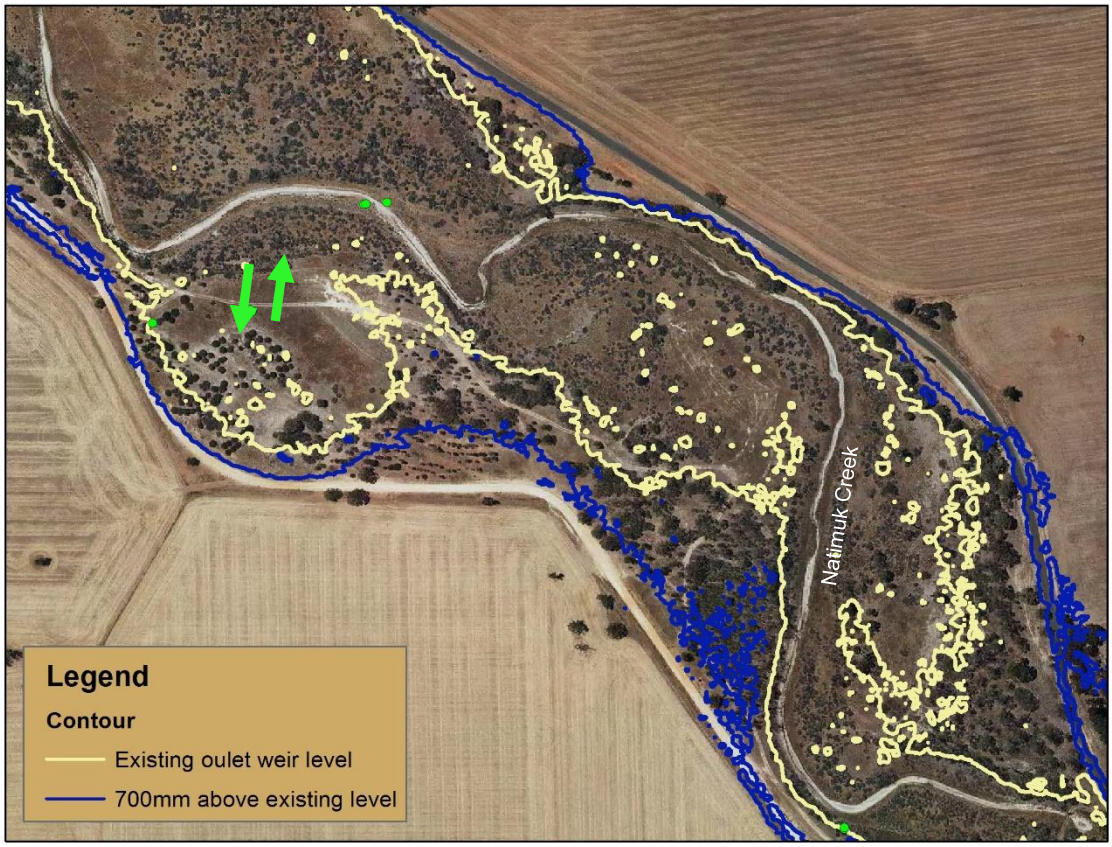

FIGURE 4-15 LOCATION E INUDATION MAPPING AND PHOTO LOCATIONS

The following comments and potential impacts can be drawn from Figure 4-15 and Figure 4-16:

- Lignum is situated within the existing outlet weir inundation level. The proposed weir will inundate these shrubs to a greater depth, however it is unlikely to totally submerge the plants nor occur for sufficient duration to damage the plants.
- The proposed weir inundation extent is expected to inundate, or more deeply inundate, Moonah trees in the vicinity of Location E. Moonah has high tolerance to waterlogging and salinity and should not be affected by periodic inundation.
- There are numerous dead trees near the main channel of Natimuk Creek in the vicinity of Location E. Most of these dead trees were relatively young/small when they died. It is presumed these are River Red Gums that have succumbed to drought/water stress, possibly during the recent Millennium Drought, or salinisation.

