Mallee CMA Region Environmental Water Management Plan for the Johnstons and Chaffey Bend Waterway Management Units

Version no. 3

mallee catchment management authority

State Government Victoria

Department of Environment and Primary Industries

Version number	Description	Issued to	Issue date
1	Draft of Johnstons and Chaffey EWMP (version 1)	Mallee CMA	14/03/2014
2	Draft of Johnstons and Chaffey EWMP (version 2)	Mallee CMA	29/05/2014
3	Johnstons and Chaffey EWMP	Mallee CMA	04/06/2014

Citation

Please cite this document as:

Australian Water Environments (2014) *Mallee CMA Region Environmental Water Management Plan for Johnstons and Chaffey Bend WMUs*. Prepared for Mallee Catchment Management Authority, Victoria, May 2014.

Table of Contents

Executive summary 2

Introduction 4

Site overview 5

Hydrology and System Operations 15

Water Dependent Values 19

Ecological Condition and Threats 27

Management Objectives 30

Managing Risks to Achieving Objectives 33

Management options 35

Knowledge Gaps and Recommendations 36

References 39

Abbreviations and Acronyms 41

Appendix 1 – Fauna Species List 42

Appendix 2 – Bird Survey at Mildura WWTP 47

Appendix 3 – Flora Species List 54

Appendix 4 – Cultural heritage Contingency Plan 57

Executive summary

Environmental Water Management Plans (EWMP) are being prepared for key sites in the Mallee region. The key sites include the Johnstons and Chaffey Bend Waterway Management Units (WMUs). This plan has been developed to guide future environmental watering activities at these sites.

The Johnstons and Chaffey Bend WMUs are located within the Murray Scroll Belt bioregion, between river km 875 and 884.3 north-west of Mildura and contain a range of land uses. This EWMP focuses on the area of the Johnstons and Chaffey Bend WMUs that is dominated by native vegetation (i.e. the Target Area).

Environmental values for the Johnstons and Chaffey Bend WMUs Target Area include a variety of Ecological Vegetation Classes (EVCs) that are classified as having depleted status, such as Grassy Riverine Forest, Intermittent Swampy Woodland, Lignum Swampy Woodland and Riverine Chenopod Woodland. In these EVCs, species that are of interest include River Red Gum and Black Box. These communities provide habitat for a wide range of fauna species, some of which are threatened or endangered. The site also contains high recreational, cultural and economic values.

The management goal for the Target Area is to preserve and emplace sufficient, fresh groundwater and soil moisture to support healthy ecosystems at the study area.

Ecological objectives for this study site include:

- Preserve remnant old Red Gums along the riverfront;
- Promote recruitment of Red Gums (i.e. germination and retention of seedlings);
- Preserve extent and support health of Black Box across the floodplains;
- Promote recruitment of Black Box (i.e. germination and retention of seedlings);

It appears that the study site is unable to be managed through surface water delivery. Previous surface water inundation at these WMUs delivered a poor vegetation health response compared to other watering sites. The poor vegetation health response correlates with the observation that the Johnstons and Chaffey Bend WMUs are underlain by a saline hydrogeological system that is influenced by a range of groundwater inputs and processes. These include Salt Interception Scheme bore operation, drainage from the Wastewater Treatment Plant lagoons and associated irrigated areas, irrigation district drainage, and evapotranspiration. These have a significant influence on the system's behaviour. It is suspected that groundwater plays an important role in vegetation health at this site. Therefore, understanding the relationship between groundwater, surface water and vegetation health is crucial to achieving the management goal and ecological objectives.

Three trials are proposed to evaluate the effect of groundwater management. These focus on preservation of the remaining mature Red Gums fringing the River. These trials include irrigation, treated water injection, and groundwater pumping to create a freshwater lens. These trials need to be supported by monitoring, and will require a design and construction phase. Development of a concept design groundwater management plan is highly recommended.

It is highly recommended that a thorough concept design for groundwater management options be developed. However, in the absence of a concept design for groundwater management, the following interim surface watering regime has been derived using the ecological and hydrological objectives for the sites

Minimum watering regime

Inundate River Red Gum communites along the river three times in ten years with a maximum interval of three years between events. Extend the inundation area to include Black Box communities at least once every seven years. Allow ponding on the floodplain for at least three months to maintain River Red Gum and Black Box communities. Timing is not critical in terms of mature tree health but flooding during spring may produce best results.

Optimal watering regime

Inundate River Red Gum communites along the river every one to three years with a maximum interval of three years between events. Extend the inundation area to include Black Box communities three times in ten years with a maximum interval of seven years between events. Allow ponding on the

floodplain for five months to improve River Red Gum and Black Box communities. Timing is not critical in terms of mature tree health but flooding during spring may produce best results.

Maximum watering regime

Inundate the River Red Gum communites along the river every one to three years with a minimum interval of six months between events. Extend the inundation area to include Black Box communities every three years with a minimum interval of one year between events. Allow ponding for up to 6 months (variability in flood duration is encouraged) to improve River Red Gum and Black Box communities. Timing is not critical in terms of mature tree health but flooding during spring may produce best results..

Introduction

Australian Water Environments (AWE) has been engaged by Mallee Catchment Management Authority (Mallee CMA) to prepare the Environmental Water Management Plan (EWMP) for Johnstons and Chaffey Bend Waterway Management Units (WMUs) to establish the long-term management goals for these sites.

The key purposes of the EWMP are to:

- identify the key issues, long-term objectives and water requirements for the floodplain, identified as a high priority by the CMA;
- identify knowledge gaps that need to be further investigated;
- provide a vehicle for community consultation, including for the long-term objectives and water requirements of the floodplain;
- inform the development of seasonal watering proposals and seasonal watering plans;
- inform Long-term Watering Plans that will be developed under Basin Plan requirements.

Site overview

Site Location

The Mallee CMA region is located in the north-west of Victoria covering approximately 39,000 km^2 with an estimated regional population of 60,000 (2001). Major towns include Mildura, Birchip, Sea Lake, Ouyen, Robinvale, Red Cliffs and Merbein (MCMA 2006). The area is semi-arid, with an annual rainfall of around 250mm. Average daily temperature at Mildura ranges from 32^{0}C in summer to 15^{0}C in winter (MCMA 2006). The Mallee CMA region is the largest catchment in the state given its extent is almost one fifth of Victoria (Figure 1). This catchment runs along the Murray River from Nyah to the South Australia border (MCMA 2014).

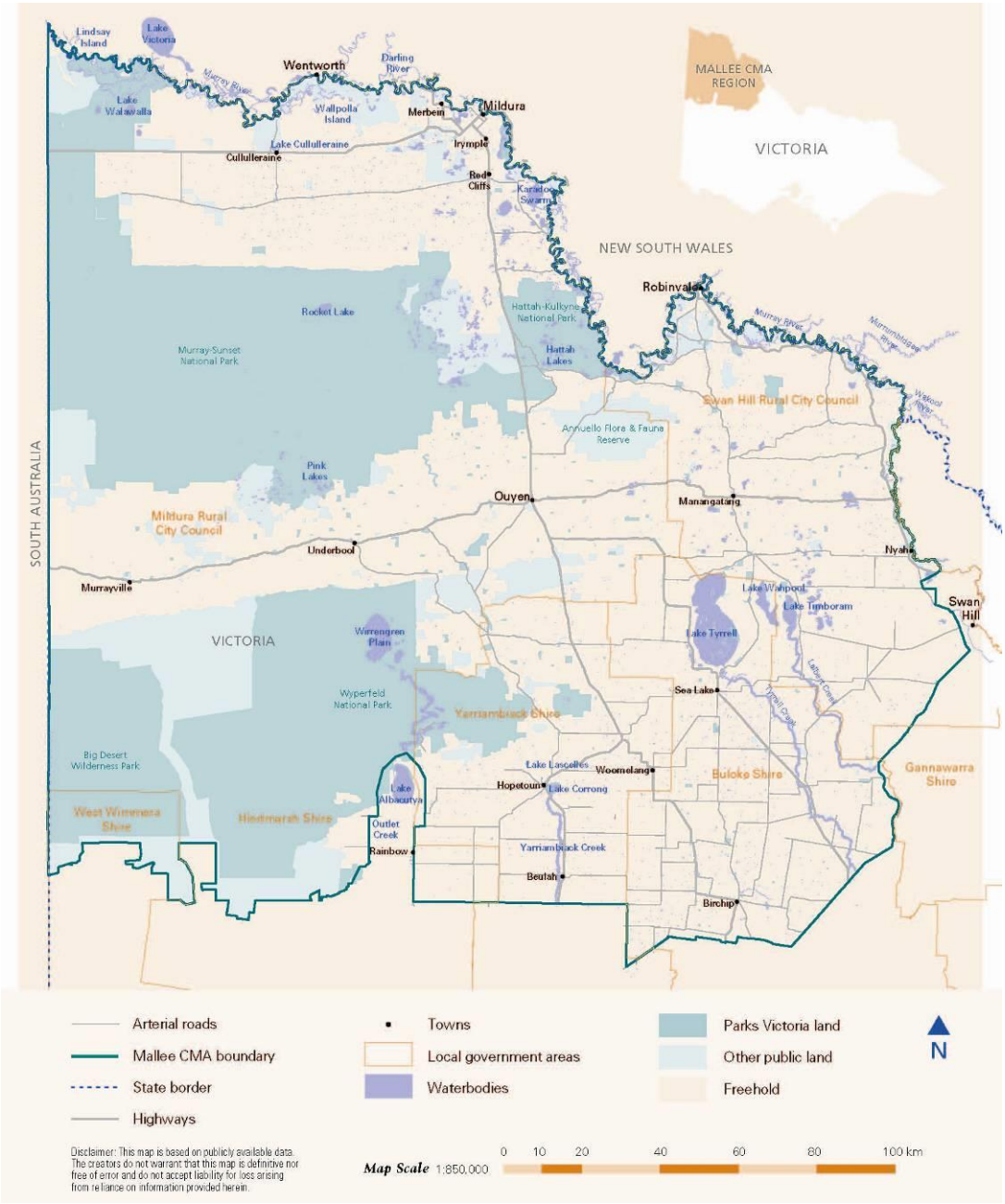


Figure 1: Map of the CMA region

The Mallee CMA region consists of 38% of public land which is mainly National parks, Reserves and large tracts of riverine and dryland State Forest. The rest of the region is important for dryland farming of sheep and cereals, and irrigated horticulture (MCMA 2006).

In 2007, Ecological Associates (EA) conducted an investigation on water management options for the Murray River floodplain from Robinvale to Wallpolla Island. EA (2007) has divided the floodplain into different Waterway Management Units (WMUs) in which water regimes can be managed independently of another WMU. These WMUs form a basis to develop EWMPs, including this EWMP for Johnstons and Chaffey Bend.

The Chaffey Bend WMU is located between river km 878.5 and 884, 3 km north-west of Mildura. The Johnstons Bend WMU is located between 875 and 878 river km, next to and immediately downstream of the Chaffey Bend WMU (Figure 2) (EA 2007). Johnstons and Chaffey Bend are small sites located next to each other and are known to have similarities in natural settings and conditions. Therefore, these two areas are combined into one EWMP.

This EWMP focuses on the area of the Johnstons and Chaffey Bend WMUs that is dominated by native vegetation (i.e. the Target Area).

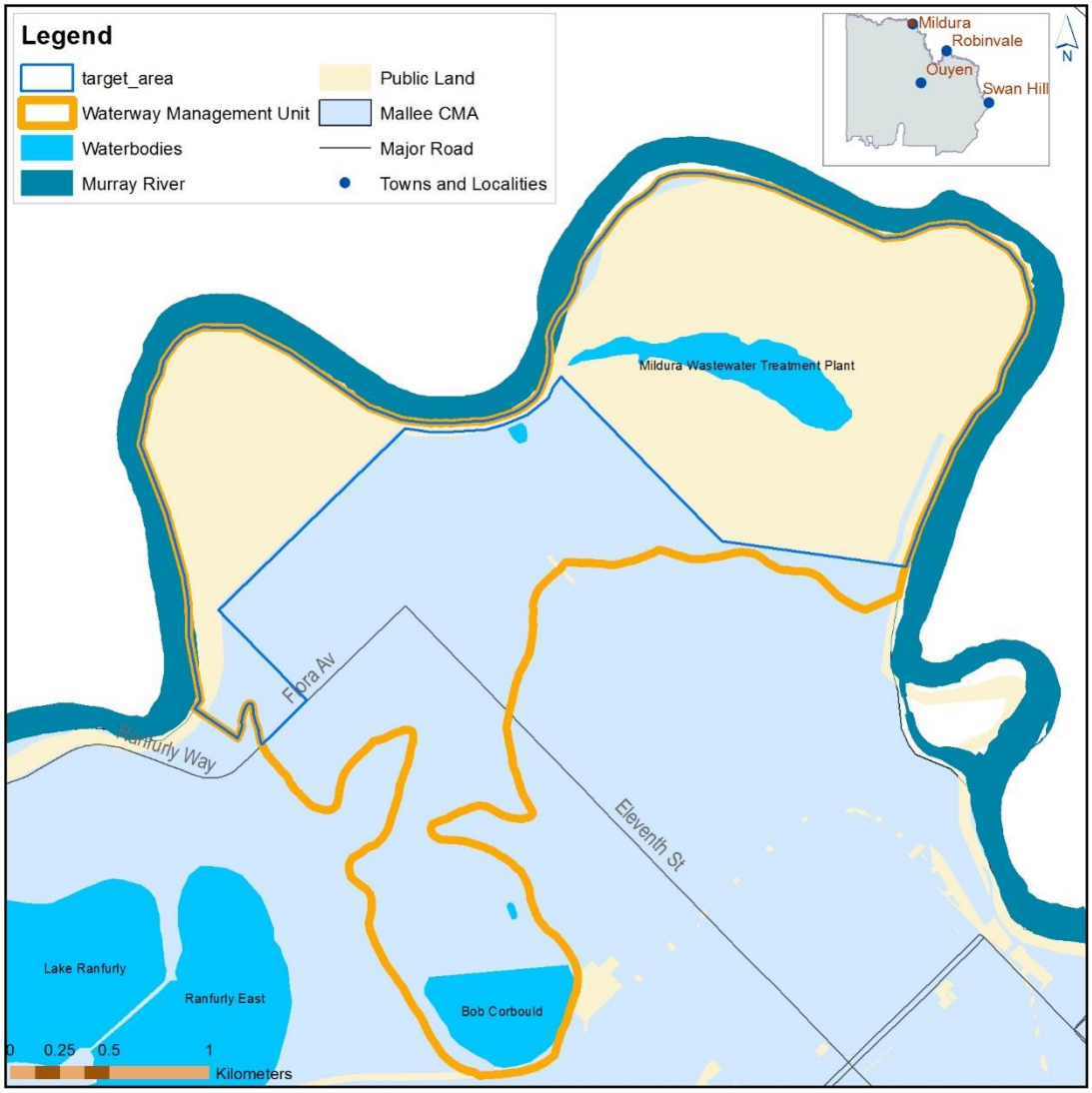


Figure 2: Target Area in Johnstons and Chaffey Bend Waterway Management Units

Catchment Setting

Johnstons and Chaffey Bend WMUs (Figure 2) are within the Murray Scroll Belt bioregion. Johnstons and Chaffey Bend are meander scroll complexes, and support Red Gum woodland near the river, and Lignum and Chenopod shrublands and Black Box communities inland from the River.

The Johnstons and Chaffey Bend WMUs are unique in their hydrogeological setting and the natural hydraulic regime of these floodplains has been altered significantly since regulation of the Murray River. They occur immediately downstream of Lock 11, are the target of Salt Interception works, and are located adjacent a significant irrigation district. Part of the Chaffey Bend WMU is operated as a disposal basin and irrigation disposal area for treated effluent (EA 2007). The Mildura weir and Lock 11 were installed in 1927 for navigation purposes and they are located at river km 884. The Mildura weir was constructed in a unique way, with the Lock and Weir separated by an island (AWE 2009).

Hydrogeological setting

The study area is located at the approximate centre of the Murray Geological Basin. The geological units in the region are typical of the Murray Basin, and consist of marine, marginal marine, fluvial and lacustrine units deposited in the Tertiary and Quaternary geologic period (55 Ma to 0.7 Ma) plus a series of more recent alluvial deposits in the river valley (< 0.7 Ma) (Brown and Stephenson 1991).

Essentially the Basin is a closed system with little or no opportunity for discharge to the sea, other basins or aquifer systems. The major mechanism of salt discharge is through the River Murray valley including the floodplain and river itself. Salt accumulation within the regional aquifers has occurred over thousands of years so that many of the regional aquifers are saline. Saline groundwater inflows are responsible for much of the salt additions to the River Murray from the study region (Brown and Stephenson 1991, AWE 2011).

The major stratigraphic units encountered on the floodplains, in order of increasing depth, include the Coonambidgal Clay, Monoman Formation, Parilla Sands and Lower Parilla Clay.

The Coonambidgal Clay consists of fine silts and stiff, low plasticity clays that act as an aquitard at the top of the sedimentary sequence within the River Murray trench. Generally, older clays found on floodplain terraces are less permeable whereas younger clays closer to the river are sandier as they have been reworked (AWE 2009 & 2013).

The Monoman Formation forms the floodplain aquifer and consists of grey to brown, fine to coarse sands and clays. The aquifer is semi-confined by the Coonambidgal Clay in the floodplain, and can become locally unconfined due to pumping from nearby SIS bores. The Monoman Formation is variably connected to the Parilla Sand aquifer throughout the project extent. There is little to differentiate between the Monoman Formation and Upper Parilla Sand Formation (AWE 2009 & 2013).

The Parilla Sands underlie the Monoman Formation and form the regional aquifer occurring across both the highland and floodplain. The Parilla Sands can be subdivided into an upper and a lower unit. The Upper Parilla Sand consists of unconsolidated to weakly cemented, fine to coarse quartz sands. The top of the Upper Parilla Sands was found to occur either below a tight clay layer at the base of the Monoman Formation or where sands became fine and slightly clayey, often accompanied by a colour change to light grey. The Lower Parilla Sands consist of fine, well-sorted sands or silty sands. The change from the Upper to Lower Parilla Sands is marked by a colour change to dark grey (AWE 2009 & 2013).

Land Management Status

The Johnstons and Chaffey Bend WMUs are primarily managed by Mildura Rural City Council and Parks Victoria. A strip of land of approximately 60 m wide along the river is under Council management and the rest of the floodplain located in the Murray River Reserve is managed by Parks Victoria (Sunraysia Environmental 2010).

The WMUs are directly or indirectly managed or used by a range of stakeholders (presented in Table 1). Through these stakeholders, extensive experience and expertise are available to assist in the management of the site (MCMA 2003).

Table 1: Stakeholders for the Johnstons and Chaffey Bend WMUs

Group	Role
Parks Victoria	Land Manager
Mallee Catchment Management Authority (MCMA)	Regional environmental management
The Departments of Environment and Primary Industries	State level environmental management
Lower Murray Water Authority	Water management
Mildura Rural City Council (MRCC)	Riverfront management
Aboriginal Communities	Indigenous Representation
Murray Darling Basin Authority (MDBA)	River Murray operations
Murray-Darling Freshwater Research Centre	Research operations
Goulburn-Murray Water	Mildura Merbein Salt Interception Scheme and Lock 11 operators
Landowners	Landowners
Recreational users	Land user
General community	Land user

Waterways Management Unit Characteristics

Johnstons and Chaffey Bend WMUs fall within the Murray Scroll Belt bioregion. Chaffey Bend WMU contains a large vegetated area with predominantly River Red Gum and Black Box communities. The Mildura Wastewater Treatment Plant (WWTP) is located in Chaffey Bend. The plant and its associated irrigation area are located on 150 ha, 2 km north of the city of Mildura. Treated effluent from the WWTP is stored in a 30 ha lagoon on site. The lagoon is classified as permanent open freshwater according to the Corrick classification. The lagoon supports bird life and a diverse population of native fish, and leakage from the lagoon provides water to surrounding remnant vegetation (Lower Murray Water 2011). A small proportion in the south and south-west of Chaffey Bend is private land which is used mainly for agricultural and horticultural purposes. The Johnstons Bend WMU contains a large proportion of land used for horticulture, recreation and waste disposal, and includes the Bob Corbould stormwater wetland. Native vegetation is distributed mainly along the river and in the northern side of the WMU.

This EWMP focuses only on the vegetated area of the floodplain within the Johnstons and Chaffey Bend WMUs (Figure 2). The excluded area consists of mainly private ownership and/or non-vegetated area. Also the Bob Corbould wetland is not included in in this EWMP as it forms part of the stormwater network and is managed to achieve stormwater management outcomes.

The study area is located between a groundwater mound caused by extensive irrigation (see Figure 3), and the River Murray. The groundwater hydraulic gradient indicates that groundwater is generally flowing from the Mildura irrigation mound through the floodplain towards the river,

Groundwater is generally saline. Figure 4 and 5 shows the average salinity in the Parilla Sand Aquifer (below 25 m AHD) ranges from 50000 to 100000 µS/cm and the shallower water salinity (above 25 m AHD) ranges from 2000 to 50000 µS/cm.

The lower salinity groundwater is mostly located around the Treated Wastewater (TWW) lagoon, and is derived from leakage from the lagoon and irrigation drainage from the associated woodlots and agricultural land watered from the lagoon. The recreational areas in the south east of the Johnstons Bend WMU are also irrigated with TWW lagoon water. The groundwater heads are influenced by infiltration from the TWW lagoon and its associated irrigation. Groundwater modelling also indicates elevated recharge rates occur beneath the pond/irrigation area (AWE 2013).

Figure 6 has mapped out the position of fresh/saline groundwater interface in the study area. This indicates that approximately 30 m of freshwater occurs underneath the TWW lagoon, and extends southward from the site. The freshwater lens gets thinner further away from the lagoon. It also shows that there is not much freshwater available for vegetation use near the River.

The health of the vegetation overlying the TWW freshwater lens is generally in better condition than on the rest of the floodplain (AWE site visit, 2014).

Environmental Water Sources

The Environmental Water Reserve (EWR) is the legally recognised amount of water set aside to meet environmental needs. The Reserve can include minimum river flows, unregulated flows and specific environmental entitlements. Environmental entitlements can be called out of storage when needed and delivered to wetlands or streams to protect their environmental values and health.

The Victorian Minister for Environment and Climate Change has appointed Commissioners to Victoria's first independent body for holding and managing environmental water, The Victorian Environmental Water Holder (VEWH). They will be responsible for holding and managing Victoria's environmental water entitlements, and making decisions on their use.

Environmental water for the Target Area may be sourced from the water entitlements and their agencies listed in the table below. Detailed descriptions of these sources can be sought from the Regional context document.

Recent environmental watering that has occurred at the Target Area is outlined in the 'Hydrology and System Operations' section below.

Table 2: Summary of environmental water sources available to Johnstons and Chaffey Bend WMUs (Mallee CMA 2014)

Water Entitlement	Responsible Agency
River Murray Unregulated Flows	Murray Darling Basin Authority
Bulk Entitlement (River Murray - Flora and Fauna) Conversion order 1999	Victorian Environmental Water Holder
Commonwealth Environmental Water Holdings	Commonwealth Environmental Water Holder
Donated Water	Mallee CMA

* Other sources of water may become available through water trading or changes in water entitlements.

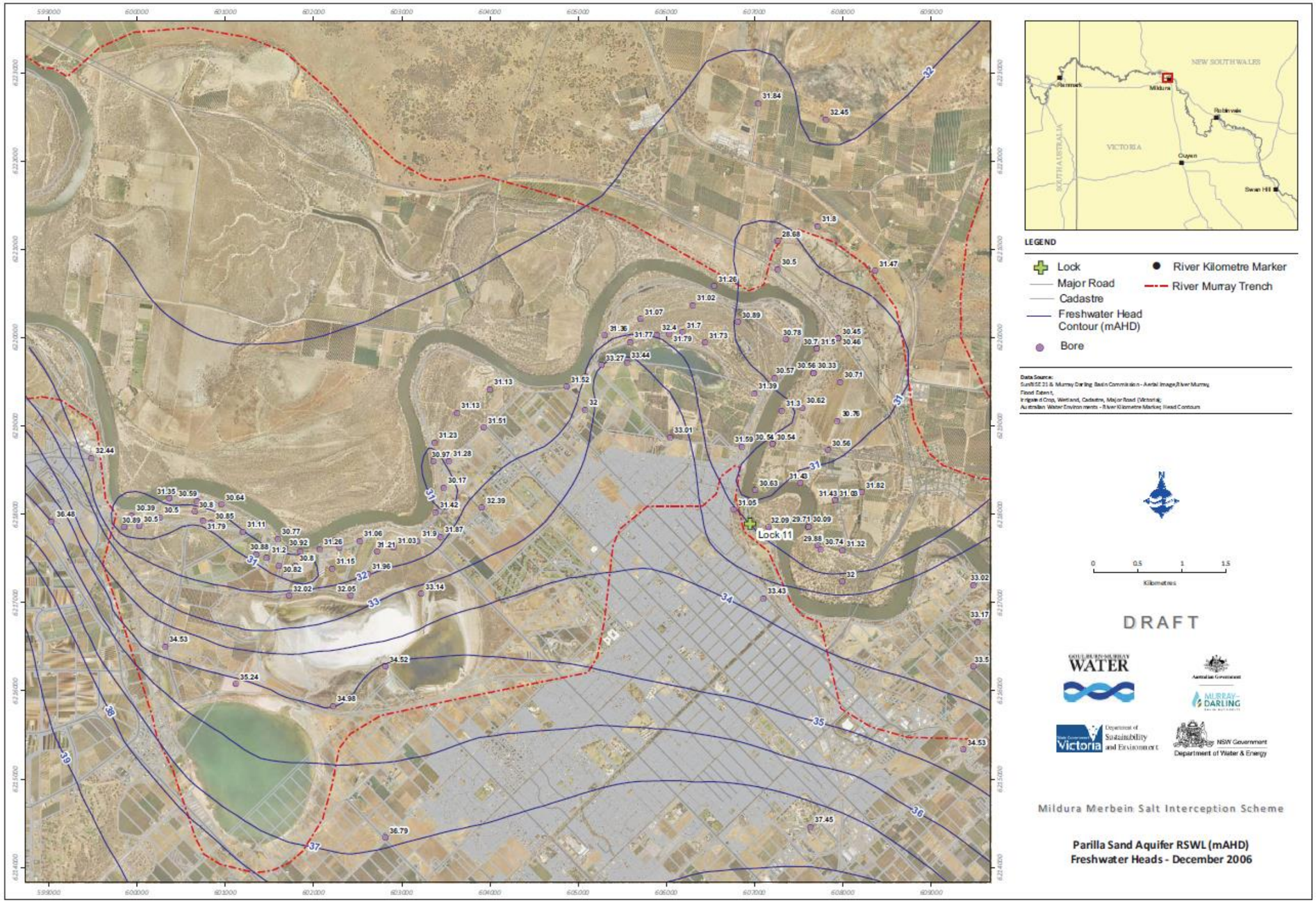


Figure 3: Groundwater heads in Parilla Sand Aquifer (AWE 2013)

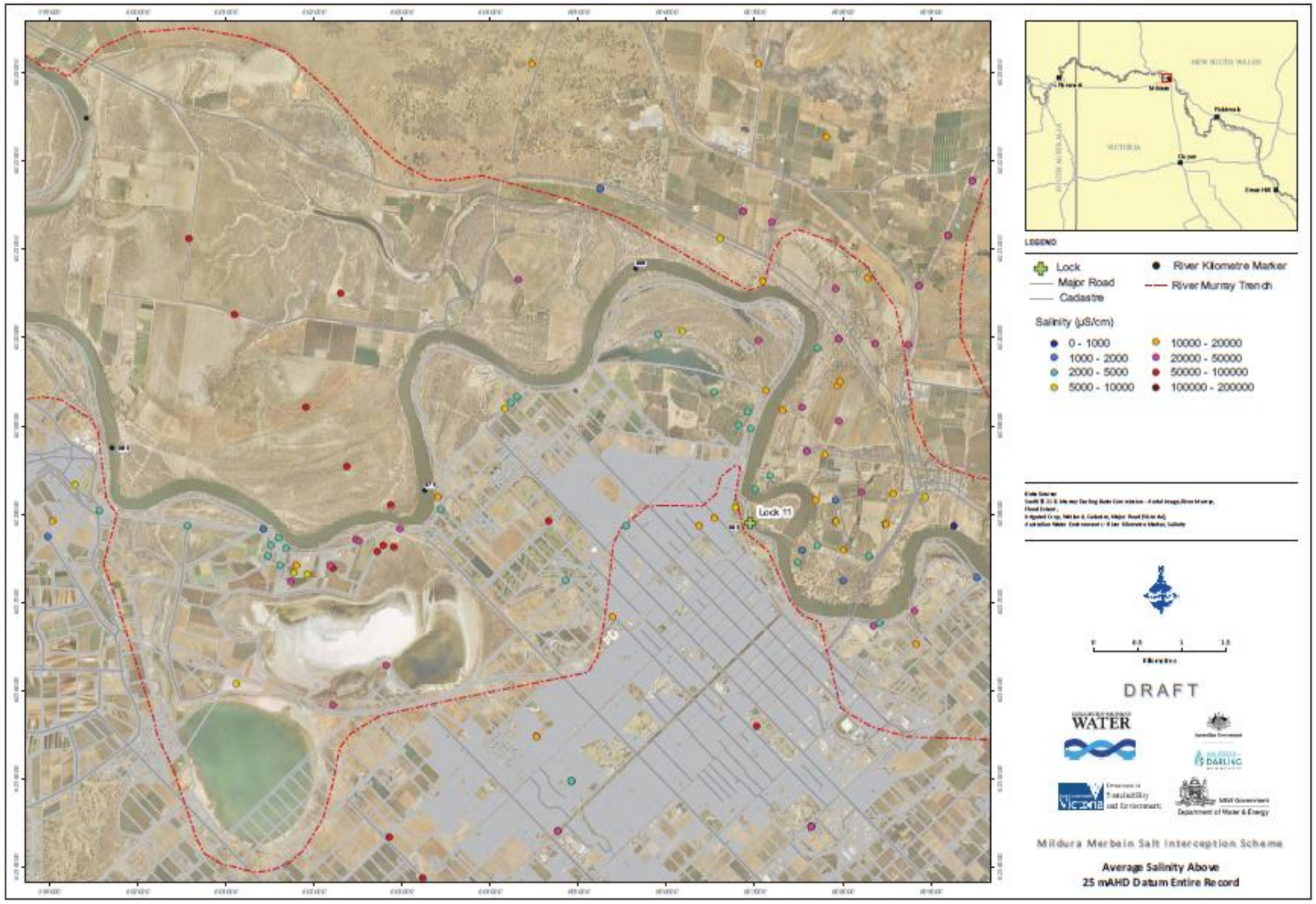


Figure 4: Average salinity above 25 m AHD (AWE 2013

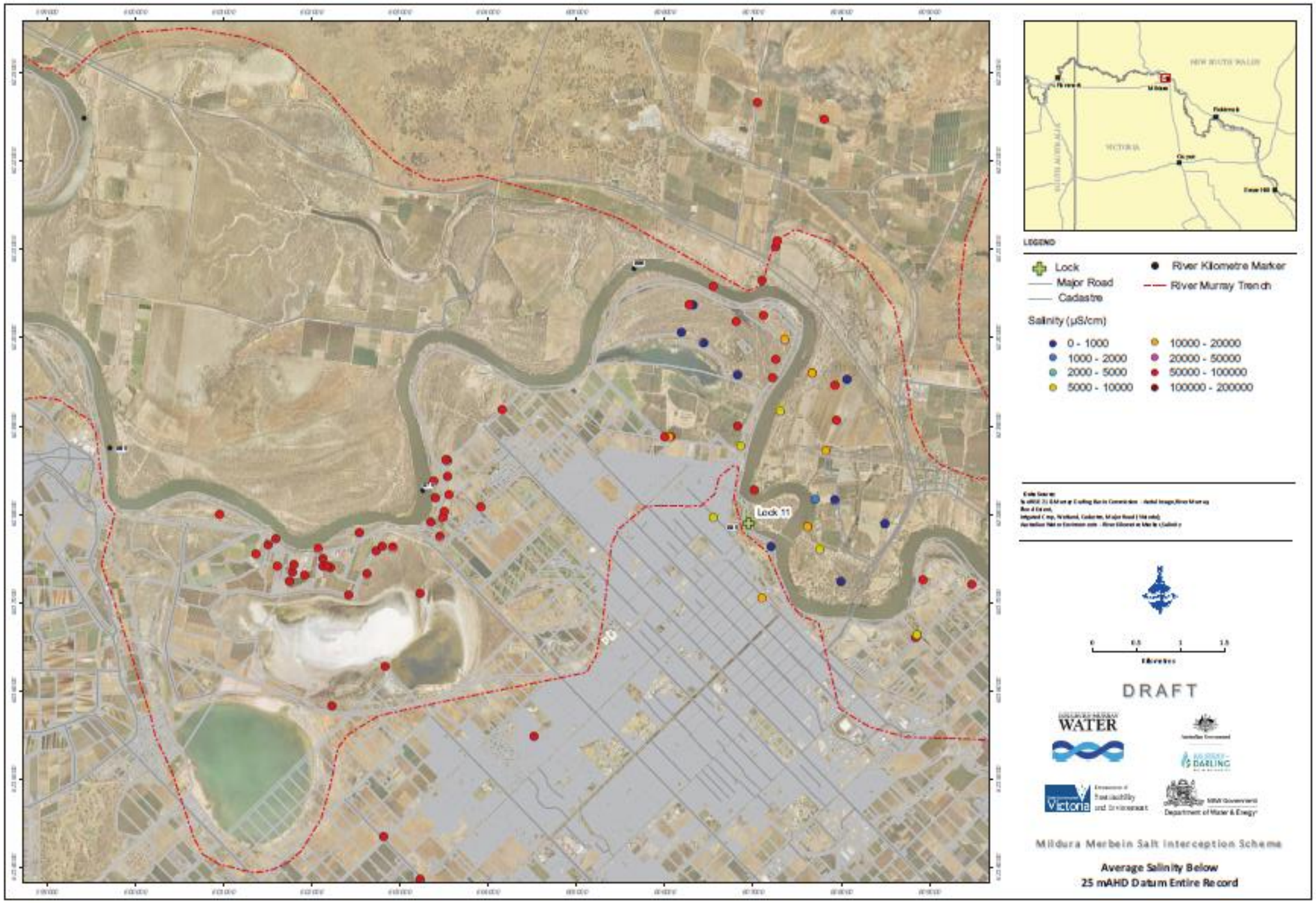


Figure 5: Average salinity below 25 m AHD (AWE 2013)

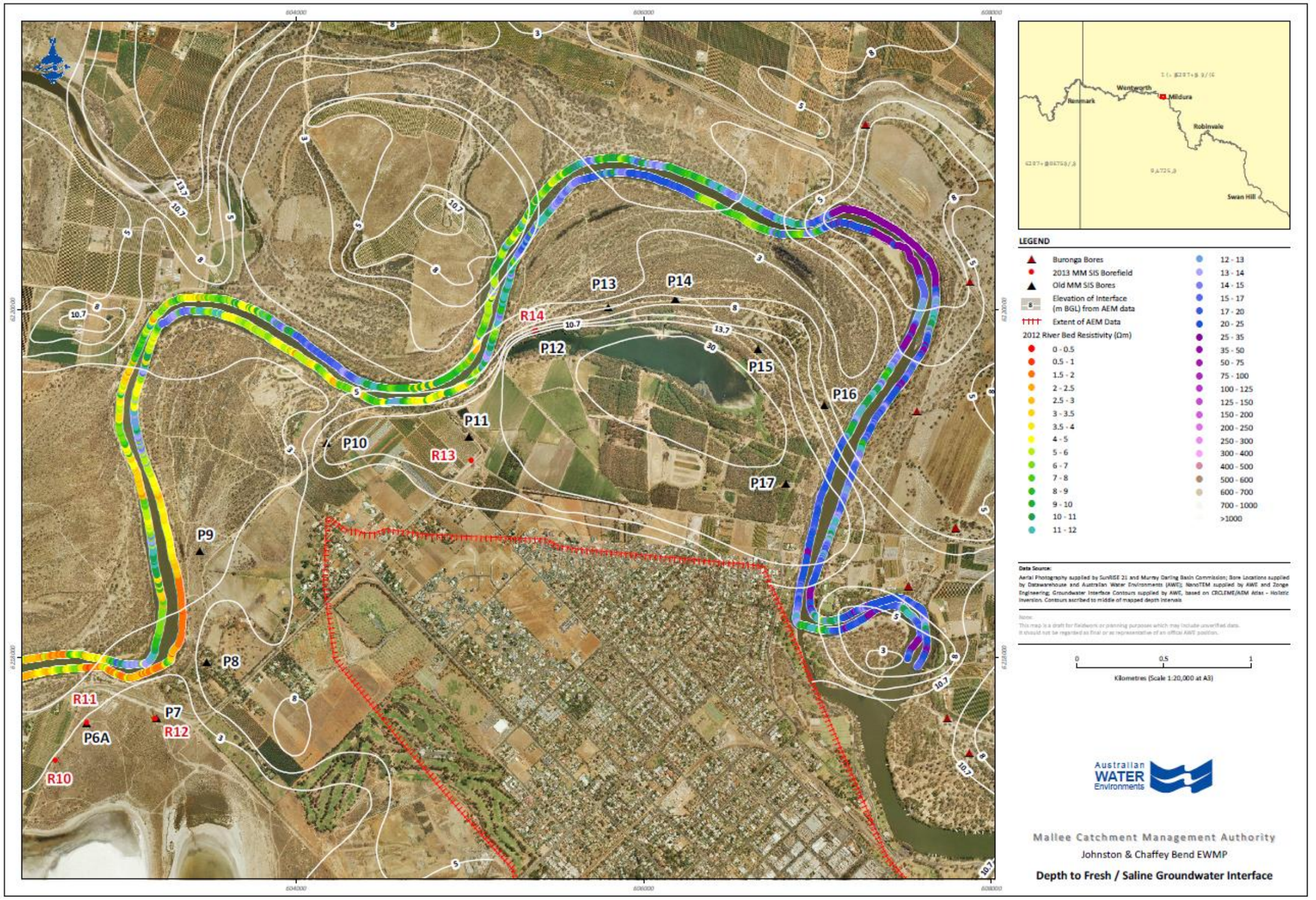


Figure 6: Depth to fresh/saline Groundwater interface

Related Agreements, Policy, Plans and Activities

The Target Area has been covered with a range of investigations and activities including:

- Flood management program (SKM 2000)
- Flood Response action plan (MCMA 2006c)
- The 2007 investigation of water management options for the Murray River floodplain from Robinvale to Wallpolla Island by Ecological Associates. (reference)
- Studies on the ecological values of WMUs, e.g. Bat survey (Gee 2002), Bird observations, River Red Gum and Black Box conditions (Cunningham et al. 2010), etc.
- The Department of Environment and Primary Industries (DEPI), Parks Victoria and the Mallee CMA have invested significant resources into the environmental watering program in this area (Sunraysia Environmental 2008 and Kelly 2006).
- Studies on environmental impacts of Mildura WWTP (Lower Murray Water 2011)
- The Target Area is managed under Murray Riverfront Reserves Management Plan 2011 to 2015 (Sunraysia Environmental 2010)
- This area is also be the subject of detailed hydrological and river salinity studies to support the refurbishment of the Mildura-Merbein Salt Interception Scheme including AWE & SKM (2003), AWE (2013) and AWE (2012).

Hydrology and System Operations

FMU Hydrology, Water Management and Delivery

Pre-regulation

With the effects of major storages and river regulation on the Murray River, the frequency, duration and magnitude of most flood events have decreased compared to natural conditions. Prior to river regulation, floodplain inundation would have occurred more frequently. In order to inundate low floodplain terraces and many wetlands, the flood peak has to be in the order of 20,000 to 60,000 ML/d. These high flow events occurred more often, with longer duration and at higher frequency compared to current conditions (EA 2007).

The Floodplain Inundation Model (FIM) (Figure 7) (AWE 2009) shows the areas of floodplain inundated at various flow ranges. The FIM data does not include, in this area, the inundation areas for flows that are higher than 120,000 ML/d. However, it is clear that much of the floodplain does not get inundated by flows less than 120,000 ML/d.

Prior to irrigation development and locking, it is likely that losing stream conditions would have prevailed along this section of river and the floodplain aquifer would have been recharged by fresh River Murray water under most flow regimes. Prior to locking, river and groundwater levels would have fallen significantly lower than current levels during times of drought. Regional groundwater flow would have been driven by rainfall and occurred in a broadly east to west direction (AWE and SKM 2003).

Post-regulation

Since 1922, 13 weirs and locks across the Murray River have been constructed. The hydrology of the region has been altered significantly. River regulation and increased consumptive water use have reduced overbank flows that stimulate flora and fauna (Sunraysia Environmental 2008). Figure 8 shows the impacts of river regulation (i.e. reducing the frequency and duration of peaks in river flow). On top of river regulation, a decade of drought has put extensive additional pressure on the river and the floodplain system, leading to a decline in river and floodplain health (Sunraysia Environmental 2008). The flooding regime has also been affected by local works such as changes to anabranches and wetland sills, which prevent or reduce inflows to flood-dependent ecosystems (EA 2007).

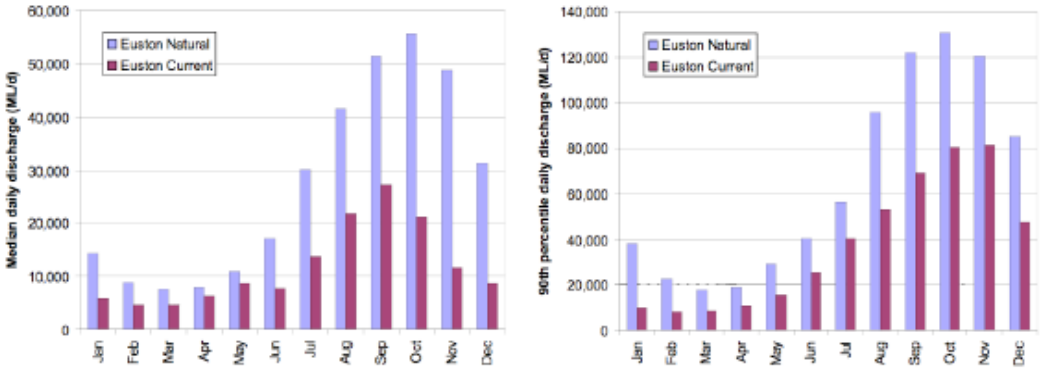


Figure 8: Distribution of median flows and 90th percentile flows for each month at Euston Weir for natural and current (benchmark) conditions. Source: derived from MDBC MSM Bigmod 109 year data (EA 2007).