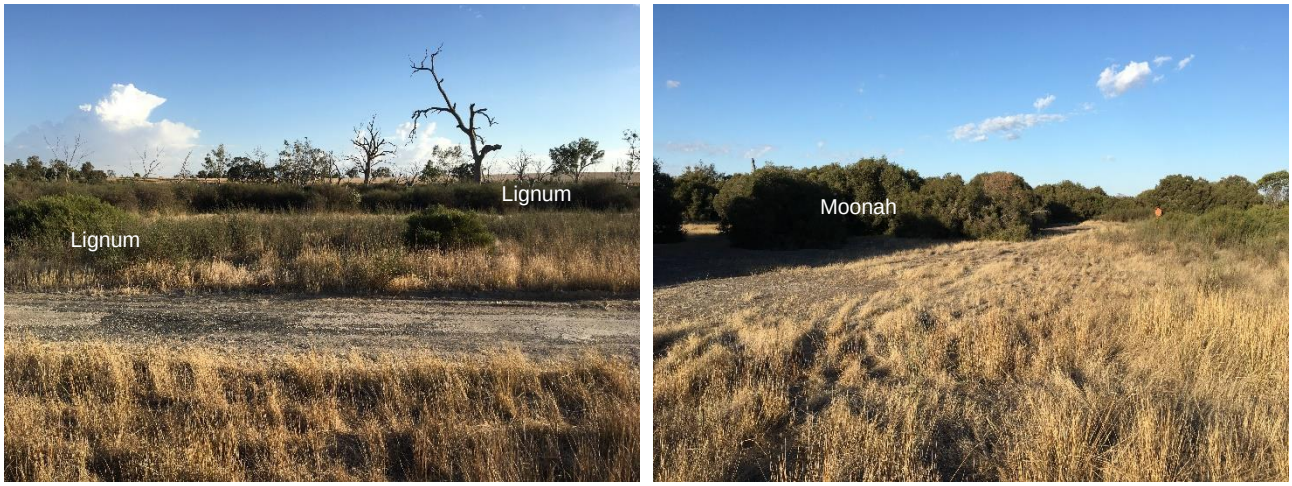

FIGURE 4-16 VIEW TOWARDS THE CREEK SHOWING LIGNUM AND DEAD TREES, AND OFFSTREAM TOWARDS MOONAH

4.5 Impacts on Natimuk Creek downstream of Lake Natimuk

Natimuk Creek flows for approximately 2.5km north-westerly from Lake Natimuk to Lake Wyn Wyn (Figure 4-17). Lake Wyn Wyn is supplied by saline groundwater, local runoff, direct precipitation and overflow from Lake Natimuk via Natimuk Creek.

FIGURE 4-17 NATIMUK CREEK DOWNSTREAM OF LAKE NATIMUK

The potential impact of the proposed raised weir on this reach of Natimuk Creek is as follows:

- Flow down the creek will be delayed until the higher weir is overtopped.
- Overall flow down the creek will be reduced by the additional volume of water captured by the higher weir.
- The creek may not receive any passing flows if the proposed higher weir does not spill.

The creekline was viewed at a number of locations to assess the potential impacts of reduced flows to Natimuk Creek. The Locations F to H (Figure 4-17) are described and the potential impacts of the proposed weir are discussed.

Location F – Downstream of the Lake Natimuk outlet

Natimuk Creek Reserve extends from Lake Natimuk through to Lake Wyn Wyn. There is evidence of revegetation at the upstream end and appears to transition to a remnant woodland.

FIGURE 4-18 NATIMUK CREEK RESERVE, AND GRASSED CHANNEL

There are no highly water dependent species observed within the channel and banks, indicating that the creek flows very infrequently and mostly receives localised runoff. Trees are dominated by Black Box, *Eucalyptus largiflorens*, rather than River Red Gum. Depending upon groundwater availability, depth and salinity, Black Box have been observed to survive inter-flood dry-periods exceeding 30 years, whereas River Red Gums have a maximum inter-flood dry-period of 3-4 years (Rogers and Ralph 2011). The absence of River Red Gum along this section of creek indicates that the Natimuk Creek rarely flows and surface and groundwater is saline and insufficient to support the species.

Since there are no strongly water dependent species observed, it is suggested that a reduced flow in this section of the creek will not adversely affect groundcover vegetation or habitats in and around the creek channel. The water table recharging benefit of passing flows to trees and shrubs within the reserve corridor is not known however it is likely to provide some benefit. The impact on tree vigour and health might need to be monitored to ensure tree vitality is maintained. If the proposed higher weir were to be commissioned, it is recommended the structure be fitted with gates or other mechanism (e.g. a pipe outlet), to allow lower passing flows down to the existing weir height. Gates would enable a level of weir operation should Lake Natimuk need to be drawn down or if the Natimuk Creek was deteriorating due to a lack of flow.