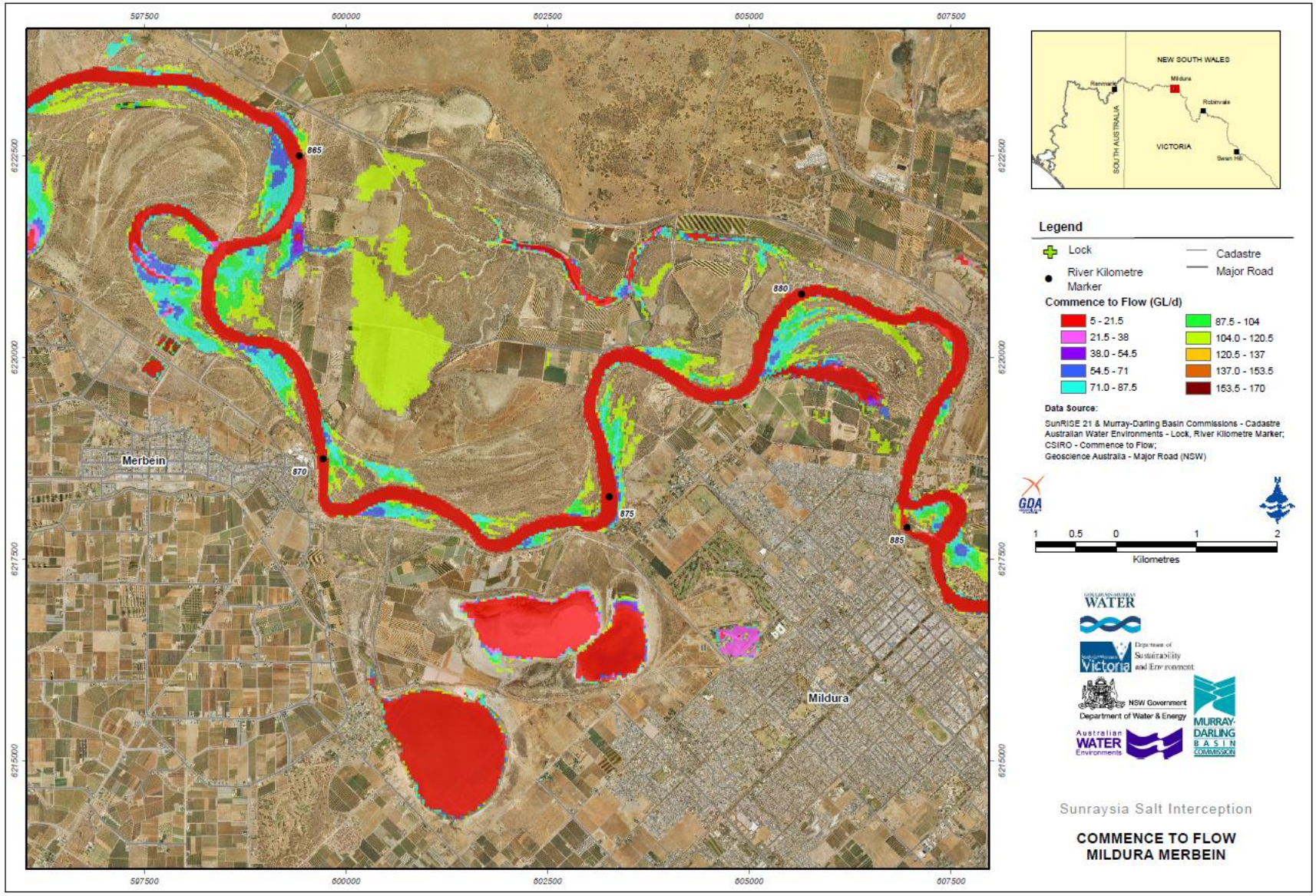


Figure 7: Commence to flow Mildura Merbein (AWE 2009)

Groundwater Trend

Construction of Lock 11 at the upstream end of Chaffey Bend created a weir pool that is held above the pre-development groundwater level in the adjacent floodplain (AWE and SKM 2003). Since irrigation development, significant additional recharge to the groundwater system has occurred which has created a large irrigation mound to the south of Johnstons and Chaffey Bend WMUs. The mound influences the flow of groundwater within the project area. Elevated groundwater levels have created a radial flow pattern away from the mound and towards the river in the study area (AWE 2009). Groundwater contours for the Parilla Sands aquifer are presented in Figure 3. Maximum heads in the Parilla Sands aquifer are in excess of 39 m AHD, which is approximately 5m above the upstream pool level of Lock 11 (34.4 m AHD) and 8m above the downstream pool level (30.8 m AHD)(AWE 2013).

Groundwater heads are also elevated in bores adjacent the TWW lagoon in comparison to the surrounding floodplain and are approximately 4m above the downstream pool level of Lock 11. This provides opportunity for TWW water to drain from the lagoon into the aquifer, and across the floodplain.

Groundwater levels in the irrigation mound vary only slightly, but are highest in summer/autumn and lowest in winter/spring. This trend is caused by excess irrigation drainage water recharging the Parilla Sands aquifer. Low groundwater levels coincide with winter/spring when irrigation rates are reduced. Recent declines in groundwater levels within the irrigation mound may be attributed to consecutive years of below average rainfall and improvements in irrigation efficiencies (AWE 2009).

The Johnstons and Chaffey Bend floodplains can be considered gaining floodplains (AWE 2013) where the regional groundwater system (Parilla Sand) is discharging to the floodplain alluvium. The groundwater is sourced from regional groundwater flux and from irrigation induced groundwater recharge. The elevated heads have increased the rate of groundwater (and salt) movement to the river (AWE 2013) and much of the River would be a gaining stream without the implementation of the SIS.

Groundwater levels on the floodplain are affected by a combination of factors including flood events, floodplain surface water features, river flow regime, SIS pumping, rainfall, and irrigation. During periods of high river stage, groundwater levels on the floodplain are strongly influenced by river levels. This is evident from observation bores located within approximately 1 km of the river, which show clear flood peaks during high flow periods and flood recessions on the falling limb of the flood. Under low flow conditions, rainfall and irrigation effects can be observed in the hydrograph data (AWE 2009).

NanoTEM surveys and groundwater head data suggest that gaining stream conditions occur along the river reach adjacent the Johnstons and Chaffey Bend floodplains. That is, groundwater currently discharges from the floodplain aquifer to the river downstream of Lock 11. This represents a reversal of the pre-locking and pre-irrigation conditions (AWE 2013).

Mildura Waste Water Treatment Plant (WWTP)

The Mildura Wastewater treatment plant (WWTP) and associated farm is located on 150 hectares of land adjacent the Chaffey Bend floodplain (Lower Murray Water 2011). A lagoon is also located within the study site, has an area of 30 hectares. The lagoon has a total capacity of 507 ML but volume varies from 34 ML (in March) up to 480 ML (July to October). It was previously used for wet weather storage but has not held water for around two years. The plant receives approximately 1,150ML of wastewater per year and discharges treated water via flood irrigation to a tree plantation (59.7 hectares) and pasture plantation (56 hectares). Treated water is also used for irrigation of the Aerodrome Ovals and Recreation Complex located adjacent the study area.

Environmental Watering

The emergency watering program was carried out to maintain the health of River Red Gum over three years from 2005 to 2007 (Sunraysia Environmental 2008). According to Kelly (2006), the Department of Sustainability and Environment (DSE) has been leading a program to attempt to resurrect the health of the River Red Gums, *Eucalyptus camaldulensis*, along the Victorian Murray River floodplain. A total of 13,005 ML of water was delivered to the River Channel sites which are along the Murray River from Swan Hill to Lock 10 in Wentworth during the three-year period. Among these sites, Johnstons Bend State Forest and Chaffey Bend received 277 ML and 212 ML respectively. The water was pumped directly from the River into flood runners (Sunraysia Environmental 2008). Details of the watering events in the Target Area during 2005-2006 are presented in Table 3.

Table 3: Watering events at Johnstons and Chaffey Bend (Sunraysia Environmental 2008)

Site	Year	Volume (ML)	Area (ha)	Distance (km)
Johnstons Bend	2005	88	10	2
	14-18/6/2006	52	10	2
Chaffey Bend	2005	151	13	2
	13-18/6/2006	61	13	2

In 2006, environmental water allocated for Johnstons and Chaffey Bend came from 5,578 megalitres of donated water from Victorian Mallee Irrigators. The amount of donated water was used to water sixteen selected sites along the Murray River including Johnstons Bend (52 ML) and Chaffey Bend (61 ML).

Johnstons Bend has good access to site. The water was able to reach the severely stressed communities including Red Gums, Black Box and lignum with only three runners (Kelly 2006).

Both Johnstons and Chaffey Bends are part of a Salt Interception Scheme (SIS). Kelly (2006) recommended that the SIS and the watering activity should be monitored to check the effectiveness of the scheme and watering on the health of the Red Gums (Kelly 2006).

Water Dependent Values

Environmental Values

Floodplains are temporary storage areas of alluvial material adjacent to the main river channel. They are a vital component of the ecology of the lowland rivers in the Murray Darling Basin. Floodplains are formed by a complex interaction of fluvial processes. Floodplains are an oscillating boundary between aquatic and terrestrial systems. Therefore, biota that reside on floodplains have to be able to adapt to both wet and dry conditions. The composition of a community on the floodplain is strongly influenced by the wetting and drying periods (e.g. duration of individual events, time of year they occur). High biodiversity is a common feature of a floodplain.

Listings and Significance

A full list of fauna and flora species can be found in Appendix 1 and Appendix 3.

Fauna

There have not been many thorough studies on fauna in the Johnstons and Chaffey Bend Target Area, except a few investigations around Mildura WWTP. According to Sluiter (2006), water bird census counts were carried out annually at the Mildura WWTP and the information is presented in the Appendix 2. The most significant bird species recorded at the Mildura WWTP are presented in Table 4.

Another highly significant wildlife species — the carpet python (*Morelia spilota variegata*) — may also occur at the WWTP. Carpet python is considered to be endangered within Victoria. Currently, based on available information, its existence has not been confirmed (Sluiter 2006).

Bats

A bat survey (Gee 2002) at the treatment area was conducted on the 26th November 2002. During the survey period, five different species of micro chiropteran bats were either caught or detected including Gould's wattle bat (*Chalinolobus gouldii),* little broad-nosed bat (*Scotorepens greyii)*, Long-eared bat (*Nyctophilus spp.)*, Forest bat (*Vespadelus spp.) and* Little Pied Bat (*Chalinolobus picatus)*.The greater long-eared bat is a rare species. Even though no greater long-eared bats were caught during the survey, experts believe it is quite feasible for it to be at the study site. The number of species found or detected was expected to be higher if the weather had been in better condition during the survey time.

The Eastern Hooded Scaly-foot (*Pygopus schraderi)*

Eastern Hooded Scaly-foot is listed as a threatened taxon under the Victoria Flora and Fauna Guarantee Act 1988. In Victoria, this species has been found in areas of clay and clay-loam soils dominated by Black Box. A study on an SIS site adjacent to Johnstons Bend suggested that even though no Eastern Hooded Scaly-foot were found in the survey area, the study site is still considered as high potential habitat for this species. Curl Snake was found at the survey site which is known to have similar habitat requirement to the Eastern Hooded Scaly-foot. Therefore, Johnstons Bend also has high potential for providing habitat for the Eastern Hooded Scaly-foot species (GHD 2012).

Table 4: Listed fauna species recorded in the Johnstons and Chaffey Bend Target Area

1) Common name	2) Scientific name	Type	EPBC status	FFG status	DEPI status
freckled duck	*(Stictonetta naevosa)*	B	NL	L	EN
great egret	*(Ardea alba)*	B	NL	L	
Australasian shoveler	*(Anas rhynchotis)*	B	NL	NL	V
hardhead	*(Aythya australis)*	B	NL	NL	V
blue-billed duck	*(Oxyura australis)*	B	NL	L	EN
musk duck	*(Biziura lobata)*	B	NL	NL	V
Carpet python	*Morelia spilota metcalfei*	R	NL	L	EN
Gould's wattle bat	*Chalinolobus gouldii*	B	NL	NL	
Little broad-nosed bat	*Scotorepens greyii*	B	NL	NL	NT
Forest bat	*Vespadelus spp.*	B	NL	NL	
Little Pied bat	*Chalinolobus picatus*	B	NL	NL	

Eastern Hooded Scaly-foot	*Pygopus schraderi*	R	NL	L	CR

Legend

Type: Invertebrate, Fish, Amphibian, Reptile, Bird, Mammal

EPBC status: EXtinct, CRitically endangered, ENdangered, VUlnerable, Conservation Dependent, Not Listed

FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing

DEPI status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known, Not Listed

Groundwater Dependent Ecosystems (GDEs)

The National Atlas of Groundwater Dependent Ecosystems (GDE Atlas) was developed by CSIRO & SKM (2012) with an aim to provide a tool to help achieve better understanding and management of GDEs across Australia. The GDE Atlas comprises of location maps for both known and potential GDEs across the whole nation. According to the Atlas, most of the area in Johnstons and Chaffey Bend WMUs is classified as high potential for groundwater interaction (Figure 9), which indicated the importance of managing groundwater for vegetation health in the Target Area.

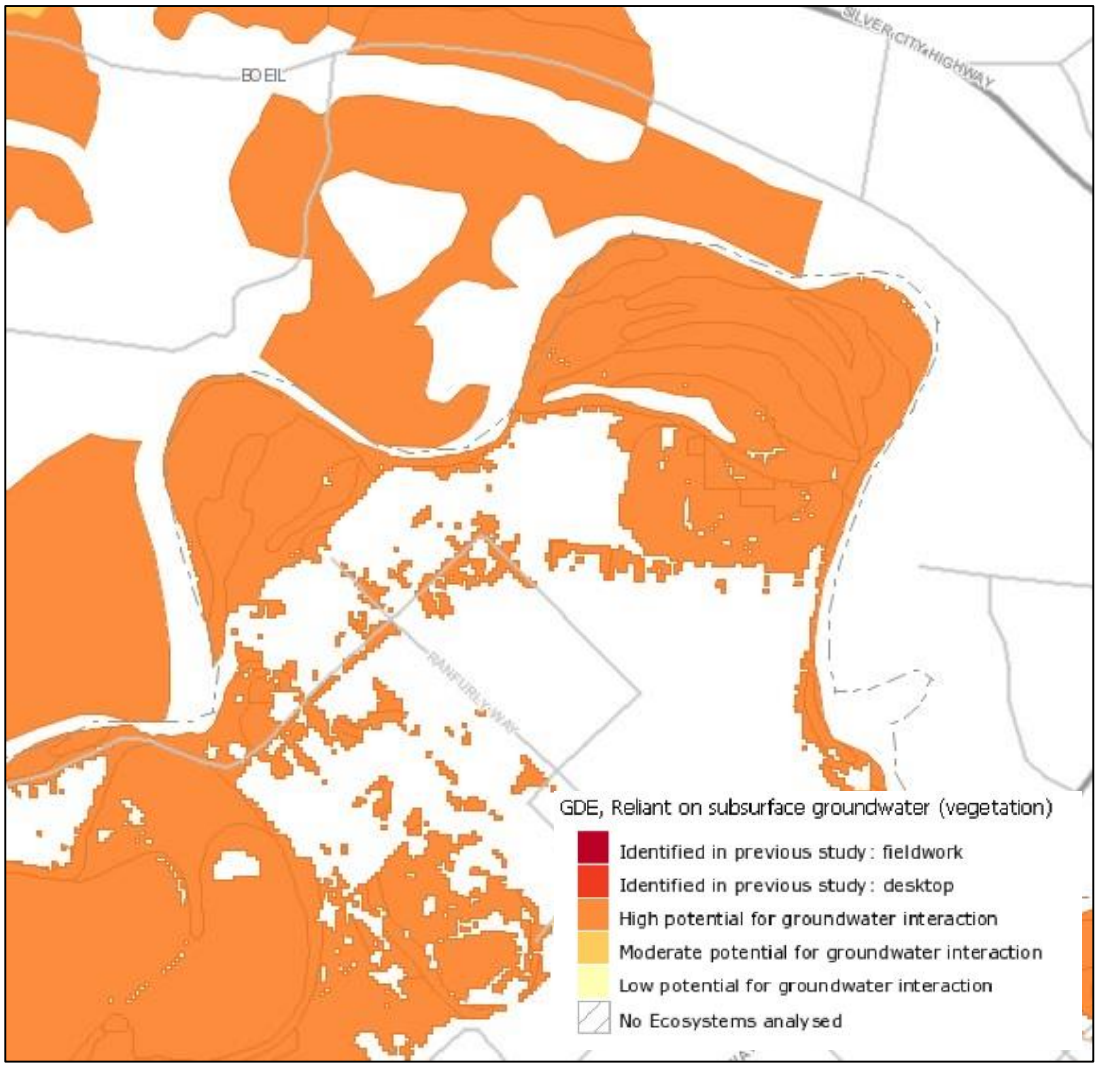


Figure 9: GDE, reliant on subsurface groundwater (Source: www.bom.gov.au)

Vegetation Communities

Within the Target Area, there are different ecological vegetation classes (EVCs) presented in Table 5 and Figure 10. A few of them are classified as Depleted including Grassy Riverine Forest, Intermittent Swampy Woodland, Lignum Swampy Woodland, Low Chenopod Shrubland, Riverine Chenopod Woodland and Semi-arid Chenopod Woodland

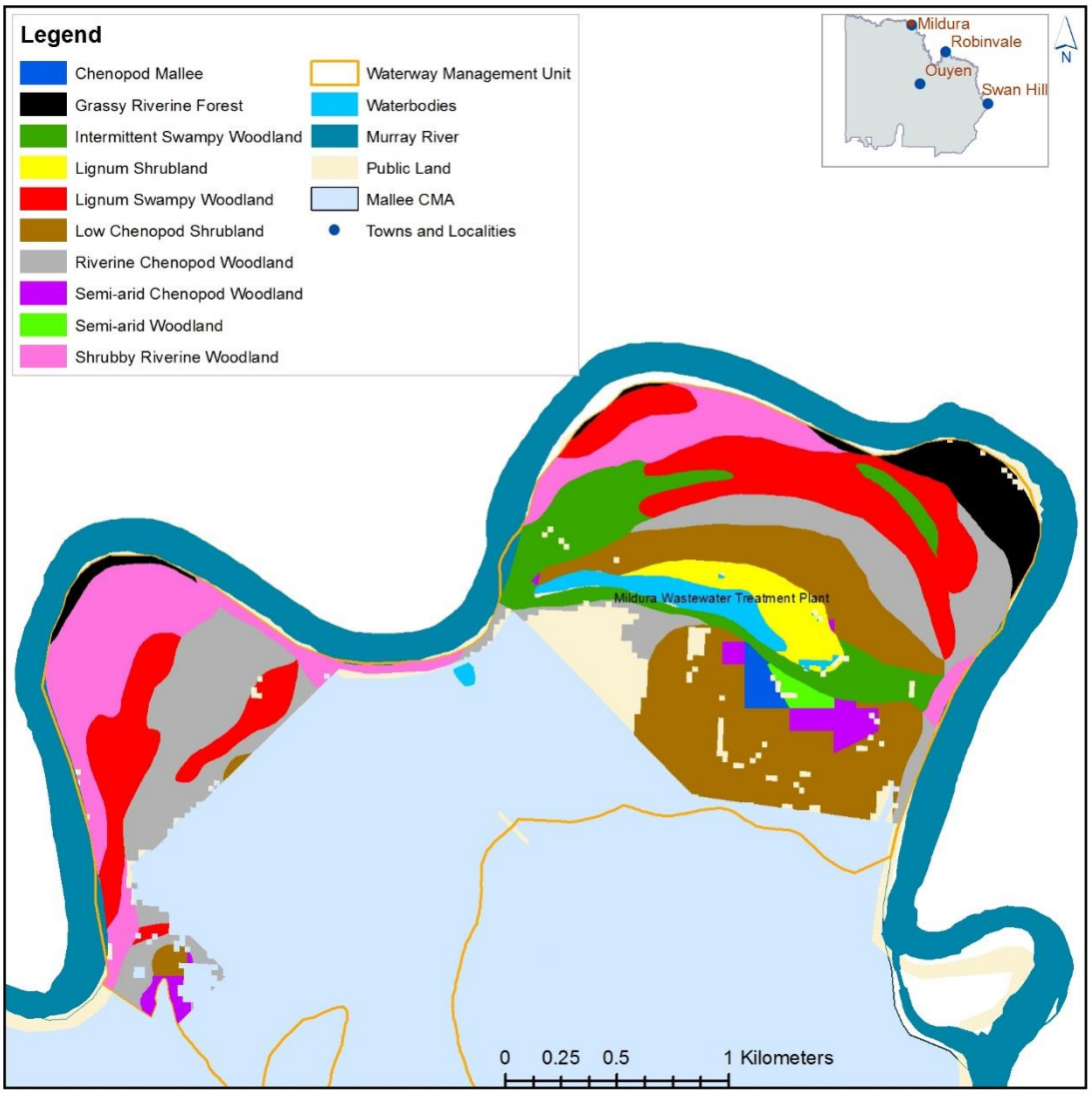


Figure 10: EVCs within the Target Area

Table 5: List of EVCs and its bioregional Conservation Status (MCMA 2012).

EVC no.	EVC name	Area (ha)	Bioregional Conservation Status	Description
106	Grassy Riverine Forest	21.6	Depleted	Occurs on the floodplain of major rivers, in an elevated position where floods are not frequent, on deposited silts and sands, forming fertile alluvial soils. River Red Gum forest to 25 m tall with a ground layer dominated by graminoids. Occasional tall shrubs present.
813	Intermittent Swampy Woodland	34.9	Depleted	Eucalypt woodland to 15m tall at best development dominated by flood stimulated species in association with flora tolerant of inundation. Flooding is unreliable but extensive when it happens. Occupies low elevation areas on river terraces and lacustrine verges. Soils often have a shallow sand layer over heavy and frequently slightly brackish soils.
808	Lignum Shrubland	14.8	Least concern	Relatively open shrubland of species of divaricate growth form. The ground-layer is typically herbaceous or a turf grassland, rich in annual/ephemeral herbs and small chenopods. Characterised the open and even distribution of relatively small Lignum shrubs. Occupies heavy soil plains along Murray River, low-lying areas on higher-level (but still potentially flood-prone) terraces.
823	Lignum Swampy Woodland	77.2	Depleted	Understorey dominated by Lignum, typically of robust character and relatively dense, in association with a Eucalypt and/or Acacia woodland to 15m tall. The ground layer includes a component of obligate wetland flora that is able to persist even if dormant over dry periods.
102	Low Chenopod Shrubland	36.8	Depleted	Chenopod shrubland to 1 m tall occupying broad, flat alluvial terraces occur along the Murray River, west from Mildura to the border. Also found in narrow bands fringing raak and saline lakes such as Lake Tyrell and on relict lakebed surfaces such as Pine Plains. The field layer is characterised by succulents and a suite of annual herbs.
103	Riverine Chenopod Woodland	76.8	Depleted	Eucalypt woodland to 15 m tall with a diverse shrubby and grassy understorey occurring on most elevated riverine terraces. Confined to heavy clay soils on higher level terraces within or on the margins of riverine floodplains (or former floodplains), naturally subject to only extremely infrequent incidental shallow flooding from major events if at all flooded.
98	Semi-arid Chenopod Woodland	2.4	Depleted	Sparse, low non-eucalypt woodland to 12 m tall of the arid zone with a tall open chenopod shrub-dominated understorey to a treeless, tall chenopod shrubland to 3 m tall. This EVC may occur as either a woodland (typically with a very open structure but tree cover >10%) or a shrubland (tree cover <10%) with trees as an occasional emergent.
818	Shrubby Riverine Woodland	68	Least concern	Eucalypt woodland to open forest to 15 m tall of less flood-prone (riverine) watercourse fringes, principally on levees and higher sections of point-bar deposits. The understorey includes a range of species shared with drier floodplain habitats with a sparse shrub component, ground-layer patchily dominated by various life-forms. A range of large dicot herbs (mostly herbaceous perennial, several with a growth-form approaching that of small shrub) are often

				conspicuous.
158	Chenopod Mallee	3.4	Vulnerable	Open to very open Mallee woodland to 12 m tall, almost invariably dominated by Yorrell (Eucalyptus gracilis), supported by thin Woorinen deposits typically overlying gypsiferous and sodic clays. In undisturbed remnants, this EVC is characterised by the dominance of saltbushes and semi-succulent understorey shrubs.
97	Semi-arid Woodland	2.4	Vulnerable	Sparse, low non-eucalypt woodland to 12 m tall of the arid zone with a tall open chenopod shrub-dominated understorey to a treeless, tall chenopod shrubland to 3 m tall. This EVC may occur as either a woodland (typically with a very open structure but tree cover >10%) or a shrubland (tree cover <10%) with trees as an occasional emergent.

Flora

The Johnstons and Chaffey Bend Target Area contains River Red Gum and Black Box dominant forest woodland and shrubland communities in varied condition.

River Red Gum (*Eucalyptus camaldulensis* Dehnh.)

River Red Gum is the most widespread species on the Murray River floodplain in Victoria. River Red Gum communities are an important part in the nutrient cycling between floodplains and rivers and provide extensive habitat for a wide range of plants and animals (such as Carpet Python, White-bellied Sea Eagle and Regent Parrot). It also provides a good source of timber. River Red Gum forests can be used extensively for grazing and recreation (Cunningham et al. 2006, Roberts & Marston 2011). Flooding is one of the three sources of water for riparian trees including River Red Gums, the others being groundwater and rainwater (Roberts and Marston 2011). River Red Gum communities receive more regular flooding than Black Box woodlands (MDBA 2009).

According to Roberts & Marston (2011), River Red Gum communities require flooding every two to four years with duration of two to four months. Tree growth is greatest when flooded under warm conditions such as summer and wood production increases with increasing flood duration. Spring-summer floods followed by summer recession provide suitable condition for germination. Regeneration is optimised if the flood recession is in spring-early summer (Roberts & Marston 2011). The relationship between River Red Gum health and soil salinity has not been thoroughly investigated. River Red Gum can be observed to have growth reduction when root-zone soil salinities of an extract from a saturated soil paste (ECe) range from 2 to 5 dS/m, but survival is likely to be affected at soil ECe > 15 dS/m (MDBA 2003). Another study cited in MDBA 2003 suggested that soil salinity threshold for River Red Gum is around 25 dS/m as total absence of River Red Gum stands were observed beyond that value.

Black Box (*Eucalyptus largiflorens* F.Muell.)

Black Box is also a dominant tree species on the Murray River floodplain. Black Box forests play an important role in nutrient cycling between floodplains and rivers (Baldwin, 1999) and provide valuable habitat for plants and animals (Mac Nally et al. 2001). Under drier and less frequently flooded conditions,Black Box trees have a twisted shape with dead limbs and hollows providing refuge, breeding holes and crevices for birds, lizards and small mammals (Roberts and Marstons 2011). With tolerance to prolonged drought, Black Box woodlands occur higher on the floodplain than River Red Gum communities. Black Box can effectively exclude salt from its root system, but the tree health can be affected by the additional effect of reducing transpiration (Roberts & Marston 2011).

Research on Black Box woodlands has found that Black Box is ecologically flexible and opportunistic in water use. However, Black Box trees are at their healthiestwhen they were flooded for 4-6 months every 4-5 years but flooding duration should not exceed 12 months (Roberts & Marston 2011).

In the Mildura WWTP, a biodiversity audit of the lagoon site commissioned by Lower Murray Water (2011) found the dominant vegetation community to be Riverine Chenopod Woodland, which is considered to be a ‘depleted’ community type in the region. The audit detailed a significant stand of Black Box trees and a number of rare and vulnerable flora species including Tall Kerosene grass (*Aristida holathera var.holathera)*, Sarcozona (*Sarcozona praecox*), Silky Umbrella grass (*Digitaria ammophila*) and Purple Plume grass (Triraphis mollis) (Lower Murray Water 2011). A number of threatened plant species were also identified including Spreading Emu bush *(species name*), Umbrella Wattle (*species name)* and Purple Love grass (*species name*) (Table 6). The vegetation community was considered to be in good to

very good condition and is located on an elevated floodplain terrace on the northern side of the lagoon (Lower Murray Water 2011).

Tangled Lignum (*Muehlenbeckia florulenta)*

Lignum is also a common species in these floodplains. It is known as a high drought and salinity tolerant plant and can rapidly expand and regenerate following floods or high rainfalls. Tangled Lignum is an important understorey component in River Red Gum and Black Box communities (MCMA 2012). It provides habitat and nesting sites for migratory waterbirds and helps prevent erosion (Roberts & Marston 2011). It is observed that the distribution of lignum is mainly in areas with a flood frequency of every three to 10 years and lignum cover is greatest in high flood frequency zones. However, prolonged flooding (>12 months) will cause lignum to die under anoxic conditions (Rogers & Ralph 2011).

A recent site visit by the project team indicates that Lignum communities are under better condition compared to River Red Gums and Black Box woodlands.

River Coobah (*Acacia stenophylla)*

River Coobah is also known as river myall and can be found in Intermittent Swampy Woodland. It is adapted to swampy conditions which occur on the heavy, brackish soils on the low elevation areas of the riverine terraces (MCMA 2012). There is little information about water requirements for the survival and maintenance of River Coobah. River Coobah is thought to have water requirements that fall within the ranges for River Red Gum and Black Box, as it is usually between zones occupied by River Red Gum and Black Box. River Coobah is somewhat salt-tolerant but growth might be reduced when soil salinity of 10-15 dS/m and survival is limited at salinities greater than 15 dS/m (Rogers & Ralph 2011)

White Cypress (*Callitris columnaris*)

The Mallee regionformerly had extensive stands of non-eucalypt woodlands dominated by Slender Cypress pine (or White Cypress pine in the north-west corner), Buloke, Belah and Sugarwood. However, it has been extensively cleared for timber or agriculture as it typically occurs in fertile loam and clay soils (MCMA 2012). According to Kelly (2014, pers comm.), a small stand of this species is found near the nursery area.

Table 6: Listed vegetation species identified at Mildura WWTP

Common name	**Scientific name**	**EPBC status**	**FFG status**	**DSE status**
Tall Kerosene grass	*Aristida holathera var.holathera*	NL	NL	V
Sarcozona	*Sarcozona praecox*	NL	NL	R
Silky Umbrella grass	*Digitaria ammophila*	NL	NL	V
Purple Plume grass	*Triraphis mollis*	NL	NL	R
Spreading Emu bush	*Eremophila divaricata subsp. divaricata*	NL	NL	R
Umbrella Wattle	*Acacia oswaldii*	NL	NL	
Purple Love grass	*Eragrostis lacunaria*	NL	NL	V

Legend

Type: Invertebrate, Fish, Amphibian, Reptile, Bird, Mammal

EPBC status: EXtinct, CRitically endangered, ENdangered, VUlnerable, Conservation Dependent, Not Listed

FFG status: Listed as threatened, Nominated, Delisted, Never Listed, Ineligible for listing

DSE status: presumed EXtinct, Regionally Extinct, Extinct in the Wild, CRitically endangered, ENdangered, Vulnerable, Rare, Near Threatened, Data Deficient, Poorly Known, Not Listed

Wetland

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

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

None of the post-1994 wetland mapping is contained within this State wetland database.

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

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

Comparison between the wetland layers has demonstrated the impact of European settlement and development on Victorian wetlands. This has been severe, with approximately one-third of the state's wetlands being lost since European settlement; many of those remaining are threatened by continuing degradation from salinity, drainage and agricultural practices.

The Target Area in Johnstons and Chaffey Bend WMUs currently contains one wetland. It is a treated wastewater lagoon with covers area of 25.39 ha and is classified as Permanent open freshwater.

Social Values

The Johnstons and Chaffey Bend Target Area is subject to intensive recreation pressure and has been impacted over time.

Cultural Values

The Johnstons and Chaffey Bend Target Area is an important cultural site for the local indigenous people. A search of the Department of Primary Industries GeoVic Database shows that large areas in the WMU around the River Murray and the flood runners are areas of Cultural Heritage Sensitivity. There are no Registered Aboriginal Parties (RAP) that cover this area. As is the case for most of the Murray River floodplain and beyond, it is recognized that waterways and floodplains are highly significant for the indigenous culture but the true extent of the number and types of sites present is still unknown. A contingency plan (Appendix 4) is in place should any further evidence of cultural heritage sites be discovered during site visits or works.

Frontages to the River Murray from Robinvale to Merbein hold important European heritage value, which is reflected through homesteads, grave sites and historic markers from the early settlement of the region. The area was first explored by Major Thomas Mitchell and Captain William Sturt in the 1830s with much of it developed for large grazing runs. Closer settlement was established after the success of the Mildura Irrigation Colony in the early 1900s and the Red Cliffs and Robinvale Soldier Settlement Scheme of the 1920s and 1940s. A notable heritage site in this study area is Chaffey Grave Sites at Chaffey Bend (MCMA 2003).

SIS bores

SIS bores at the Johnstons and Chaffey Bend Target Area are a part of the Mildura Merbein SIS which have been constructed and started their commission from 1979 to 1981. The SIS was designed to intercept groundwater discharge to the River Murray driven by local groundwater mounds that have developed as a result of irrigation practices and associated drainage water management practices (AWE 2013).

Recreation

The study area is popular for different recreational activities including boating camping, fishing and picnicking. These activities are supported with a wide range of facilities, i.e. Motorbike club, Mildura lifesaving club, Gun club, boat ramp, caravan parks and Mildura walking trails. For examples, the northern portion of the Old Mildura Homestead Reserve connects to Chaffey Bend Reserve and contains a well-maintained shared path, a picnic setting and is adjacent to the Chaffey graves and memorial site. Along the Chaffey Bend reserve's length, there are a large number of picnic tables and scenic locations (Sunraysia Environmental 2010).

Economic Values

The Target Area in Johnstons and Chaffey Bend WMUs has been used for irrigated horticulture, cropping, vine fruits; grazing; firewood collection and forest production. River Red Gum forests are an important source of timber for use as fuels, posts and railway sleepers. Firewood is also collected from the area under licence and illegally (MCMA 2003). Red Gum and Black Box woodlands is also valuable for providing important sites for honey production (MCMA 2003). Tree death in recent years has resulted in the award of timber cutting licences to remove large dead standing trees.

Conceptualisation of the Site

The conceptualisation of the study site is summarised in the following diagrams (Figure 9) in which key processes influenced the behavior of the Site system are identified.

Significance

The environmental, social and economic values outlined indicate the significance of this site. While these values do not constitute Johnstons and Chaffey Bend being a unique or pristine site, the riparian and floodplain communities of the

Murray River are important to the functioning of the river system and its sustainability. The area is rich in biodiversity, essential as habitat to native species and a refuge for listed flora and fauna species.

This area is dominant with River Red Gum and Black Box communities, which have played an important role in providing habitat for many listed species. Therefore, maintaining and improving the conditions for remnant River Red Gums and other River Red Gum and Black Box forests is a vital part in managing this area. Also, the Johnstons and Chaffey Bend Target Area has significant recreational values. These values make this area a priority for protection and enhancement through environmental water management.

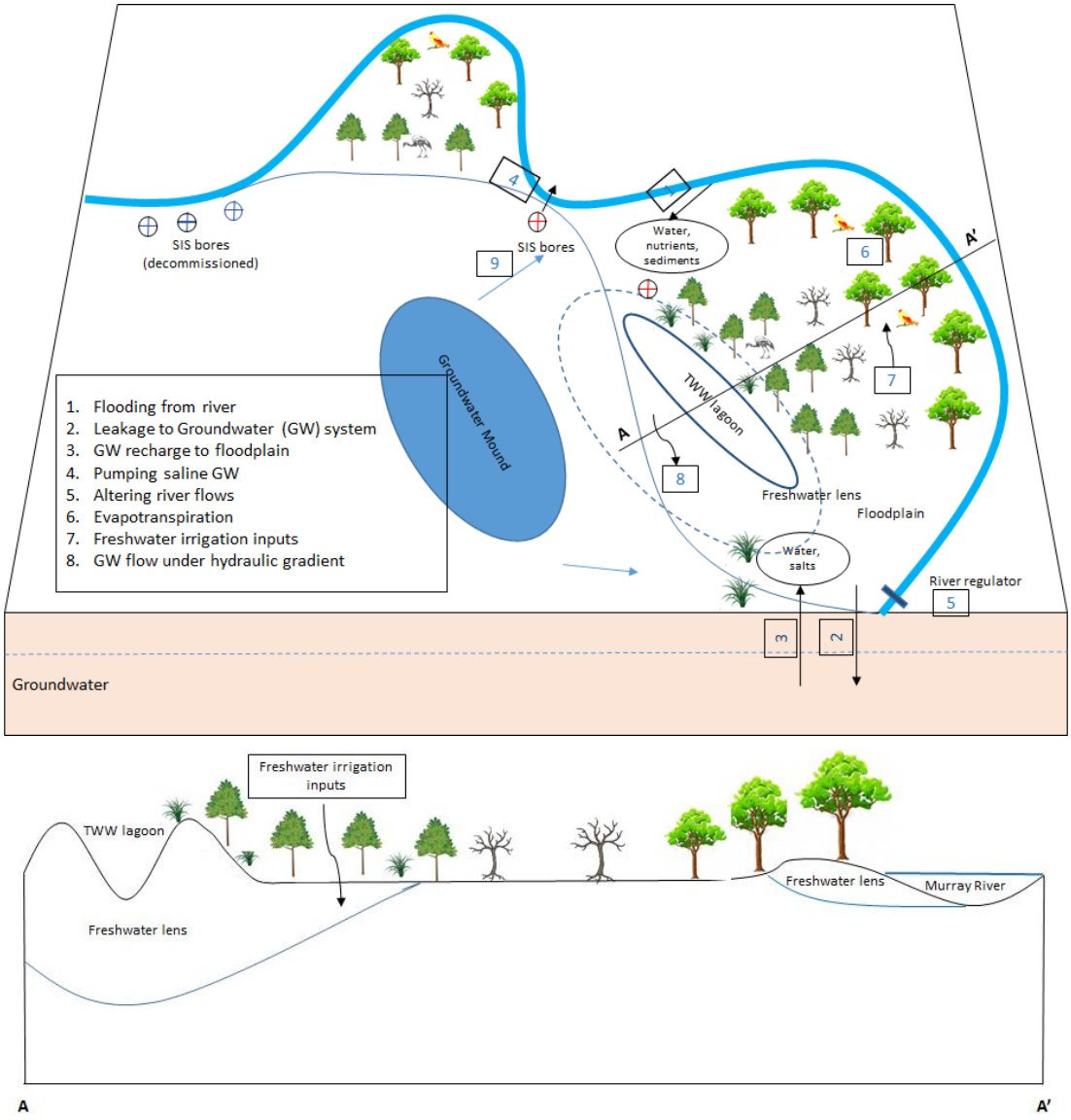


Figure 9: Conceptual diagram of Johnstons and Chaffey Bend

Ecological Condition and Threats

Current Condition

Along the Murray River, surveys of River Red Gum forest have shown an apparently substantial decline in tree condition over the past twenty years. For example, in the late 1980s the degradation of tree canopies increased dramatically below the Wakool Junction in the Mallee. Survey of River Red Gum condition in 2006 indicates 70% of these forests across the Victorian Murray River floodplain were in stressed condition (Cunningham et al. 2010) Stressed trees are usually found away from the banks of the Murray River and permanently inundated anabranches on the floodplain (Cunningham et al., 2006).

Cunningham et al 2006 indicates that the River Red Gum condition in Johnstons and Chaffey Bend area is generally ranging from declining to severely degraded.

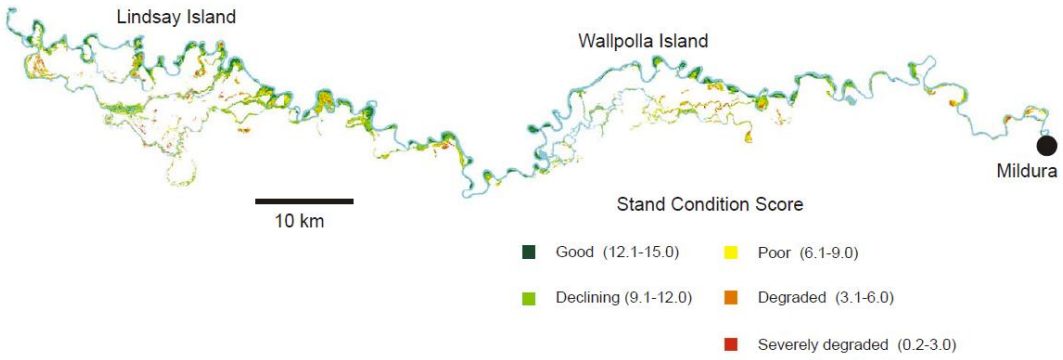


Figure 10: Condition of River Red Gum stands predicted by the PVL model (r2 = 0.78) from remotely-sensed data for the Murray Scroll Belt (Cunningham et al. 2006).

Similar to the condition of River Red Gum communities, Black Box woodlands are also under severe stress. Kelly (2006) stated that in Johnstons Bend, both River Red Gum forest and Black Box woodland were degraded.

Figure 11: Revegetation of degraded Murray River frontage at the study site (Source: MCMA)

The exception is vegetation communities around TWW lagoon in Chaffey Bend. Vegetation was considered to be in good to very good condition due to the accessibility to freshwater source from the lagoon and freshwater lens beneath (Lower Murray Water 2011, AWE 2013).

Recent inspections of both floodplains show that Red Gum stands are now generally only one tree deep along the banks of the Murray, with rapid declines in health inland and extensive tree death at distances of 100m or more from the river. Similarly, Black Box health is generally poor with significant death, except around the TWW lagoon and at the inland fringes of the vegetated floodplain areas.

The vegetation is considered to be Possibly Groundwater Dependent as described in the previous section. It is observed that vegetation health appears to be correlated with the presence of a freshwater lens. The available data, although sparse, supports a working hypothesis that tree health will decline where the groundwater salinity exceeds a threshold salinity value. Roberts and Marsden suggest threshold salinities based on data from the Murrumbidgee, however similar data is not readily available for the Lower Murray, and the threshold where the salinity is exceeded for a decade or more may be lower than where it exceeds it for only one year.

Condition Trajectory

Most of the River Red Gum (including the remnant River Red Gums along the river side) and Black Box communities are in poor condition and without any effective management plan, vegetation health in the study site will continue to decline. Therefore, the correlation between the presence of "fresh" groundwater beneath the wastewater lagoon and good tree health in this area supports the idea that allowing these communities to get access to freshwater supports tree growth. Therefore, maintaining the freshwater lens is also a crucial part in maintaining/improving vegetation health in the Target Area.

If the irrigated disposal area around the TWW lagoon was decommissioned, the freshwater lens beneath the wastewater lagoon will be eventually replaced by the saline groundwater causing the current healthy vegetation communities there to gradually degrade in condition. Therefore, without any strategies emplaced, the vegetation condition at Johnstons and Chaffey Bend is expected to be worsen with time.

The previous watering program and the 2011/2012 floods have shown only a small beneficial response in vegetation health at the Johnstons and Chaffey Bend Target Area compared to other places (Louise Searle pers comm.). Where natural flooding and environmental watering has occurred in these WMU's, both Black Box and occasionally Red Gum show evidence of epicormic growth. However, the longevity of any beneficial effect of the flooding/watering is still ambiguous. These effects are constrained to the inundated areas. The current trajectory, particularly for Black Box, is continued decline in condition.