Location G – 1km downstream from the Lake Natimuk outlet

When moving downstream the first Salt Paperbarks, *Melaleuca halmaturorum* ssp. *halmaturorum,* were identified at Location G, 1km downstream from Lake Natimuk. At this location and downstream, saltmarsh vegetation (e.g. Noon-flower, *Disphyma* sp.) is now present in the bed of the creek (Figure 4-19). Both the Salt Paperbark and Noon-flower are highly salt and waterlogging tolerant. It is unknown if there is saline groundwater present however it is suggested that this location is around the upstream limit of backwater from Lake Wyn Wyn when it is full.

FIGURE 4-19 LOCATION G WHERE THE MOST UPSTREAM PAPERBARKS WERE OBSERVED, THE CHANNEL NOW SUPORTING SALTMARSH SPECIES.

The presence of Salt Paperbarks suggests that this vegetation is receiving water from the channel more often or regularly than further upstream. The water source is therefore presumably not from Lake Natimuk and may be localised runoff, Lake Wyn Wyn backwater or groundwater fed. Although this vegetation is likely to benefit from flows from Lake Natimuk, it is assumed it is not critically reliant on those flows although, again, there may be localised groundwater recharge benefits.

Location H – Natimuk Creek around Lake Avenue

The creek around Lake Avenue clearly backwatered by Lake Wyn Wyn when full. The channel is occupied by an abundance of salt tolerant shrubs and herbs and the adjacent banks are lined with Salt Paperbark (Figure 4-20). As with Location G, although the creekline vegetation is likely to benefit from fresh water from Natimuk Creek, the vegetation appears to be influenced more by saline water from the Lake Wyn Wyn, localised runoff and potentially groundwater.

FIGURE 4-20 NATIMUK CREEK UPSTREAM AND DOWNSTREAM OF LAKE AVENUE

There is some evidence of recent dryer periods, and lack of inundation, with young Salt Paperbarks growing along the edge of the inset channel upstream of Lake Avenue (see red arrow Figure 4-20)

4.6 Summary of potential impacts to biodiversity and mitigation actions

The following summarises potential impacts to biodiversity and suggested impact mitigation actions:

- This report considers the ecological impacts of increasing the weir height given the existing catchment conditions and rainfall. Should supplementary or artificial watering be proposed, potentially altering the frequency, seasonality and duration of filling, a new ecological impact report would need to be completed. Conversely, changes in climate and land use are understood to be leading to reductions in volumes entering the lake.
- Lake Natimuk:
  - It was noted that there have been native vegetation losses associated with the prior construction of a concrete weir wall. Some large trees in the vicinity of the works are showing signs of poor canopy health which may be a symptom of tree root damage (Figure 4-21). Any future construction of the weir and adjacent abutments should avoid further damage to adjacent vegetation, particularly large River Red Gums. Soil has been excavated from the area around the pre-constructed wall and pushed around adjacent River Red Gums (Figure 4-21). This built up sandy soil should be reinstated to the depression lines or removed. The excavated depressions may be in preparation for the construction of abutment walls. Care must be taken to avoid further tree root damage and the soil returned as close as practicable to the natural surface level. If large trees die due to the previous works, the dead stags must be protected and preserved as habitat.

FIGURE 4-21 CONSTRUCTED WEIR WALL, EXCAVATION AND TREE DECLINE

  - Installing gates, drop boards or an adjacent pipe outlet on any new weir structure will allow some control of water operation above the existing weir level.
  - A raised weir height will inundate more of the lakeside margins. In general, there may be displacement (i.e. substitution of terrestrial species with wetland/flood tolerant species) of native

ground covers in the increase inundation zones. There is little that can be done to prevent this process, but this infrequent and temporary displacement over a relatively small area is not considered to have any substantial or ongoing environmental impact.