Continued decline in vegetation health, and changes in vegetation community to more salt tolerant species, will lead to the decline in valuable habitat and associated environmental, social and economic values.

Water Related Threats

Groundwater Inputs

Changes in groundwater conditions are expected to be a major controller of long-term trends in vegetation health.

Leakage from the irrigated disposal area around the TWW Lagoon

Decreases in the volumes of water irrigated on the adjacent land of the TWW lagoon will decrease the recharge of fresher water into the aquifers. This may have an adverse effect on vegetation health in the long term. The timing and magnitude of the impact are not possible to predict with current information.

SIS decommissioning

The Mildura-Merbein SIS construction commenced in the late 1970s targeting the interception of saline groundwater from the Monoman and Parilla Sand Aquifers. However, recently, all of the production bores have been decommissioned except two bores located on the western area of the Chaffey floodplain.

The changes in operation of the Mildura-Merbein SIS has resulted in a reduction of groundwater pumping from the Chaffey floodplain, north of the WWTP lagoon. The pumping has been progressively reduced over the last two decades. An immediate effect is that groundwater water levels will be higher immediately adjacent the borefield, resulting in less leakage from the lagoon on that northern side. Conversely, the bores are no longer extracting the fresher lagoon recharge, so the lagoon leakage may extend further northward into the floodplain. Groundwater analysis is required to identify if the "freshwater lens" will increase or decrease in extent northward from the lagoon under future SIS operations.

The Buronga SIS may be contributing to beneficial outcomes, through pulling the freshwater lens across the floodplain toward the borefield.

Reductions in Irrigation Drainage

Changes in irrigation volumes and improvements in irrigation efficiency will have reduced the groundwater flux into the floodplains, and the salinity is likely to be trending slowly downward in the incoming groundwater due to progressive dilution of the saline native groundwater by fresher irrigation recharge.

The correlation of good vegetation health around the TWW lagoon with better quality groundwater suggests that improvements in groundwater quality coming into the floodplain should support improvement of floodplain vegetation health. Some additional work needs to be undertaken to derive salinity thresholds that might be expected to affect improvements in vegetation health, and the time lag between changes in groundwater salinity and improvements in vegetation health.

Caravan Park watering

Watering for amenity improvement at the Caravan Park will have provided fresh water in the unsaturated zone, and may have contributed to emplacement of a (thin) layer of fresh groundwater. Remnant River Red Gum health may be better where this irrigation occurs.

Altered River flow regimes

The altered surface water regime also poses threats for the Johnstons and Chaffey Bend WMUs. Flow modification of the Murray River system has occurred to satisfy the increasing demand in navigation, irrigation and urban water use. River regulations cause changes in the frequency, magnitude and duration of flows and flood events. The construction of locks, weirs and dams has altered the wetting and drying periods on river frontage and associated wetlands, consequently causing significant impacts on River Red Gum, Black Box communities, fish populations, nutrient cycling, riparian vegetation, biodiversity, water quality, channel shape and form and aquatic macrophytes (MCMA 2006).

Levees, such as along the Ranfurly Way, can also alienate large areas of the floodplain affecting flood conveyance, flood storage, water quality and bank erosion (NRE, 1998). This can lead to the decline or death of existing native vegetation and reduced regeneration (MCMA 2003).

Poor Surface Water Quality

The key water quality parameters include salinity, turbidity, pH, toxicity, temperature and dissolved oxygen. These parameters are controlled by catchment activities and adjacent land use. Low water quality can have an adverse effect on river capacity for productive use (MCMA 2006b).

Management Objectives

Management Goal

Emplace and maintain sufficient fresh groundwater and soil moisture to support healthy ecosystems across the floodplains.

The goal considers the values the wetland supports and the potential threats that need to be managed. This includes consideration of the values the wetland has historically supported and the likely values it could support into the future.

Ecological Objectives

Ecological objectives are the desired ecological outcomes from the site. In line with the Victorian Waterway Management Strategy, the ecological objectives are based on the key values of the area.

These ecological objectives are as follows:

Table 7: Ecological objectives for the study site

Ecological objective	Justification (value based)
Preserve remnant old Red Gums along the riverfront and promote recruitment of Red Gums (i.e. germination and retention of seedlings)	Remnant old Red Gums along the riverfront at Johnstons and Chaffey Bend WMUs are in severely degraded conditions. Their health is essential to maintaining a functioning floodplain and river system. They provide breeding habitat for waterbirds and hollow-dependent species.
Preserve extent and support health of Black Box across the floodplains and promote recruitment of Black Box (i.e. germination and retention of seedlings)	Black Box communities at Johnstons and Chaffey Bend floodplains are under stress. In a healthy state, these species provide habitat and food for listed species found in the Target Area.

The outlined ecological objectives mainly focus on the health of umbrella species like River Red Gum and Black Box to meet habitat and feeding requirements of many of the fauna species listed in the Target Area. Attainment of these ecological objectives is likely to have wider benefits for the study site and possible result can be:

- Improving understorey productivity
- Providing and improving habitat, feeding and nesting opportunities for listed fauna species

As more is learnt about the area and the response to the watering events are monitored the principle of adaptive management along with availability of environmental water sources will guide future requirements and management actions at this and other environmental watering sites.

Hydrological Objectives

Surface water inundation has been observed to be less effective at improving the health of vegetation communities in the Johnstons and Chaffey Bend WMUs compared to at other WMUs. The most likely reason is differences in antecedent groundwater and soil salinity prior to watering. The key focus of hydrogeological strategies is to include groundwater management (i.e. maintain, enhance and/or create the freshwater lens within the study area) in the regimes employed to achieve the ecological objectives. However, in the absence of a concept design for groundwater management strategies, the hydrological objectives based on surface water inundation were developed to guide future environmental watering activities in the interim at this study area.

River Red Gums require flooding every two to four years with durations of two to four months. Flood events may differ and a variance in ponding duration around the mean requirement for this species is encouraged. Although the timing of flooding is not vital for River Red Gum, spring-summer flooding encourages greater growth. Timing is also important for understorey plant communities. The critical interval for Red Gum Woodlands is five to seven years to prevent deterioration of tree condition (Roberts & Marston 2011).

Black Box stands occur in all the Woodland EVC's within the Target Area. They require flooding to occur every three to seven years with duration of two to six months. This species can tolerate shorter flood durations but plant vigour will suffer. Although timing of flood events is not critical for Black Box it will affect understorey and other woodland biota. Black Box trees may survive prolonged periods of 12 to 16 years with no flooding but tree health will suffer and woodlands will become dysfunctional (Roberts & Marston 2011).

In terms of regeneration of River Red Gum trees, a flood recession occuring during spring or later is likely to provide soil moisture conditions that promote seed germination and early growth (Roberts & Marston 2011). Subsequent flooding to

recharge soil moisture in the same year or the year following germination is likely to aid seedling establishment (Roberts & Marston 2011). Any follow up fooding should be shallow and avoid completely inundating seedlings that are less than a year old. Roberts and Marston (2011) recommend flood duration of four to six weeks for seedlings however; longer periods of indundation may be tolerated depeding on the age of seedlings and the depth of inundation. Soil moisture recharge following germination may also be achieved naturally through high rainfall events or via floodplain irrigation.

Black Box regeneration is generally throught to be episodic often following major flood events or wet winters (Roberts & Marston 2011). However, floods may not be the only contributing factor to episodic recruitment and it is advisable to determine what other factors may also be limiting recruitment. In terms of regeneration of Black Box trees, a flood recession during spring or summer can provide favourable soil moisture conditions for seed germination. Provision of additional soil moisture is recommended to improve seedling establishment during the first or second year following germination, particularly if the summer is very hot (Roberts & Marston 2011). Black box seedlings are not very tolerant of saturated conditions and additional soil moisture may be provided through high rainfall events, short, shallow inundation events or floodplain irrigation.

Table 8: Hydrological objectives for Johnstons and Chaffey Bend WMUs

Ecological objective	Water management area	Hydrological objectives												
		Mean frequency of events (number per 10 years)			Tolerable interval between events (years)		Duration of ponding (months)			Preferred timing of inflows	Target supply level (m)	Volume to fill to TSL[1] (ML)	Volume to maintain at TS (ML)	Total volume per event (ML)
		Min	Opt	Max	Min	Max	Min	Opt	Max					
Preserve remnant old River Red Gums along the riverfront	floodplain	3	4	5	1	3	3	5	6	Spring to Summer				
Improve health of River Red Gum communities		4	8	10	0	2	3	5	6	Spring to Summer				
Promote recruitment of River Red Gums										Flood recession during spring or later				
Preserve extent of Black Box communities		1	2	3	3	10	2	4	6	Spring to Summer				
Improve health of Black Box communities		2	3	5	1	7	2	4	6	Spring to Summer				
Promote recruitment of Black Box										Flood recession during spring or summer				

In the absence of a concept design for groundwater management, an interim surface watering regime has been derived using the ecological and hydrological objectives described above in Table 7 & 8. A surface watering regime is provided for optimal conditions as well as the maximum and minimum tolerable watering scenarios.

Minimum watering regime

Inundate River Red Gum communites along the river three times in ten years with a maximum interval of three years between events. Extend the inundation area to include Black Box communities at least once every seven years. Allow ponding on the floodplain for at least three months to maintain River Red Gum and Black Box communities. Timing is not critical in terms of mature tree health but flooding during spring may produce best results.

Optimal watering regime

Inundate River Red Gum communites along the river every one to three years with a maximum interval of three years between events. Extend the inundation area to include Black Box communities three times in ten years with a maximum interval of seven years between events. Allow ponding on the floodplain for five months to improve River Red Gum and Black Box communities. Timing is not critical in terms of mature tree health but flooding during spring may produce best results.

Maximum watering regime

Inundate the River Red Gum communites along the river every one to three years with a minimum interval of six months between events. Extend the inundation area to include Black Box communities every three years with a minimum interval of one year between events. Allow ponding for up to 6 months (variability in flood duration is encouraged) to improve River Red Gum and Black Box communities. Timing is not critical in terms of mature tree health but flooding during spring may produce best results.

Managing Risks to Achieving Objectives

Threat	Likelihood	Consequence	Risk – H, M, L (likelihood x consequence)	Management Measure	Residual Risk
WWTP decommissioned	Low	Major (Long-term erosion of freshwater lens)	High	Maintain irrigation around the lagoon using other sources of water	Low
Surface water delivery does not achieve the ecological objectives	High	Major (Ecological outcomes not achieved)	High	Monitor soil and groundwater response to watering Develop alternate water delivery mechanism	Medium (Results inform optimum watering regime and alternate management strategies)
Groundwater management creates in-river salinity impacts	High	Minor (Downstream ecological and non-ecological outcomes compromised)	Low	Manage quantum and timing of salt inputs	Low
Groundwater management does not achieve the ecological objectives	Moderate	Major (Ecological outcomes not achieved)	High	Document evidence of Groundwater-Vegetation health linkages	Medium (Data gaps in available evidence)
Environmental watering program affects cultural values	Moderate	Major (Cultural heritage site degraded)	High	Full cultural heritage management plan	Low

Management options

Constraints

Environmental water deliveryto Chaffey Bend has some issues including getting water to higher reaches, surface water restricting access to a popular walking areas, and difficulty stopping vehicles going off track (Kelly 2006). Also, surface watering program did not show much improvement on the vegetation health at Johnstons and Chaffey Bend compared to other places. Data availability regarding groundwater and unsaturated zone salinity restricts the ability to be more precise about the causality of vegetation decline, the poor vegetation response to surface water inundation, and the probability of success of groundwater manipulation.

Infrastructure or complementary works recommendations

The current management options for Johnstons and Chaffey Bend include:

- Implementation of the surface water inundation program in 14/15, but with monitoring to collect valuable data on the salinity of surface water, the soils and the groundwater. The monitoring should also be undertaken, in parallel, at a site where the vegetation response is strong and positive to surface water inundation. This data would be used to test our model of how groundwater and surface water manipulation affect vegetation response. The proposed surface water inundation area is presented in Figure 12. A baseline and operational monitoring strategy will be required.

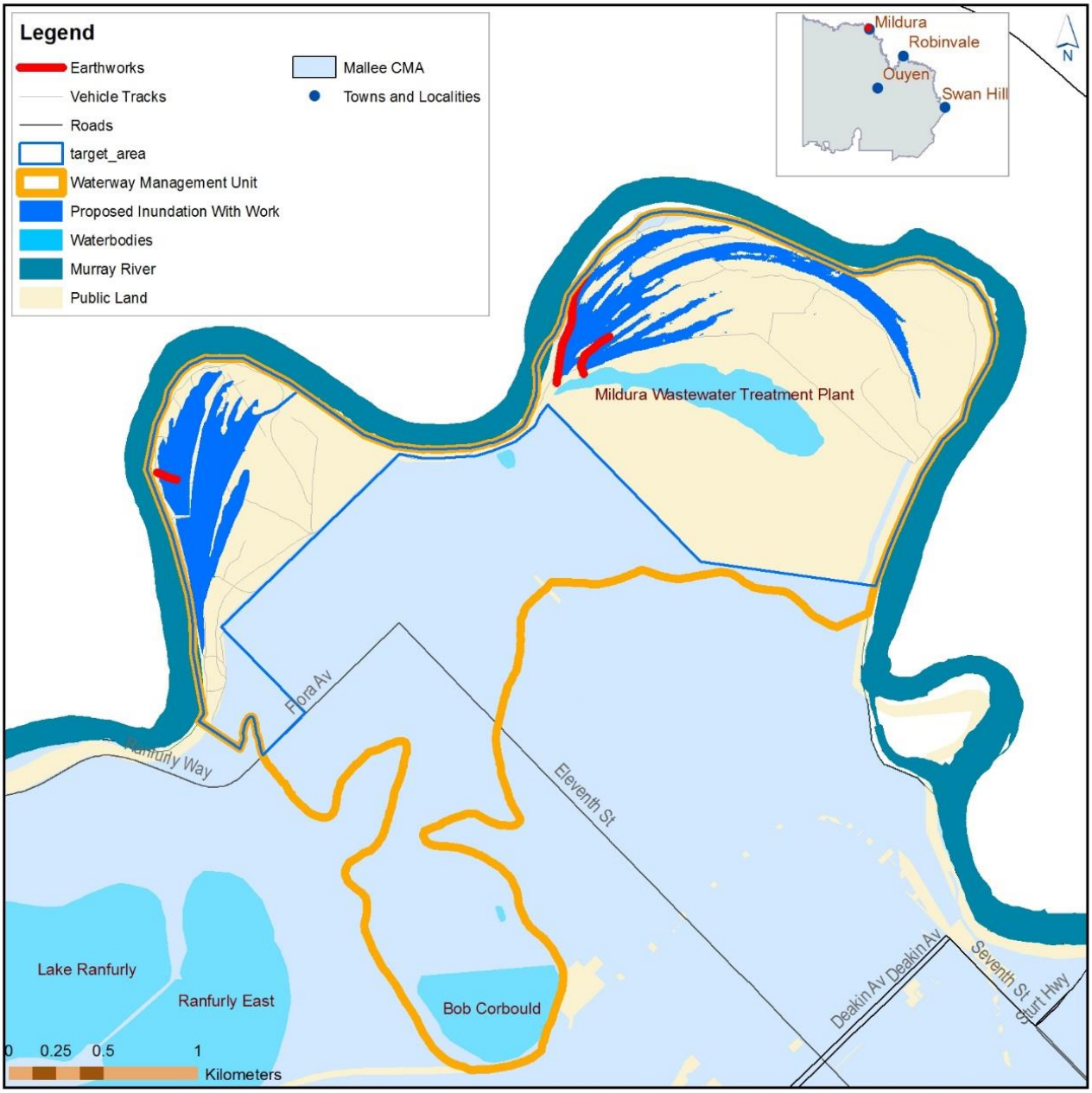


Figure 12: Proposed inundation area with earth work

Consultation

This EWMP was developed in collaboration with key stakeholders, namely Parks Victoria, the Department of Environment and Primary Industries and Lower Murray Water. The information gathered about ecological values and hydrogeological processes present at Johnstons and Chaffey Bend through the development of the EWMP will form the basis of consultation with Traditional Owner groups, and local community in the near future and values amended as required.

Table 9 Consultation Process for development of Spence's Bend WMU Environmental Water Management Plan

Meeting Date	Stakeholders	Details
Ongoing	Parks Victoria	Discussion to introduce concept of plan
2 April 2014	Lower Murray Water	Discussion regarding operation of Mildura Wastewater Treatment Plant
TBA	Traditional Owner groups	Presentation and review of draft plan

Knowledge Gaps and Recommendations

Vegetation health has not responded well to surface water inundation, and the vegetation is classified as being of “High potential for groundwater interaction”. It seems likely that soil and groundwater salinities are hostile to good tree health. If the vegetation communities are groundwater dependent, and where groundwater and soil conditions are hostile to long-term sustenance of the existing vegetation or recruitment of new vegetation, new models of water management for ecological benefit need to be developed that go beyond surface water inundation. Groundwater management needs to be considered.

The floodplains contain a complex hydrogeological system, and their groundwater salinity regimes are influenced by many factors including SIS bore operation, TWW and irrigation drainage as well as the more traditional rainfall and surface water inundation drivers.

It is likely that the existing TWW freshwater lens will be modified by changes to the SIS pumping regime, which may also affect the condition of floodplain vegetation. The extent and thickness of the lens may also be influenced by the management of the wastewater lagoon, the frequency of flood events, and changes in the water table elevation and salinity. This relationship between the surface water inputs, the groundwater factors and vegetation health have not yet been adequately analysed or documented at this site, which remains a major knowledge gap.

It is highly recommended that a thorough concept design for groundwater management options be developed. In the meantime, implementing trials to evaluate the effectiveness of direct groundwater manipulation for preservation of remnant old Red Gums is suggested. It is recommended that concept designs be developed to identify the most appropriate methodologies and locations. Key methodologies include surface water irrigation to provide fresh soil moisture, groundwater injection to emplace fresh groundwater and groundwater pumping to induce bank recharge of fresh groundwater and manipulate the extent of freshwater lenses. Each of the following trials will need baseline and operation monitoring strategies, and investment in infrastructure. Indicative trial locations are shown on Figure 13:

- A watering trial, in conjunction with the Caravan Park on Chaffey Bend, to evaluate the efficacy of sprinkler irrigation of mature trees.
- A trial to inject mains water into the aquifer, in conjunction with the Caravan Park or Council on Chaffey Bend, to emplace fresh water direct to the aquifer to support the remaining mature Red Gums lining the river bank.
- An extraction trial on Johnstons Bend, where irrigation in NSW appears to have developed a shallow lens that may already extend beneath the River into Victoria.

The trails may need new infrastructure, including one injection and one extraction bore. The extraction bore could be run using solar power, with discharge of pumped water back to the River (with appropriate approvals). The monitoring strategy will need to be carefully designed to maximise learnings from the trial without being overly costly.

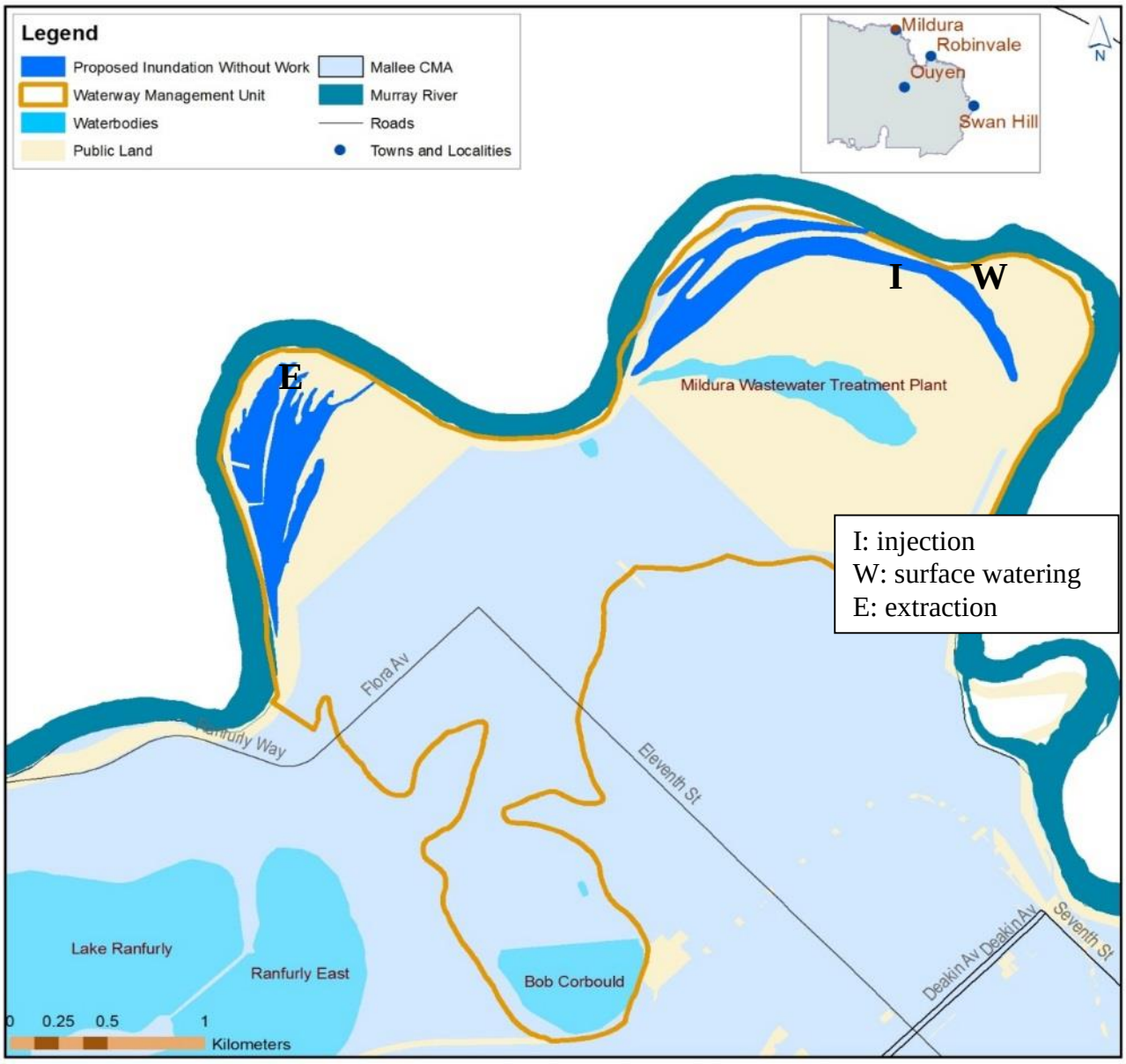


Figure 13: Trial locations for the management options for Johnstons and Chaffey Bend

Also, cultural heritage values of the target area have not been thoroughly investigated. Therefore, a full cultural heritage survey and management plan is highly recommended to provide better understanding of cultural values of the area and adequately estimate the associated risk of cultural heritage site degradation due to environmental watering program.

References

Australian Water Environments (2009) *Sunraysia Salt Interception Hydrogeology Design Inputs*. Prepared for Goulburn Murray Water, November 2009.

Australian Water Environments (2011) *River Murray Floodplain Salt Mobilisation and Salinity Exceedances at Morgan*. Final report for Murray-Darling Basin Authority, January 2011.

Australian Water Environments (2012) *2012 NanoTEM Survey, Waikerie to Murtho and Mildura/Merbein.* Prepared for SA Water and Goulburn-Murray Water.

Australian Water Environments (2013) *Mildura-Merbein SIS Refurbishment Anticipated Benefits from Phase 1*. Prepared for Goulburn Murray Water, February 2013.

AWE/SKM (2003) *Review and Optimisation of SIS in the Sunraysia Region.* Prepared for the Department of Land and Water Conservation.

Brown CM & Stephenson AE (1991) *Geology of the Murray Basin, southeastern Australia*. Bureau of Mineral Resources, Canberra.

CSIRO & SKM (2012) *Atlas of Groundwater Dependent Ecosystems (GDE Atlas), Phase 2 Task 5 Report: Identifying and mapping GDEs.* National Water Commission.

Cunningham SC, Griffioen P, White M and Nally RM (2010) *Mapping The Condition Of River Red Gum (Eucalyptus camaldulensis Dehnh.) and Black Box (Eucalyptus largiflorens F.Muell.) Stands In The living Murray Icon Sites.* Murray-Darling Basin Authority.

Cunningham SC, Nally RM, White M, Read J, Baker PJ, Thomson J and Griffioen P (2006) *Mapping The Current Condition Of River Red Gum (Eucalyptus camaldulensis Dehnh.) Stands Along The Victorian Murray River Floodplain.* Northern Victorian Catchment Management Authorities and the Department of Sustainability and Environment.

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

GHD (2012) *Mildura-Merbein Salt Interception Scheme Phase 1 Result from a targeted search for Hooded Scaly-foot*, Goulburn-Murray Water Australian Water Environments.

Kelly P. (2006) *Donate Water program June 2006, Delivering water to Stressed and Dying Red Gums.* Department of Sustainability and Environment, Victoria, July 2006.

MCMA (2003) *Robinvale to Merbein Murray River Frontage Action Plan.* Mallee Catchment Management Authority, Victoria, February 2003.

MCMA (2006a) *Mallee Wetland Strategy 2006-2011*. Mallee Catchment Management Authority, Victoria.

MCMA (2006b) *Mallee River Health Strategy*. Mallee Catchment Management Authority, Victoria.

MCMA (2006c) *Mallee CMA Flood Response Action Plan*, Mallee Catchment Management Authority, December 2006.

MCMA (2007) *Final Report Investigation of Water Management Options for the River Murray – Robinvale to Wallpolla Island.* Mallee Catchment Management Authority, Victoria, April 2007.

MCMA (2012) *Mallee Ecology Manual 2012*, Mallee Catchment Management Authority, Victoria.

MCMA (2012) *Mallee Regional Catchment Strategy 2012-18.* Public Consultation Draft.

MCMA (2014) *Murrumbidgee Junction Waterway Management Unit Environmental Water Management Plan*. Mallee Catchment Authority, Victoria, January 2014.

MCMA (2014) *Seasonal Watering Proposal Murray River Wetlands 2014-15*. Mallee Catchment Authority, Victoria, May 2014.

MDBA (2003) *Preliminary Investigation into Observed River Red Gum Decline along the River Murray below Euston.* Technical Report 03/03, March 2003.

Roberts J. & Marston f. (2011) *Water regime for Wetland and Floodplain Plants: A Source Book for the Murray-Darling Basin.* National Water Commission, Canberra, ACT.

Rogers K & Ralph TJ (2011) *Floodplain wetland biota in the Murray Darling Basin.* CSIRO Publishing, Collingwood.

SKM (2000) *Flood Data Transfer Project*. Department of Natural Resources and Environment, June 2000.

Sluiter IRK (2006) *Lower Murray Water Biodiversity Asset Register Review.* Ogyris Ecological Research Report No.2006/01.

Sunraysia Environmental (2008) *River Red Gum Emergency Watering May 2004 to December 2006.* Department of Sustainability and Environment, Victoria, August 2008.

Sunraysia Environmental (2010) *Murray Riverfront Reserves Management Plan 2011 to 2015.* Mildura Rural City Council, Victoria, December 2010.

Abbreviations and Acronyms

CMAs	Catchment Management Authorities
DES	Department of Sustainability and Environment
DNRE	Department of Natural Resources and Environment
EA	Ecological Associates
EPBC	Environment Protection and Biodiversity Conservation Act
EVC	Ecological Vegetation Class
EWMP	Environmental Water Management Plan
EWR	Environmental Water Reserve
FFG	Flora Fauna Guarantee Act
GDE	Groundwater Dependent Ecosystem
MCMA	Mallee Catchment Management Authority
MDBA	Murray Darling Basin Authority (formally Murray Darling Basin Commission, MDBC)
MRCC	Mildura Rural City Council
SIS	Salt Interception Scheme
TWW	Treated Wastewater
VEWH	Victorian Environmental Water Holder
WMU	Waterway Management Unit
WWTP	Wastewater Treatment Plan

Appendix 1 – Fauna Species List

Taxon ID	Scientific Name	Common Name	DSE Advisory List	Discipline	Count of Sightings
10100	*Microcarbo melanoleucos*	Little Pied Cormorant		Terrestrial fauna	22
10700	*Cracticus nigrogularis*	Pied Butcherbird		Terrestrial fauna	15
10030	*Geopelia striata*	Peaceful Dove		Terrestrial fauna	21
10034	*Phaps chalcoptera*	Common Bronzewing		Terrestrial fauna	6
10043	*Ocyphaps lophotes*	Crested Pigeon		Terrestrial fauna	30
10046	*Gallirallus philippensis*	Buff-banded Rail		Terrestrial fauna	1
10049	*Porzana fluminea*	Australian Spotted Crake		Terrestrial fauna	13
10051	*Porzana tabuensis*	Spotless Crake		Terrestrial fauna	2
10055	*Gallinula ventralis*	Black-tailed Native-hen		Terrestrial fauna	31
10056	*Gallinula tenebrosa*	Dusky Moorhen		Terrestrial fauna	12
10058	*Porphyrio porphyrio*	Purple Swamphen		Terrestrial fauna	23
10059	*Fulica atra*	Eurasian Coot		Terrestrial fauna	33
10060	*Podiceps cristatus*	Great Crested Grebe		Terrestrial fauna	3
10061	*Tachybaptus novaehollandiae*	Australasian Grebe		Terrestrial fauna	21
10062	*Poliocephalus poliocephalus*	Hoary-headed Grebe		Terrestrial fauna	26
10096	*Phalacrocorax carbo*	Great Cormorant		Terrestrial fauna	29
10097	*Phalacrocorax sulcirostris*	Little Black Cormorant		Terrestrial fauna	24
10099	*Phalacrocorax varius*	Pied Cormorant	Near threatened	Terrestrial fauna	5
10101	*Anhinga novaehollandiae*	Darter		Terrestrial fauna	14
10106	*Pelecanus conspicillatus*	Australian Pelican		Terrestrial fauna	55
10110	*Chlidonias hybridus javanicus*	Whiskered Tern	Near threatened	Terrestrial fauna	1
10112	*Hydroprogne caspia*	Caspian Tern	Near threatened	Terrestrial fauna	13
10125	*Chroicocephalus novaehollandiae*	Silver Gull		Terrestrial fauna	58
10132	*Erythrogonys cinctus*	Red-kneed Dotterel		Terrestrial fauna	32
10133	*Vanellus miles*	Masked Lapwing		Terrestrial fauna	58
10140	*Charadrius bicinctus*	Double-banded Plover		Terrestrial fauna	1
10143	*Charadrius ruficapillus*	Red-capped Plover		Terrestrial fauna	4
10144	*Elseyornis melanops*	Black-fronted Dotterel		Terrestrial fauna	29
10147	*Cladorhynchus leucocephalus*	Banded Stilt		Terrestrial fauna	3
10148	*Recurvirostra novaehollandiae*	Red-necked Avocet		Terrestrial fauna	16
10154	*Tringa glareola*	Wood Sandpiper	Vulnerable	Terrestrial fauna	1
10158	*Tringa nebularia*	Common Greenshank	Vulnerable	Terrestrial fauna	6
10159	*Tringa stagnatilis*	Marsh Sandpiper	Vulnerable	Terrestrial fauna	19
10161	*Calidris ferruginea*	Curlew Sandpiper	Endangered	Terrestrial fauna	4
10162	*Calidris ruficollis*	Red-necked Stint		Terrestrial fauna	2
10163	*Calidris acuminata*	Sharp-tailed Sandpiper		Terrestrial fauna	11
10174	*Burhinus grallarius*	Bush Stone-curlew	Endangered	Terrestrial fauna	1
10179	*Threskiornis molucca*	Australian White Ibis		Terrestrial fauna	52

10180	*Threskiornis spinicollis*	Straw-necked Ibis		Terrestrial fauna	17
10181	*Platalea regia*	Royal Spoonbill	Near threatened	Terrestrial fauna	2
10182	*Platalea flavipes*	Yellow-billed Spoonbill		Terrestrial fauna	32
10186	*Ardea intermedia*	Intermediate Egret	Endangered	Terrestrial fauna	3
10187	*Ardea modesta*	Eastern Great Egret	Vulnerable	Terrestrial fauna	14
10188	*Egretta novaehollandiae*	White-faced Heron		Terrestrial fauna	46
10189	*Ardea pacifica*	White-necked Heron		Terrestrial fauna	5
10192	*Nycticorax caledonicus hillii*	Nankeen Night Heron	Near threatened	Terrestrial fauna	1
10197	*Botaurus poiciloptilus*	Australasian Bittern	Endangered	Terrestrial fauna	1
10202	*Chenonetta jubata*	Australian Wood Duck		Terrestrial fauna	41
10203	*Cygnus atratus*	Black Swan		Terrestrial fauna	66
10207	*Tadorna tadornoides*	Australian Shelduck		Terrestrial fauna	85
10208	*Anas superciliosa*	Pacific Black Duck		Terrestrial fauna	77
10210	*Anas castanea*	Chestnut Teal		Terrestrial fauna	16
10211	*Anas gracilis*	Grey Teal		Terrestrial fauna	83
10212	*Anas rhynchotis*	Australasian Shoveler	Vulnerable	Terrestrial fauna	45
10213	*Malacorhynchus membranaceus*	Pink-eared Duck		Terrestrial fauna	38
10214	*Stictonetta naevosa*	Freckled Duck	Endangered	Terrestrial fauna	12
10215	*Aythya australis*	Hardhead	Vulnerable	Terrestrial fauna	32
10216	*Oxyura australis*	Blue-billed Duck	Endangered	Terrestrial fauna	17
10217	*Biziura lobata*	Musk Duck	Vulnerable	Terrestrial fauna	15
10219	*Circus approximans*	Swamp Harrier		Terrestrial fauna	6
10221	*Accipiter fasciatus*	Brown Goshawk		Terrestrial fauna	2
10222	*Accipiter cirrhocephalus*	Collared Sparrowhawk		Terrestrial fauna	3
10224	*Aquila audax*	Wedge-tailed Eagle		Terrestrial fauna	1
10225	*Hieraaetus morphnoides*	Little Eagle		Terrestrial fauna	7
10228	*Haliastur sphenurus*	Whistling Kite		Terrestrial fauna	32
10229	*Milvus migrans*	Black Kite		Terrestrial fauna	29
10232	*Elanus axillaris*	Black-shouldered Kite		Terrestrial fauna	1
10235	*Falco longipennis*	Australian Hobby		Terrestrial fauna	2
10236	*Falco hypoleucos*	Grey Falcon	Endangered	Terrestrial fauna	1
10237	*Falco peregrinus*	Peregrine Falcon		Terrestrial fauna	2
10240	*Falco cenchroides*	Nankeen Kestrel		Terrestrial fauna	5
10242	*Ninox novaeseelandiae*	Southern Boobook		Terrestrial fauna	1
10258	*Glossopsitta concinna*	Musk Lorikeet		Terrestrial fauna	1
10269	*Cacatua galerita*	Sulphur-crested Cockatoo		Terrestrial fauna	2
10270	*Lophocroa leadbeateri*	Major Mitchell's Cockatoo	Vulnerable	Terrestrial fauna	1
10271	*Cacatua sanguinea*	Little Corella		Terrestrial fauna	5
10273	*Eolophus roseicapilla*	Galah		Terrestrial fauna	15
10274	*Nymphicus hollandicus*	Cockatiel		Terrestrial fauna	2
10282	*Platycercus elegans*	Crimson Rosella		Terrestrial fauna	9
10288	*Platycercus eximius*	Eastern Rosella		Terrestrial fauna	1
10295	*Psephotus haematonotus*	Red-rumped Parrot		Terrestrial fauna	29

10296	*Psephotus varius*	Mulga Parrot		Terrestrial fauna	1
10297	*Northiella haematogaster*	Blue Bonnet		Terrestrial fauna	1
10319	*Alcedo azurea*	Azure Kingfisher	Near threatened	Terrestrial fauna	1
10322	*Dacelo novaeguineae*	Laughing Kookaburra		Terrestrial fauna	22
10325	*Todiramphus pyrropygia pyrropygia*	Red-backed Kingfisher	Near threatened	Terrestrial fauna	1
10326	*Todiramphus sanctus*	Sacred Kingfisher		Terrestrial fauna	8
10329	*Merops ornatus*	Rainbow Bee-eater		Terrestrial fauna	9
10337	*Cuculus pallidus*	Pallid Cuckoo		Terrestrial fauna	6
10338	*Cacomantis flabelliformis*	Fan-tailed Cuckoo		Terrestrial fauna	2
10342	*Chrysococcyx basalis*	Horsfield's Bronze-Cuckoo		Terrestrial fauna	3
10357	*Petrochelidon neoxena*	Welcome Swallow		Terrestrial fauna	21
10359	*Petrochelidon nigricans*	Tree Martin		Terrestrial fauna	5
10360	*Petrochelidon ariel*	Fairy Martin		Terrestrial fauna	2
10361	*Rhipidura albiscarpa*	Grey Fantail		Terrestrial fauna	8
10364	*Rhipidura leucophrys*	Willie Wagtail		Terrestrial fauna	31
10369	*Myiagra inquieta*	Restless Flycatcher		Terrestrial fauna	1
10381	*Petroica goodenovii*	Red-capped Robin		Terrestrial fauna	9
10398	*Pachycephala pectoralis*	Golden Whistler		Terrestrial fauna	1
10401	*Pachycephala rufiventris*	Rufous Whistler		Terrestrial fauna	15
10408	*Colluricincla harmonica*	Grey Shrike-thrush		Terrestrial fauna	22
10415	*Grallina cyanoleuca*	Magpie-lark		Terrestrial fauna	34
10424	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike		Terrestrial fauna	10
10430	*Lalage sueurii*	White-winged Triller		Terrestrial fauna	1
10445	*Pomatostomus superciliosus*	White-browed Babbler		Terrestrial fauna	6
10446	*Pomatostomus ruficeps*	Chestnut-crowned Babbler		Terrestrial fauna	1
10448	*Epthianura albifrons*	White-fronted Chat		Terrestrial fauna	10
10463	*Gerygone fusca*	Western Gerygone		Terrestrial fauna	1
10465	*Smicrornis brevirostris*	Weebill		Terrestrial fauna	16
10466	*Aphelocephala leucopsis*	Southern Whiteface		Terrestrial fauna	1
10471	*Acanthiza nana*	Yellow Thornbill		Terrestrial fauna	11
10481	*Acanthiza uropygialis*	Chestnut-rumped Thornbill		Terrestrial fauna	10
10486	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill		Terrestrial fauna	9
10508	*Cincloramphus cruralis*	Brown Songlark		Terrestrial fauna	1
10522	*Megalurus gramineus*	Little Grassbird		Terrestrial fauna	18
10524	*Acrocephalus stentoreus*	Clamorous Reed Warbler		Terrestrial fauna	9
10529	*Malurus cyaneus*	Superb Fairy-wren		Terrestrial fauna	24
10535	*Malurus leucopterus*	White-winged Fairy-wren		Terrestrial fauna	6
10536	*Malurus lamberti*	Variegated Fairy-wren		Terrestrial fauna	13
10543	*Artamus leucorynchus*	White-breasted Woodswallow		Terrestrial fauna	2
10547	*Artamus cyanopterus*	Dusky Woodswallow		Terrestrial fauna	2

10561	*Climacteris affinis*	White-browed Treecreeper	Vulnerable	Terrestrial fauna	2
10564	*Dicaeum hirundinaceum*	Mistletoebird		Terrestrial fauna	8
10565	*Pardalotus punctatus*	Spotted Pardalote		Terrestrial fauna	4
10574	*Zosterops lateralis*	Silvereye		Terrestrial fauna	5
10583	*Melithreptus brevirostris*	Brown-headed Honeyeater		Terrestrial fauna	1
10585	*Plectorhyncha lanceolata*	Striped Honeyeater		Terrestrial fauna	1
10594	*Phylidonyris albifrons*	White-fronted Honeyeater		Terrestrial fauna	2
10608	*Lichenostomus virescens*	Singing Honeyeater		Terrestrial fauna	6
10623	*Lichenostomus plumulus*	Grey-fronted Honeyeater	Vulnerable	Terrestrial fauna	1
10625	*Lichenostomus penicillatus*	White-plumed Honeyeater		Terrestrial fauna	31
10634	*Manorina melanocephala*	Noisy Miner		Terrestrial fauna	29
10635	*Manorina flavigula*	Yellow-throated Miner		Terrestrial fauna	1
10638	*Anthochaera carunculata*	Red Wattlebird		Terrestrial fauna	23
10640	*Acanthagenys rufogularis*	Spiny-cheeked Honeyeater		Terrestrial fauna	11
10641	*Entomyzon cyanotis*	Blue-faced Honeyeater		Terrestrial fauna	10
10645	*Philemon corniculatus*	Noisy Friarbird		Terrestrial fauna	1
10646	*Philemon citreogularis*	Little Friarbird		Terrestrial fauna	6
10653	*Taeniopygia guttata*	Zebra Finch		Terrestrial fauna	4
10675	*Struthidea cinerea*	Apostlebird		Terrestrial fauna	3
10691	*Corvus bennetti*	Little Crow		Terrestrial fauna	6
10693	*Corcorax melanorhamphos*	White-winged Chough		Terrestrial fauna	10
10697	*Strepera versicolor*	Grey Currawong		Terrestrial fauna	1
10702	*Cracticus torquatus*	Grey Butcherbird		Terrestrial fauna	3
10705	*Gymnorhina tibicen*	Australian Magpie		Terrestrial fauna	19
10930	*Corvus coronoides*	Australian Raven		Terrestrial fauna	21
10934	*Philomachus pugnax*	Ruff		Terrestrial fauna	1
10948	*Anas platyrhynchos*	Northern Mallard		Terrestrial fauna	1
10954	*Corvus mellori*	Little Raven		Terrestrial fauna	2
10957	*Columba livia*	Rock Dove		Terrestrial fauna	1
10976	*Pardalotus striatus*	Striated Pardalote		Terrestrial fauna	14
10977	*Ardea ibis*	Cattle Egret		Terrestrial fauna	1
10991	*Turdus merula*	Common Blackbird		Terrestrial fauna	7
10995	*Passer domesticus*	House Sparrow		Terrestrial fauna	10
10999	*Sturnus vulgaris*	Common Starling		Terrestrial fauna	22
11113	*Trichosurus vulpecula*	Common Brushtail Possum		Terrestrial fauna	1
11510	*Oryctolagus cuniculus*	European Rabbit		Terrestrial fauna	1
12092	*Gehyra variegata*	Tree Dtella		Terrestrial fauna	3
12105	*Heteronotia binoei*	Bynoe's Gecko		Terrestrial fauna	1
12204	*Pogona vitticeps*	Central Bearded Dragon		Terrestrial fauna	1
12271	*Varanus gouldii*	Sand Goanna		Terrestrial fauna	1
12283	*Varanus varius*	Lace Monitor	Endangered	Terrestrial fauna	2
12326	*Cryptoblepharus pannosus*	Carnaby's Wall Skink		Terrestrial fauna	1