- The eastern shoreline in particular is susceptible to wind and boat wash generated wave action erosion. Many areas along the eastern/lunette side of the lake have been rocked for bank and tree root erosion protection. If the lake is filled to a higher level, banks and trees the above existing rockwork will be exposed. More rockwork is likely to be required to prevent ongoing erosion. If it is agreed that rock is an acceptable erosion control measure, it should be budgeted in advance and placed prior to significant damage occurring. The susceptible areas might be identified after the first filling event and actioned prior to subsequent inundation.
- A more detailed survey may be required to identify the exact location of the proposed weir inundation level and consider the potential costs of additional rockwork prior to the full commissioning.
- It is unlikely that fauna will be stranded within large trees that now become inundated. However, if there were significant habitat or feeding trees thought to be disconnected to dry land, logs could be placed to help bridge the zone of inundation.
- Shrubs and small trees that have germinated on the lower bank or bed of the lake are likely to be drowned by deeper and more prolonged inundation. This is not considered a detrimental impact as this woody vegetation encroachment (lake bed terrestrialisation) can occur after prolonged dry spells and subsequent drowning out in wet years is a natural occurrence.
- There is an unknown as to what dormant aquatic plants are present and where. An impact may arise if plants have occupied areas of a particular depth and may not have the ability to grow with an additional 700mm of depth. Minor losses or movement of species might be acceptable; however, large areas of aquatic plants (e.g. Watermilfoil, Pondweed, Water Ribbons) should be monitored to ensure mass drownings do not occur. Losses could be mitigated by opening weir gates and maintaining or drawing down the water levels.
- The potential impacts of increased water levels and water residence time on migratory birds are presumed to be negligible. The various depths utilised by wading birds will remain, although they may be present a little later as the lake draws down.

- Natimuk Creek upstream of Lake Natimuk:
  - The impact of a raised weir is the minor potential drowning or displacement of ground cover vegetation and shrubs.
  - Ground dwelling animals might also be displaced as a large proportion of the inset floodplain will now be inundated. However, the species at risk and presence is unknown. Observation or more formal surveys at the time of inundation is advised to ensure there are no significant impacts. If problems are observed, the weir gates could be opened to maintain or reduce inundation levels.
  - The modelled proposed weir inundation extents show water encroaching on both Lake Road and Lake Avenue. Although not a direct biological threat, if it is shown that this level causes an unacceptable impact to road or other assets, the maximum weir height should be reduced. A reduction in weir height will reduce impacts throughout the system. Further investigation of impacts on adjacent roads and tracks is required.
- Natimuk Creek downstream of Lake Natimuk:
  - The raised weir height has the potential to reduce or stop water flow down Natimuk Creek to Lake Wyn Wyn. There is uncertainty around the biological impact of reduced flows in this reach. Field observations suggest that native vegetation's reliance on flow in this reach from Lake Natimuk may not be high. To mitigate the risk of this uncertainty, it is suggested that, once the level of the existing weir is exceeded, passing flows be managed via open gates on the proposed weir for a period prior

to closing gates and filling the additional 700mm. More work is required to determine what recommended minimum passing flow should be provided prior to closing the proposed weir's gates and raising the water levels beyond the current maximum level.

5 REFERENCES

Birds Australia 2002, Management Plan for the Natimuk-Douglas Saline Wetland System, Birds Australia Melbourne

DEDJTR 2018a, Moonah, Victorian Resources Online, Agriculture Victoria, Department of Economic Development, Jobs, Transport and Resources, Website accessed 4 September 2018, http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/water_sss_moonah

DEDJTR 2018b, Salinity Indicator Plants – A guide to spotting soil salting, Victorian Resources Online, Agriculture Victoria, Department of Economic Development, Jobs, Transport and Resources, Website accessed 4 September 2018, http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/water_spotting_soil_salting

DELWP 2018, Department of Environment, Land, Water and Planning - NatureKit biodiversity decision support tool, website accessed 6 August 2018, http://maps.biodiversity.vic.gov.au/viewer/?viewer=NatureKit

DELWP 2018a, Bioregional Conservation Status for each BioEVC, Department of Environment, Land, Water and Planning, Website accessed 3 September 2018, https://www.environment.vic.gov.au/__data/assets/pdf_file/0012/50511/Bioregional-Conservation-Status-for-each-BioEVC.pdf

DELWP 2018b, Department of Environment, Land, Water and Planning - Bioregions and EVC benchmarks, website accessed 6 August 2018, https://www.environment.vic.gov.au/biodiversity/bioregions-and-evc-benchmarks

DSE 2009, A field guide to Victorian Wetland Ecological Vegetation Classes for the Index of Wetland Condition, Department of Sustainability and Environment.

Rogers K. & Ralph T. (2011), Floodplain Wetland Biota in the Murray-Darling Basin, Water and Habitat Requirements, CSIRO Publishing

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