12583	*Tiliqua rugosa*	Stumpy-tailed Lizard		Terrestrial fauna	3
12655	*Demansia psammophis*	Yellow-faced Whip Snake	Near threatened	Terrestrial fauna	1
13058	*Limnodynastes dumerilii*	Southern Bullfrog (ssp. unknown)		Terrestrial fauna, Aquatic fauna, Aquatic invertebrates	1
13059	*Limnodynastes fletcheri*	Barking Marsh Frog		Terrestrial fauna, Aquatic fauna, Aquatic invertebrates	5
13063	*Limnodynastes tasmaniensis*	Spotted Marsh Frog (race unknown)		Terrestrial fauna, Aquatic fauna, Aquatic invertebrates	8
13131	*Crinia parinsignifera*	Plains Froglet		Terrestrial fauna, Aquatic fauna, Aquatic invertebrates	6
13204	*Litoria peronii*	Peron's Tree Frog		Terrestrial fauna, Aquatic fauna, Aquatic invertebrates	2
13207	*Litoria raniformis*	Growling Grass Frog	Endangered	Terrestrial fauna, Aquatic fauna, Aquatic invertebrates	1
60284	*Platycercus elegans flaveolus*	Yellow Rosella		Terrestrial fauna	11
60291	*Barnardius zonarius barnardi*	Mallee Ringneck		Terrestrial fauna	1
62969	*Morelia spilota metcalfei*	Carpet Python	Endangered	Terrestrial fauna	1
528553	*Limosa limosa*	Black-tailed Godwit	Vulnerable	Terrestrial fauna	7
528555	*Himantopus himantopus*	Black-winged Stilt		Terrestrial fauna	46
528558	*Anser anser*	Domestic Goose		Terrestrial fauna	1

Appendix 2 – Bird Survey at Mildura WWTP

birdlife

P.O. Box 1722 Mildura VIC 3502

Mildura Sewerage Pond Survey

Survey Date 12/02/2012

Weather:	*Fine, light breeze*	**Time Start:** *8:00 AM*	**Time Finish:** *Noon*
Observers:	*P Bartels, K & M Rix, A & S Hawtin, B & E Williams, L & R Jeffers, A Blakney S Fisher, H Devilee, A Taylor, R Lonsdale, R Wells, Aileen ?, Laura ?*	**Recorded by:**	*P Bartels*

Stubble Quail				Australian Spotted Crake				White-winged Triller			
Brown Quail	6			Spotless Crake				Rufous Whistler	2		
Freckled Duck	2			Black-tailed Native-hen	1			Grey Shrike-thrush	1		
Black Swan	164			Dusky Moorhen	12			White-breasted Woodswallow			
Australian Shelduck	125			Eurasian Coot	230			Masked Woodswallow			
Australian Wood Duck	2			Black-winged Stilt	70			White-browed Woodswallow	2		
Pink-eared Duck	640			Red-necked Avocet				Black-faced Woodswallow			
Australasian Shoveler	132			Black-fronted Dotterel	42			Dusky Woodswallow	2		
Grey Teal	2700			Red-kneed Dotterel				Grey Butcherbird			
Chestnut Teal	3			Masked Lapwing	34			Pied Butcherbird	2		
Pacific Black Duck	45			Common Greenshank				Australian Magpie	7		
Hardhead	115			Marsh Sandpiper				Grey Fantail			
Blue-billed Duck				Wood Sandpiper	2			Willie Wagtail	14		
Australasian Grebe	35			Sharp-tailed Sandpiper	2			Australian Raven	3		
Hoary-headed Grebe	55			Curlew Sandpiper				Little Raven	9		
Great Crested Grebe				Little Button-quail				Restless Flycatcher	1		
Rock Dove				Caspian Tern				Magpie-lark	26		
Common Bronzewing	2			Whiskered Tern				White-winged Chough	3		
Crested Pigeon	16			Silver Gull				Jacky Winter			
Peaceful Dove	10			Galah	3			Red-capped Robin			
Tawny Frogmouth				Little Corella				Australian Reed-Warbler	1		
Australasian Darter	28	Br		Cockatiel				Little Grassbird			
Little Pied Cormorant	5			Crimson Rosella	2			Rufous Songlark			
Great Cormorant	18			Red-rumped Parrot	26			Brown Songlark			
Little Black Cormorant	6			Horsfield's Bronze-Cuckoo				Silvereye			
Pied Cormorant				Pallid Cuckoo				Welcome Swallow	18		
Australian Pelican				Fan-tailed Cuckoo				Fairy Martin			
White-necked Heron				Barking Owl				Tree Martin	6		
Eastern Great Egret				Southern Boobook				Common Blackbird			
Intermediate Egret				Laughing Kookaburra	2			Common Starling	20		
Cattle Egret				Sacred Kingfisher	1			Mistletoebird			
White-faced Heron	2			Rainbow Bee-eater	6			Zebra Finch			
Little Egret				Superb Fairy-wren	5			House Sparrow			
Nankeen Night-Heron				Splendid Fairy-wren							
Australian White Ibis	26			Variegated Fairy-wren							
Straw-necked Ibis	7			Weebill	9						
Royal Spoonbill				Western Gerygone							
Yellow-billed Spoonbill	2			Yellow Thornbill							
Black-shouldered Kite	1			Yellow-rumped Thornbill				*Black Falcon*	1		
White-bellied Sea-Eagle				Striated Pardalote	3			*Brown Treecreeper*	2		
Whistling Kite	8			Singing Honeyeater							
Black Kite	29			White-plumed Honeyeater	26						
Brown Goshawk				White-fronted Honeyeater							
Collared Sparrowhawk				Noisy Miner	31						
Swamp Harrier				Spiny-cheeked Honeyeater							
Wedge-tailed Eagle				Red Wattlebird	24						
Little Eagle				White-fronted Chat							
Nankeen Kestrel				Blue-faced Honeyeater	1						
Australian Hobby				Little Friarbird	18						
Peregrine Falcon				Striped Honeyeater							
Purple Swamphen	1			White-browed Babbler	4						
Buff-banded Rail				Varied Sittella							
Baillon's Crake				Black-faced Cuckoo-shrike	4						

Sunraysia Branch of the Bird Observers Club — PO Box 1722 Mildura Vic 3502

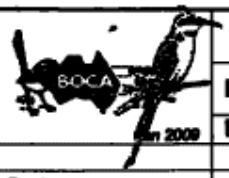
Mildura Sewerage Pond Survey (Count)

Survey Date(s) 5.:.11.:2011

Weather : Warm, northerly breeze, some cloud(high) Times : Start 8·00 Finish 11·15

Observers : 13 SunBOCA/Birdlife Mildura members Recorded By : Rae Jeffers

Aust. Grebe	17			Eurasian Coot	600			Yell-rump Th/bill			
Hoary-head Grebe	6			Black-winged White-headed Stilt	6			Yellow Thornbill			
Gr.Crested Grebe	2			Red-necked Avocet				Weebill			
Australian Pelican				Masked Lapwing	6			Western Gerygone			
Little Bl. Cormorant	1			Red-kneed Dotterel	16	2j		White-fronted Chat			
Great Cormorant	17			Bl-fronted Dotterel	10			Varied Sittella			
Pied Cormorant				Marsh Sandpiper				Mistletoebird			
L. Pied Cormorant	1			Common Greenshank				Striated Pardalote	✓		
Darter	7	2j	nest	Wood Sandpiper				Silvereye	✓		
White-necked Heron	2			Sharp-tailed S/piper				Singing Honeyeater			
Great Egret	7			Curlew Sandpiper				White-plumed H/E	✓		
Intermediate Egret				Silver Gull				Little Friarbird	✓		
White-faced Heron	1			Caspian Tern				White-fronted H/E			
Little Egret	1			Whiskered Tern	4			Striped Honeyeater			
Cattle Egret				Rock Dove				Blue-faced H/E			
Nankeen Night-Heron	4	3j		Common Bronzewing				Noisy Miner	✓		
Aust.White Ibis	20			Crested Pigeon				Spiny-cheeked H/E			
Straw-necked Ibis				Peaceful Dove	✓			Red Wattlebird			
Royal Spoonbill				Galah				Magpie-lark	✓		
Y-billed Spoonbill	2			Little Corella				White-winged Chough	✓		
Black Swan	17			Cockatiel				Wh-breast W/swallow	✓		
Freckled Duck	120			Yellow Rosella	✓			Masked Woodswallow			
Australian Shelduck	2	4j		Red-rumped Parrot	✓			Wh-brow W/swallow			
Australian Wood Duck				Pallid Cuckoo				Bl-face W/swallow			
Grey Teal	700			Fan-tailed Cuckoo				Dusky Woodswallow	✓		
Chestnut Teal				H/field Br Cuckoo				Grey Butcherbird			
Pacific Black Duck	48			Barking Owl				Pied Butcherbird			
Aust Shoveller	45			Southern Boobook				Australian Magpie			
Pink-eared Duck	30			Tawny Frogmouth				Australian Raven			
Hardhead	65			Laughing Kookaburra				Little Raven	✓		
Blue-billed Duck	1			Sacred Kingfisher	✓			Common Starling			
Bl-shouldered Kite				Rainbow Bee-eater	✓			House Sparrow			
Black Kite	6			Welcome Swallow				Zebra Finch			
Whistling Kite	3			Tree Martin							
Wh-bellied Sea-Eagle				Fairy Martin							
Swamp Harrier				Bl-faced C/shrike	✓			Brown-headed Honeyeater	✓		
Brown Goshawk				White-winged Triller							
Collared Sparrowhawk				Common Blackbird							
Wedge-tailed Eagle				Aust. Reed-Warbler	✓			Bar-shouldered Dove	✓		
Little Eagle				Little Grassbird	✓						
Nankeen Kestrel				Brown Songlark	✓						
Australian Hobby				Rufous Songlark							
Peregrine Falcon				Willie Wagtail	✓			63 species			
Stubble Quail				Grey Fantail							
Brown Quail	1			Restless Flycatcher	✓						
Little Button-quail				Jacky Winter							
Buff-banded Rail				Red-capped Robin							
Baillon's Crake	2			Rufous Whistler	✓						
Aust. Spotted Crake	2			Grey Shrike-thrush							
Spotless Crake				White-browed Babbler							
Purple Swamphen	3			Superb Fairy-wren	✓						
Dusky Moorhen	12			Splendid Fairy-wren							
Bl-tailed Native-hen	90			Variegated F/wren	✓						



BIRD OBSERVATION & CONSERVATION AUSTRALIA - SUNRAYSIA BRANCH
SHORT BIRD LIST

Date: 29.11.09 | Weather: Fine, some cloud. | Observers: B. MacMillan, G. Kerridge, J. Greatz

Locality: Mildura Sewerage Pond | Notes

Emu					Red-kneed Dotterel					Little Friarbird					
Musk Duck					Banded Lapwing					Striped Honeyeater					
Freckled Duck	14				Masked Lapwing	2				White-browed Babbler					
Black Swan	75				Common Greenshank					Chestnut-crowned Babbler					
Australian Shelduck	10				Marsh Sandpiper					Chestnut Quail-thrush					
Australian Wood Duck	40				Red-necked Stint					Varied Sittella					
Pink-eared Duck	82				Sharp-tailed Sandpiper					Black-faced Cuckoo-shrike					
Australasian Shoveler	4				Curlew Sandpiper					White-winged Triller					
Grey Teal	132				Caspian Tern					Crested Shrike-tit					
Chestnut Teal					Whiskered Tern					Red-lored Whistler					
Pacific Black Duck	20				Silver Gull					Gilbert's Whistler					
Hardhead	171				Major Mitchell's Cockatoo					Golden Whistler					
Blue-billed Duck	42				Galah					Rufous Whistler					
Australasian Grebe	15				Little Corella					Grey Shrike-thrush					
Hoary-headed Grebe	2				Sulphur-crested Cockatoo					Crested Bellbird					
Great Crested Grebe					Cockatiel					White-breasted Woodswallow					
Rock Dove					Rainbow Lorikeet					Masked Woodswallow					
Common Bronzewing	2				Regent Parrot					White-browed Woodswallow					
Crested Pigeon					Crimson Rosella					Black-faced Woodswallow					
Peaceful Dove					Australian Ringneck					Dusky Woodswallow					
Tawny Frogmouth					Blue Bonnet					Grey Butcherbird					
Australian Owlet-nightjar					Red-rumped Parrot					Pied Butcherbird					
Australasian Darter	2				Mulga Parrot					Australian Magpie					
Little Pied Cormorant	5				Budgeriger					Grey Currawong					
Great Cormorant	2				Blue-winged Parrot					Grey Fantail					
Little Black Cormorant	6				Horsfield's Bronze-Cuckoo					Willie Wagtail					
Pied Cormorant					Pallid Cuckoo					Australian Raven					
Australian Pelican	21				Southern Boobook					Little Raven					
White-necked Heron					Laughing Kookaburra					Little Crow					
Eastern Great Egret					Red-backed Kingfisher					Restless Flycatcher					
White-faced Heron	2				Sacred Kingfisher					Magpie-lark	3				
Glossy Ibis	3				Rainbow Bee-eater					White-winged Chough					
Australian White Ibis	45				Brown Treecreeper					Apostlebird					
Straw-necked Ibis	2				Superb Fairy-wren					Jacky Winter					
Royal Spoonbill					Splendid Fairy-wren					Red-capped Robin					
Yellow-billed Spoonbill	3				White-winged Fairy-wren					Hooded Robin					
Black-shouldered Kite					Variegated Fairy-wren					Australian Reed-Warbler	2				
White-bellied Sea-Eagle					Weebill					Little Grassbird					
Whistling Kite	2				Yellow Thornbill					Rufous Songlark					
Black Kite	3				Yellow-rumped Thornbill					Brown Songlark					
Brown Goshawk					Chestnut-rumped Thornbill					Silvereye					
Collared Sparrowhawk					Inland Thornbill					White-backed Swallow					
Swamp Harrier					Southern Whiteface					Welcome Swallow	56				
Wedge-tailed Eagle					Spotted Pardalote					Fairy Martin					
Little Eagle					Striated Pardalote					Tree Martin					
Nankeen Kestrel					Pied Honeyeater					Common Blackbird					
Brown Falcon					Singing Honeyeater					Common Starling					
Australian Hobby					White-eared Honeyeater					Mistletoebird					
Peregrine Falcon					Yellow-plumed Honeyeater					Zebra Finch					
Purple Swamphen	2				White-plumed Honeyeater					House Sparrow					
Australian Spotted Crake					White-fronted Honeyeater					Australasian Pipit					
Black-tailed Native-hen	1				Noisy Miner					European Goldfinch					
Dusky Moorhen					Yellow-throated Miner										
Eurasian Coot	710				Spiny-cheeked Honeyeater										
Black-winged Stilt	8				Red Wattlebird										
Red-necked Avocet					Orange Chat										
Banded Stilt					White-fronted Chat										
Red-capped Plover					Brown-headed Honeyeater										
Black-fronted Dotterel					Blue-faced Honeyeater										

Sunraysia Branch of the Bird Observers Club   PO Box 1722 Mildura Vic 3502

Mildura Sewerage Pond Survey (Count)   Survey Date(s) 8/2/09

Weather : Fine Warm	Len & Mae Jeffers, Geoff Dunans, Pauline Bartels, Judith Petslund	Times : Start 8.00am Finish 12.00am
Observers : Alec : Sharon Hawtin, Ken : Marilyn Aix	Doug : Betty Woods, George Kilbridge	Recorded By : Pauline Bartels

Aust. Grebe ✓	6			Eurasian Coot ✓	140			Yell-rump Th/bill			
Hoary-head Grebe ✓	25			White-headed Stilt ✓	111			Yellow Thornbill			
Gr.Crested Grebe				Red-necked Avocet ✓	1			Weebill ✓	5		
Australian Pelican ✓	12			Masked Lapwing ✓	33			Western Gerygone			
Little Bl. Cormorant ✓	1			Red-kneed Dotterel ✓	19			White-fronted Chat ✓	3		
Great Cormorant ✓	3			Bl-fronted Dotterel ✓	13			Varied Sittella			
Pied Cormorant				Marsh Sandpiper ✓	8			Mistletoebird			
L. Pied Cormorant ✓	3			Common Greenshank				Striated Pardalote ✓	5		
Darter ✓	1			Wood Sandpiper				Silvereye			
White-necked Heron				Sharp-tailed S/piper ✓	1			Singing Honeyeater ✓	1		
Great Egret ✓	1			Curlew Sandpiper				White-plumed H/E ✓	2		
Intermediate Egret				Silver Gull ✓	53			Little Friarbird ✓	1		
White-faced Heron ✓	4			Caspian Tern ✓	2			White-fronted H/E			
Little Egret				Whiskered Tern				Striped Honeyeater			
Cattle Egret				Rock Dove				Blue-faced H/E			
Nankeen Night-Heron				Common Bronzewing				Noisy Miner ✓	2		
Aust.White Ibis ✓	37			Crested Pigeon				Spiny-cheeked H/E ✓	5		
Straw-necked Ibis ✓	8			Peaceful Dove ✓	3			Red Wattlebird ✓	7		
Royal Spoonbill				Galah				Magpie-lark ✓	14		
Y-billed Spoonbill ✓	7			Little Corella				White-winged Chough ✓	6		
Black Swan ✓	48			Cockatiel				Wh-breast W/swallow			
Freckled Duck ✓	2			Yellow Rosella				Masked Woodswallow			
Australian Shelduck ✓	65			Red-rumped Parrot ✓	7			Wh-brow W/swallow			
Australian Wood Duck ✓	7			Pallid Cuckoo				Bl-face W/swallow			
Grey Teal ✓	1600			Fan-tailed Cuckoo				Dusky Woodswallow			
Chestnut Teal				H/field Br Cuckoo				Grey Butcherbird ✓	1		
Pacific Black Duck ✓	6			Barking Owl				Pied Butcherbird			
Aust Shoveller ✓	31			Southern Boobook				Australian Magpie			
Pink-eared Duck ✓	110			Tawny Frogmouth				Australian Raven ✓	1		
Hardhead ✓	135			Laughing Kookaburra ✓	1			Little Raven ✓	22		
Blue-billed Duck				Sacred Kingfisher				Common Starling			
Bl-shouldered Kite				Rainbow Bee-eater ✓	6			House Sparrow			
Black Kite ✓	1			Welcome Swallow				Zebra Finch			
Whistling Kite ✓	2			Tree Martin ✓	64			✓			
Wh-bellied Sea-Eagle				Fairy Martin				Treecreeper Brown	2		
Swamp Harrier ✓	2			Bl-faced C/shrike ✓	1						
Brown Goshawk				White-winged Triller							
Collared Sparrowhawk ✓	1			Common Blackbird							
Wedge-tailed Eagle				Aust. Reed-Warbler							
Little Eagle				Little Grassbird							
Nankeen Kestrel				Brown Songlark							
Australian Hobby				Rufous Songlark							
Peregrine Falcon				Willie Wagtail ✓	2						
Stubble Quail				Grey Fantail							
Brown Quail				Restless Flycatcher							
Little Button-quail				Jacky Winter							
Buff-banded Rail				Red-capped Robin							
Baillon's Crake				Rufous Whistler							
Aust. Spotted Crake				Grey Shrike-thrush ✓	2						
Spotless Crake				White-browed Babbler ✓	5			TOTAL			
Purple Swamphen				Superb Fairy-wren ✓	7			SPECIES	61		
Dusky Moorhen				Splendid Fairy-wren							
Bl-tailed Native-hen				Variegated F/wren ✓	6						

Sunraysia Branch of the Bird Observers Club — PO Box 1722 Mildura Vic 3502

Mildura Sewerage Pond Survey (Count)

Survey Date(s) 18/11/08

Weather: OVERCAST MILD — Observers: PAULINE BARTELS, GEORGE HERRIDGE, JUDITH FISHER, BILL EVELYN WILLIAMS, RICHARD WELLS — Times: Start 8-30 Finish 12-30 — Recorded By: PAULINE BARTELS

Aust. Grebe ✓	44			Eurasian Coot ✓	780			Yell-rump Th/bill					
Hoary-head Grebe				White-headed Stilt ✓	11			Yellow Thornbill					
Gr.Crested Grebe				Red-necked Avocet				Weebill					
Australian Pelican ✓	48			Masked Lapwing ✓	9			Western Gerygone					
Little Bl. Cormorant ✓	4			Red-kneed Dotterel ✓	15			White-fronted Chat					
Great Cormorant				Bl-fronted Dotterel ✓	6			Varied Sittella					
Pied Cormorant ✓	1			Marsh Sandpiper				Mistletoebird					
L. Pied Cormorant ✓	5			Common Greenshank				Striated Pardalote					
Darter				Wood Sandpiper				Silvereye					
White-necked Heron				Sharp-tailed S/piper				Singing Honeyeater					
Great Egret				Curlew Sandpiper				White-plumed H/E ✓	12				
Intermediate Egret				Silver Gull ✓	10			Little Friarbird ✓	2				
White-faced Heron ✓	6			Caspian Tern				White-fronted H/E					
Little Egret				Whiskered Tern ✓	2			Striped Honeyeater					
Cattle Egret				Rock Dove				Blue-faced H/E					
Nankeen Night-Heron				Common Bronzewing				Noisy Miner ✓	6				
Aust.White Ibis ✓	17			Crested Pigeon ✓	20			Spiny-cheeked H/E ✓	1				
Straw-necked Ibis ✓	5			Peaceful Dove ✓	4			Red Wattlebird					
Royal Spoonbill				Galah ✓	2			Magpie-lark ✓	6				
Y-billed Spoonbill ✓	2			Little Corella ✓	4			White-winged Chough ✓	15				
Black Swan ✓	50			Cockatiel ✓	2			Wh-breast W/swallow ✓	4				
Freckled Duck ✓	16			Yellow Rosella ✓	8			Masked Woodswallow					
Australian Shelduck ✓	25			Red-rumped Parrot ✓	20			Wh-brow W/swallow					
Australian Wood Duck	7			Pallid Cuckoo				Bl-face W/swallow					
Grey Teal ✓	800			Fan-tailed Cuckoo				Dusky Woodswallow ✓	2				
Chestnut Teal				H/field Br Cuckoo				Grey Butcherbird					
Pacific Black Duck ✓	10			Barking Owl				Pied Butcherbird ✓	1				
Aust Shovellor ✓	22			Southern Boobook				Australian Magpie ✓	1				
Pink-eared Duck ✓	250			Tawny Frogmouth				Australian Raven					
Hardhead ✓	30			Laughing Kookaburra ✓	3			Little Raven ✓	6				
Blue-billed Duck				Sacred Kingfisher				Common S-arling ✓	4				
Bl-shouldered Kite				Rainbow Bee-eater				House Sparrow					
Black Kite ✓	8			Welcome Swallow				Zebra Finch					
Whistling Kite ✓	2			Tree Martin ✓	100								
Wh-bellied Sea-Eagle				Fairy Martin				TREECREEPER AUSTA	8				
Swamp Harrier ✓	1			Bl-faced C/shrike ✓	4			KINGFISHER RED BACK	1				
Brown Goshawk				White-winged Triller	1								
Collared Sparrowhawk				Common Blackbird									
Wedge-tailed Eagle ✓	1			Aust. Reed-Warbler ✓	3								
Little Eagle				Little Grassbird									
Nankeen Kestrel				Brown Songlark									
Australian Hobby				Rufous Songlark									
Peregrine Falcon				Willie Wagtail ✓	6								
Stubble Quail				Grey Fantail									
Brown Quail				Restless Flycatcher ✓	2								
Little Button-quail				Jacky Winter				TOTAL					
Buff-banded Rail				Red-capped Robin				SPECIES	61				
Baillon's Crake				Rufous Whistler									
Aust. Spotted Crake				Grey Shrike-thrush ✓	2								
Spotless Crake				White-browed Babbler ✓	6								
Purple Swamphen				Superb Fairy-wren ✓	6								
Dusky Moorhen				Splendid Fairy-wren									
Bl-tailed Native-hen ✓	35			Variegated F/wren									

Mildura Sewerage Pond Survey (Count)

Survey Date(s) 29/1/17

Weather : HOT

Times : Start 8.30 **Finish** 10-50 a.m

Observers : PAULINE BARTELS BILL WILLIAMS GEORGE KERRIDGE

Recorded By : PAULINE BARTELS

Aust. Grebe	✓	32			Eurasian Coot	✓	1100			Yell-rump Th/bill			
Hoary-head Grebe	✓	30			White-headed Stilt	✓	20			Yellow Thornbill			
Gr.Crested Grebe					Red-necked Avocet					Weebill			
Australian Pelican	✓	52			Masked Lapwing	✓	50			Western Gerygone			
Little Bl. Cormorant	✓	2			Red-kneed Dotterel					White-fronted Chat			
Great Cormorant					Bl-fronted Dotterel	✓	6			Varied Sittella			
Pied Cormorant	✓	1			Marsh Sandpiper					Mistletoebird			
L. Pied Cormorant					Common Greenshank					Striated Pardalote	✓		
Darter	✓	1			Wood Sandpiper					Silvereye			
White-necked Heron					Sharp-tailed S/piper					Singing Honeyeater			
Great Egret					Curlew Sandpiper					White-plumed H/E	✓		
Intermediate Egret					Silver Gull					Little Friarbird			
White-faced Heron	✓	4			Caspian Tern					White-fronted H/E			
Little Egret					Whiskered Tern					Striped Honeyeater			
Cattle Egret					Rock Dove					Blue-faced H/E			
Nankeen Night-Heron					Common Bronzewing					Noisy Miner	✓		
Aust.White Ibis	✓	9			Crested Pigeon	✓				Spiny-cheeked H/E			
Straw-necked Ibis					Peaceful Dove	✓				Red Wattlebird			
Royal Spoonbill					Galah	✓				Magpie-lark	✓		
Y-billed Spoonbill	✓	2			Little Corella					White-winged Chough	✓		
Black Swan	✓	110			Cockatiel					Wh-breast W/swallow			
Freckled Duck	✓	16	34		Yellow Rosella	✓				Masked Woodswallow			
Australian Shelduck	✓	180			Red-rumped Parrot	✓				Wh-brow W/swallow			
Australian Wood Duck	✓	2			Pallid Cuckoo					Bl-face W/swallow			
Grey Teal	✓	3000			Fan-tailed Cuckoo					Dusky Woodswallow	✓		
Chestnut Teal					H/field Br Cuckoo					Grey Butcherbird			
Pacific Black Duck	✓	8			Barking Owl					Pied Butcherbird	✓		
Aust Shoveller	✓	45			Southern Boobook					Australian Magpie	✓		
Pink-eared Duck	✓	200			Tawny Frogmouth					Australian Raven	✓		
Hardhead	✓	55			Laughing Kookaburra					Little Raven			
Blue-billed Duck	✓	4			Sacred Kingfisher					Common S-arling	✓		
Bl-shouldered Kite					Rainbow Bee-eater					House Sparrow			
Black Kite	✓	1			Welcome Swallow					Zebra Finch	✓		
Whistling Kite	✓	2-1			Tree Martin								
Wh-bellied Sea-Eagle					Fairy Martin								
Swamp Harrier					Bl-faced C/shrike	✓	1			GLOSSY IBIS	✓	6-1	
Brown Goshawk					White-winged Triller					MUSK DOCK	✓	1	
Collared Sparrowhawk					Common Blackbird								
Wedge-tailed Eagle					Aust. Reed-Warbler	✓	5						
Little Eagle					Little Grassbird	✓	1						
Nankeen Kestrel					Brown Songlark								
Australian Hobby					Rufous Songlark								
Peregrine Falcon					Willie Wagtail	✓							
Stubble Quail					Grey Fantail	✓							
Brown Quail					Restless Flycatcher								
Little Button-quail					Jacky Winter								
Buff-banded Rail					Red-capped Robin								
Baillon's Crake					Rufous Whistler								
Aust. Spotted Crake					Grey Shrike-thrush								
Spotless Crake					White-browed Babbler								
Purple Swamphen					Superb Fairy-wren	✓							
Dusky Moorhen					Splendid Fairy-wren								
Bl-tailed Native-hen		6			Variegated F/wren	✓							

Mildura Sewerage Pond Survey (Count)

Survey Date(s) 12.11.95

Weather : FINE COOL WINDY THEN WARM

Times : Start 8-30 **Finish** 11-30 am

Observers : RIGHT MEMBERS SUNBOC (PTO)

Recorded By : ALEC HAWTIN

Aust. Grebe	9			Eurasian Coot	900	+		Yell-rump Th/bill			
Hoary-head Grebe	50	+		White-headed Stilt	12			Yellow Thornbill			
Gr.Crested Grebe				Red-necked Avocet				Weebill			
Australian Pelican	12			Masked Lapwing				Western Gerygone			
Little Bl. Cormorant				Red-kneed Dotterel				White-fronted Chat			
Great Cormorant	2			Bl-fronted Dotterel				Varied Sittella			
Pied Cormorant				Marsh Sandpiper				Mistletoebird			
L. Pied Cormorant				Common Greenshank				Striated Pardalote			
Darter	1			Wood Sandpiper				Silvereye			
White-necked Heron				Sharp-tailed S/piper				Singing Honeyeater			
Great Egret				Curlew Sandpiper				White-plumed H/E	11		
Intermediate Egret				Silver Gull	33			Little Friarbird	13		
White-faced Heron	4			Caspian Tern				White-fronted H/E			
Little Egret				Whiskered Tern				Striped Honeyeater			
Cattle Egret				Rock Dove	15			Blue-faced H/E			
Nankeen Night-Heron				Common Bronzewing				Noisy Miner	12		
Aust.White Ibis	16			Crested Pigeon	2			Spiny-cheeked H/E			
Straw-necked Ibis				Peaceful Dove	6			Red Wattlebird	2		
Royal Spoonbill				Galah				Magpie-lark	11		
Y-billed Spoonbill				Little Corella				White-winged Chough	3		
Black Swan	69	+		Cockatiel				Wh-breast W/swallow	2		
Freckled Duck	55	+		Yellow Rosella	5			Masked Woodswallow			
Australian Shelduck	30	+		Red-rumped Parrot	36	+		Wh-brow W/swallow			
Australian Wood Duck	26	+		Pallid Cuckoo				Bl-face W/swallow			
Grey Teal	50	+		Fan-tailed Cuckoo				Dusky Woodswallow	6	17	
Chestnut Teal				H/field Br Cuckoo				Grey Butcherbird			
Pacific Black Duck	35	+		Barking Owl				Pied Butcherbird	1		
Aust Shoveller	27	+		Southern Boobook				Australian Magpie			
Pink-eared Duck	159	+		Tawny Frogmouth				Australian Raven	3		
Hardhead	164	+		Laughing Kookaburra				Little Raven			
Blue-billed Duck	6			Sacred Kingfisher				Common Starling			
Bl-shouldered Kite				Rainbow Bee-eater				House Sparrow			
Black Kite	1			Welcome Swallow	2			Zebra Finch			
Whistling Kite	14			Tree Martin							
Wh-bellied Sea-Eagle				Fairy Martin							
Swamp Harrier	2			Bl-faced C/shrike	1			MUSK DUCK	3		
Brown Goshawk				White-winged Triller				APOSTLE BIRD	1		
Collared Sparrowhawk				Common Blackbird							
Wedge-tailed Eagle				Aust. Reed-Warbler	4						
Little Eagle				Little Grassbird	3						
Nankeen Kestrel				Brown Songlark							
Australian Hobby				Rufous Songlark							
Peregrine Falcon				Willie Wagtail	6			48 Species			
Stubble Quail				Grey Fantail							
Brown Quail				Restless Flycatcher							
Little Button-quail				Jacky Winter							
Buff-banded Rail				Red-capped Robin							
Baillon's Crake				Rufous Whistler							
Aust. Spotted Crake				Grey Shrike-thrush							
Spotless Crake				White-browed Babbler	5						
Purple Swamphen				Superb Fairy-wren	15	+					
Dusky Moorhen				Splendid Fairy-wren							
Bl-tailed Native-hen	4			Variegated F/wren							

BIRDS COUNTED APPROX 1800 +
ESTIMATED ANOTHER 2000 VARIOUS WATER FOWL

Appendix 3 – Flora Species List

Taxon ID	Scientific Name	Common Name	DSE Advisory List	Discipline	Count of Sightings
501200	*Eremophila divaricata subsp. divaricata*	Spreading Emu-bush	Rare	Flora	3
500070	*Acacia oswaldii*	Umbrella Wattle		Flora	2
500101	*Acacia victoriae subsp. victoriae*	Bramble Wattle	Rare	Flora	1
500286	*Asphodelus fistulosus*	Onion Weed		Flora	2
500317	*Atriplex eardleyae*	Small Saltbush		Flora	2
500320	*Atriplex lindleyi subsp. inflata*	Corky Saltbush		Flora	5
500321	*Atriplex leptocarpa*	Slender-fruit Saltbush		Flora	2
500325	*Atriplex nummularia*	Old-man Saltbush		Flora	3
500332	*Atriplex semibaccata*	Berry Saltbush		Flora	1
500335	*Atriplex suberecta*	Sprawling Saltbush		Flora	1
500336	*Atriplex vesicaria*	Bladder Saltbush		Flora	1
500349	*Osteocarpum acropterum var. deminutum*	Babbagia		Flora	5
500452	*Brachyscome ciliaris*	Variable Daisy		Flora	1
500494	*Brassica tournefortii*	Mediterranean Turnip		Flora	1
500504	*Bromus rubens*	Red Brome		Flora	1
500556	*Calandrinia volubilis*	Twining Purslane	Rare	Flora	2
500578	*Callitris gracilis*	Slender Cypress-pine		Flora	1
500618	*Lepidium draba*	Hoary Cress		Flora	5
500656	*Carpobrotus modestus*	Inland Pigface		Flora	1
500658	*Carrichtera annua*	Ward's Weed		Flora	1
500698	*Centaurea melitensis*	Malta Thistle		Flora	1
500740	*Chenopodium curvispicatum*	Cottony Saltbush		Flora	1
500747	*Chenopodium nitrariaceum*	Nitre Goosefoot		Flora	2
500759	*Chondrilla juncea*	Skeleton Weed		Flora	1
500859	*Crassula colorata*	Dense Crassula		Flora	1
500866	*Crassula sieberiana s.l.*	Sieber Crassula		Flora	2
500961	*Rytidosperma caespitosum*	Common Wallaby-grass		Flora	2
500986	*Datura stramonium*	Common Thorn-apple		Flora	1
501073	*Disphyma crassifolium subsp. clavellatum*	Rounded Noon-flower		Flora	6
501074	*Dissocarpus biflorus var. biflorus*	Twin-flower Saltbush	Rare	Flora	2
501075	*Dissocarpus paradoxus*	Hard-head Saltbush		Flora	1
501123	*Echium plantagineum*	Paterson's Curse		Flora	1
501133	*Einadia nutans*	Nodding Saltbush		Flora	1
501156	*Enchylaena tomentosa var. tomentosa*	Ruby Saltbush		Flora	6
501157	*Enneapogon avenaceus*	Common Bottle-washers		Flora	1
501160	*Enteropogon acicularis*	Spider Grass		Flora	5
501190	*Eragrostis lacunaria*	Purple Love-grass	Vulnerable	Flora	1
501195	*Eragrostis setifolia*	Bristly Love-grass	Vulnerable	Flora	1

501258	*Eucalyptus camaldulensis*	River Red-Gum		Flora	1
501292	*Eucalyptus largiflorens*	Black Box		Flora	4
501374	*Frankenia serpyllifolia*	Bristly Sea-heath	Rare	Flora	1
501564	*Hakea leucoptera subsp. leucoptera*	Silver Needlewood		Flora	4
501588	*Tecticornia halocnemoides subsp. halocnemoides*	Grey Glasswort		Flora	1
501592	*Tecticornia pergranulata*	Blackseed Glasswort		Flora	2
501593	*Tecticornia pruinosa*	Bluish Glasswort		Flora	1
501601	*Hedypnois rhagadioloides*	Hedypnois		Flora	1
501701	*Hordeum leporinum*	Barley-grass		Flora	2
501747	*Hypochaeris glabra*	Smooth Cat's-ear		Flora	1
502078	*Lycium ferocissimum*	African Box-thorn		Flora	8
502096	*Maireana aphylla*	Leafless Bluebush	Poorly known	Flora	2
502097	*Maireana appressa*	Grey Bluebush		Flora	5
502098	*Maireana brevifolia*	Short-leaf Bluebush		Flora	3
502109	*Maireana pyramidata*	Sago Bush		Flora	8
502116	*Maireana turbinata*	Satiny Bluebush		Flora	3
502117	*Malacocera tricornis*	Goat Head	Rare	Flora	3
502138	*Medicago minima*	Little Medic		Flora	2
502174	*Mesembryanthemum crystallinum*	Common Ice-plant		Flora	1
502175	*Mesembryanthemum nodiflorum*	Small Ice-plant		Flora	6
502199	*Minuria cunninghamii*	Bush Minuria	Rare	Flora	2
502230	*Duma horrida subsp. horrida*	Spiny Lignum	Rare	Flora	1
502272	*Nicotiana glauca*	Tree Tobacco		Flora	1
502278	*Nitraria billardierei*	Nitre-bush		Flora	4
502352	*Opuntia robusta*	Wheel Cactus		Flora	1
502397	*Tecticornia triandra*	Desert Glasswort	Rare	Flora	1
502765	*Psilocaulon granulicaule*	Wiry Noon-flower		Flora	3
502930	*Rhagodia spinescens*	Hedge Saltbush		Flora	7
502993	*Salsola tragus*	Prickly Saltwort		Flora	1
503014	*Sarcozona praecox*	Sarcozona	Rare	Flora	6
503027	*Schinus molle*	Pepper Tree		Flora	1
503028	*Schismus barbatus*	Arabian Grass		Flora	3
503066	*Sclerochlamys brachyptera*	Short-wing Saltbush		Flora	2
503072	*Sclerolaena diacantha*	Grey Copperburr		Flora	4
503077	*Sclerolaena obliquicuspis*	Limestone Copperburr		Flora	2
503081	*Sclerolaena tricuspis*	Streaked Copperburr		Flora	6
503086	*Tecticornia tenuis*	Slender Glasswort		Flora	1
503108	*Senecio glossanthus s.l.*	Slender Groundsel		Flora	1
503140	*Sida ammophila*	Sand Sida	Vulnerable	Flora	3
503142	*Sida fibulifera*	Pin Sida	Vulnerable	Flora	3
503143	*Sida intricata*	Twiggy Sida	Vulnerable	Flora	4
503159	*Sisymbrium erysimoides*	Smooth Mustard		Flora	4
503176	*Solanum esuriale*	Quena		Flora	2

503204	*Sonchus oleraceus*	Common Sow-thistle		Flora	6
503274	*Austrostipa eremophila*	Desert Spear-grass		Flora	2
503283	*Austrostipa nitida*	Balcarra Spear-Grass		Flora	2
503535	*Vittadinia cervicularis*	Annual New Holland Daisy		Flora	1
503673	*Convolvulus remotus*	Grass Bindweed		Flora	2
503695	*Hordeum murinum s.l.*	Barley-grass		Flora	4
503837	*Limonium companyonis*	Riviera Sea-lavender		Flora	2
503924	*Phyllanthus lacunellus*	Sandhill Spurge	Rare	Flora	3
504117	*Zygophyllum angustifolium*	Scrambling Twin-leaf	Rare	Flora	2
504428	*Dodonaea viscosa subsp. angustissima*	Slender Hop-bush		Flora	2
504742	*Stemodia florulenta*	Blue Rod		Flora	1
504945	*Swainsona reticulata*	Kneed Swainson-pea	Vulnerable	Flora	1
505569	*Carpobrotus aff. rossii (N.W. Victoria)*	Mallee Pigface	Rare	Flora	1
505570	*Enchylaena tomentosa var. tomentosa (shrubby form)*	Ruby Saltbush (shrubby inland form)		Flora	1
508098	*Avena spp.*	Oat		Flora	2
508492	*Goodenia spp.*	Goodenia		Flora	1
508821	*Opuntia spp.*	Prickly pear		Flora	1
509099	*Austrostipa spp.*	Spear Grass		Flora	2

Appendix 4 – Cultural heritage Contingency Plan

CONTINGENCY PLANS

In the event that Aboriginal cultural heritage is found during the conduct of the activity, contingency measures are set out below. The contingency measures set out the sponsor's requirements in the event that Aboriginal cultural heritage is identified during the conduct of the activity.

1 Management of Aboriginal Cultural Heritage found during the Activity

In the event that new Aboriginal cultural heritage is found during the conduct of the activity, then the following must occur:

∗ The person who discovers Aboriginal cultural heritage during the activity will immediately notify the person in charge of the activity;

∗ The person in charge of the activity must then suspend any relevant works at the location of the discovery and within 5m of the relevant place extent;

∗ In order to prevent any further disturbance, the location will be isolated by safety webbing or an equivalent barrier and works may recommence outside the area of exclusion;

∗ The person in charge of the activity must contact the **Mallee CMA Indigenous Facilitator**

∗ Within a period not exceeding 1 working day a decision/ recommendation will be made by the **Mallee CMA Indigenous Facilitator** and the **Aboriginal stakeholder;**

∗ as to the process to be followed to manage the Aboriginal cultural heritage in a culturally appropriate manner, and how to proceed with the works;

∗ **A separate contingency plan has been developed in the event that suspected human remains are discovered during the conduct of the activity.**

2 Notification of the Discovery of Skeletal Remains during the carrying out of the Activity

1. Discovery:

∗ If suspected human remains are discovered, all activity in the vicinity must ***stop*** to ensure minimal damage is caused to the remains, and,

∗ The remains must be left in place, and protected from harm or damage.

2. Notification:

∗ Once suspected human skeletal remains have been found, Victoria Police (use the local number) and the Coroner's Office (1300 309 519) must be notified immediately;

∗ If there is reasonable grounds to believe that the remains could be Aboriginal, the DSE Emergency Co-ordination Centre must be immediately notified on 1300 888 544; and

∗ All details of the location and nature of the human remains must be provided to the relevant authorities.

∗ If it is confirmed by these authorities that the discovered remains are Aboriginal skeletal remains, the person responsible for the activity must report the existence of the human remains to the Secretary, DPCD in accordance with s.17 of the Act.

3. Impact Mitigation or Salvage:

∗ The Secretary, after taking reasonable steps to consult with any Aboriginal person or body with an interest in the Aboriginal human remains, will determine the appropriate course of action as required by s.18(2)(b) of the Act.

∗ An appropriate impact mitigation or salvage strategy as determined by the Secretary must be implemented.

4. Curation and Further Analysis:

∗ The treatment of salvaged Aboriginal human remains must be in accordance with the direction of the Secretary.

5. Reburial:

∗ Any reburial site(s) must be fully documented by an experienced and qualified archaeologist, clearly marked and all details provide to AAV;

Appropriate management measures must be implemented to ensure that the remains ***are not disturbed in the future***